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JUN 10 2014

Mr. Donald W. Kinard
Chief, Regulatory Division
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Ref.: Regional General Permit SAJ-82 (SAJ-2007-1590), Florida Keys, Monroe County, Florida

Dear Mr. Kinard:

Enclosed is the National Marine Fisheries Service's (NMFS's) Biological Opinion based on our review of the impacts associated with the renewal and revision of the U.S. Army Corps of Engineers Jacksonville District's (USACE's) Regional General Permit SAJ-82 for use in the Florida Keys, Monroe County, Florida.

The Opinion analyzes the project's effects on sea turtles (loggerhead, leatherback, Kemp's ridley, hawksbill, and green), smalltooth sawfish, corals (elkhorn and staghorn), *Acropora* critical habitat, corals proposed for listing, and proposed critical habitat for loggerhead sea turtles, and is based on project-specific information provided by the USACE and NMFS's review of published literature. We conclude that SAJ-82 is not likely to adversely affect leatherback sea turtles, hawksbill sea turtles, or smalltooth sawfish and is likely to adversely affect, but is not likely to jeopardize the continued existence of green, loggerhead, and Kemp's ridley sea turtles.

We look forward to further cooperation with you on other USACE projects to ensure the conservation and recovery of our threatened and endangered marine species. If you have any questions regarding this consultation, please contact Nicole Bonine, Consultation Biologist, at (727) 824-5336, or by email at Nicole.Bonine@noaa.gov.

Sincerely,

Miles M. Croom

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure

File: 1514-22.F.4

Endangered Species Act - Section 7 Consultation
Biological Opinion

Agency:	U.S. Army Corps of Engineers
Applicant:	U.S. Army Corps of Engineers, Jacksonville District
Activity:	Renewal of General Permit SAJ-82 (SAJ-2007-01590)
Consulting Agency:	National Marine Fisheries Service Southeast Regional Office Protected Resources Division Consultation No. SER-2008-2958
Date Issued:	JUN 10 2014
Approved By:	Miles M. Croom for Roy E. Crabtree, Ph.D. Regional Administrator

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Appendix A: USACE Jacksonville District General Permits
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Appendix C: SAJ-82 Noise Effects Matrix and BMPs

ACRONYMS AND ABBREVIATIONS

BMPs	Best Management Practices
°C	Degrees Celsius
CCL	Curved Carapace Length
CPUE	Catch per Unit Effort
DPS	Distinct Population Segment
DWH	Deep Water Horizon
ESA	Endangered Species Act
FDEP	Florida Department of Environmental Protection
FKNMS	Florida Keys National Marine Sanctuary
FMCA	Florida Marine Contractors Association
FP	Fibropapillomatosis
FWRI	Florida Fish and Wildlife Research Institute
MHWL	Mean High Water Line
NMFS	National Marine Fisheries Service
NOAA	National Ocean and Atmospheric Association
NWA DPS	Northwest Atlantic Distinct Population Segment
NWP	Nationwide Permit
OHWL	Ordinary High Water Line
PGP	Programmatic General Permit
PDC	Project Design Criteria
RGP	Regional General Permit
SAJ	South Atlantic Jacksonville
SAV	Submerged Aquatic Vegetation
SCL	Straight Carapace Length
SEFSC	Southeast Florida Science Center
SPGP IV-RI	State Programmatic General Permit IV-RI
STSSN	Sea Turtle Stranding and Salvage Network
TED	Turtle Excluder Device
TEWG	Turtle Expert Working Group
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

Background

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of those species. When the action of a federal agency may affect a protected species or its critical habitat, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the protected species that may be affected.

Consultations on most listed marine species and their designated critical habitat are conducted between the action agency and NMFS. Consultations are concluded after NMFS determines the action is not likely to adversely affect listed species or critical habitat or issues a Biological Opinion ("Opinion") that determines whether a proposed action is likely to jeopardize the continued existence of a federally-listed species, or destroy or adversely modify federally-designated critical habitat. The Opinion also states the amount or extent of listed species incidental take that may occur and develops nondiscretionary measures that the action agency must take to reduce the effects of said anticipated/authorized take. The Opinion may also recommend discretionary conservation measures. No incidental destruction or adverse modification of critical habitat may be authorized. The issuance of an Opinion detailing NMFS's findings concludes ESA Section 7 consultation.

This document represents NMFS's Opinion based on our review of impacts associated with the renewal and revision of the U.S. Army Corps of Engineers (USACE), South Atlantic Division, Jacksonville District's Regional General Permit SAJ-82 (aka SAJ-2007-01590) for use in the Florida Keys, Monroe County, Florida. Activities covered under this general permit include lot fills; construction of minor structures, minor pile supported structures, and marginal docks, including repair or replacement of these; boat ramps; riprap revetments, bulkheads, and backfill in principally residential canals. These activities will take place in waters of the United States or on existing wetland lots in platted subdivisions within the Florida Keys, excluding federally maintained navigation channels, flood control projects, and Adams Cut.

This Opinion analyzes project effects on sea turtles (loggerhead, leatherback, Kemp's ridley, hawksbill, and green); smalltooth sawfish; corals (elkhorn and staghorn); and designated critical habitat for smalltooth sawfish and elkhorn and staghorn corals in accordance with Section 7 of the ESA. It also analyzes project effects to proposed (for ESA listing) corals and proposed (for ESA designation) loggerhead critical habitat. The analysis begins with a description of the types of the actions(i.e., activities) covered under the general permit and the action area in which they can occur, how the project will be reviewed, and the requirements it must meet to be permitted. This discussion is followed by the status of listed species and critical habitat within the action area, the environmental baseline conditions of the action area, and an analysis of the effects of the proposed action on species likely to be affected. A discussion of cumulative effects precedes the jeopardy analysis, which is based on the status of the affected species and on the information presented in the environmental baseline, effects of the action, and cumulative effects sections of this Opinion. Finally, we present our conclusions and conservation recommendations. This

Opinion is based on project information provided by the USACE. NMFS also utilized published literature.

Programmatic Consultations
NMFS and the USFWS have developed a range of techniques to streamline the procedures and time involved in consultations for broad agency programs or numerous similar activities with well-understood predictable effects on listed species and critical habitat. Some of the more common of these techniques and the requirements for ensuring that streamlined consultation procedures comply with Section 7 of the ESA and its implementing regulations are discussed in the October 2002 joint Services memorandum, *Alternative Approaches for Streamlining Section 7 Consultation on Hazardous Fuels Treatment Projects* (http://www.fws.gov/endangered/pdfs/MemosLetters/streamlining.pdf; see also, 68 FR 1628 [January 13, 2003]). Provided below is a generalized discussion about programmatic consultations. The specific requirements set forth for this programmatic consultation are provided in Section 2.

Programmatic consultations can be used to evaluate the expected effects of groups of related agency actions expected to be implemented in the future, where specifics of individual projects such as project location are not definitively known. It is important to note that the term programmatic is defined differently by NMFS when discussing a programmatic consultation than it is by the USACE when discussing a programmatic general permit (see Section 2.2). According to NMFS, a programmatic consultation must identify project design criteria (PDCs) or standards that will be applicable to all future projects implemented under the consultation document. PDCs serve to prevent adverse effects to listed species, or to limit adverse effects to predictable levels that will not jeopardize the continued existence of listed species or destroy or adversely modify critical habitat, at the individual project level or in the aggregate from all projects implemented under the Programmatic Opinion. Programmatic consultations allow for streamlined project-specific consultations because much of the effects analysis is completed up front in the programmatic consultation document. At the project-specific consultation stage, a proposed project is reviewed to determine if it can be implemented according to the PDCs, and to evaluate or tally the aggregate effects that will have resulted by implementing projects under the programmatic consultation to date, including the proposed project. The following elements should be included in a programmatic consultation to ensure its consistency with ESA Section 7 and its implementing regulations:

1. PDCs to prevent or limit future adverse effects on listed species and critical habitat;

2. Description of the manner in which projects to be implemented under the programmatic consultation may affect listed species and critical habitat, an evaluation of expected level of effects from covered projects, and a programmatic incidental take statement if applicable;

3. Process for evaluating expected, and tracking actual aggregate or net additive effects of all projects expected to be implemented under the programmatic consultation, including project-specific incidental take if applicable. The programmatic consultation document must demonstrate that when the PDCs are applied to each project, the aggregate effect of

all projects will not adversely affect listed species or their critical habitat, or will not jeopardize species or destroy or adversely modify their critical habitat, as applicable;

4. Procedures for streamlined project-specific consultation. As discussed above, if an approved programmatic consultation document is sufficiently detailed, project-specific consultations ideally will consist of certifications and concurrences between action agency biologists and consulting agency biologists, respectively. An action agency biologist or team will provide a description of a proposed project, or batched projects, and a certification that the project(s) will be implemented in accordance with the PDCs. The action agency also provides a description of anticipated project-specific effects and a tallying of net effects to date resulting from projects implemented under the program, and certification that these effects are consistent with those anticipated in the programmatic consultation document. If a project is likely to result in prohibited take of a listed species, a project-specific incidental take statement must be developed and appended to the programmatic consultation. The consulting agency biologist reviews the submission and provides concurrence, or adjustments to the project(s) necessary to bring it (them) into compliance with the programmatic consultation document. The project-specific consultation process must also identify any effects that were not considered in the programmatic consultation. Finally, the project-specific consultation procedures must provide contingencies for proposed projects that cannot be implemented in accordance with the PDCs; full stand-alone consultations may be performed on these projects if they are too dissimilar in nature or in expected effects from those projected in the programmatic consultation document.

5. Procedures for monitoring projects and validating effects predictions; and

6. Comprehensive review of the program, generally conducted annually.

1 Consultation History

The USACE first issued SAJ-82 in 2003. In 2007, the USACE went through rulemaking to revise it to include minor fill for existing single-family lots. It was reissued on April 26, 2007. For both the 2003 initial issuance and the 2007 revision, NMFS provided a “not likely to adversely affect” determination for species listed under the ESA at the time of the consultation.

On May 12, 2008, NMFS received a request for reinitiation of ESA consultation on SAJ-82 from the USACE dated May 8, 2008. The USACE determined that SAJ-82 needed reorganization and updating by simplifying and shortening the permit, and adding current listed species and essential fish habitat considerations. The permit was set to expire on April 26, 2012. The USACE determined that the proposed revised SAJ-82 may affect, but is not likely to adversely affect, sea turtles (loggerhead, leatherback, Kemp’s ridley, hawksbill, and green); smalltooth sawfish; corals (elkhorn and staghorn); and designated critical habitat for smalltooth sawfish and elkhorn and staghorn corals; and requested NMFS concurrence. Formal consultation was initiated on November 16, 2012, after NMFS determined that the activities would have greater than insignificant or discountable effects on smalltooth sawfish critical habitat. After further

clarification from the USACE, it was determined that action area did not include smalltooth sawfish critical habitat.

Included below is a list of items that have occurred since the request for consultation:

- January 25, 2012: USACE provided a completed Section 7 checklist and Public Notice.
- April 26, 2012: SAJ-82 permit expired.
- June 8, 2012: USACE and NMFS met to discuss the renewal of all of the USACE general permits used in the state of Florida. At that time, it was decided to group 12 of the general permits into 1 formal consultation/Biological Opinion. SAJ-82 was excluded from that Biological Opinion because of its potential impacts to corals and the pending determination for the proposed listing of additional corals in the area.
- August 15, 2012: NMFS requested additional information regarding effects determination, noise impacts, vessel strike risk, etc.
- December 19, 2012: NMFS issued an Opinion on 12 USACE general permits (NMFS 2012), excluding SAJ-82.
- March 29, 2013: NMFS reassigned SAJ-82 ESA consultation responsibilities to Nicole Bailey.
- April 5, 2013: USACE provided a response by letter to NMFS's August 15, 2012, request for information.
- April 19, 2013: NMFS began calling marine contractors in the Florida Keys to better understand the level of noise impacts that would result from construction materials and installation methods used in this area.
- May 2, 2013: NMFS called Megan Clouser, USACE project manager, to discuss impacts to mangroves and smalltooth sawfish critical habitat. The USACE and NMFS agreed to incorporate the proposed corals as part of a conference opinion in this consultation. NMFS sent an email to Ms. Clouser with the list of questions and answers discussed during the call and requested further clarification regarding impacts to red mangroves.
- May 23, 2013: First call between the Florida Marine Contractors Association (FMCA) and NMFS to discuss pile installation and potential noise impacts in the Florida Keys. NMFS requested additional information from the FMCA about specific construction materials and installation methods throughout the state.
- May 28-30, 2013: Ms. Clouser responded that the SAJ-82 is limited to just the Florida Keys and does not include mainland Monroe County; therefore, it does not include smalltooth sawfish critical habitat. She also stated that mangrove removal was allowed under SAJ-82 because, according to her, the Florida Department of Environmental Protection (FDEP) exempts mangrove removal in man-made canals.
- June 19, 2013: NMFS called Stuart Santos, USACE, to discuss impacts to mangroves under SAJ-82. NMFS and USACE determined that since the USACE does not have the authority to regulate trimming of red mangroves, the best way to protect mangrove shorelines as habitat for smalltooth sawfish is to add a condition to SAJ-82 prohibiting impacts to red mangrove prop roots.
- July 10, 2013: FMCA provided a written response to the USACE which was forwarded to NMFS about construction materials and installation methods used throughout the different regions in Florida.
- August 6, 2013: NMFS and USACE held a conference call to discuss potential noise impacts from pile installation in the Florida Keys.

- August 9, 2013: NMFS, USACE, and FMCA held a conference call to gather more information about pile installation and to discuss potential noise attenuation measures necessary in the Florida Keys.
- August 19, 2013: FMCA provided a written response to questions raised during the August 9, 2013 conference call.
- September 23, 2013: NMFS provided the USACE with a draft of the proposed Best Management Practices (BMPs) to reduce noise levels from projects covered under this programmatic consultation. Comments were received on September 27, 2013.
- September 27, 2013: USACE provided the FMCA with a draft of the noise BMPs.
- October 3, 2013: FMCA returned comments by letter to the USACE expressing concern about some of the noise BMPs.
- October 25, 2013: USACE acknowledged the FMCA's concerns about the noise BMPs and stated that they would be taken into consideration, but that the BMPs are based on the best available information.
- March 3, 2014: USACE stated that they wanted to increase the estimate of activities that they anticipate will be covered under SAJ-82 during the next 5-year authorization period. This is based on the number of activities that have required Section 7 consultation in the past 12 months and changes made to the permit allowing 4 foot (ft) walkway for docks.
- March 5, 2014: USACE updated estimated increase in vessel traffic to 500 vessels anticipated over the next 5-year authorization period.

2 Description of the Proposed Action

2.1 Authorities under Which the Action will be Conducted

Pursuant to Section 404 of the Clean Water Act (33 U.S.C. 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403), the USACE has authority to issue general permits[1] (regional, programmatic, and nationwide) for any category of projects that are substantially similar in nature, and result in no more than minimal adverse effects on the environment, either individually or cumulatively. Section 10 of the Rivers and Harbors Act authorizes all structures or work in navigable water of the United States while Section 404 of the Clean Water Act covers the discharge of dredged or fill materials in waters of the United States. The USACE uses a combination of all 3 types of these general permits when authorizing activities within the state of Florida, provided it has been determined that the environmental consequences of the activities are individually and cumulatively minimal (see 33 CFR 325.2(e) and 33 CFR Part 330). All general permits are valid for a maximum of 5 years (33 CFR 325.2(e)(2)), and must be reevaluated prior to reissuance. A list of general permits used by the USACE to permit activities in the state of Florida is included as Attachment A at the end of this document. Below is a description of the 3 types of general permits used by the USACE to authorize activities within the state of Florida along with the list of the related permits authorized under these types of permit. The permits used by the USACE in Florida are provided in Appendix A along with a description of the types of activities authorized under each permit.

[1] The term "general permit" is defined at 33 CFR 322.2(f) and 33 CFR 323.2(h). PGPs are a type of general permit, and are defined at 33 CFR 325.5(c)(3).

1. **Regional General Permit:** RGPs are a type of general permit specific to a given region (in this case, Florida). Within the state of Florida, USACE staff individually review permit applications to determine if they meet the PDCs defined by an RGP. All RGPs in Florida require an applicant to submit a preconstruction notification and cannot begin construction until they have received a written verification from the USACE that their project is authorized in accordance with the terms and conditions of the RGP. RGPs under NMFS's purview in Florida include SAJ-5, 12, 13, 14, 17, 20, 33, 34, 46, and 82.

2. **Nationwide permits:** NWPs are a type of general permit issued for activities that occur throughout the United States. The USACE authorizes activities in Florida under NWPs: when the permit specific conditions are met then the specified activities can take place without the need for an individual or regional permit. These NWPs were reissued and published in the Federal Register on February 12, 2012, and became effective March 19, 2012. This consultation was reinitiated and is under review. Projects are only authorized under a NWP if the USACE project manager determines the project will have no effect to listed species or a Section 7 consultation is completed prior to authorization of the permit for the activity.

3. **Programmatic general permits:** PGPs are a type of general permit issued by the USACE that authorize, for the purposes of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act, certain activities that are also regulated by another federal, tribal, state, or local regulatory authority. The purpose of PGPs is to improve the regulatory process for applicants, enhance environmental protection, reduce unnecessary duplicative procedures and evaluations, and make more efficient use of limited resources. In Florida, the USACE provides delegated authorization to the following agencies to permit activities under the listed permit: SAJ-91 provides administrative limited authority to the City of Cape Coral, SAJ-96 provides administrative limited authority to Pinellas County, SAJ-42 provides administrative limited authority to Miami-Dade County, SAJ-99 provides administrative limited authority to the Florida Department of Agriculture and Consumer Services, SAJ-71 provides administrative limited authority to National Ocean and Atmospheric Association (NOAA), and State Programmatic General Permit IV-RI (SPGP IV-RI) provides administrative limited authority to the FDEP.

The USACE retains the authority to modify, suspend, or revoke any RGP/PGP when the USACE believes that appropriate protection is not being afforded to the environment or any other aspect of the public interest, or when the USACE concludes that adverse environmental effects are more than minimal, either individually or cumulatively. Additionally, the USACE always retains its authority to require an individual USACE permit in any given case for any particular project, even if the project otherwise meets all the requirements of the RGP/PGP. The USACE exercises this authority when it concludes that the processing of an individual USACE permit is necessary to protect the environment or any other aspect of the public interest, or when impacts are more than minimal, either individually or cumulatively. Last, the USACE retains the full range of its enforcement authority and options where it believes that a project does not comply with the terms or conditions of the RGP/PGP, regardless of whether the project has been permitted by the federal, tribal, state, or local regulatory authority. Implementing regulations for permits issued by the USACE can be found at 33 CFR 320-332.

Individual permits: If a project is not covered by an RGP, NWP, or PGP because the effects of the action will be more than minor in nature or if the project needs an additional level of review, then it is addressed as an individual permit. Individual permits include authorization that is issued following a case-by-case evaluation by the USACE for a specific structure or work in accordance with the procedures of this regulation and 33 CFR Part 325, and a determination that the proposed structure or work is in the public interest pursuant to 33 CFR Part 320. Individual permits require Section 7 coordination with NMFS for projects involving in-water work that may affect listed species under our purview.

2.2 Description of SAJ-82

This Opinion addresses the reissuance of RGP SAJ-82, which gives general authority for several types of in-water construction activities in the Florida Keys, Monroe County, Florida. Every in-water construction activity permitted under the conditions of this permit is subject to nondiscretionary requirements that avoid or reduce the potential effects of permitted activities on listed species. SAJ-82 expired April 26, 2012. All general permits issued have a 5-year expiration date (maximum) from the date of issuance.

SAJ-82 covers the following activities for single-family residential projects: (1) lot fills; (2) construction of minor structures, minor pile-supported structures, and marginal docks, including repair or replacement of said structures; (3) boat ramps, and (4) riprap revetments, bulkheads and backfill in residential canals. Activities will be located in waters of the United States on, or within existing wetland lots in platted subdivisions within the Florida Keys, Monroe County, Florida, excluding federally maintained navigation channels, flood control projects, and the Marvin D. Adams Waterway (Adam's Cut), in accordance with the following conditions:

Lot fill:

- This is restricted to platted residential lots in existing developments having public roads and utilities.
- Fill cannot exceed 4,800 ft^2 of wetland per lot. This activity does not occur in marine waters and therefore does not authorize activities under NMFS's purview.

Construction of minor structures, minor pile-supported structures and marginal docks, including repair or replacement of said structures:

- Minor structures are defined as mooring piles, dolphin piles (not to exceed a cluster of 4), boat lifts, hoists, davits, davit pads, fenders, fender piles, mooring whips and cleats.
- Projects are limited to single-family residences which do not provide mooring for more than 4 slips at the subject site.
- Marginal docks are defined as docks placed parallel to the shoreline, along a seawall, revetment or bulkhead. Marginal docks are normally only permitted when a "T" or "L" style dock is not practicable. A "T" or "L" dock may not be practicable when encroachment into the navigable waterway exceeds 25% of the waterway width, or when mangrove fringe, wetland vegetation and/or submerged aquatic vegetation (SAV) are absent.

- A benthic survey will be required for new pile supported structures located in open water to document the presence/absence of SAV or corals.
- When mangroves, SAV, or emergent wetlands are present under or adjacent to the dock, marginal docks shall be limited to no more than 66% of the shoreline length, shall not exceed 40 ft in length, and shall not exceed 5 ft in width from the mean high water line (MHWL). .
- The "T" or "L" dock terminal platform must be installed at least 1 ft beyond the root zone (including emergent and submerged prop roots of a mangrove fringe); the terminal platform shall not be located over seagrass; the portion of the dock parallel to the shoreline (i.e., the terminal platform) may run the entire shoreline length of the parcel and shall not exceed 5 ft in width; a pile supported access walkway shall be located so as to avoid or minimize covering wetland vegetation, mangroves, and/or seagrass. The walkway connecting the dock to the shore shall not exceed 4 ft in width, be constructed of grated material and/or with 0.5-inch spacing between deck boards, and when seagrass is present on an open-water shoreline, be elevated a minimum of 5 ft above mean high water. The structure shall not be longer than twice the linear shoreline frontage of the parcel or 200 ft, whichever is less. The dock length is measured from the MHWL out to the waterward extension of the dock.
- All types of dock structures shall conform to the USACE/NMFS *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat*, dated August 2001.
- Boatlifts covers are not allowed over seagrass beds

Boat ramps:

- Boat ramps for single-family residences are authorized but shall be confined to shorelines where a mangrove fringe or SAV are absent from the project area.
- The width of boat ramps, including side slopes, is limited to 15 ft. All above-water ramp, side slope, or wall structures shall be located landward of the original MHWL.
- A maximum of 2, short (no longer than 20 ft in length), accessory docks abutting either or both sides of the ramp, are allowed. These docks may extend landward beyond the MHWL.
- Construction of a boat ramp will not involve any filling of surface waters except for the minimum amount needed for the actual boat ramp surface, side slopes, or walls. Walls cannot exceed 2 ft in width.

Shoreline stabilization:

- No placement of riprap below the MHWL can be authorized under SAJ-82 unless the Florida Keys National Marine Sanctuary (FKNMS) issues a NOAA permit or authorization that signifies the proposed activity is consistent with Title III of the Marine Protection, Research and Sanctuaries Act of 1972, as amended (if within the FKNMS boundary).
- Riprap, bulkheads, and/or backfill on unvegetated shorelines within an existing canal system which do not support submerged aquatic resources shall not extend any farther waterward than the existing bulkheads in the immediate area or any further waterward

than the high tide line. If the USACE determines that the proposed work may cause a shoreline discontinuity, the project would need to be reviewed under a Letter of Permission or a Standard Permit.

- Riprap or other fill exceeding 1 yd^3 per linear foot (lin ft) along any authorized shoreline stabilization structure is not authorized under SAJ-82.
- No new seawalls, bulkheads, or other hardened vertical structures on open water will be authorized under the SAJ-82.

SAJ-82 was applied 311 times during the last the 5-year authorization period between April 26, 2007, and April 26, 2012. This resulted in the authorization of 353 different activities because multiple activities could be included in 1 permit application (e.g., a dock and a seawall authorized under 1 permit application). A breakdown of the number of times that each activity was permitted is provided in Table 1 below (E. Reusch, USACE, pers. comm. to A. Livergood, NMFS, May 21, 2012). The USACE stated that this information is based on the best available data from the USACE database. It is important to note that the USACE project tracking database was updated several times during this time period, resulting in inconsistent data collection. For example, marginal dock sizes were originally entered in the database in linear feet (lin ft) and are now entered in the square feet (ft^2) of the total dock size. Progressive iterations of the database also included additional fields of information not originally entered. This included entries that may not have included all of the activity types permitted or the extent of the activity. During the USACE's date compilation for this permit renewal, they also discovered that 10 records showed the project location occurring in Miami-Dade County even though SAJ-82 is restricted to work in the Florida Keys in Monroe County. The USACE has stated that these activities were accurately authorized under SAJ-82 and that only the location information was entered in the database incorrectly.

According to the USACE database, projects in the last 5 years resulted in approximately 45,846 ft^2 (1.05 acres) of impacts from piles, lot fills, and shoreline stabilization. These impacts resulted in the loss of approximately 9,480 ft^2 (0.22 acre) of red mangroves and shallow euryhaline habitat, though none of these losses were reported to have occurred in smalltooth sawfish critical habitat. An estimated 190 ft^2 (0.004 acre) of seagrasses were impacted. This number may be inaccurate because macroalgae was included in seagrass impacts at the beginning of the last 5-year period. These numbers represent only direct impacts and not the indirect impacts of shading from dock structures since this information is not recorded by the USACE.

Table 1. Number of activities authorized under SAJ-82 between 2007 and 2011

Project type	**Activities Permitted**
Pile-supported dock	48
Marginal dock	57
Boatlift	211
Lot fill	9
Shoreline armoring	26
Boat ramp	2
Total	353

The USACE also carefully analyzed the types of activities that were permitted over the last five years and which of those would result in new vessel storage. According to their calculations, they anticipate that an additional 500 new vessels could be added as a result of the authorization of SAJ-82 over the next 5 years.

2.3 Project-Specific Review

This section describes the required project review for SAJ-82. In the state of Florida, there are 2 different ways in which an applicant can apply for an in-water permit. Applicants either apply directly to a regional delegated authority or to the FDEP through the SPGP IV-RI. Applications submitted through the FDEP for SAJ-82 are then forwarded to the USACE for review since SPGP IV-RI does not authorize activities in Monroe County. In 2012, the USACE's Jacksonville District (SAJ) office upgraded their website to provide application forms for in-water work. This joint application form is used by both FDEP and the USACE. Therefore, applicants can apply directly to the USACE especially for projects that are known to not be covered by FDEP, such as activities in Monroe County that may be authorized under SAJ-82.

The submission and review process for SAJ-82 is described below. A flow chart (see Figure 1) demonstrating the application process for a dock construction project is provided at the end of this section that demonstrates the submission process for all general permits.

1. **Project Application**: SAJ-82 can either be submitted on-line to the FDEP or an application can be downloaded directly from the USACE website and submitted to the USACE Miami Permitting Office. If the application is submitted to the FDEP, it will be forwarded to the USACE since the FDEP can only authorize activities covered under the PGP SPGP IV-R1. This PGP does not authorize activities in Monroe County.

2. **Authorization of SAJ-82**: Once the permit application reaches the USACE, the USACE determines if the activity requested is eligible for authorization under SAJ-82. Before a project is authorized, the USACE may also conduct a site visit to ensure that it will not impact SAV, corals, or the essential features of staghorn and elkhorn critical habitat. The Office of Management and Budget-approved performance measures require the USACE to look at a minimum of 5% of all general permit applications. This 5% is made up of a combination of NWPs, RGPs, and PGPs that the USACE authorizes in a given fiscal year. The enforcement/compliance sections are generally selected at random but can also be selected on the basis of area of geographic concern or for areas of specific concern (e.g., smalltooth sawfish critical habitat). Through numerous conversations with the USACE staff about how they determine which sites are visited in the Florida Keys, it has been explained that they concentrate on areas with the highest likelihood of impacting resources based on their knowledge of the area. The USACE has also stated that they require compensatory mitigation for unavoidable impacts to resources such as mangroves. If the PDCs are met including the avoidance of impacts to SAV, corals, or the essential features of staghorn and elkhorn critical habitat, then it is submitted to NMFS as stated in step 3 below.

3. **Submission to NMFS:** The USACE must email NMFS the following information to *nmfs.ser.SAJ82@noaa.gov*:
    a. A completed Excel spreadsheet attachment in the format shown below in Table 2. Table 2 provides the necessary headings along with 2 examples for demonstration. Below Table 2 are descriptions and formatting requirements for each of the columns.
    b. A completed form stating how each of the PDCs is met or is not applicable and why. The USACE will develop a standardized form to submit this information.
    c. Any other supporting documentation necessary to support the determination made by the USACE. This may include project application, site survey (e.g., benthic, seagrass, coral and hardbottom, etc.), photos, environmental assessment, and more.

    NMFS will acknowledge receipt of the USACE's email submission through an auto reply email. NMFS will review each e-mail submission sent to us by the USACE. If the USACE receives acknowledgement of NMFS's receipt of the application package, and receives no subsequent notification within the 10-day review period that the project does not comply with the programmatic consultation, then the USACE may proceed with processing the project application.

4. **Section 7 Consultation**: If a project does not meet the PDCs defined in this document for general permit SAJ-82s, it must undergo separate Section 7 consultation with NMFS. After this review, if NMFS provides a "may affect but not likely to adversely affect determination," then the USACE may authorize the activity under the original general permit (i.e., SAJ-82). If NMFS provides a "may affect" determination, the USACE may authorize the activity under a Standard Permit or Letter of Permission. Projects authorized by the USACE that require separate Section 7 consultation are not covered by this consultation.

Table 2. SAJ-82 USACE project-specific review provided to NMFS (shown below with examples)

Date Sent to NMFS	Permit Tracking Number	Project Address	Latitude	Longitude	Critical Habitat Unit	Total In-Water Impact	Overwater Area (ft^2)	Impact Type	New Construction, Repair, or Replacement	All PDCs Met
11/1/13	SAJ-2012-1234	123 Main St., Key West	24.12345	-81.12345	A CH	125	210	dock, seawall	replacement	yes
1/2/14	SAJ-2013-4321	123 Main St., Key Largo	25.12345	-81.12345	N/A	50	N/A	Boat ramp	new construction	yes

Formatting requirements:

1. Date Sent to NMFS: This is the date the email was provided to NMFS.
2. Permit Tracking Number: This is the in-water construction permit application number assigned by the USACE to the applicant/project.
3. Project Address: This is the address of the project location. Any formatting is fine in this category, though the state and zip code are not required.
4. Latitude: This shall be formatted in decimal degrees to 5 places as shown in the examples.
5. Longitude: This shall be formatted in decimal degrees to 5 places as shown in the examples. Please provide a negative symbol before the longitude to denote the western hemisphere.
6. Critical Habitat Unit: This shall be provided in the following acronym style with no spaces or hyphens, as shown in the examples. This allows for accurate sorting in Excel. Projects occurring in critical habitat and proposed critical habitat are only authorized if they do not impact the essential features of said critical habitat.
    - A CH (*Acropora* critical habitat).
    - PL CH (proposed loggerhead critical habitat)
    - N/A (not applicable because the project is not located within a critical habitat unit)
7. Total In-Water Impact: Defined as the total area of in-water substrate that is permanently changed below MHWL. This loss is calculated in square feet and includes seawalls, riprap, and boat ramps.
8. Overwater Area: Includes the total square footage of all overwater structures including docks, boats, etc.
9. New Construction, Repair, or Replacement: Please note which type of activity is being authorized. Repair and replacement are defined as occurring within the same footprint as the existing structure. New construction is defined as a partial or completely new project footprint.
10. All PDCs Met: Are all of the applicable PDCs defined in this document being met by the proposed project? Answer “yes” or “no.”

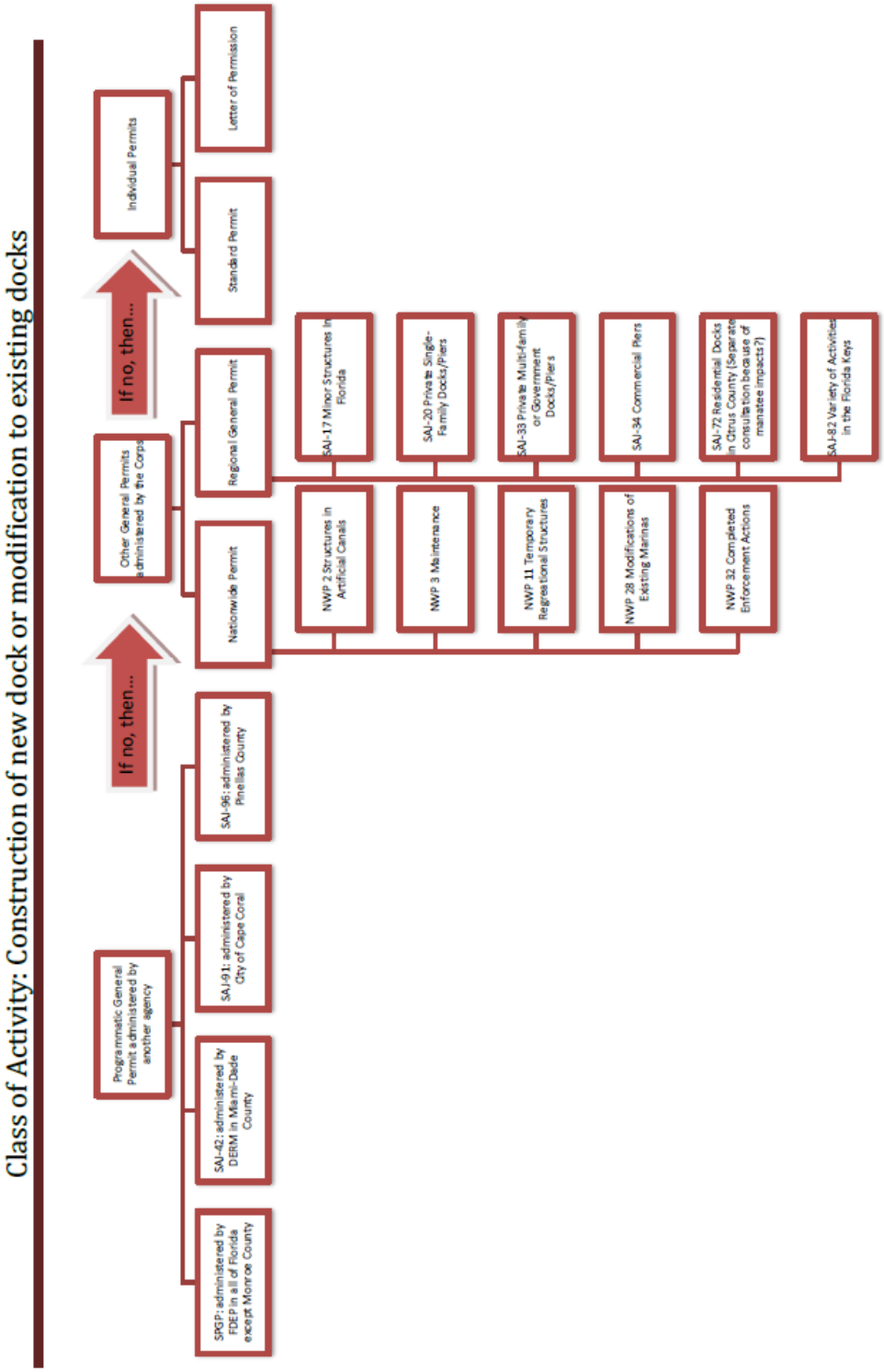

Figure 1. USACE decision-making tree

2.4 Program Review

NMFS and USACE will conduct program reviews to evaluate, among other things, whether the nature and scale of the assumptions and effects predicted continue to be valid; whether the PDCs continue to be appropriate; and whether the project-specific consultation procedures are being complied with and are effective. The purpose of this is to verify conclusions and assumptions regarding the potential effects to ESA-listed species and critical habitat, review data on the cumulative impacts of the combined projects from the previous year, and evaluate and suggest any procedural changes prompted by the review of data. If the results of the program review show that the anticipated impacts to listed species or critical habitat defined in this document are being exceeded, reinitiation of consultation may be required. The program review consists of both the programmatic review and the in-depth project specific review described below.

Programmatic review: This annual review will determine if the PDCs, assumptions, and effects analysis remain valid, as discussed above. If the results of the programmatic review show that the anticipated impacts to listed species or critical habitat defined in this document have been exceeded or differ in a manner or extent not previously analyzed, reinitiation of consultation may be required. The annual review will cover all projects that occur within a given calendar year and the review will occur at the end of that year but no later than March 31st of the following year. This review will be conducted as an in-person meeting or conference call between NMFS and the USACE. The meeting will discuss the results of the in-depth project reviews; administrative issues; concerns or necessary changes in the assumptions, PDCs, or effects of this consultation; and any other procedural changes required. NMFS will document the results of the annual review in a formal letter to the USACE.

In-depth project-specific review: This in-depth project review is in addition to the programmatic review described above and the project-specific review detailed in Section 2.3. Periodically, NMFS will conduct a detailed review of a random sample of projects authorized under SAJ-82. During this detailed review, NMFS may request additional information from the USACE for individual projects beyond the required information submitted to NMFS described in Section 2.3. If this review results in questions or concerns by NMFS, an in-person meeting or conference call will be scheduled with the USACE to resolve any issues.

2.5 Project Design Criteria

Based on past permitting practices of the USACE and review of consultations with similar in-water construction activities, NMFS has identified PDCs that can typically be applied to permitted in-water construction activities to limit effects to those that are insignificant or discountable in nature and never result in adverse effects to listed species or adverse effects to the essential features of designated critical habitat. The nature of the in-water construction activities involved in a proposed project will dictate which of the PDCs will be applicable to future projects covered by this consultation. The PDCs for several types of in-water construction activities may apply to a single proposed project (e.g., a proposed project may include both shoreline stabilization and installation of a single-family pier). Below is a list of each of the activities that are covered under SAJ-82 and the required PDCs necessary to issue this permit

(see Table 3). For projects that utilize the any construction guidelines in the PDCs below, the USACE shall ensure that applicants are using the current guidelines including any updates.

Table 3. PDCs for SAJ-82

All projects	All projects and activities shall meet the following conditions: • No work shall be authorized by SAJ-82 which may have direct or indirect adverse effects on ESA-listed elkhorn and staghorn coral; corals proposed for listing under the ESA (i.e., pillar coral [*Dendrogyra cylindrus*], lobed star coral [*Montastraea annularis*], mountainous star coral [*Montastraea faveolata*], knobby star coral [*Montastraea franksi*], rough cactus coral [*Mycetophyllia ferox*], Lamarck's sheet coral [*Agaricia lamarcki*], elliptical star coral [*Dichocoenia stokesii*]); without prior approval from FKNMS (if within its boundary) and without undergoing Section 7 consultation with NMFS. • No projects shall be authorized that impact the essential features of *Acropora* critical habitat (i.e., substrate of suitable quality and availability, in water depths of 30 m or less, to support successful recruitment and population growth. This includes areas of exposed hard substrate and dead coral skeleton free of sediment cover and turf and fleshy macroalgae cover) without prior approval from FKNMS (if within its boundary) and without undergoing Section 7 consultation with NMFS. • No work shall be authorized that impacts the prop roots of red mangroves without undergoing Section 7 consultation with NMFS. Unavoidable impacts to black or white mangroves, estuarine emergent vegetation, and/or the following SAV: shoal grass (*Halodule wrightii*), paddle grass (*Halophila decipiens*), star grass (*Halophila engelmannii*), manatee grass (*Syringodium filiforme*), widgeon grass (*Ruppia maritima*), and turtle grass (*Thalassia testudinum*) may be permissible with prescribed mitigation, only after appropriate avoidance and minimization have been fully achieved, as determined by the USACE. • For projects in waters accessible to sea turtles and smalltooth sawfish, the permittee will utilize NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006, and any added requirements, as appropriate for the proposed activity. Under these guidelines, all construction personnel shall be on the look-out for the presence of ESA-listed species and construction activities will cease if sea turtles or smalltooth sawfish are observed in the area. • The permittee shall use only clean fill material. The fill material shall be upland sources and be free of items such as trash, debris, automotive parts, asphalt, construction materials, concrete block with exposed reinforcement bars, and soils contaminated with any toxic substance, in toxic amounts in accordance with Section 307 of the Clean Water Act.

	All projects are required to use turbidity curtains for the smallest practicable area, that are monitored daily to ensure listed species are not being impacted by their presence, and be removed upon project completion, and that will not appreciably interfere with use of the area by any listed species. Turbidity control measures, including best management practices, shall be used throughout construction to control erosion and siltation to ensure there are no violations of state Water Quality Standards as established in Sections 62-4.242 and 62-4.244 of the Florida Administrative Code and Chapters 62-302, 62-520, 62-522, and 62-550 of the Florida Administrative Code. All projects are prohibited on or contiguous to ocean beaches. Projects shall follow the *Noise Best Management Practices (BMPs*) for SAJ-82 identified and defined in Appendix B. Installation of steel piles or steel sheet piles by impact hammer are prohibited. No blasting is authorized under SAJ-82.
Lot fill	Projects do not occur with marine waters and will not impact species or habitat under NMFS's purview.
Minor structures, minor pile-supported structures and marginal docks, including repair or replacement of said structures	A benthic survey will be required for new pile-supported structures located in open water to document the presence/absence of SAV or corals. Repair and Replacement of Minor Structures: Should corals be present on the existing structures, no work can be authorized under SAJ-82 unless the FKNMS issues a NOAA permit or authorization that signifies the proposed activity is consistent with Title III of the Marine Protection, Research and Sanctuaries Act of 1972, as amended (if within the FKNMS boundary) or NMFS completes a Section 7 consultation. Marginal docks, placed parallel to the shoreline, along a seawall, revetment or bulkhead are authorized. o Marginal docks are normally only permitted when a "T" or "L" style dock is not practicable. A "T" or "L" dock may not be practicable when encroachment into the navigable waterway exceeds 25% of the waterway width, or when mangrove fringe, wetland vegetation and/or SAV are absent. o If a mangrove fringe, wetland vegetation, and/or SAV are present, then no overwater portion of the marginal dock facility shall exceed 5 ft in width from the MHWL. o When located over submerged aquatic resources and/or emergent wetlands, marginal docks shall be limited to no more than 66% of the shoreline length and shall not exceed 40 ft in length. This limitation shall also apply to any location where SAV are present and vessel operation (including access and mooring) would result in significant direct or indirect impacts to the SAV. "T" and "L" Style Docks on Residential Canal Shorelines: Where a mangrove fringe, wetland vegetation, and/or SAV exists along the shoreline, and/or submerged shelf, a dock with a walkway perpendicular to the shoreline, such as a "T" or "L" dock, is permitted if constructed as

	follows: o The “T” or “L” dock terminal platform must be installed at least 1 ft beyond the root zone (including emergent and submerged prop-roots of a mangrove fringe); o the terminal platform shall not be located over seagrass; o the portion of the dock parallel to the shoreline (i.e., the terminal platform) may run the entire shoreline length of the parcel and shall not exceed 5 ft in width; o a pile supported access walkway shall be located so as to avoid or minimize covering wetland vegetation, mangroves, and/or seagrasses; o the walkway connecting the dock to the shore shall not exceed 4 ft in width and should be of grated material and/or with 0.5-inch spacing between deck boards; and o when seagrass is present on an open-water shoreline, the walkway shall be elevated a minimum of 5 ft above the MHWL. Water Access Walkways and Water Observation Platforms (on open water shorelines): Water access walkways may be permitted, provided such structures are oriented approximately perpendicular to the shoreline; do not exceed twice the length of the applicant owned shoreline. “T” and “L” Style Docks on Open Water Shorelines: The structure shall not be longer than twice the linear shoreline frontage of the parcel or 200 ft, whichever is less. The dock length is measured from the MHWL out to the waterward extension of the dock. Mooring of no more than 4 vessels shall be authorized. No high-and-dry storage is authorized. All types of dock structures shall conform to the USACE/NMFS document, *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat*, dated August 2001. No dredging associated with dock construction is authorized.
Boat ramps	Boat ramps for single-family residences are authorized but shall be confined to shorelines where a mangrove fringe or SAV are absent from the project area. The width of boat ramps, including side slopes, is limited to 15 ft. All above-water ramp, side slope or wall structures shall be located landward of the original MHWL. A maximum of 2 short (no longer than 20 ft in length) accessory docks, abutting either or both sides of the ramp, are allowed. These docks may extend landward beyond the MHWL. Construction of a boat ramp will not involve any filling of surface waters except for the minimum amount needed for the actual boat ramp surface, side slopes, or walls. Walls cannot exceed 2 ft in width. Excavated spoil material shall be deposited in a self-contained upland (i.e., non-wetland pursuant to current federal criteria) disposal site that will prevent spoil material and/or return water from reentering any water

	of the United States or interfering with natural drainage
Shoreline stabilization	No placement of riprap below the MHWL can be authorized under SAJ-82 unless the FKNMS issues a NOAA permit or authorization that signifies the proposed activity is consistent with Title III of the Marine Protection, Research and Sanctuaries Act of 1972, as amended (if within the FKNMS boundary) or NMFS completes a Section 7 consultation. Riprap, bulkheads, and/or backfill on unvegetated shorelines within an existing canal system which do not support submerged aquatic resources or red mangrove shoreline shall not extend any farther waterward than the existing bulkheads in the immediate area or any further waterward than the high tide line. If the Corps determines that the proposed work may cause a shoreline discontinuity, the project would require separate Section 7 consultation and would then be authorized under a a Letter of Permission or a Standard Permit. Riprap or other fill exceeding 1 yd^3 per lin ft along any authorized shoreline stabilization structure is not authorized under SAJ-82. No new seawalls, bulkheads, or other hardened vertical structures on open water will be authorized under the SAJ-82. This permit does not authorize fill activities other than placement of riprap previously specified and backfill behind seawalls or bulkhead.

2.6 Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The action area for SAJ-82 is limited to waters within the Florida Keys in Monroe County, Florida. This includes the North Key Largo/ Ocean Reef south to Key West. All of the proposed actions (i.e., activities) under SAJ-82 occur within nearshore waters or do not extend into the Atlantic Ocean or Gulf of Mexico further than a 200-ft-long residential dock. Therefore, direct impacts are limited to these areas and the surrounding waters. Indirect impacts include vessel traffic from the dock and boatlifts proposed under these general permits. Since residential vessels typically stay in inland and nearshore waters, the action area includes nearshore waters (Florida state waters) from indirect impacts from vessel traffic.

Though all activities covered under SAJ-82 occur within the Florida Keys, below is a list of specific exemptions and exclusions for SAJ-82.

- The use of SAJ-82 is specifically excluded from use within the geographical boundaries or in-holdings of the following state parks: John Pennekamp Coral Reef State Park, Lignum Vitae Key State Botanical Site and Aquatic Preserve, Long Key State Park, Curry Hammock State Park, and Bahia Honda State Park.
- SAJ-82 is also excluded from all federal navigation channels, flood control projects, and the Marvin D. Adams Waterway (Adam's Cut).
- All projects are prohibited that are on or contiguous with the ocean beaches.
- New seawalls, bulkheads, and other hardened vertical structures are prohibited on open water and are therefore limited to canals in the Florida Keys.

Since we do not know the specific location of each of the activities that may be authorized under this general permit, we consider the action area, PDCs, and number of activities authorized under the previous 5-year authorization period to determine whether any action might be located or aggregated in any area of particular importance to listed species.

2.7 Assumptions

Because this is a programmatic consultation, the exact location, number of activities, and effects of each individual project are unknown. Therefore, we must look at the likely outcome of each project individually and the combined cumulative effect of all of the activities over time. Below is a list of assumptions made and the rationale for the assumption. The effects analyses for this programmatic consultation are based on these assumptions. The project-specific and programmatic reviews discussed in Section 2.4, allow for regular reviews between NMFS and USACE to determine if the assumptions and effects of the action are in-line with those that were anticipated by this document. This review process includes determining if changes are occurring in the number of permits predicted to be authorized for activities covered under these general permits. At the time of review, consultation would be re-initiated if the effects seen in a given time frame did not match those defined in this document. With the implementation of the project-specific and programmatic reviews, better data will be collected during the next 5 years regarding impacts, the number of times SAJ-82 is used to authorize activities, project locations, and the spatial relationship between projects and critical habitat.

Since it is impossible to know the exact number of times a general permit will be used to authorize activities in the next 5 years, exactly where these projects will occur, and the potential increase in vessel traffic resulting from these projects, we look at the number of factors to estimate these numbers. These estimates are used to calculate the level of impact that can occur from the authorization of this permit. We then set a cap on the number of activities that can be authorized under SAJ-82 in the next five years to ensure that our assumptions and calculations are accurate. If this threshold is exceeded, then consultation will need to be reinitiated. Our estimates are based on the following information:

1. According to the USACE's records, 353 activities (311 projects/ permit applications) were authorized during the last five years authorization period for SAJ-82 (i.e., 70.6 activities per year). The USACE believes that the number of activities that will be permitted under SAJ-82 will increase in the next 5 years. The main reason that they believe this increase will occur is that the previous permit authorized 3 ft walkways on docks and the new permit allows for 4 ft walkways consistent with the USACE/NMFS *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat.* They believe that this will result in up to 100 additional activities authorized under SAJ-82 during the next 5 year authorization period. Therefore, 353 activities previously authorized in 5 year plus an additional 100 activities in the next 5 years would result in an estimated 453 activities for the next 5 years.

   This potential increase in activities is consistent with our records. According to our records, we have consulted on 128 projects in Monroe County between January 2013 and January 2014, while SAJ-82 was not in effect. It is unknown how many total activities

were authorized by these 128 projects. The USACE authorized 311 projects during the last five year period, which equates to 62 projects per year. Although we do not know for sure how many of the 128 projects we consulted on during the last year would have been covered under SAJ-82, this is about double the projects authorized yearly during the last 5 years SAJ-82 was effective and indicates that there is likely to be an increase in the number of projects authorized under SAJ-82 during the next 5 years. We also looked at the number of vessels registered in the state of Florida over the last ten years (http://www.flhsmv.gov/dmv/vslfacts.html). This data was used as a comparison to the amount of coastal development in Florida from docks and shoreline armoring where boats may be stored. This is not a perfect comparison since many docks authorized under SAJ-82 are a repair or a replacement versus a new construction. However, it gives us an estimated percent change that may be seen in coastal development and use in an area. Between 2002 and 2006, there was a net increase of 6% more vessels registered in Florida resulting in a likely increase of 6% more vessels traveling Florida coastal waters. Between 2007 and 2011, this number decreased 10%. This resulted in an overall decrease of 4% over the 10-year period. Because the number of activities that will be authorized under SAJ-82 during the next 5 years is unknown, we increased the amount of anticipated impacts by 10% to allow for variability, as seen in vessel registrations above. Therefore, we anticipate no more than 498 activities will be authorized under SAJ-82 in the next 5 years. This is calculated by adding the total number of activities anticipated to be permitted in the next 5 years (453 as discussed in the previous assumption) plus 10% (45.3) for a total of 498 activities. If the number of activities authorized under SAJ-82 exceeds this number, re-initiation of consultation will be required.

2. Since the exact location of each project that may be authorized under the general permits is unknown, we must look at the most likely conditions to be encountered and the worst case scenario for each species. For example, when considering effects to smalltooth sawfish from a typical residential dock project, we consider a typical site with conditions commonly found in this area. These projects are usually found in highly developed man-made canals throughout the Keys. These canals often are comprised of shallow, euryhaline banks along canals that are routinely dredged in the center to maintain adequate depths for vessel navigation. Most of these canals have patchy coverage of mangroves along the shoreline. We also consider the worst case scenario of in-water construction in which the project could possibly harm or impede movement of this species, or remove foraging or refuge habitat.

   Some of the areas that these species are found are not considered within our action area. For instance, effects to hatchling sea turtles are not considered under this consultation because they are under the jurisdiction of the USFWS on nesting beaches and the PDCs for this consultation prohibit activities on or contiguous to ocean beaches, making these areas outside of the action area.

3. Since we do not know the level of development that will occur within a given region or the distance between projects authorized under these general permits, we make the assumption that projects are not likely to occur simultaneously in the immediate vicinity of each other. For instance, it is likely that only 1 dock or seawall will be installed at any

given time within a given canal or small stretch of coast line. We can define the project area as the area where construction occurs plus the limits of the known indirect effects. In this case, we will define this area as the largest known area of noise disturbance defined in Section 3.1.4. This distance is 736 m of behavioral impacts from the installation of metal sheet pile with impact hammer and noise abatement. We also consider the cumulative effects, if more than 1 project occurred simultaneously within a region (e.g., adjacent neighbors performing in-water construction). Since each of these projects is likely to be completed quickly (a couple of days to a couple of weeks depending on the type of activity), it is unlikely that project will occur simultaneously. For the effects analysis, we assume a conservative, worst case scenario of up to 2 projects occurring in the same area simultaneously.

4. Since we do not know the exact size and number of vessels that will be stored at docks and minor structures authorized by these general permits, we look to studies conducted in the state of Florida that analyzed vessel use. According to these studies, the average size vessel stored at a residential dock is 22 ft in length with a draft of 2 ft (Sidman et al. 2007). This is consistent with the center console recreational vessel common in Florida waters. The largest dock/pier structure authorized under SAJ-82 is a 200 ft long that is only authorized to support up to 4 vessels. However, the USACE stated that they anticipate that most single-family docks in the Florida Keys can only accommodate 1 or 2 vessels based on the shoreline length and canal width at most residential properties. This is consistent with our assumption.

3 Status of Listed Species and Critical Habitat

The following endangered (E) and threatened (T) species and their designated critical habitat under the jurisdiction of NMFS may occur in or near the action area (see Table 4 and Table 5).

Table 4: Listed species likely to occur in or near the action area

Common Name	Scientific Name	3.1.1 Status
Turtles		
Green sea turtle	*Chelonia mydas*[2]	E/T
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Loggerhead sea turtle	*Caretta caretta*[3]	T
Hawksbill sea turtle	*Eretmochelys imbricata*	E
Fish		
Smalltooth sawfish	*Pristis pectinata*[4]	E
Invertebrates and Marine Plants		

[2] Green turtles are listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are listed as endangered.
[3] Northwest Atlantic Ocean (NWA) distinct population segment (DPS).
[4] The U.S. DPS.

Common Name	Scientific Name	3.1.1 Status
Elkhorn coral	*Acropora palmata*	T
Staghorn coral	*Acropora cervicornis*	T

Table 5: Designated critical habitat likely to occur in or near the action area

Species	Unit
Staghorn and elkhorn coral	Florida Area

Proposed for Listing
An additional 5 coral species occurring within the action area are proposed for listing (*Montastraea annularis, M. faveolata, Agaricia lamarcki, Mycetophyllia ferox, Dichocoenia stokes*). After conducting a comprehensive status review, NMFS proposed to add 66 corals to the Endangered Species List on December 7, 2012. At this time, we also proposed to change the status of staghorn and elkhorn coral from threatened to endangered. Of the 66 corals proposed for listing in the United States, 7 occur in the Caribbean and southeastern United States and 59 occur in the Pacific Islands. Caribbean species proposed as threatened include elliptical star coral and Lamarck's sheet coral. Caribbean species proposed as endangered include lobed star coral, knobby star coral, mountainous star coral, pillar coral, and rough cactus coral. These 5 Caribbean species may occur within the action area and potential impacts to listed coral and the proposed for listing species are considered as part of a conference opinion below.

Proposed for Designation
On July 18, 2013, we proposed designating critical habitat for the NWA DPS of loggerhead sea turtles within the Atlantic Ocean and the Gulf of Mexico. The regulations require agencies to "focus on the principal biological or physical constituent elements" (hereafter referred to as "Primary Constituent Elements") within the specific areas considered for designation, which "may include, but are not limited to, the following: nesting grounds, spawning sites, feeding sites, seasonal wetland or dry land, water quality or quantity, geological formation, vegetation type, tide, and specific soil types" (50 CFR 424.12(b)).

Specific areas proposed for designation include 36 occupied marine areas within the range of the NWA DPS of loggerhead sea turtle. These areas contain a single or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. We describe the physical or biological features essential to nearshore reproductive habitat as a portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season.

The nearshore reproductive habitat units in the Florida Keys (Long Key and Bahia Honda Key) shown in Figure 2 on the following page were included to ensure conservation of nearshore reproductive habitat off the unique nesting habitat in the Florida Keys. However, based on the PDCs in Section 2.5 above (i.e., all projects are prohibited on or contiguous to ocean beaches),

these open-water areas adjacent to nesting beaches are excluded from the action area and therefore will not be affected by SAJ-82.

Critical habitat is also proposed for “concentrated” breeding habitat in the Florida Keys as shown in Figure 2. Concentrated breeding aggregations were identified via a review of the literature and expert opinion. We determined that such areas are essential to the conservation of the species because, as a result of the high concentration of breeding individuals, the areas likely represent important established locations for breeding activities and the propagation of the species. Although there is no clear, distinct boundary for these concentrated breeding sites, we chose to constrain the boundaries of the proposed designation to what we consider the “core” areas where data indicate adult males congregate to gain access to receptive females. We describe the physical or biological features of concentrated breeding habitat as sites with high concentrations of both male and female adult individuals during the breeding season. There are primary constituent elements (i.e., essential features) of this concentrated breeding habitat: (1) high concentrations of reproductive male and female loggerheads, (2) proximity to primary Florida migratory corridors, and (3) proximity to Florida nesting grounds. Based on the actions proposed (i.e., repair and construction of nearshore residential seawalls and docks and boat ramps, etc.) and the PDCs that prohibit such projects in open-water areas and areas adjacent to nesting beaches, proposed critical habitat designated for breeding habitat does not occur within the action area and, therefore, will not be affected by the issuance of SAJ-82.

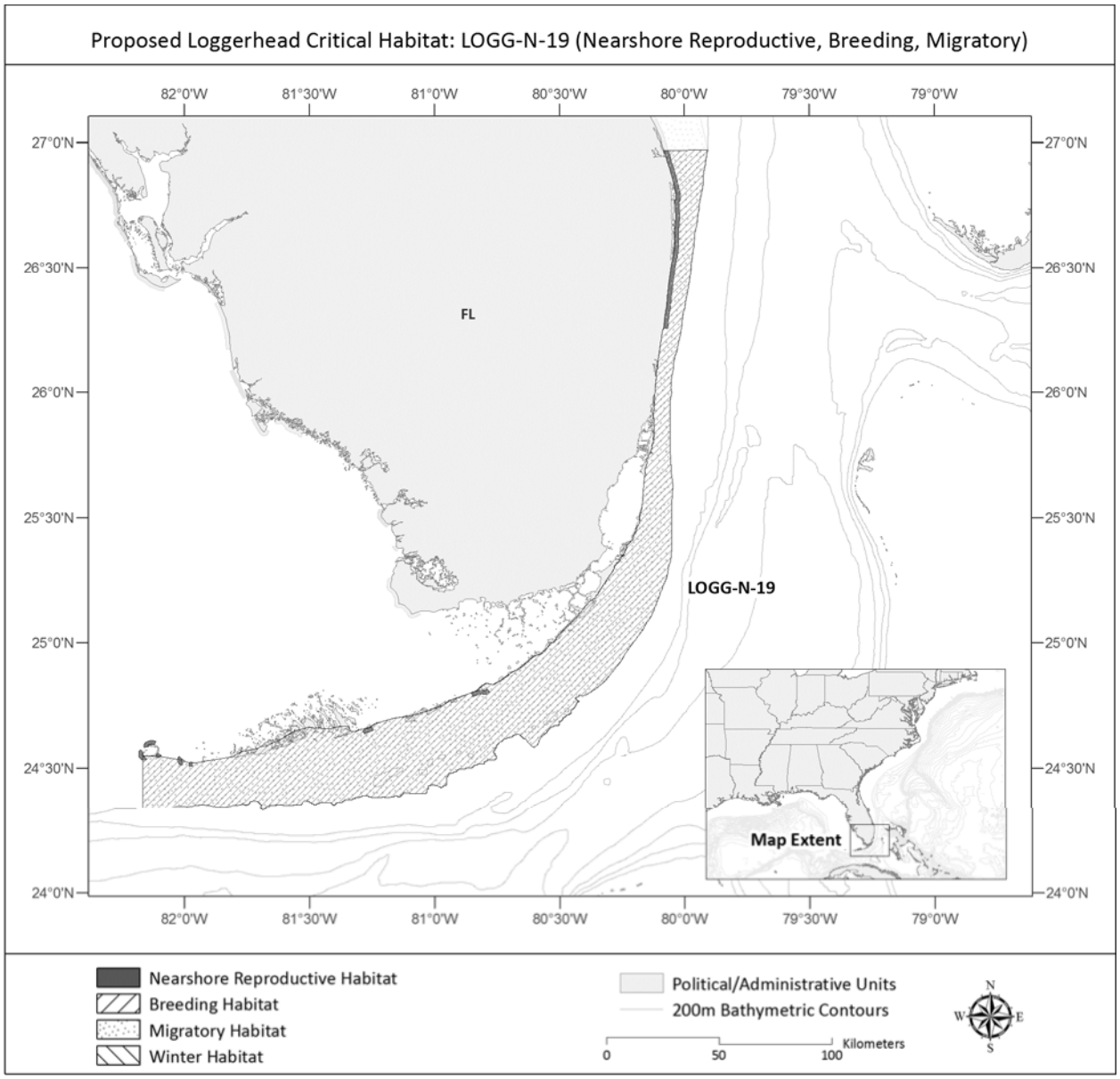

Figure 2. Migratory, breeding, and nearshore reproductive habitat (LOGG-N-19)

3.1 Potential Effects to Species and Critical Habitat in the Action Area

As discussed below, individual activities authorized under SAJ-82 may affect sea turtles (loggerhead, green, hawksbill, Kemp's ridley, and leatherback), smalltooth sawfish, and corals (staghorn and elkhorn) protected by the ESA, corals proposed for ESA listing, and coral critical habitat. During the last 5-year authorization period, SAJ-82 was used to permit 48 pile supported structures, 57 marginal docks, and 211 boatlifts (see Table 1). Potential individual and additive effects to these listed species and critical habitat are discussed below. NMFS generally concurs with your project-effect determinations that none of the actions covered under SAJ-82 are likely to adversely these listed species as described below. The only exception is that NMFS believes three species of sea turtles (loggerhead, green, hawksbill) are likely to be adversely affected by indirect impacts from an increase in vessel traffic. Our effects determination are provided in detail below and continued in Section 5.

3.1.1 Construction of minor structures, minor pile-supported structures, and marginal docks, including repair or replacement of said structures.

Potential routes of effects to sea turtles and smalltooth sawfish:
Effects include the risk of injury from construction activities including physical impacts from construction materials or operating construction machinery during construction activities. Construction of docks and boatlifts typically involves the use of small boats and/or barges, and pile driving, vibratory hammer, or jetting-in of piles. Some work also may be conducted from the uplands. Due to the hard substrate in this region, some piles will be installed by first making a hole using an auger or a punch that is repeatedly dropped from a barge. Pile types and installation methods are described in more detail in Section 3.1.5. No dredging is authorized under these permits. These species are mobile and can avoid this type of construction activity. Implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* further reduces interaction risk because these conditions require construction to stop temporarily if a sea turtle or smalltooth sawfish is sighted within 50 ft of operating machinery. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas. Additionally, turbidity controls will serve as a barrier to species presence during construction. For all of these reasons, NMFS believes that the risk of injury from these activities is discountable. The effects of noise from the installation of docks and boatlifts are discussed separately below for all species.

Sea turtles and smalltooth sawfish may be affected by being temporarily unable to use the sites due to avoidance of construction activities, related noise, and physical exclusion from areas blocked by turbidity curtains. Impacts to adult smalltooth sawfish will be insignificant, given each of the project's limited footprints and short, daylight-only construction periods. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas in accordance with the NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*. Additionally, turbidity controls will enclose only a small portion of the project sites at any time, will be removed after construction, and will not appreciably (temporally) block use of the area by ESA-listed species but will help prevent species presence in the active construction area. In addition, the Florida Keys provide ample foraging and

sheltering habitat adult smalltooth sawfish outside of the man-made canals where projects are typically located.

Juvenile smalltooth sawfish exhibit site fidelity to the areas in which they are pupped for the first several years of their lives, typically in very shallow, nearshore waters where they can avoid predation by coastal shark species. In South Florida, smalltooth sawfish have established distinct nursery areas where they utilize shallow (typically less than 3 ft deep), euryhaline habitat and red mangroves for foraging and refuge; some of these areas in Charlotte, Lee, and Monroe Counties (i.e., the Charlotte Harbor Estuary Unit and the Everglades/Ten Thousand Islands Unit) have been designated under the ESA as critical habitat for the species. Though smalltooth sawfish critical habitat does not occur within the action area, it does occur within northern Monroe County extending just north and west of the Florida Keys. In addition, there are numerous sightings of very small and small juvenile sawfish throughout the Florida Keys. Therefore, the removal of red mangroves or dredge-and-fill projects may affect juvenile smalltooth sawfish. SAJ-82 prohibits the removal of red mangrove prop roots that may be used for sheltering by juvenile smalltooth sawfish. Dock design is restricted by the NMFS-USACE jointly developed *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat - August 2001* to minimize impacts to mangroves. For example, these guidelines restrict the width of access walkways to 4 ft where mangroves are present. Therefore, the risk to juvenile sawfish from loss of foraging and refuge habitat is discountable due to the PDCs prohibiting removal of mangrove prop roots, potentially used by juvenile sawfish, and because docks do not change the shallow water depth preferred by juveniles.

Impacts to sea turtle foraging and refuge habitat from the construction of docks and minor structures authorized under SAJ-82 are insignificant for the following reasons. First, in areas where seagrasses are present or known to occur, the *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation (SAV), Marsh or Mangrove Habitat - August 2001* will be followed to minimize impacts to seagrasses that may be used by certain species of sea turtles for foraging. Second, no impacts to nesting beaches are anticipated from the construction of docks because the PDCs for these permits prohibit construction where nesting beaches are located. Specifically, all construction is prohibited on or contiguous to ocean beaches. Third, impacts to coral reefs used for foraging and refuge by certain species of sea turtles are prohibited under the PDC. Most of the pile-supported structures that can be authorized under SAJ-82 occur in man-made canals that are periodically maintenance dredged. Since the Florida Keys are made up of a series of small islands (i.e., keys), this leaves ample foraging habitat around the Keys where most coral and seagrass habitat occurs.

Potential routes of effects to staghorn and elkhorn corals:
Elkhorn and staghorn corals could be adversely affected by direct impacts from construction activities or increases in turbidity due to construction, or indirect impacts from shading if structures are built where these species are growing. However, the PDCs prohibit construction where hard or soft corals occur. The USACE requires in-water surveys at sites that may have corals present to ensure that no impacts occur. An example of an area that would likely not require a survey would be a maintained (i.e., regularly dredged) man-made canal known to have

silted or mud bottom that would not support coral growth. SAJ-82 does not authorize structures where listed corals or corals proposed for listing are growing, or structures that result in shading or turbidity effects to these corals. The PDCs also prohibit activities that impact hardbottom or other essential features within staghorn or elkhorn coral designated critical habitat further limiting impacts to places where these corals may occur. Also these structures are not allowed on or contiguous with ocean beaches and the majority of these are built in residential man-made canals, where coral is less likely to occur. Because the PDCs limit the location and prohibit impacts to corals and the hardbottom and coral skeletons that are used by spreading coral colonies, the risk of potential impact of SAJ-82 to corals is discountable.

Potential routes of effects to *Acropora* (staghorn and elkhorn) coral critical habitat:
SAJ-82 does allow construction in *Acropora* critical habitat. The physical feature of *Acropora* critical habitat essential to *Acropora* conservation is substrate of suitable quality and availability to support larval settlement and recruitment, and reattachment and recruitment of asexual fragments. Substrate of suitable quality and availability is defined as consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover, occurring in water depths from the MHWL to 30 m (73 FR 72210; November 26, 2008). As stated in the critical habitat rule, "all existing (meaning already constructed at the time of this critical habitat designation) federally-authorized or permitted man-made structures such as aids-to-navigation (ATONs), artificial reefs, boat ramps, docks, piles, channels, or marinas do not provide the essential feature that is essential to the species' conservation." Therefore, if these projects occur in channels (e.g., man-made residential canals) or new structures are attached to existing piles already in place at the time of critical habitat listing, then they would occur within the critical habitat unit but would not impact the essential features of the habitat.

According to the USACE, projects in the Florida Keys are reviewed by USACE staff familiar with the location or by means of a site visit prior to issuing a permit to ensure that sensitive resources are not impacted by the proposed project. The site visits assess if the essential features of hardbottom or coral skeleton are present to support either existing living coral or future recruitment of *Acropora* species. The risk of impact to the essential features of coral critical habitat is discountable since the PDCs prohibit impacts to these features.

Potential impacts from vessel traffic:
Stranding reports have documented that vessel traffic, both recreational and commercial, adversely affects protected species such as marine mammals and sea turtles. Because sea turtles may be adversely affected by the potential increase in vessel traffic and vessel strikes, these impacts are discussed below in Section 5. There are no known stranding reports of smalltooth sawfish being struck by vessels. This is likely due to the fact that smalltooth sawfish are demersal and rarely would be at risk from moving vessels. The small size of the docks that can be authorized under SAJ-82 limits the size of the vessels that will be moored at these structures to smaller recreational vessels with an average length of 22 ft and average draft of 2 ft (see Section 2.7). Since vessels need sufficient water to navigate without striking the bottom, shallow areas are marked with navigational markers to aid recreational boaters to avoid these areas. Therefore, impacts are not anticipated and the risk of effects to smalltooth sawfish from vessel traffic is discountable.

3.1.2 Boat ramps including appurtenant structures (bulkheads, rub-rails, tie-up piers)

SAJ-82 allows for the installation of boat ramps in areas lacking mangrove shoreline and submerged aquatic vegetation. During the previous 5-year authorization period (i.e., 2007–2012), SAJ-82 was used to authorize 2 boat ramps. Potential routes of effects to each of the listed species in Table 4 and *Acropora* critical habitat are discussed below.

Potential routes of effects to sea turtles and smalltooth sawfish:
Sea turtles and sawfish may be affected by the interaction with minor dredging equipment used to shape the boat ramp; however, this risk is discountable. These species are mobile and can avoid this minor dredging in a small, nearshore boat ramp location. Implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* further reduces interaction risk because these conditions require construction to stop temporarily if a sea turtle or smalltooth sawfish is sighted within 50 ft of operating machinery. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas. Additionally, turbidity controls will serve as a barrier to species presence during construction. For all of these reasons, NMFS believes that the risk of injury from minor dredging activities is discountable.

Sea turtles and smalltooth sawfish may be affected by being temporarily unable to use a project site for foraging due to potential avoidance of construction activities and related noise, and physical exclusion from areas contained by turbidity curtains, but these effects will be insignificant for the following reasons. Boat ramp placement is restricted to areas lacking mangrove shorelines and submerged aquatic vegetation that may be used by these species for foraging or refuge. Turbidity controls will only enclose a small portion of the project sites at any time, will be removed after construction, and will not appreciably (temporally) block use of the area by ESA-listed species. In addition, the Florida Keys provide ample foraging and sheltering habitat for sea turtles and smalltooth sawfish outside of the canals where projects are located.

The effects of noise from the installation of shoreline stabilization projects are discussed separately below for all species.

Sea turtles are also susceptible to vessel strikes. Private boat ramp construction can indirectly (i.e., later in time) result in increased vessel traffic effects by new vessels accessing the water at these locations. An analysis of the projected increase in vessel traffic on sea turtles from use of SAJ-82 is included in Section 5.

Potential routes of effects to corals and *Acropora* critical habitat:
Elkhorn and staghorn corals are not likely to be adversely affected by boat ramps permitted under SAJ-82. This permit restricts boat ramp placement to unvegetated shorelines lacking submerged aquatic resources. The permit also does not allow activities that would directly or indirectly impact corals or the essential features (i.e., primary constituent elements) of *Acropora* critical habitat. Therefore, the risk of impacts to corals and *Acropora* critical habitat from the construction of boat ramps will be discountable.

3.1.3 Riprap revetments, bulkheads, and backfill in principally residential canals

Shoreline stabilization projects authorized under SAJ-82 include vertical sea walls and riprap placement. During the previous 5-year authorization period (i.e., 2007–2012), SAJ-82 was used to authorize 26 shoreline stabilization projects. Potential routes of effects to sea turtles, smalltooth sawfish, corals, and *Acropora* critical habitat are discussed below

Potential routes of effects to sea turtles and smalltooth sawfish:
Effects on sea turtles and smalltooth sawfish include the risk of injury from operating construction machinery. No dredging is authorized under these permits other than minor dredging to allow for the placement of riprap along the shoreline and backfilling behind the seawall and for the same reasons explained above, the risk of injury from minor dredging is discountable. Sea turtles and smalltooth sawfish may be affected by being temporarily unable to use the sites due to avoidance of construction activities, related noise, and physical exclusion from areas blocked by turbidity curtains. These effects will be insignificant, given each of the project's limited footprints and short, daylight-only construction periods. Limiting construction to daylight hours will help construction workers to spot any ESA-listed species near the project areas. The conservation measures in place during construction (implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*) further reduce interaction risk. These require construction to stop temporarily if a sea turtle is sighted within 50 ft of operating machinery. Additionally, turbidity controls will only enclose a small portion of the project sites at any time, will be removed after construction, and will not appreciably (temporally) block use of the area by ESA-listed species. Importantly, the PDCs limit shoreline stabilization to canals lacking shoreline vegetation or submerged vegetation. Armoring will also be limited to areas at or above the high tide line or in line with surrounding shorelines. Therefore, shoreline armoring authorized under SAJ-82 is not expected to impact habitat that is used by sea turtles or smalltooth sawfish for foraging or refuge. In addition, the Florida Keys provide ample foraging and sheltering habitat for sea turtles and smalltooth sawfish outside of the man-made residential canals where projects are located.

The effects of noise from the installation of shoreline stabilization projects are discussed separately below for all species.

Potential routes of effects to corals and *Acropora* critical habitat:
Corals are not likely to be adversely affected by shoreline armoring authorized by SAJ-82. This permit restricts shoreline armoring to unvegetated shorelines within existing canal systems which do not support submerged aquatic resources. The permit also prohibits activities that would directly or indirectly impact corals or the essential features of *Acropora* critical habitat. Therefore, shoreline armoring under SAJ-82 would have no effect on corals or *Acropora* critical habitat because (1) adverse impacts are not allowed to hard or soft corals and specifically to elkhorn or staghorn, (2) man-made canals where projects would occur do not contain the essential features of *Acropora* critical habitat, and (3) if the canal was not man-made, activities cannot be permitted if the essential features of critical habitat are present.

3.1.4 Noise

We believe that the noise generated during the installation of piles and seawalls under SAJ-82 and the noise generated by an increase in recreational vessels stored at structures authorized under this permit may affect sea turtles (loggerhead, green, hawksbill, Kemp's ridley, and leatherback) and smalltooth sawfish. Our analysis is based on information provided by the FMCA in coordination with the USACE during numerous phone calls and emails referenced in the consultation history in Section 1 regarding the types of construction materials and installation methods used in the Florida Keys. The calculations to determine the level of noise and effects to listed species are based on our review of noise from these types of residential construction projects. Based on our noise analysis and published thresholds for injury and behavioral effects (Appendix B), we developed a noise impact effects matrix and BMPs (Appendix C) for the activities permitted under SAJ-82. The PDCs require that projects adhere to the BMPs. This section discusses potential noise impacts to listed species and how the measures prescribed in the BMPs will reduce the identified risks to discountable levels. We also provided an explanation of the calculations and rationale for our noise impact analysis in Appendix B.

Potential Routes of Effects to Sea Turtles and Smalltooth Sawfish

Sea turtles and smalltooth sawfish are low-frequency hearing generalists and are able to detect the vibrations and lower frequency sound components associated with construction noise. During pile driving, noise is produced when the energy from the hammer is transferred to the pile and released as pressure waves into the surrounding water and sediments. Depending on the type and location of pile-driving activity, pile-driving noise can result in potential effects ranging from the animal hearing the noise, to being disturbed by it, to (in very extreme cases) death (Figure 3). Even at relatively close distances, we believe there is an extremely low and implausible risk of death to smalltooth sawfish or sea turtles from these small-scale residential projects. The risk of injury from noise levels above the thresholds used in this analysis (Appendix B) primarily come from the vulnerability of gas-filled organs, such as swim bladders, lungs, and ears, as they expand and contract with passage of a pressure wave. These potential effects to sea turtles and smalltooth sawfish from pile-driving noise authorized under SAJ-82 are described in more detail below.

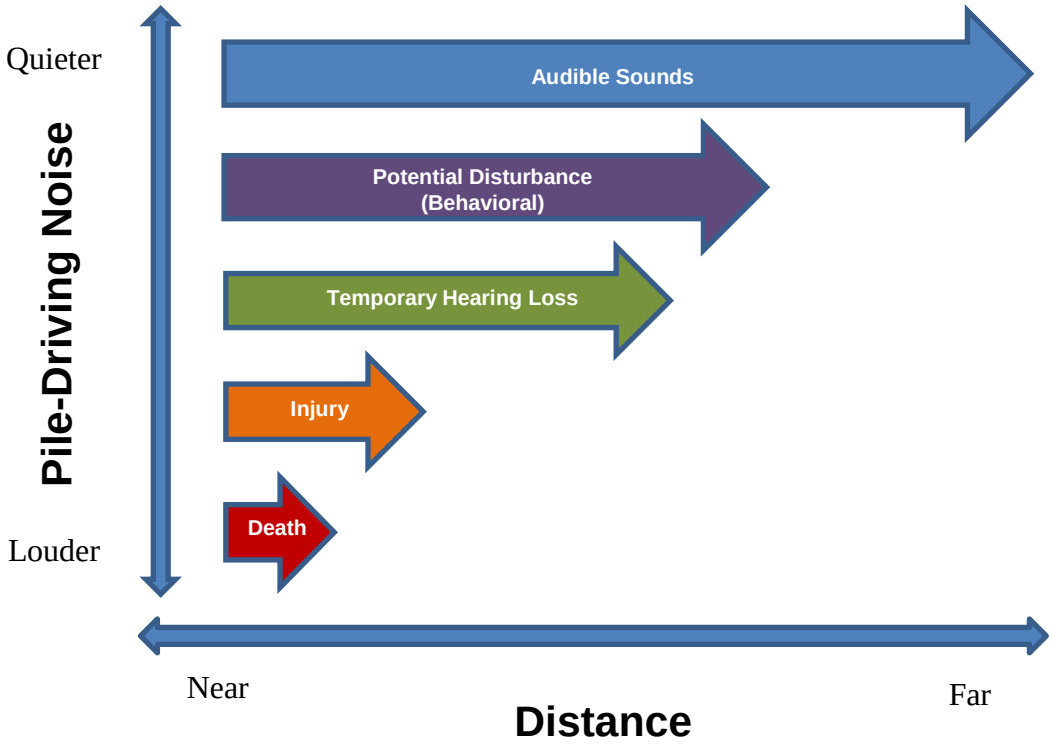

Figure 3. Diagram of the relative magnitude of effects from noise with loudness level and distance from a pile driver

Recent studies (Halvorsen et al. 2012a; Halvorsen et al. 2012b) show that the organ systems (liver, kidneys, and intestines) vulnerable to damage from noise pressure waves in ray-finned fish are also very prominent in the elasmobranch body plan (such as sawfish). Another consideration for bottom-dwelling elasmobranchs (such as sawfish) is they are often in contact with the substrate (Casper et al. 2012), where vibrations from pile driving can also affect the animal by passing through the sediment. Many of the organs of these dorsoventrally flattened fishes are in close proximity to the bottom surface of the body, providing little protection from pile-driving vibrations. Sawfish may be attracted to man-made structures and there is documentation that elasmobranchs tend to aggregate around coastal and offshore structures (Stanley and Wilson 1991), which may result in additional exposure risk from coastal construction noise. Hearing-related effects may include temporary threshold shifts (TTS, or recoverable hearing loss), permanent threshold shifts (PTS or non-recoverable hearing loss), or the masking of important sounds (important acoustic signals obscured by underwater noise) used to detect others of the same species, prey, or threats. Behavioral responses to underwater noise may be important depending on the location, habitat, or life stage of a species.

Potential for Injury to Sea Turtles and Smalltooth Sawfish

To determine the potential for injury from pile driving, we estimated noise levels for projects under SAJ-82 based on reported source levels of noise from the literature (CALTRANS 2009). We calculated both the noise exposure level from a single pile strike and the daily cumulative noise exposure level for the upper diameter size of each pile type considered in this analysis. The potential for injury from 1 pile strike, as well as from the daily cumulative exposure to

noise, was then compared to the injury thresholds in Appendix B. For noise levels above the injury threshold, we further calculated the distance to which injurious sound could propagate before decreasing below the threshold level. The summary results of our analysis for injury potential from pile installation are summarized in the noise effects matrix in Appendix C, along with a full analysis of how they were derived in Appendix B. The noise effects matrix and BMPs in Appendix C, calculations in Appendix B, and explanations provided below are based on a series of assumptions. These assumptions and resulting key points are provided in the list below and discussed further in this section. For more detailed information about the assumptions, equations, and resulting data, see Appendix B.

1. We considered the following pile types in the analysis: wood (round timber), vinyl sheet piles, concrete (in a variety of shapes including round and square), metal boatlift I-beams (steel or marine-grade aluminum), and metal pile or sheet pile used for docks and seawalls (steel or marine-grade aluminum). As discussed further below and stated in the PDCs, metal piles and metal sheet piles may not be installed by impact hammer under SAJ-82 due to their potential for single-strike injury, large injury impact zones, and large daily cumulative noise exposure zones. Metal piles and sheet piles may be installed under SAJ-82 by hand or vibratory hammer. Pile installation discussed in this Opinion also refers to installation of piles and sheet pile used for docks and seawalls. Seawalls are constructed of either pre-fabricated concrete slabs, metal sheet pile with concrete caps, or vinyl sheets. Construction of this type of project is typically conducted from the uplands. Typically, residential seawalls are installed by excavating with land-based equipment, jetting, or vibratory hammer. Some seawalls are also installed by impact hammer.

2. Although no noise measurements exist for vinyl sheet piles, we assumed the noise produced during their installation is similar to that of wood pile installation. We made this assumption given the similar properties between wood and vinyl. Although specific measurements are still needed for vinyl piles, for the purpose of this analysis we used the best data available to estimate the noise generated during vinyl pile installation.

3. For this analysis, we considered impact pile driving as a combustion driven device used to install piles. There are 2 main classes of impact hammers: external combustion and internal combustion. External combustion hammers use cables, steam, compressed air, or pressurized hydraulic fluid to raise the ram which is then dropped by gravity (e.g., a drop hammer). Internal combustion hammers do not rely on gravity and instead force the ram into the pile (e.g., a diesel hammer). During impact pile driving, noise is produced when the energy from the hammer is transferred to the pile and released into the surrounding air, water, and sediment. By contrast, hand installation of any type of pile was determined to not result in injurious or behavioral noise impacts and does not require mitigation.

4. We considered effects associated with the location of a project in a confined space versus open water. If a project is located in a confined space, an animal may be afraid to move through or past the noise source to escape it. This could result in a daily cumulative impact to any remaining animals. In contrast, an open-water environment would permit

individuals to move away from the noise without passing through or by the source. For this consultation, we defined a confined space as any area that has another solid object (e.g., shorelines or jetties) or structure within 150 ft of the pile installation site that would effectively serve as a barrier or otherwise prevent species from moving past it to exit the area. Examples of this include coastal sites with an islands/key across from it, any canal less than 150 ft wide, boat basins, small coves, or inlets along the shoreline. This does not include objects such as docks or other pile supported structures that would not stop or reflect noise. The 150 ft represents twice the distance to which injurious noise levels associated with the daily installation of 10 concrete piles (cumulative noise exposure level) could propagate (see Appendix B). According to the FMCA, 10 piles is the maximum number of piles that contractors stated could be installed in 1 day. Therefore, even if all 10 piles were installed resulting in the largest daily zone of cumulative exposure, species in an open-water project location could escape the area without further noise exposure. This allows the animal at least twice the distance of the impact zone to be able to escape.

5. Based on all of the calculations, only 1 activity allowed under this programmatic has the potential to cause injurious noise levels to sea turtles and smalltooth sawfish that would require noise abatement measures. This activity is the installation of more than 5 concrete piles within a confined space (see definition above) during a single day. Noise abatement measures are explained further below and defined in the PDCs.

Single Strike and Daily Cumulative Noise Exposure from Pile Driving

Our analysis shows that none of the installation methods allowed under this programmatic result in a single-strike injury potential. Because installation of these pile types does not result in a single-strike exposure potential, we only expect a potential for non-lethal injuries (e.g., noise-induced hearing loss) based on the relatively small cumulative injury distances (9-22 m). Daily cumulative noise exposures from pile driving could result in injury if an animal remained within the construction zone during the entire installation process. Daily cumulative noise exposure (cSEL) is the exposure to pile-driving noise over time. The daily cumulative exposure zone created by both pile type and installation method for activities allowed under SAJ-82 are discussed further below and summarized in the noise effects matrix in Appendix C:

1. **Wood and vinyl pile installation with an impact hammer**: For wood and vinyl pile installation, the maximum (based on 10 piles) daily cumulative exposure zone is 9 m (the zone in which cumulative noise from pile installation could cause injury). The USACE has proposed a permit condition that requires contractors to maintain a watch for listed species and to shut down equipment when sea turtles and sawfish are within 50 ft (15.2 m) of a project area. Residential dock and seawall construction activities typically occur during the day in residential areas when an observer can effectively monitor for listed species that may be foraging or sheltering within 50 ft of the project area. Based on this permit condition to monitor for listed species and shut down equipment when animals are sighted within a 50-ft distance, these species are extremely unlikely to be exposed to the cumulative noise effect, thus reducing the risk of injury from noise to discountable levels. *Because noise levels produced from impact hammer driving of wood and vinyl piles have a single strike and daily cumulative noise exposure zone radius of less than 50 ft, no additional noise abatement measures are required.*

2. **Concrete pile installation with an impact hammer**: Injurious noise levels associated with the installation of concrete piles have the potential to propagate beyond the 50-ft observation zone radius discussed previously. For example, the installation of the assumed maximum of 10 concrete piles by an impact hammer in a single day has the potential to produce injurious noise levels that extend 72 ft (22 m) from the source. However, the daily cumulative exposure distances for the installation of 5 or fewer concrete piles per day with an impact hammer do not result in a daily cumulative noise exposure zone beyond the 50-ft shutdown radius (Appendix B). Because dock construction activities occur during the day in residential areas when an observer can effectively monitor for listed species that may be foraging or sheltering within 50 ft of the project area, protected species are not likely to be exposed to the cumulative noise effect. Therefore, the risk of injury from noise is reduced to discountable levels. Because *noise levels produced from 5 or fewer concrete piles have a single strike and daily cumulative noise exposure zone radius of less than 50 ft, no additional noise abatement measures are required.*

   If 6 or more concrete piles are installed by an impact hammer in a single day, the daily cumulative noise exposure zone exceeds the 50-ft observation zone required in permit conditions. In order to minimize potential impacts to species, projects occurring in a confined space (as defined earlier as having structures or objects within 150 ft of the noise source that may restrict/block a protected species' voluntary departure from the project area) will be required to use noise abatement measures to reduce noise levels as described in this opinion (e.g., TNAP, bubble curtains, etc), thereby reducing the risk of injury from noise to discountable levels. Noise abatement measures include temporary noise attenuation piles (TNAPs), bubble curtains, or switching to vibratory pile driving, as described in the noise effects matrix and BMPs in Appendix C.

   If the project occurs within open water (as defined earlier as being unrestricted to 150 ft from the noise source), then noise abatement is not required. As stated above, 150 ft is approximately twice the distance to which injurious noise levels associated with the daily installation of 10 concrete piles could propagate based cumulative noise exposure levels. According to the FMCA, 10 piles is the maximum number of piles that contractors stated could be installed in a single day. Therefore, even if all 10 piles were installed, resulting in the largest daily cumulative exposure zone, species in an open-water project location could escape the area without further noise exposure. This allows the animal at least twice the distance of the impact zone to be able to escape resulting in insignificant effect to species in the area from pile installation noise.

3. **Boatlift I-beam pile installation with an impact hammer**: The daily cumulative exposure zone (the zone in which cumulative noise from pile installation could cause injury) associated with the installation of 2 boatlift I-beams in a single day and using an impact hammer would be 20 m (66 ft). However, the FMCA has explained that these boatlifts are installed in a unique way. The boatlift consists of 2 I-beams attached to an existing structure such as a seawall or dock, as shown in the Image 1 below. The I-beams are installed at an angle to counterbalance the weight of the boat lift against the seawall

or dock. The I-beams are positioned in a device that assures the accurate angle of installation of the beam which is then hammered into position through the silt layer until it comes to rest on bedrock. At this point, the I-beam is not installed any further. At most, the I-beam penetrates the bedrock only a few inches to achieve stability. Because these are installed so quickly per beam and do not require hammering through bedrock, we believe the daily cumulative noise exposure distance is an overestimate and that the installation of 2 boatlift I-beams will not produce injurious noise beyond the 50-ft-shut-down radius. Based on the permit condition to monitor for listed species and shut down equipment when animals are sighted within a 50-ft distance, these species are extremely unlikely be exposed to the cumulative noise effect. Therefore, the risk of injury from noise is reduced to discountable levels. *Because we believe that the noise levels produced to install 2 boatlift I-beams have a single strike and daily cumulative noise exposure zone radius less than 50 ft, no additional noise abatement measures are required.*

Image 1. Example of an I-beam boatlift

4. **Metal sheet pile and metal piles installed by impact hammer**: In Appendix B we analyzed the potential noise impacts of installing metal sheet pile by impact hammer and determined that the single-strike injury potential and daily cumulative noise exposure zone were too high even with noise attenuation to be considered under SAJ-82. As a result, installations of metal piles and metal sheet piles by impact hammer are prohibited in the PDCs. The FMCA has indicated that the use of metal sheet piles in Monroe County for marine and property armoring is uncommon. Vinyl sheet piles are the preferred construction material due to their resistance to corrosion in salt water. For this reason, we do not believe that removing this installation option from SAJ-82 will

interfere with the ability of contractors to install docks and seawalls in Monroe County. If an applicant requires the installation of metal piles or metal sheet pile(s) by impact hammer, a separate USACE permit and Section 7 consultation will be required. Installation of metal piles and sheet piles are still allowed using a vibratory hammer or hand installation under SAJ-82.

5. **Vibratory hammer pile installation**: The noise levels associated with the use of vibratory hammers for any of the pile types used in small docks and seawalls does not have any potential for injury. *Because there is no potential for injury, vibratory hammer installation of wood, vinyl, metal pile, metal sheet pile, or boatlift I-beams does not require any additional noise abatement measures.*

Behavioral Effects from Pile Driving

This section evaluates the potential for pile-driving noise to result in adverse behavioral reactions. Behavioral thresholds for sea turtles and sawfish used in this Opinion are 160 dB re 1 µPa (RMS) and 150 dB re 1 µPa (RMS), respectively. These thresholds are used for both the impulsive sounds from impact pile driving, as well as the continuous sounds from vibratory pile driving. The NMFS interim noise criteria to evaluate potential noise impacts to marine mammals from continuous noise is 120 dB (RMS), but we do not find the literature supports such a low threshold level for sea turtles and smalltooth sawfish. Compared to the highly specialized hearing capabilities of marine mammals, sawfish and sea turtles are hearing generalists with relatively lower auditory sensitivities than marine mammals; thus, we are not applying the marine mammal criteria to these species.

The use of sound in sea turtles and elasmobranchs is not well understood, but their hearing may be used in the detection and avoidance of threats, navigation, and the detection of sounds produced by prey species. Although avoidance responses are advantageous at preventing direct injury from a perceived threat a noise may present, we must consider the potential consequences of the noise avoidance behavior on individuals. Effects on individuals may be important if they disrupt feeding, mating, migration, sheltering, or indirectly increase the risk to individuals (e.g., via predation). Some individuals may be biologically motivated to remain in a habitat for feeding, sheltering, mating, and other biologically important reasons, or may temporarily use the area as an established pathway between habitats. Other individuals may abandon use of the area altogether. Habituation to noise is of concern from long-term noise exposure if animals become accustomed to a noise and no longer perceive the noise as a threat in the environment. On the other hand, some animals could become sensitized to repeated noise, resulting in increased behavioral responses once an animal associates adverse consequences with the onset of the noise. Behavioral reactions have been reported for sea turtles in response to airgun noise (DeRuiter and Doukara 2010; McCauley et al. 2000a; McCauley et al. 2000b), another loud impulsive noise source in the ocean, but there are no reported studies of noise effects on the behavior of sawfish species.

We do not have enough information at this time to determine the specific behavioral effect that may occur to smalltooth sawfish and sea turtles in the Southeast. Yet, we believe that behavioral impacts have the potential to result in the animals simply hearing the noise and not responding to it. The noise may also interfere with or alter the use of foraging habitats, interfere with use of

sheltering locations or startling an animal from an existing refuge habitat, or disturb smalltooth sawfish pupping locations. It is our opinion that all of these effects will be insignificant for the following reasons:

Effects on smalltooth sawfish in foraging and refuge habitat: Sawfish may be affected by the noise generated during pile installation but we believe these effects will be insignificant. The maximum behavioral noise impact zone for these activities is 215 m for impact hammer installation (see Appendix B). Sawfish are known to utilize residential canals as part of their refuge habitat. This 215 m distance is much larger than the average width of a canal in the Florida Keys. If an individual is observed within 50 ft of the project site, construction will cease until the animal has had the opportunity to leave on its own volition. Beyond the 50-ft observation zone, the animals will either stay or leave the site depending on the level of annoyance. We believe that areas in and throughout the Florida Keys provide adequate foraging and refuge habitat that species can move into during construction noise or during periods when noise has ceased. These areas include undeveloped mangrove shoreline both along sections of the developed keys as well as numerous smaller undeveloped keys through the region. If the animal remains during the construction noise, it may be disturbed enough that it does not eat during that time. However, construction will be limited to daytime hours and the animal can forage after construction ceases or move at that time to an alternative adequate foraging and refuge location.

Effects on Pupping Females and Juvenile Sawfish: Juvenile sawfish may be more sensitive to habitat disruptions because they are dependent upon healthy red mangrove habitats as shelter and foraging sites. If a project were to generate noise levels of 150 dB re 1 µPa or greater in juvenile sawfish habitat, the noise produced could result in either the displacement of juveniles from the juvenile habitat or the displacement of forage fish from these areas. Displacement resulting in sawfish abandoning the area could result in increased risks of predation during the period of displacement or reduced foraging success if the newly colonized habitat is less suitable. Thus, the effects resulting from displacement or abandonment of these juvenile habitats could have negative consequences on an animal. However, juvenile sawfish can move along the shoreline of the canals without traversing deeper water that may expose them to predation and the Florida Keys provide ample foraging and sheltering habitat for smalltooth sawfish outside of the limited areas where projects may be located. Due to the relatively small acoustic footprint from wood, concrete, vinyl, and boat lift I-beams; the short duration of the pile-driving activities, the proposed noise abatement measures required when 6 or more concrete piles are to be installed daily (see Appendix C for noise BMPs), and the fact that juvenile sawfish are able to leave the area along the shoreline of the canal to limit exposure to predators the potential for adverse behavioral reactions will be reduced to insignificant levels. Smalltooth sawfish is the only species considered in this Opinion that is known to birth within the action area. As a result, behavioral noise impacts have a greater chance to impact the species by potentially deterring a reproducing female from delivering young in an area disturbed by increased noise. A female smalltooth sawfish likely selects a pupping area based on a strategy of choosing a habitat which will maximize the potential for pup survival. Any behavioral changes or disruptions to the

pupping behavior of females could have adverse effects on both the survival of the pups and fitness of the female. Once a female has successfully pupped, it will leave the pups to shelter and forage on their own. For the first several months of life, pups will stay close to the areas in which they were pupped. The early stages of development are the most vulnerable to any impacts associated with foraging success, sheltering, and predation risks, and are therefore extremely critical to the survival of pups. Starvation and predation rates are highest in young animals and animals are sensitive to any disruptions that may affect their foraging success or predation risk. In the Biological Opinion for 12 USACE SAJ GPs (Jacksonville District General Permits) (NMFS Consultation Tracking Number SER-2011-1939, dated December 19, 2012), we identified a noise restriction zone in areas likely to be most frequently used by smalltooth sawfish to pup their young. Our records indicate that there are reports of very small juvenile smalltooth sawfish in the Florida Keys. However, this area was not included in the designation of critical habitat for the protection of nursery habitat and at this time, our records do not show any areas of concentrated very small juveniles and we do not have any records of pupping "hot spots" from scientific surveys in the Florida Keys. Due to the relatively small acoustic footprint from wood, concrete, vinyl, and boat lift I-beams; the short duration of the pile-driving activities; and the proposed requirement for noise abatement measures when 6 or more concrete piles will be installed daily; the potential for adverse behavioral reactions for pupping smalltooth sawfish will be reduced to insignificant levels.

Effects on sea turtles in foraging and refuge habitat: As with sawfish, sea turtles may be affected by noise generated during pile installation but we believe these effects will be insignificant. The maximum behavioral noise impact zone for these activities is 46 m for impact hammer installation (see Appendix B). If a sea turtle is seen within 50 ft of the project site, construction will cease until the animal has had the opportunity to leave. If noise propagates outside of that 50-ft range, the animal will either stay or leave the site depending on the level of annoyance to the species. We would anticipate that the sea turtles within the action area are all subadults and adults based on their life history and the location limits of the project excluding areas in front of nesting beaches. Therefore, noise generated by activities authorized under SAJ-82 would not impact adult females approaching a nesting beach or hatchlings leaving the beach. Adult sea turtles are able to successfully forage over large areas throughout the Florida Keys. Based on their preferred foraging and refuge habitat, we would expect that turtles would be only temporary visitors in canals where most projects covered under SAJ-82 occur. We believe that due to the large areas used by sea turtles to successfully forage, temporary displacements from construction noise in the relatively small project areas would have insignificant behavioral effects on sea turtles.

Underwater Construction Noises Below Threshold Levels for Adverse Effects

Other construction methods may be used as part of pile-driving activities including auger drilling, drop punch, or water jetting. These activities can temporarily increase ambient noise levels in an area, but are not expected to result in any effects to listed species. Sometimes a pilot hole is drilled into harder base rock substrates commonly found in this area, by either using an

auger to drill out a hole, or by drop punching. Noise levels from small-scale drilling operations that are representative of dock construction methods have been measured to be no more than 107 dB re 1 µPa (0-peak) at 7.5 m from the source (Willis et al. 2010). Our back-calculation resulted in an approximate source level no greater than 120 dB re 1 µPa (0-peak). These methods produce noise levels that are below the behavioral and injury thresholds used in this analysis and do not have the potential to adversely affect listed species.

1. **Drop punching** is a method that uses a 12- to 24-inch-diameter steel punch dropped repeatedly from a barge-mounted crane. After the pilot hole is created, the pile is inserted then driven to resistance using an impact hammer. Noise generated during drop punching has either not been measured or is unreported in the available literature. The best available information on construction equipment striking the sea bottom comes from measurements of bucket dredge noise. The noise produced from the heavy bucket dropped onto the channel bottom was measured to be 124 dB re 1 µPa (RMS) at 150 m from the work site (Dickerson et al. 2001). Back-calculating the noise attenuation 150 m results in a potential source level of 156 dB re 1 µPa (RMS), 6 dB above the behavioral threshold for smalltooth sawfish. However, drop punch noise drops below 150 db dB re 1 µPa (RMS) within a few feet of a pile, and is well below the potential injury thresholds used in this analysis. Drop punch noise has no plausible route of effect to adversely affect listed species since there are no known injury effects and behavioral effects are limited to a few feet. In addition, the PDCs and Noise BMPs in Appendix C require crews to shut down construction equipment if any protected species are sighted within 50 ft of the project.

2. **Jetting** uses high-pressure water sprayed beneath the pile to excavate sediment and sand layers, and is often used in conjunction with other pile-driving methods to assist penetration of the pile into the substrate. Jetting results in much lower noise levels than either impact or vibratory pile driving alone and minimizes the amount of hammering necessary. Noise measurements taken with water jetting turned on or off during pile driving resulted in no additional noise recorded above that of the pile-driving noise (CALTRANS 2007). If used by itself as the sole pile-driving method, source levels for jetting are well below the 150 dB re 1 µPa RMS threshold for behavioral disturbance to smalltooth sawfish and the 160 dB re 1 µPa RMS threshold for sea turtles. Water jetting noise is below the behavioral and injury thresholds used in this analysis, and has no plausible route of effect to adversely affect listed species.

3. **Land-based equipment** does not generate noise levels in the marine environment that reach the behavioral and injury thresholds used in this analysis because the air-water interface is an almost perfect reflector of acoustic waves. Therefore, the noise generated by land-based mechanical excavators, generators, or other machinery will reflect off the surface and will not be transmitted into the water at noise levels expected to be heard by these species.

Effectiveness of Noise Abatement Measures at Reducing Injurious Noise Levels
This section evaluates the effectiveness of the proposed mitigation/noise abatement measures defined in the Noise BMPs in Appendix C for the installation of 6 or more concrete piles installed in a single day, to reduce daily cumulative noise exposure from potentially injurious levels. As previously discussed, if 6 or more concrete piles are installed by an impact hammer in a single day, the daily cumulative noise exposure zone exceeds the 50-ft observation zone required in USACE in-water construction permit conditions.

Based on consultation with the USACE and discussion with the FMCA, the preferred noise abatement method for impact driving of concrete piles is a TNAP. These sleeves consist of a casing lined with noise-insulating foam that is placed over the pile during installation. A TNAP design is a hollow-walled (air-filled) pile casing (dewatered) or foam-lined casing placed around the pile being driven. This method is best applied to vertical, non-interlocking piles. A TNAP can reduce noise levels by an average of 11 dB (8 to 14 dB) (Laughlin 2010), but has been reported in previous studies to have an even greater capacity to reduce noise. Laughlin (2010) reports a double-wall TNAP was constructed using 2 concentric pipes with outside diameters of 48 inches and 60 inches with a wall thickness of 1 inch. In this study, a 5-inch space between the inner and outer steel tubes was partially filled with a 4-inch-thick, sound-absorbing material. Tests were conducted both without bubbles and with bubbles between the pile and the hollow tube via a bubble ring at the bottom of the TNAP. TNAPs with bubbles resulted in a slightly greater reduction of 1-3 dB than TNAPs without bubbles. Laughlin (2010) recommended that TNAPs could be used as an alternative to the bubble curtain as an underwater noise mitigation device since the average noise reduction is about the same.

Another noise attenuation method allowed is the confined bubble curtain. Confined bubble curtains consist of some type of aquatic barrier that is filled with bubbles around a pile, as described in more detail in Appendix B. The bubbles are created by forcing compressed air through small holes drilled in PVC pipe. The bubble curtain disrupts the sound waves as they pass through it, thereby reducing noise levels transmitted beyond the curtain. In order to be effective the bubble curtain must fully enclose the pile through the entire water column and the ring emitting the bubbles must be seated properly on the sea floor. Reductions in peak pressure, RMS pressure, and energy are typically on the order of 5dB-20dB or more. Although the effectiveness of confined bubble curtains is more variable than TNAPs, the average noise reduction is about the same.

We calculated the potential noise levels associated with impact pile driving with and without noise abatement. The daily cumulative injury distance for the installation of a maximum of 10 concrete piles is reduced to less than 50 ft when noise abatement measures are used (see Appendix C). Because the USACE's proposed permit condition to require the shutdown of equipment when sea turtles and smalltooth sawfish are within 50 ft, the risk of any listed species being exposed to harmful noise levels is reduced to discountable levels, for the installation of up to 10 concrete piles by impact hammer installation using noise abatement measures..

Vessel Noise
Noise generated by vessels may affect sea turtles and smalltooth sawfish. Vessels transmit noise through water and cumulatively are a significant contributor to increases in ambient noise levels in many areas. The dominant source of vessel noise from the proposed action is propeller cavitation of recreational vessels, as well as that produced from work barges. The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Vessel noise is most significant at frequencies from 20 to 300 Hz, but is also present above ambient noise levels up to 1 kHz. The low frequencies produced overlap with the low-frequency hearing abilities of sea turtles (see Appendix B).

Effects of Vessel Noise on Sea Turtles and Sawfish
Increases in ambient noise could to be a potential threat to some animals by masking communication. Effects on communication in sea turtles are not expected since these species are not known to vocalize underwater, and are not known to communicate with sound. Due to their lack of reliance on their auditory sense, increases in ambient noise levels from the small scale projects in this consultation are not a potential route of effect for sea turtles. For sea turtles, the potential for disturbance from vessels appears to be more of a function of the physical presence of the vessel and reaction to motor noise at close distances to the vessel. The exposure of animals to vessels and propeller noise is dependent on the number and proximity of the vessels to an animal. Since the location of noise is limited to the position of a moving vessel, both noise and the presence of the vessel on the water may potentially affect the behavior of animals at relatively close distances where the vessel noise is more audible and the vessel may be visible from both below and above the surface. Sea turtles may react to an oncoming vessel by swimming rapidly at the surface or diving beneath the surface. These reactions are expected to be immediate reactions to avoid vessels and do not have any long-term consequences; thus, these reactions are insignificant effects.

We believe that sawfish will not be affected by vessel noise. Sawfish are not known to vocalize, and masking of communication signals is not a potential effect. Smalltooth sawfish are expected to hear vessel noise from operations at relatively close distances, but the sound levels do not exceed the sound level (> 150 dB) considered to elicit responses which would result in animals abandoning the area. Exposure to noise from individual passing vessels is ephemeral and below thresholds considered to result in adverse behavioral responses. Thus, the vessel noise is not a potential adverse effect for smalltooth sawfish.

Summary of the Effects to Sea Turtles and Sawfish from Construction Noise
Impact pile driving has the greatest potential to affect the hearing abilities of these species. The noise produced by vibratory installation of the pile types and sizes considered in this Opinion are below levels that would have the potential for adverse effects to listed species of sea turtles and sawfish. However, impact pile driving of 6 or more concrete piles in a confined space could be harmful and requires the use of noise abatement measures to reduce this risk. The PDCs require adherence to the Noise BMPs defined in Appendix C and explain when noise abatement measures are required. All projects will require an observer (i.e., construction crew members looking out for species in the area) and shut-down procedures when animals are sighted within 50 ft of a work site to reduce the potential for injury from noise exposure to discountable levels.

We believe any behavioral effects to sea turtles will be insignificant since the PDCs prohibit construction on or contiguous to ocean beaches that may be used for nesting and there are ample foraging opportunities throughout the Florida Keys. In addition, we do not believe that reproduction of smalltooth sawfish will be affected for the following reasons: (1) the PDCs and Noise BMPs required to reduce noise levels; (2) the action area is not within critical habitat for smalltooth sawfish, which was designated for the protection of nursery habitat; and (3) there are no known pupping "hot spots" in the Florida Keys. We do not believe that noise from construction of projects covered under this Opinion will have an adverse effect on the selection or use of foraging or refuge habitat for smalltooth sawfish as there are ample areas for those activities throughout the Florida Keys.

3.1.5 Cumulative effect of all activities authorized under SAJ-82 to listed species and critical habitat

None of the activities authorized under this permit result in direct impacts to ESA-listed species or critical habitat since all of the direct impacts are minimized by the use of PDCs. The types of activities covered under this general permit are also not likely to change the landscape of the nearshore waters in the Florida Keys. SAJ-82 allows for the continued development of the Florida Keys while protecting species and critical habitat because project impacts are minimized by the PDCs. The effectiveness of these PDCs are monitored and tracked through the programmatic review process defined in this Opinion (see Section 2.4). An indirect impact of concern is the cumulative increase in vessel traffic resulting from the construction of docks and boat ramps authorized under SAJ-82. Section 5 discusses the potential mortality of turtles from this increased vessel traffic and its impact on the recovery of the species.

3.2 Status of Species Likely to be Adversely Affected

Of the listed species under NMFS's jurisdiction occurring within the action area, NMFS believes sea turtles (loggerhead, green, hawksbill, Kemp's ridley, and leatherback), may be adversely impacted by an increase in vessel traffic resulting as an indirect effect of the authorization of SAJ-82. The remaining sections of this Opinion will focus solely on these species.

The following subsections are synopses of the best available information on the status of the species that are likely to be adversely affected by one or more components of the proposed action, including information on the distribution, population structure, life history, abundance, and population trends of each species and threats to each species. The biology and ecology of these species as well as their status and trends inform the effects analysis for this Opinion. Additional background information on the status of sea turtle species can be found in a number of published documents, including: recovery plans for the Atlantic green sea turtle (NMFS and USFWS 1991), hawksbill sea turtle (NMFS and USFWS 1993), Kemp's ridley sea turtle (NMFS and USFWS 1992b), leatherback sea turtle (NMFS and USFWS 1992a), and loggerhead sea turtle (NMFS and USFWS 2008a); Pacific sea turtle recovery plans (NMFS and USFWS 1998a; NMFS and USFWS 1998b; NMFS and USFWS 1998c; NMFS and USFWS 1998b); and sea turtle status reviews, stock assessments, and biological reports (Conant et al. 2009a; NMFS-SEFSC 2001; NMFS-SEFSC 2009; NMFS and USFWS 1995; NMFS and USFWS 2007a;

NMFS and USFWS 2007b; NMFS and USFWS 2007c; NMFS and USFWS 2007d; NMFS and USFWS 2007e; TEWG 1998; TEWG 2000b; TEWG 2007; TEWG 2009).

3.2.1 Loggerhead Sea Turtle– NW Atlantic DPS

The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS published a final rule designating nine DPSs for loggerhead sea turtles (76 FR 58868, September 22, 2011, effective October 24, 2011). The DPSs established by this rule include (1) Northwest Atlantic Ocean (threatened), (2) Northeast Atlantic Ocean (endangered), (3) South Atlantic Ocean (threatened), (4) Mediterranean Sea (endangered), (5) North Pacific Ocean (endangered), (6) South Pacific Ocean (endangered), (7) North Indian Ocean (endangered), (8) Southeast Indo-Pacific Ocean (endangered), and (9) Southwest Indian Ocean (threatened). The Northwest Atlantic (NWA) DPS is the only one that occurs within the action area and therefore is the only one considered in this opinion.

Species Description and Distribution
Loggerheads are large sea turtles with the mean straight carapace length (SCL) of adults in the southeast United States being approximately 3 ft (92 cm). The corresponding mass is approximately 255 lb (116 kg) (Ehrhart and Yoder 1978). Adult and sub-adult loggerhead sea turtles typically have a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, five pairs of costals, 5 vertebrals, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes (Dodd 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). Habitat uses within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Sub-adult and adult loggerheads are primarily found in coastal waters and prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC 1990). In the western North Atlantic, loggerhead nesting is concentrated along the coasts of the United States from southern Virginia to Alabama. Additional nesting beaches are found along the northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), off the southwestern coast of Cuba (Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Non-nesting, adult female loggerheads are reported throughout the United States and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches although aerial surveys suggest that loggerheads in U.S. waters are distributed as a whole in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Within the NWA, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf Coast of Florida. Previous Section 7 analyses have recognized at least five Western Atlantic subpopulations, divided geographically as follows: (1) a Northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29ºN; (2) a south Florida nesting subpopulation, occurring from 29°N on the east coast of the state to Sarasota on the west coast; (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting subpopulation, occurring on the Eastern Yucatán Peninsula, Mexico (Márquez M 1990; TEWG 2000a); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS-SEFSC 2001). The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded, based on recent advances in genetic analyses, that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula and that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are as follows: (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia), (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas), and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS and USFWS 2008a). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

Life History Information

The Northwest Atlantic Loggerhead Recovery Team defined the following eight life stages for the loggerhead life cycle, including the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[5]), (4) juvenile stage (oceanic zone), (5) juvenile stage (neritic zone), (6) adult stage (oceanic zone), (7) adult stage (neritic zone), and (8) nesting female (terrestrial zone) (NMFS and USFWS 2008). Loggerheads are long-lived organisms that reach sexual maturity between 20 and 38 years of age, although this varies widely among populations (Frazer and Ehrhart 1985; NMFS and SEFSC 2001). The annual mating season for loggerhead sea turtles occurs from late March to early June, and female turtles lay eggs throughout the summer months. Female loggerheads deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins 1984) but an individual female only nests every 3.7 years on average (Tucker 2010). Along the southeastern United States, loggerheads lay an average of 100 to 126 eggs per nest (Dodd 1988) which incubate for 42 to 75 days before hatching (NMFS and USFWS 2008b). Hatchling loggerheads are generally 1.5-2 inches in length and weigh about 0.7 ounces (20 grams).

[5] Neritic refers to the inshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters.

As post-hatchlings, loggerheads hatched on U.S. beaches migrate offshore and become associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986; Witherington 2002). Juvenile loggerheads leading a pelagic existence grow at rates of 1-2 inches (2.9-5.4 cm) per year (Bjorndal et al. 2003; Snover 2002) over a period as long as 7-12 years (Bolten et al. 1998) before moving to more coastal habitats. Recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Bolten and Witherington 2003; Laurent et al. 1998). These studies suggest some turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or move back and forth between pelagic and coastal habitats interchangeably (Witzell 2002). Stranding records indicate that when immature loggerheads reach 15-24 inches (40-60 cm) SCL, they begin to occur in coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell 2002).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the United States, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads.

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads use the relatively enclosed shallow-water estuarine habitats with limited ocean access are less frequently than the juveniles. Areas such as Pamlico Sound, North Carolina, and the Indian River Lagoon, Florida, are regularly used by juveniles but not adult loggerheads. In comparison, adult loggerheads tend to use estuarine areas with more open ocean access, such as Chesapeake Bay in the U.S. Mid-Atlantic. Shallow-water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads. Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of Mid-Atlantic shelf waters, especially offshore New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has also been documented (Hawkes et al. 2007; Georgia Department of Natural Resources, unpublished data; South Carolina Department of Natural Resources, unpublished data). Satellite telemetry has identified the shelf waters along the west Florida coast, The Bahamas, Cuba, and the Yucatán Peninsula as important resident areas for adult female loggerheads that nest in Florida (Foley et al. 2008; Girard et al. 2009; Hart et al. 2012). The southern edge of the Grand Bahama Bank is important habitat for loggerheads nesting on the Cay Sal Bank in The Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands as well as Florida Bay in the United States, and the north coast of Cuba (A. Bolten and K. Bjorndal, University of Florida, unpublished data). Moncada et al. (2010) report the recapture in Cuban waters of five adult female loggerheads originally flipper tagged in Quintana Roo, Mexico, indicating that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

Status and Population Dynamics
A number of stock assessments and similar reviews (Conant et al. 2009b; Heppell et al. 2003a; NMFS-SEFSC 2009; NMFS and SEFSC 2001; NMFS and USFWS 2008a; TEWG 1998; TEWG 2000a; TEWG 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Numbers of nests and nesting females can vary widely from year to year. Nesting beach surveys, though, can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of female loggerhead sea turtles, as long as such studies are sufficiently long and effort and methods are standardized [see, e.g., (NMFS and USFWS 2008a)]. NMFS and USFWS (2008a) concluded that the lack of change in two important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population.

Peninsular Florida Recovery Unit
The Peninsular Florida Recovery Unit (PFRU) is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (NMFS and USFWS 2008a). The statewide estimated total for 2012 was 98,601 nests (FWRI nesting database).

In addition to the total nest count estimates, the Florida Fish and Wildlife Research Institute (FWRI) uses an index nesting beach survey method. The index survey uses standardized data-collection criteria to measure seasonal nesting and allow accurate comparisons between beaches and between years. This provides a better tool for understanding the nesting trends (Figure 4). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989-2012) (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/). Three distinct trends over that time period were identified. From 1989-1998 there was a 23% increase, that was then followed by a sharp decline over the subsequent decade. However, recent large increases in loggerhead nesting occurred since then. FWRI examined the trend from the 1998 nesting high through 2012 and found the decade-long post-1998 decline had reversed and there was no longer a demonstrable trend. Looking at the data from 1989 through 2012 FWRI concluded that there was an overall positive change in the nest counts.

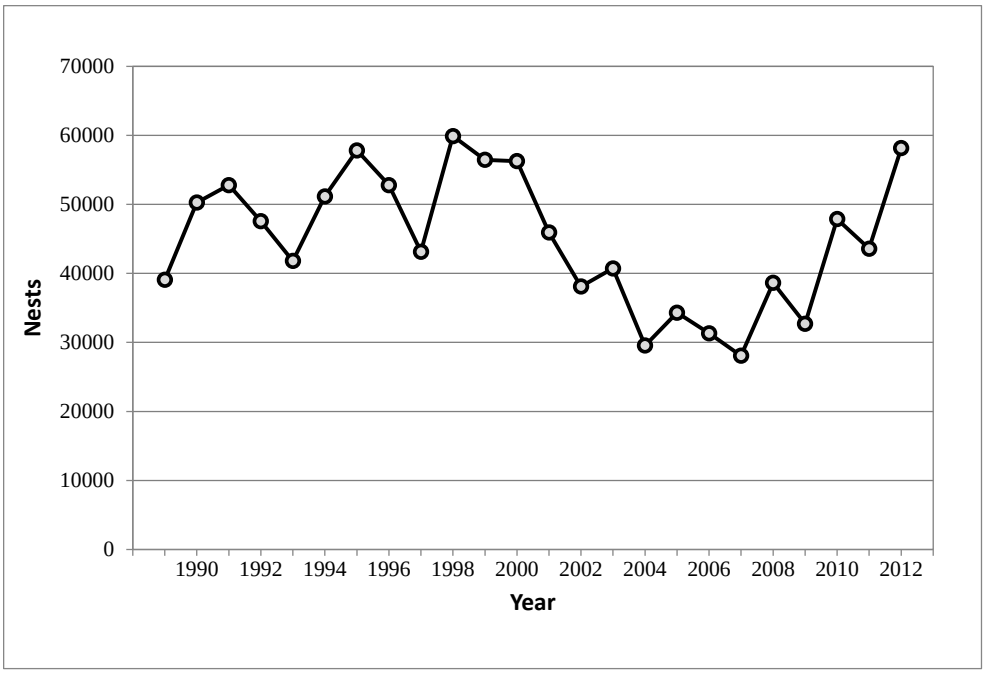

Figure 4. Loggerhead sea turtle nesting at Florida index beaches since 1989

Northern Recovery Unit

Annual nest totals from beaches within the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (Georgia Department of Natural Resources (GDNR) unpublished data, North Carolina Wildlife Resources Commission (NCWRC) unpublished data, South Carolina Department of Natural Resources (SCDNR) unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy and Hopkins 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989-2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9% annual decline in nesting in South Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the NRU had experienced a long-term decline over that period of time.

Data since that analysis (Table 7) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting has rebounded to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release, http://www.georgiawildlife.com/node/3139). South Carolina and North Carolina nesting have also begun to show a shift away from the past declining trend.

Table 7. Total Number of NRU Loggerhead Nests (GADNR, SCDNR, and NCWRC nesting datasets)

Nests Recorded	2008	2009	2010	2011	2012
Georgia	1,649	997	1,761	1,992	2,218
South Carolina	4,500	2,183	3,141	4,015	4,615
North Carolina	841	276	846	948	1,069
Total	6,990	3,456	5,748	6,955	7,902

South Carolina also conducts an index beach nesting survey similar to the one described for Florida. Although the survey only includes a subset of nesting, the standardized effort and locations allow for a better representation of the nesting trend over time. Increases in nesting were seen for the period from 2009-2012, with 2012 showing the highest index nesting total since the start of the program (Figure 5).

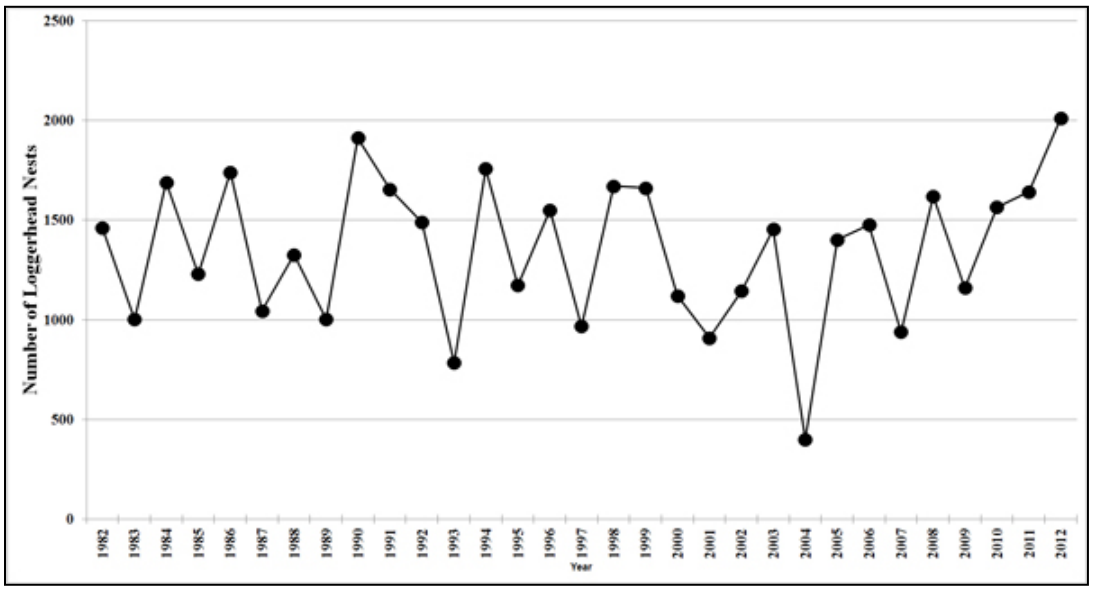

Figure 5. South Carolina Index Nesting Beach Counts for Loggerhead Sea Turtles (from the SCDNR website, http://www.dnr.sc.gov/seaturtle/nest.htm)

Other NW Atlantic DPS Recovery Units

The remaining three recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages but still considered essential to the continued existence of the species. Nesting surveys for the DTRU are conducted as part of Florida's statewide survey program. Survey effort was relatively stable during the 9-year period from 1995-2004 (although the 2002 year was missed). Nest counts ranged from 168-270, with a mean of 246, but with no detectable trend during this period (NMFS and USFWS 2008a). Nest counts for the NGMRU are focused on index beaches rather than all beaches where nesting occurs. Analysis of the 12-year dataset (1997-2008) of index nesting beaches in the area shows a statistically significant declining trend of 4.7% annually (NMFS and USFWS 2008a). Nesting on the Florida Panhandle index beaches, which represents the majority of NGMRU nesting, had shown a large increase in 2008, but then declined again in 2009 and 2010 before rising back to a level similar to the 2003-2007 average in 2011. Nesting survey effort has been inconsistent among the GCRU nesting beaches and no trend can be determined for this subpopulation. Zurita et al. (2003) found a statistically significant increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008a).

In-water Trends

Nesting data are the best current indicator of sea turtle population trends; however, in-water data also provide some insight. Such research suggests the abundance of neritic juvenile loggerheads is steady or increasing. Although Ehrhart et al. (2007) found no significant regression-line trend in a long-term dataset, researchers have observed notable increases in catch per unit effort (CPUE) over the past several years (Arendt et al. 2009; Ehrhart et al. 2007; Epperly et al. 2007). Researchers believe that this increase in CPUE is likely linked to an increase in juvenile abundance, though it is unclear whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence. Bjorndal et al. (2005), cited in NMFS and USFWS (2008a), caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest oceanic/neritic juveniles (historically referred to as small benthic juveniles), which could indicate a relatively large number of individuals around the same age may mature in the near future (TEWG 2009). However, in-water studies throughout the eastern United States also indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG 2009).

Population Estimate

The NMFS Southeast Fishery Science Center developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS-SEFSC 2009). The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Resulting trajectories of model runs for each individual recovery unit, as well as the western North Atlantic population as a whole, were found to be very similar. The model run estimates, from the adult female population size for the western North Atlantic (from the 2004-2008 time frame),suggests the adult female population size approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS-SEFSC 2009). A less robust estimate for total benthic females in the western North Atlantic was also obtained, yielding approximately 30,000-300,000 individuals, up to less than 1 million (NMFS-SEFSC 2009).

Threats (General Threats Faced by All Sea Turtle Species)

Sea turtles face numerous natural and anthropogenic threats that shape their status and affect their ability to recover. As many of the threats are either the same or similar in nature for all listed sea turtle species, those identified in this section below are discussed in a general sense for all listed sea turtles. Threat information specific to a particular species are then discussed in the corresponding status sections where appropriate.

Fisheries

Incidental bycatch in commercial fisheries is identified as a major contributor to past declines, and threat to future recovery, for all of the sea turtle species (NMFS and USFWS 1991, 1992, 1993, 2008, 2011). Domestic fisheries often capture, injure, and kill sea turtles at various life stages. Sea turtles in the pelagic environment are exposed to U.S. Atlantic pelagic longline

fisheries. Sea turtles in the benthic environment in waters off the coastal United States are exposed to a suite of other fisheries in federal and state waters. These fishing methods include trawls, gillnets, purse seines, hook-and-line gear [including bottom longlines and vertical lines (e.g., bandit gear, handlines, and rod-reel)], pound nets, and trap fisheries. Refer to the Environmental Baseline section of this opinion for more specific information regarding federal and state managed fisheries affecting sea turtles within the action area). The Southeast U.S. shrimp fisheries have historically been the largest fishery threat to benthic sea turtles in the southeastern United States, and continue to interact with and kill large numbers of sea turtles each year.

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further impeding the ability of sea turtles to survive and recover on a global scale. For example, pelagic stage sea turtles, especially loggerheads and leatherbacks, circumnavigating the Atlantic are susceptible to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al. 1995; Bolten et al. 1994; Crouse 1999). Bottom longlines and gillnet fishing is known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. Shrimp trawl fisheries are also occurring off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. Many unreported takes or incomplete records by foreign fleets make it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to sea turtle survival and recovery throughout their respective ranges.

Non-Fishery In-Water Activities

There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the United States, the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS 1997a). Sea turtles entering coastal or inshore areas have also been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, in-water construction activities, and scientific research activities.

Coastal Development and Erosion Control

Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997). These factors may decrease the amount of nesting area available to females and change the natural behaviors of both adults and hatchlings, directly or indirectly, through loss of beach habitat or changing thermal profiles and increasing erosion, respectively. (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings that are drawn away from

the water (Witherington and Bjorndal 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchling as they approach and leave the surf zone or head out to sea by creating physical blockage, concentrating predators, creating longshore currents, and disrupting of wave patterns.

Environmental Contamination

Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g., DDT, PCBs, and PFCs), and others that may cause adverse health effects to sea turtles (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area. In 2010, there was a massive oil spill in the Gulf of Mexico at BP's Deepwater Horizon (DWH) well. Official estimates are that millions of barrels of oil were released into the Gulf of Mexico. Additionally, approximately 1.8 million gallons of chemical dispersant were applied on the seawater surface and at the wellhead to attempt to break down the oil. At this time the assessment of total direct impact to sea turtles has not been determined. Additionally, the long-term impacts to sea turtles as a result of habitat impacts, prey loss, and subsurface oil particles and oil components broken down through physical, chemical, and biological processes are not known.

Marine debris is a continuing problem for sea turtles. Sea turtles living in the pelagic environment commonly eat or become entangled in marine debris (e.g., tar balls, plastic bags/pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the pelagic environment (i.e., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see http://www.climate.gov).

Climate change impacts on sea turtles currently cannot be predicted with any degree of certainty; although significant impacts to the hatchling sex ratios of sea turtles may result (NMFS and USFWS 2007c). In sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007c).

The effects from increased temperatures may be intensified on developed nesting beaches where shoreline armoring and construction have denuded vegetation. Erosion control structures could potentially result in the permanent loss of nesting beach habitat or deter nesting females (NRC 1990). These impacts will be exacerbated by sea level rise. If females nest on the seaward side of the erosion control structures, nests may be exposed to repeated tidal overwash (NMFS and USFWS 2007c). Sea level rise from global climate change is also a potential problem for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Baker et al. 2006; Daniels et al. 1993; Fish et al. 2005). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Other changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, etc.) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.) which could ultimately affect the primary foraging areas of sea turtles.

Other Threats

Predation by various land predators is a threat to developing nests and emerging hatchlings. The major natural predators of sea turtle nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Emergent hatchlings are preyed upon by these mammals as well as ghost crabs, laughing gulls, and the exotic South American fire ant (*Solenopsis invicta*). In addition to natural predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS and USFWS 2008a).

Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

Actions Taken to Reduce Threats

Actions have been taken to reduce man-made impacts to sea turtles from various sources, particularly since the early 1990s. These include lighting ordinances, predation control, and nest relocations to help increase hatchling survival, as well as measures to reduce the mortality of pelagic immatures, benthic immatures, and sexually mature age classes from various fisheries and other marine activities. Some actions have resulted in significant steps towards reducing the recurring sources of mortality of sea turtles in the environmental baseline and improving the status of all sea turtle populations in the Atlantic and Gulf of Mexico. For example, the TED regulation published on February 21, 2003 (68 FR 8456), represents a significant improvement in the baseline effects of trawl fisheries on sea turtles, though shrimp trawling is still considered to be one of the largest source of anthropogenic mortality for most of our sea turtle species (NMFS-SEFSC 2009).

Threats (Specific to Loggerhead Sea Turtles)
The threats faced by loggerhead sea turtles are well-summarized in the general discussion of threats in Section 3.2.1. Yet, the impact of fishery interactions is a point of further emphasis for this species. The Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009b).

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants as they were observed to have the highest organochlorine concentrations in sampled tissues (Storelli et al. 2008). It is thought that dietary preferences were likely to be the main differentiating factor among species. Storelli et al. (2008) analyzed tissues from stranded loggerhead sea turtles and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al. 1991).

Specific information regarding potential climate change impacts on loggerheads is also available. Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most clutches, leading to death (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), as well as short inter-nesting intervals (Hays et al. 2002) and shorter nesting season (Pike et al. 2006).

3.2.2 Green Sea Turtle

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered.

Species Description and Distribution
The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lb (159 kg) and a straight carapace length of greater than 3.3 ft (1 m). Green sea turtles have a smooth carapace with four pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green sea turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux 2001).

With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting (Hays et al. 2001). Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth and USFWS

1997). The two largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef.

Differences in mitochondrial DNA properties of green sea turtles from different nesting regions indicate there are genetic subpopulations (Bowen et al. 1992; Fitzsimmons et al. 2006). Despite the genetic differences, sea turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. Such mixing occurs at extremely low levels in Hawaiian foraging areas, perhaps making this central Pacific population the most isolated of all green sea turtle populations occurring worldwide (Dutton et al. 2008).

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed throughout inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957; Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatan Peninsula.

The complete nesting range of green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as the U.S. Virgin Islands and Puerto Rico (Dow et al. 2007; NMFS and USFWS 1991). Still, the vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard through Broward counties. For more information on green sea turtle nesting in other ocean basins, refer to the 1991 Recovery Plan for the Atlantic Green Turtle (NMFS and USFWS 1991) or the 2007 Green Sea Turtle 5-Year Status Review (NMFS and USFWS 2007a).

*Life History Informati*on

Green sea turtles reproduce sexually, and mating occurs in the waters off nesting beaches. Mature females return to their natal beaches (i.e., the same beaches where they were born) to lay eggs (Balazs 1982; Frazer and Ehrhart 1985) every 2-4 years while males are known to reproduce every year (Balazs 1983). In the southeastern United States, females generally nest between June and September, and peak nesting occurs in June and July (Witherington and Ehrhart 1989). During the nesting season, females nest at approximately two-week intervals, laying an average of 3-4 clutches (Johnson and Ehrhart 1996). Clutch size often varies among subpopulations, but mean clutch size is around 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart 1989). Eggs incubate for approximately two months before hatching. Hatchling green sea turtles are approximately 2

inches (5 cm) in length and weigh approximately 0.9 ounces (25 grams). Survivorship at any particular nesting site is greatly influenced by the level of anthropogenic stressors, with the more pristine and less disturbed nesting sites (e.g., along the Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed (e.g., Nicaragua (Campbell and Lagueux 2005; Chaloupka and Limpus 2005)).

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS and USFWS 2007b). Green sea turtles exhibit particularly slow growth rates of about 0.4-2 inches (1-5 cm) per year (Green 1993; McDonald-Dutton and Dutton 1998), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately 8-10 inches (20-25 cm) carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Growth studies using skeletochronology indicate that green sea turtles in the western Atlantic shift from the oceanic phase to nearshore developmental habitats after approximately 5-6 years (Bresette et al. 2006; Zug and Glor 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel 1974), although some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). Green sea turtles reach sexual maturity at 20-50 years of age (Chaloupka and Musick 1997; Hirth and USFWS 1997), which is considered one of the longest ages to maturity of any sea turtle species.

While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds, and it is clear they are capable of “homing in” on these sites if displaced (McMichael et al. 2003). Reproductive migrations of Florida green sea turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green sea turtles are believed to reside in nearshore foraging areas throughout the Florida Keys and in the waters southwest of Cape Sable, with some post-nesting turtles also residing in Bahamian waters as well (NMFS and USFWS 2007b).

Status and Population Dynamics

Population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. However, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends is provided in the most recent 5-year status review for the species (NMFS and USFWS 2007b) organized by ocean region (i.e., Western Atlantic Ocean, Central Atlantic Ocean, Eastern Atlantic Ocean, Mediterranean Sea, Western Indian Ocean, Northern Indian Ocean, Eastern Indian Ocean, Southeast Asia, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). Trends at 23 of the 46 nesting sites and found that 10 appeared to be increasing, 9 appeared to be stable, and 4 appeared to be decreasing. With respect to regional trends, the Pacific, the Western Atlantic, and the Central Atlantic regions appeared to show more positive trends (i.e., more nesting sites increasing than decreasing) while the Southeast Asia, Eastern Indian Ocean, and possibly the Mediterranean Sea regions appeared to show more negative trends (i.e., more nesting sites decreasing than increasing). These regional determinations should

be viewed with caution since trend data was only available for about half of the total nesting concentration sites examined in the review and that site specific data availability appeared to vary across all regions.

The Western Atlantic region (i.e., the focus of this opinion) was one of the best performing in terms of abundance in the entire review as there were no sites that appeared to be decreasing. The 5-year status review for the species identified eight geographic areas considered to be primary sites for green sea turtle nesting in the Atlantic/Caribbean and reviewed the trend in nest count data for each (NMFS and USFWS 2007a). These sites include (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau. Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precluded a meaningful trend assessment for either (NMFS and USFWS 2007a). Seminoff (2004) likewise reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic, including all of the above with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic; however, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a). More information about site-specific trends for the other major ocean regions can be found in the most recent 5-year status review for the species (see NMFS and USFWS (2007a)).

By far, the largest known nesting assemblage in the Western Atlantic region occurs at Tortuguero, Costa Rica. According to monitoring data on nest counts, as well as documented emergences (both nesting and non-nesting events), there appears to be an increasing trend in this nesting assemblage since monitoring began in the early 1970s. For instance, from 1971-1975 there were approximately 41,250 average annual emergences documented and this number increased to an average of 72,200 emergences from 1992-1996 (Bjorndal et al. 1999). Troëng and Rankin (2005) collected nest counts from 1999-2003 and also reported increasing trends in the population consistent with the earlier studies, with nest count data suggesting 17,402-37,290 nesting females per year (NMFS and USFWS 2007a). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica, population growing at 4.9% annually.

In the continental United States, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf coast of Florida (Meylan et al. 1995). More recently, green sea turtle nesting has occurred in North Carolina on Bald Head Island, just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, 6 nests in South Carolina, and 6 nests in Georgia (nesting databases maintained on www.seaturtle.org).

In Florida, index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the ten years of regular monitoring (Figure 6). According to data collected from Florida's index nesting beach survey from 1989-2012, green sea turtle nest counts across Florida have increased approximately ten-fold from a low of 267 in the early 1990s to a high of 25,553 in 2013. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in both 2010 and 2011 (Figure 6). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

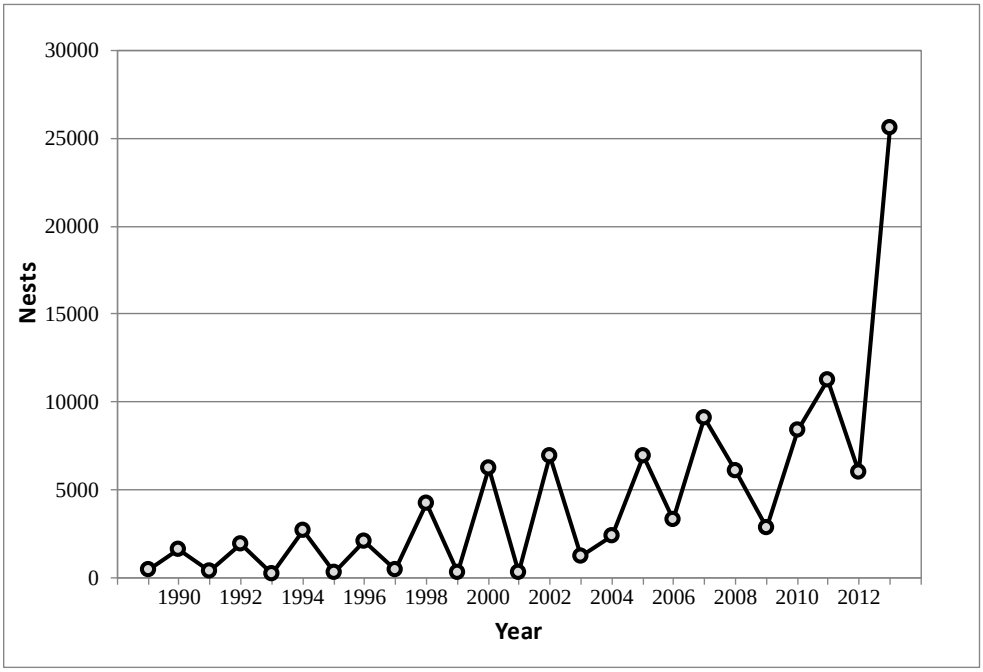

Figure 6. Green sea turtle nesting at Florida index beaches since 1989.

Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Green sea turtles also face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (e.g., plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (e.g., nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 3.2.1.

In addition to general threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). These tumors range in size from 0.1 cm to greater than 30 cm in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, though it is believed to be related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions [e.g., habitat degradation, pollution, low wave energy, and shallow water (Foley et al. 2005)]. Presently, FP is cosmopolitan, but has been found to affect large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991).

Cold-stunning is another natural threat to green sea turtles. Although it is not considered a major source of mortality in most cases, as temperatures fall below 8°-10°C turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and Ehrhart 1989). During January 2010, an unusually large cold-stunning event in the southeastern United States resulted in around 4,600 sea turtles, mostly greens, found cold-stunned, with hundreds found dead or dying. A large cold-stunning event occurred in the western Gulf of Mexico in February 2011, resulting in approximately 1,650 green sea turtles being found cold-stunned in Texas. Of these, approximately 620 were found dead or died after stranding, and approximately 1,030 were rehabilitated and released. Additionally, during this same time frame, approximately 340 green sea turtles were found cold-stunned in Mexico, though approximately 300 of those were subsequently rehabilitated and released.

3.2.3 Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act of 1969.

Species Description and Distribution

The leatherback is the largest sea turtle in the world, with a curved carapace length (CCL) often exceeding 5 ft (150 cm) and front flippers that can span almost 9 ft (270 cm) (NMFS and USFWS 1998b). Mature males and females can reach lengths of over 6 ft (2 m) and weigh close to 2,000 lb (900 kg). Leatherbacks do not have a bony shell. A leatherback's shell is approximately 1.5 inches (4 cm) thick and consists of a leathery, oil-saturated connective tissue overlaying loosely interlocking dermal bones. The ridged shell and large flippers help the leatherback during long-distance trips in search of food.

Leatherbacks have several unique traits that enable them to live in cold water, unlike other sea turtles. For example, leatherbacks have a countercurrent circulatory system (Greer et al. 1973),[6] a thick layer of insulating fat (Davenport et al. 1990; Goff and Lien 1988), gigantothermy (Paladino et al. 1990),[7] and they can increase their body temperature through increased metabolic activity (Bostrom and Jones 2007; Southwood et al. 2005). These adaptations allow leatherbacks to be comfortable in a wide range of temperatures and to travel further than any other sea turtle species (NMFS and USFWS 1995). For example, a leatherback may swim more than 6,000 miles (10,000 km) in a single year (Benson et al. 2007a; Benson et al. 2011; Eckert 2006b; Eckert et al. 2006). They search for food between latitudes 71°N and 47°S, in all oceans, and travel extensively to and from their tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (NMFS-SEFSC 2001). While leatherbacks will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003b). Leatherbacks have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey, like jellyfish and salps. A leatherback's mouth and throat also have backward-pointing spines that help retain jelly-like prey. Leatherback's favorite prey (e.g., medusae, siphonophores, and salps), occur commonly in temperate and boreal latitudes and likely has a strong influence on leatherback distribution in these areas (Plotkin 1995). Leatherbacks are known to be deep divers, with recorded depths in excess of a half mile (Eckert et al. 1989), but may also come into shallow waters to locate prey items.

Genetic analyses using microsatellite markers along with mitochondrial DNA and tagging data indicate there are seven groups or breeding populations in the Atlantic Ocean: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007). General differences in migration patterns and foraging grounds may occur between the seven nesting assemblages, although data to support this is limited in most cases.

Life History Information

The leatherback life cycle is broken into several stages: (1) egg/hatchling, (2) post-hatchling, (3) juvenile, (4) sub-adult, and (5) adult. Leatherbacks are a long-lived species that delay age of maturity, have low and variable survival in the egg and juvenile stages, and have relatively high and constant annual survival in the sub-adult and adult life stages (Chaloupka 2002; Crouse 1999; Heppell et al. 1999; Heppell et al. 2003b; Spotila et al. 1996b; Spotila et al. 2000).

Leatherbacks are believed to live a long time. While a robust estimate of the leatherback sea turtle's life span does not exist, the current best estimate for the maximum age is 43 (Avens et al. 2009). It is still unclear when leatherbacks first become sexually mature. Using skeletochronological data, Avens et al. (2009) estimated that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age, which is longer than earlier estimates by Pritchard and Trebbau (1984), 2-3 years; Rhodin (1985), 3-6 years; Zug and Parham (1996), 13-

[6] Countercurrent circulation is a highly efficient means of minimizing heat loss through the skin's surface because heat is recycled. For example, a countercurrent circulation system often has an artery containing warm blood from the heart surrounded by a bundle of veins containing cool blood from the body surface. As the warm blood flows away from the heart it passes much of its heat to the colder blood returning to the heart via the veins. This conserves heat by recirculating it back to the body core.

[7] "Gigantothermy" refers to a condition when an animal has relatively high volume compared to its surface area, and as a result, it losses less heat.

14 years for females; and Dutton et al. (2005), 12-14 years for leatherbacks nesting in the U.S. Virgin Islands. A more recent study that examined leatherback growth rates estimated an age at maturity of 16.1 years (Jones et al. 2011).

The average size of reproductively active females in the Atlantic is generally 5-5.5 ft (150-162 cm) CCL (Benson et al. 2007a; Hirth et al. 1993; Starbird and Suarez 1994). However, females as small as 3.5-4 ft (105-125 cm) CCL have been observed nesting at various sites (Stewart et al. 2007).

Female leatherbacks typically nest on sandy, tropical beaches at intervals of 2 to 4 years (Garcia M. and Sarti 2000; McDonald and Dutton 1996; Spotila et al. 2000). Unlike other sea turtle species, female leatherbacks do not always nest at the same beach year after year, some females may even nest at different beaches during the same year (Dutton et al. 2005; Eckert et al. 1989; Keinath and Musick 1993; Steyermark et al. 1996). Individual female leatherbacks have been observed with fertility spans as long as 25 years (Hughes 1996), D. Dutton, Ocean Planet Research, Inc., August 2009, pers. comm., in NMFS 2012). Females usually lay up to 10 nests during the 3-6 month nesting season (March through July in the United States), typically 8 to 12 days apart, with 100 eggs or more per nest (Eckert et al. 2012; Eckert et al. 1989; Maharaj 2004; Matos ; Stewart and Johnson 2006; Tucker 1988). However, up to approximately 30% of the eggs may be infertile (Eckert et al. 1989; Maharaj 2004; Matos ; MTN 1984; Stewart and Johnson 2006; Tucker 1988). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50% worldwide (Eckert et al. 2012), which is lower than the greater than 80% reported for other sea turtle species (Miller 1997). In the United States the emergent success is higher at 54%-72% (Eckert and Eckert 1990; Stewart and Johnson 2006; Tucker 1988). Thus, the number of hatchlings in a given year may be less than the total number of eggs produced in a season. Eggs hatch after 60-65 days, and the hatchlings have white striping along the ridges of their backs and on the edges of the flippers. Leatherback hatchlings are approximately 2-3 inches (51-76 mm) in length, with fore flippers as long as their bodies, and weigh approximately 1.5-2 ounces (40-50 g). Hatchlings grow rapidly with reported growth rates for leatherbacks 2.5-27.6 inches (6-70 cm) in length estimated at 12.6 inches (32 cm) per year (Jones et al. 2011).

In the Atlantic Basin, the sex ratio appears to be skewed toward females. TEWG (2007) reports that nearshore and onshore strandings data from the U.S. Atlantic and Gulf of Mexico coasts indicate that 60% of strandings were females. Those data also show that the proportion of females among adults (57%) and juveniles (61%) was also skewed toward females in these areas (TEWG 2007). James et al. (2007) collected size and sex data from large sub-adult and adult leatherbacks off Nova Scotia and also concluded a bias toward females at a rate of 1.86:1.

The survival and mortality rates for leatherbacks are difficult to estimate and vary by location. For example, the annual mortality rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 34.6% in 1993-1994 and 34.0% in 1994-1995 (Spotila et al. 2000). In contrast leatherbacks nesting in French Guiana and St. Croix had estimated annual survival rates of 91% (Rivalan et al. 2005) and 89% (Dutton et al. 2005), respectively. For the St. Croix population, the average annual juvenile survival rate was estimated to be approximately 63%,

and the total survival rate from hatchling to first year of reproduction for a female was estimated to be between 0.4 and 2% [assuming age at first reproduction is between 9 and 13 years (Eguchi et al. 2006)]. Spotila et al. (1996a) estimated first year survival rates for leatherbacks at 6.25%.

Migratory routes of leatherbacks are not entirely known. However, recent information from satellite tags have documented long travels between nesting beaches and foraging areas in the Atlantic and Pacific Ocean basins (Benson et al. 2007a; Benson et al. 2011; Eckert 2006a; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; James et al. 2005). Leatherbacks nesting in Central America and Mexico travel thousands of miles into tropical and temperate waters of the South Pacific (Eckert and Sarti 1997; Shillinger et al. 2008). Data from satellite tagged leatherbacks suggest that they may be traveling in search of seasonal aggregations of jellyfish (Benson et al. 2007b; Bowlby et al. 1994; Graham 2009; Shenker 1984; Starbird et al. 1993; Suchman and Brodeur 2005).

Status and Population Dynamics

The status of the Atlantic leatherback population has been less clear than the Pacific population, which has shown dramatic declines at many nesting sites (Santidrián-Tomillo et al. 2007; Sarti Martínez et al. 2007; Spotila et al. 2000). This uncertainty has been a result of inconsistent beach and aerial surveys, cycles of erosion and reformation of nesting beaches in the Guianas (representing the largest nesting area). Leatherbacks also show a lesser degree of nest-site fidelity than occurs with the hardshell sea turtle species. However, coordinated efforts of data collection and analyses by the Leatherback Turtle Expert Working Group have helped to clarify the understanding of the Atlantic population status (TEWG 2007).

The Southern Caribbean/Guianas stock is the largest known Atlantic leatherback nesting aggregation (TEWG 2007). This area includes the Guianas (Guyana, Suriname, and French Guiana), Trinidad, Dominica, and Venezuela, with most of the nesting occurring in the Guianas and Trinidad. The Southern Caribbean/Guianas stock of leatherbacks was designated after genetics studies indicated that animals from the Guianas (and possibly Trinidad) should be viewed as one population. Using nesting females as a proxy for population, the TEWG (2007) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate. This positive growth was seen within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana (TEWG 2007). More specifically, Wallace et al. (2013) report an estimated three-generation abundance change of +3%, +20,800%, +1,778%, and +6% in Trinidad, Guyana, Suriname, and French Guiana, respectively.

Researchers believe the cyclical pattern of beach erosion and then reformation has affected leatherback nesting patterns in the Guianas. For example, between 1979 and 1986 the number of leatherback nests in French Guiana had increased by about 15% annually(NMFS-SEFSC 2001). This was then followed by a nesting decline of about 15% annually. This decline corresponded with the erosion of beaches in French Guiana and increased nesting in Suriname. This pattern suggests that the declines observed since 1987 might actually be a part of a nesting cycle that coincides with cyclic beach erosion in Guiana (Schultz 1975). Researchers think that the cycle of erosion and reformation of beaches may have changed where leatherbacks nest throughout this region. The idea of shifting nesting beach locations was supported by increased nesting in

Suriname.[8] These increases were happening at the same time that the number of nests was declining at beaches that had previously shown large increases in nesting (Hilterman et al. 2003), though this information suggested the long-term trend for the overall Suriname and French Guiana population was increasing.

The Western Caribbean stock includes nesting beaches from Honduras to Colombia. Across the Western Caribbean, nesting here is most prevalent in Costa Rica, Panama, and the Gulf of Uraba in Colombia (Duque et al. 2000). The Caribbean coast of Costa Rica and extending through Chiriquí Beach, Panama, represents the fourth largest known leatherback rookery in the world (Troëng et al. 2004). Examination of data from index nesting beaches in Tortuguero, Gandoca, and Pacuaré in Costa Rica indicate that the nesting population likely was not growing over the 1995-2005 time series (TEWG 2007). Other modeling of the nesting data for Tortuguero indicates a possible 67.8% decline between 1995 and 2006 (Troëng et al. 2007). Wallace et al. (2013) report an estimated three-generation abundance change of -72%, -24%, and +6% for Tortuguero, Gandoca, and Pacuare, respectively. .

Nesting data for the Northern Caribbean stock is available from Puerto Rico, St. Croix (USVI), and the British Virgin Islands (Tortola). In Puerto Rico, the primary nesting beaches are at Fajardo and on the island of Culebra. Nesting between 1978 and 2005 has ranged between 469-882 nests, and the population has been growing since 1978, with an overall annual growth rate of 1.1% (TEWG 2007). Wallace et al. (2013) report an estimated three-generation abundance change of -4% and +5,583% at Culebra and Fajardo, respectively. At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has varied from a few hundred nests to a high of 1,008 in 2001, and the average annual growth rate has been approximately 1.1% from 1986-2004 (TEWG 2007). From 2006-2010, Wallace et al. (2013) report an annual growth rate of +7.5% in St. Croix and a three-generation abundance change of +1,058%. Nesting in Tortola is limited, but has been increasing from 0-6 nests per year in the late 1980s to 35-65 per year in the 2000s, with an annual growth rate of approximately 1.2% between 1994 and 2004 (TEWG 2007).

The Florida nesting stock nests primarily along the east coast of Florida. This stock is of growing importance, with total nests between 800-900 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (Florida Fish and Wildlife Conservation Commission, unpublished data). Using data from the index nesting beach surveys, the TEWG (TEWG 2007) estimated a significant annual nesting growth rate of 1.17% between 1989 and 2005. FWC Index Nesting Beach Survey Data indicates biennial peaks in nesting abundance beginning in 2007 (Figure 7 and Table 8). A similar pattern was also observed statewide (Table 5). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting. Overall, the trend shows growth on Florida's east coast beaches. Wallace et al. (2013) report an annual growth rate of 9.7% and a three-generation abundance change of +1,863%.

[8] Leatherback nesting in Suriname increased by more than 10,000 nests per year since 1999 and a peak of 30,000 nests in 2001.

Table 8. Number of Leatherback Sea Turtle Nests in Florida

Nests Recorded	2007	2008	2009	2010	2011
Index Nesting Beaches	517	265	615	552	625
Statewide	1,442	728	1,747	1,334	1,652

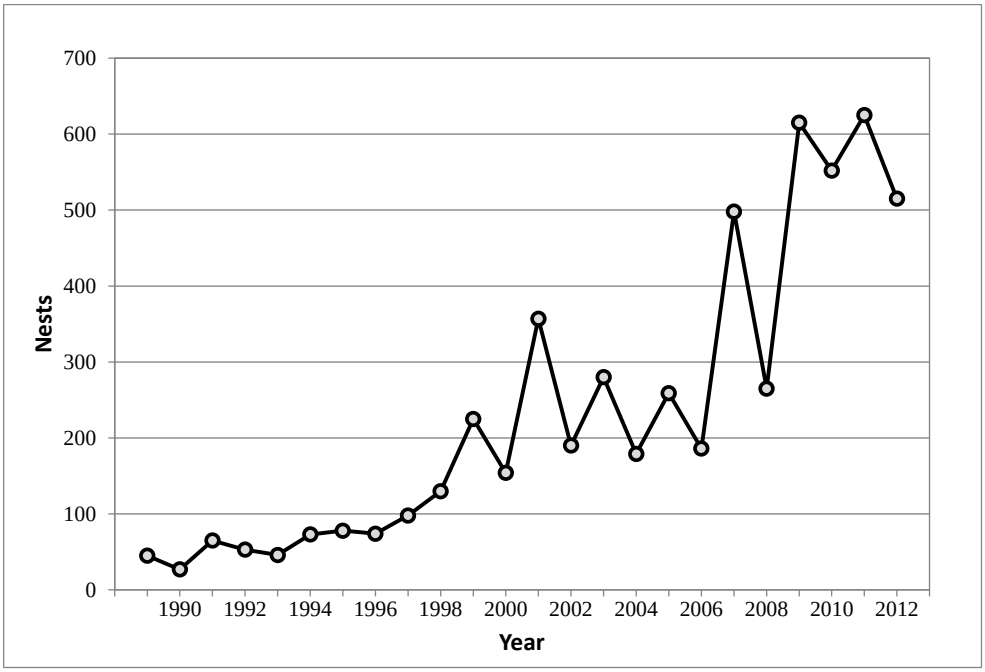

Figure 7. Leatherback sea turtle nesting at Florida index beaches since 1989

The West African nesting stock of leatherbacks is large and important, but is a mostly unstudied aggregation. Nesting occurs in various countries along Africa's Atlantic coast, but much of the nesting is undocumented and the data are inconsistent. Gabon has a very large amount of leatherback nesting, with at least 30,000 nests laid along its coast in one season (Fretey et al. 2007). Fretey et al. (2007) also provide detailed information about other known nesting beaches and survey efforts along the Atlantic African coast. Because of the lack of consistent effort and minimal available data, trend analyses were not possible for this stock (TEWG 2007).

Two other small but growing stocks nest on the beaches of Brazil and South Africa. Based on the data available, TEWG (2007) determined that between 1988 and 2003 there was a positive annual average growth rate between 1.07 and 1.08% for the Brazilian stock. TEWG (2007) estimated an annual average growth rate between 1.04 and 1.06% for the South African stock.

Because the available nesting information is inconsistent, it is difficult to estimate the total population size for Atlantic leatherbacks. Spotila et al. (1996b) characterized the entire Western Atlantic population as stable at best. They estimated the numbers of nesting females was likely around 18,800 (Spotila et al. 1996b). A subsequent analysis by Spotila (pers. comm.) indicated that by 2000, the Western Atlantic nesting levels had decreased to about 15,000 females. Spotila et al. (1996b) estimated that the adult female leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, was about 27,600

(considering both nesting and interesting females), with an estimated range of 20,082-35,133. This is consistent with the estimate of 34,000-95,000 total adults (20,000-56,000 adult females; 10,000-21,000 nesting females) determined by the TEWG (2007).

Threats

Leatherbacks face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 3.2.1; the remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact leatherback sea turtles.

Of all sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, especially gillnet and pot/trap lines. This may be because of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, their method of locomotion, and/or perhaps their attraction to the lightsticks used to attract target species in longline fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine and many other stranded individuals exhibited evidence of prior entanglement (Dwyer et al. 2002). Zug and Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities and a lack of recruitment from intense egg harvesting in some areas has caused a sharp decline in leatherback sea turtle populations and represents a significant threat to survival and recovery of the species worldwide.

Leatherback sea turtles may also be more susceptible to marine debris ingestion than other sea turtle species due to their predominantly pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding and migratory purposes (Lutcavage et al. 1997; Shoop and Kenney 1992). The stomach contents of leatherback sea turtles revealed that a substantial percentage (33.8%; 138 of 408 cases examined) contained some form of plastic debris (Mrosovsky et al. 2009). Plastic blocking the gut to an extent that could have caused death was evident in 8.7% of all leatherbacks that ingested plastic (Mrosovsky et al. 2009). Mrosovsky et al. (2009) also note that in a number of cases, the ingestion of plastic may not cause death outright, but could cause the animal to absorb fewer nutrients from food, eat less in general, etc., all of which could cause other adverse effects. The presence of plastic in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and forms of debris such a plastic bags (Mrosovsky et al. 2009). Balazs (1985) speculated that the object might resemble a food item by its shape, color, size or even movement as it drifts about, and induce a feeding response in leatherbacks.

As discussed in Section 3.2.1, global climate change can be expected to have various impacts on all sea turtles, including leatherbacks. Global climate change is likely to also influence the distribution and abundance of jellyfish, the primary prey item of leatherbacks (NMFS and USFWS 2007d). Several studies have shown leatherback distribution is influenced by jellyfish abundance [e.g., (Houghton et al. 2006; Witt et al. 2007; Witt et al. 2006)]; however, more

studies need to be done to monitor how changes to prey items affect distribution and foraging success of leatherbacks so that population-level effects can be determined.

3.2.4 Hawksbill Sea Turtle

The hawksbill sea turtle was listed as endangered throughout its entire range on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Critical habitat was designated on June 2, 1998, in coastal waters surrounding Mona and Monito Islands in Puerto Rico (63 FR 46693).

Species Description and Distribution

The hawksbill sea turtle was listed as endangered throughout its entire range on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Hawksbill sea turtles are small to medium-sized (99 to 150 lb on average [45 to 68 kg]) although nesting females are known to weigh up to 176 lb (80 kg) in the Caribbean (Pritchard et al. 1983). The carapace is usually serrated and has a "tortoise-shell" coloring, ranging from dark to golden brown, with streaks of orange, red, and/or black. The plastron of a hawksbill turtle is typically yellow. The head is elongated and tapers to a point, with a beak-like mouth that gives the species its name. The shape of the mouth allows the hawksbill turtle to reach into holes and crevices of coral reefs to find sponges, their primary food source as adults, and other invertebrates. The shells of hatchlings are 1.7 in (42 mm) long, are mostly brown, and somewhat heart-shaped (Eckert 1995; Hillis and Mackay 1989; Van Dam and Sarti 1989).

Hawksbill sea turtles have a circumtropical distribution and usually occur between latitudes 30°N and 30°S in the Atlantic, Pacific, and Indian Oceans. In the western Atlantic, hawksbills are widely distributed throughout the Caribbean Sea, off the coasts of Florida and Texas in the continental United States, in the Greater and Lesser Antilles, and along the mainland of Central America south to Brazil (Amos 1989; Groombridge and Luxmoore 1989; Lund 1985; Meylan and Donnelly 1999; NMFS and USFWS 1998b; Plotkin and Amos 1988; Plotkin and Amos 1990). They are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Adult hawksbill sea turtles are capable of migrating long distances between nesting beaches and foraging areas. For instance, a female hawksbill sea turtle tagged at Buck Island Reef National Monument (BIRNM) was later identified 1,160 miles (1,866 km) away in the Miskito Cays in Nicaragua (Spotila 2004).

Hawksbill sea turtles nest on sandy beaches throughout the tropics and subtropics. Nesting occurs in at least 70 countries, although much of it now only occurs at low densities compared to other sea turtle species (NMFS and USFWS 2007b). Meylan and Donnelly (1999) believe that the widely dispersed nesting areas and low nest densities is likely a result of overexploitation of previously large colonies that have since been depleted over time. The most significant nesting within the United States occurs in Puerto Rico and the U.S. Virgin Islands, specifically on Mona Island and BIRNM, respectively. Although nesting within the continental United States is typically rare, it can also occur along the southeast coast of Florida and the Florida Keys. The largest hawksbill nesting population in the Western Atlantic occurs in the Yucatán Peninsula of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (Garduño-Andrade et al. 1999; Spotila 2004). In the U.S. Pacific, hawksbills nest on main island beaches in Hawaii, primarily along the east coast of the island. Hawksbill nesting has also been documented in American Samoa and Guam. More information on nesting

in other ocean basins may be found in the 5-year status review for the species (NMFS and USFWS 2007b).

Mitochondrial DNA studies show that reproductive populations are effectively isolated over ecological time scales (Bass et al. 1996). Substantial efforts have been made to determine the nesting population origins of hawksbill sea turtles assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting origins commonly mix in foraging areas (Bowen and Witzell 1996). Since hawksbill sea turtles nest primarily on the beaches where they were born, if a nesting population is wiped out it might not be replenished by sea turtles from other nesting rookeries (Bass et al. 1996).

Life History Information

Hawksbill sea turtles exhibit slow growth rates although they are known to vary within and among populations from a low of 0.4-1.2 in (1-3 cm) per year measured in the Indo-Pacific (Chaloupka and Limpus 1997; Mortimer et al. 2003; Mortimer et al. 2002; Whiting 2000) to a high of 2 in (5 cm) or more per year measured at some sites in the Caribbean (Díez and Dam 2002; León and Díez 1999). Differences in growth rates are likely due to differences in diet and/or density of sea turtles at foraging sites and overall time spent foraging (Bjorndal and Bolten 2000; Chaloupka et al. 2004). Consistent with slow growth, age to maturity for the species is also long, taking between 20 and 40 years depending on the region (Chaloupka and Musick 1997; Limpus and Miller 2000). Hawksbills in the western Atlantic are known to mature faster (i.e., 20 or more years) than sea turtles found in the Indo-Pacific [i.e., 30-40 years, (Boulan 1983; Boulon 1994; Díez and Dam 2002; Limpus and Miller 2000)]. Males are typically mature when their length reaches 27 in (69 cm) while females are typically mature at 30 in [75 cm, (Eckert et al. 1992; Limpus 1992)]. Female hawksbills return to their natal (site of their birth) beaches every 2-3 years to nest (van Dam et al. 1991; Witzell 1983) and generally lay 3-5 nests per season (Richardson et al. 1999). Compared with other sea turtles, the number of eggs per nest (clutch) for hawksbills can be quite high. The largest clutches recorded for any sea turtle belong to hawksbills [approximately 250 eggs per nest, (Hirth and Abdel Latif 1980)], though nests in the U.S. Caribbean and Florida more typically contain approximately 140 eggs (USFWS hawksbill fact sheet, http://www.fws.gov/northflorida/SeaTurtles/ Turtle%20Factsheets/ hawksbill-sea-turtle.htm). Eggs incubate for approximately 60 days before hatching (USFWS hawksbill fact sheet). Hatchling hawksbill sea turtles typically measure 1-2 inches (2.5-5 cm) in length and weigh approximately 0.5 ounces (15 grams).

Hawksbills may undertake developmental migrations (migrations as immatures) and reproductive migrations that involve travel over many tens to thousands of miles (Meylan 1999a). Post-hatchlings (oceanic stage juveniles) are believed to live in the open ocean, taking shelter in floating algal mats and drift lines of flotsam and jetsam in the Atlantic and Pacific oceans (Musick and Limpus 1997) before returning to more coastal foraging grounds. In the Caribbean, hawksbills are known to almost exclusively feed on sponges (Meylan 1988; van Dam and Díez 1997) although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (León and Díez 2000; Mayor et al. 1998; van Dam and Díez 1997).

Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest and exhibit a high degree of fidelity to their nest sites. Movements of reproductive males are less certain, but are presumed to involve migrations to nesting beaches or to courtship stations along the migratory corridor. Hawksbills show a high fidelity to their foraging areas as well (van Dam and Díez 1998). Foraging sites are typically areas associated with coral reefs although hawksbills are also found around rocky outcrops and high energy shoals which are optimum sites for sponge growth. They can also inhabit seagrass pastures in mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent (Bjorndal 1997; van Dam and Díez 1998).

Status and Population Dynamics

There are currently no reliable estimates of population abundance and trends for non-nesting hawksbills at the time of this consultation; therefore, nesting beach data is currently the primary information source for evaluating trends in global abundance. Most hawksbill populations around the globe are either declining, depleted, and/or remnants of larger aggregations (NMFS and USFWS 2007b). The largest nesting population of hawksbills occurs in Australia where approximately 2,000 hawksbills nest off the northwest coast and about 6,000 to 8,000 nest off the Great Barrier Reef each year (Spotila 2004). Additionally, about 2,000 hawksbills nest each year in Indonesia and 1,000 nest in the Republic of Seychelles (Spotila 2004). In the United States, about 500-1,000 hawksbill nests were typically laid on Mona Island, Puerto Rico in the past (Diez and van Dam 2007), but the numbers appear to be increasing, as nearly 1,600 nests were counted by Puerto Rico Department of Natural and Environmental Resources in 2010 (PRDNER nesting data). Another 56-150 nests are typically laid on Buck Island off St. Croix (Meylan 1999b; Mortimer and Donnelly 2008). Nesting also occurs to a lesser extent on beaches on Culebra Island and Vieques Island in Puerto Rico, the mainland of Puerto Rico, and additional beaches on St. Croix, St. John, and St. Thomas.

Mortimer and Donnelly (2008) reviewed nesting data for 83 nesting concentrations organized among 10 different ocean regions (i.e., Insular Caribbean, Western Caribbean Mainland, Southwestern Atlantic Ocean, Eastern Atlantic Ocean, Southwestern Indian Ocean, Northwestern Indian Ocean, Central Indian Ocean, Eastern Indian Ocean, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). Historic trends (i.e., 20-100 years ago) were determined for 58 of the 83 sites while recent abundance trends (i.e., within the past 20 years) were also determined for 42 of the 83 sites. Among the 58 sites where historic trends could be determined, all showed a declining trend during the long-term period. Among the 42 sites where recent trend data were available, 10 appeared to be increasing, 3 appeared to be stable, and 29 appeared to be decreasing. With respect to regional trends, nesting populations in the Atlantic (especially in the Insular Caribbean and Western Caribbean Mainland) are generally doing better than those in the Indo-Pacific regions. For instance, 9 of the 10 sites that showed recent increases are located in the Caribbean. Buck Island and St. Croix's East End beaches support two remnant populations of between 17-30 nesting females per season (Hillis and Mackay 1989; Mackay 2006). While the proportion of hawksbills nesting on Buck Island represents a small proportion of the total hawksbill nesting occurring in the greater Caribbean region, Mortimer and Donnelly (2008) report an increasing trend in nesting at that site based on data collected from 2001-2006. This increase is likely due to the conservation measures implemented when BIRNM was expanded in 2001.

Nesting concentrations in the Pacific Ocean appear to be performing the worst of all regions despite the fact that the region currently supports more nesting hawksbills than either the Atlantic or Indian Oceans (Mortimer and Donnelly 2008). Even so, while still critically low in numbers, sightings of hawksbills in the eastern Pacific appear to have been increasing since 2007, though some of that increase may be attributable to better observations (Gaos et al. 2010). More information about site specific trends can be found in the most recent five year status review for the species [see (NMFS and USFWS 2007b)].

Threats

Hawksbills are currently subjected to the same suite of threats on both nesting beaches and in the marine environment that affect other sea turtles (e.g., interaction with federal and state fisheries, coastal construction, oil spills, climate change affecting sex ratios, etc.) as discussed in Section 3.2.1. There are also specific threats that are of special emphasis, or are unique, for hawksbill sea turtles discussed in further detail below.

The historical decline of the species is primarily attributed to centuries of exploitation for the beautifully patterned shell, which made it a highly attractive species to target (Parsons 1972). The fact that reproductive females exhibit a high fidelity for nest sites and the tendency of hawksbills to nest at regular intervals within a season made them an easy target for capture on nesting beaches. The shells from hundreds of thousands of sea turtles in the western Caribbean region were imported into the United Kingdom and France during the 19th and early 20th centuries (Parsons 1972) and additional hundreds of thousands of sea turtles contributed to the region's trade with Japan prior to 1993 when a zero quota was imposed [(Milliken and Tokunaga 1987) as cited in (Brautigram and Eckert 2006)].

The continuing demand for the hawksbill's shell, as well as other products (leather, oil, perfume, and cosmetics), represents an ongoing threat to recovery of the species. The British Virgin Islands, Cayman Islands, Cuba, Haiti, and the Turks and Caicos Islands (U.K.) all permit some form of legal take of hawksbill sea turtles. In the northern Caribbean, hawksbills continue to be harvested for their shells, which are often carved into hair clips, combs, jewelry, and other trinkets (Márquez M 1990; Stapleton and Stapleton 2006). Additionally, hawksbills are harvested for their eggs and meat while whole, stuffed sea turtles are sold as curios in the tourist trade. Also, hawksbill sea turtle products are openly available in the Dominican Republic and Jamaica despite a prohibition on harvesting hawksbills and their eggs (Fleming 2001). In Cuba, 500 sea turtles are legally captured each year and while current nesting trends are unknown, the number of nesting females is suspected to be declining in some areas (Carillo et al. 1999; Moncada et al. 1999). International trade in the shell of this species is prohibited between countries that have signed the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), but illegal trade is still occurring and remains an ongoing threat to hawksbill survival and recovery throughout its range.

Due to their preference to feed on sponges associated with coral reefs, hawksbill sea turtles are particularly sensitive to losses of coral reef communities. Coral reefs are vulnerable to destruction and degradation caused by human activities (e.g., , nutrient pollution, sedimentation, contaminant spills, vessel groundings and anchoring, recreational uses, etc.) and are also highly sensitive to the effects of climate change (e.g., higher incidences of disease and coral bleaching)

(Crabbe 2008; Wilkinson 2004). Continued loss of coral reef communities (especially in the greater Caribbean region) is expected to impact foraging and represents a major threat to the recovery of the species.

3.2.5 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Internationally, the Kemp's ridley is considered the most endangered sea turtle (Groombridge 1982; TEWG 2000b; Zwinenberg 1977).

Species Description and Distribution
The Kemp's ridley sea turtle is the smallest of all sea turtles. Adults generally weigh less than 100 lb (45 kg) and have a carapace length of around 2.1 ft (65 cm). Adult Kemp's ridley shells are almost as wide as they are long. Coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles, and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. There are 2 pairs of prefrontal scales on the head, 5 vertebral scutes, usually 5 pairs of costal scutes, and generally 12 pairs of marginal scutes on the carapace. In each bridge adjoining the plastron to the carapace, there are four scutes, each of which is perforated by a pore.

Kemp's ridley habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 ft (37 m) deep, although they can also be found in deeper offshore waters. These areas support the primary prey species of the Kemp's ridley sea turtle, which consist of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The primary range of Kemp's ridley sea turtles is within the Gulf of Mexico basin, though they also occur in coastal and offshore waters of the U.S. Atlantic Ocean. Juvenile Kemp's ridley sea turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. Historic nesting records range from Mustang Island, Texas, in the north, to Veracruz, Mexico, in the south. Kemp's ridley sea turtles have recently been nesting along the Atlantic Coast of the United States, with nests recorded from beaches in Florida, Georgia, and the Carolinas. In 2012, the first Kemp's ridley sea turtle nest was recorded in Virginia. The Kemp's ridley nesting population is exponentially increasing, which may indicate a similar increase in the population as a whole (NMFS et al. 2011).

Life History Information
Kemp's ridley sea turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After 45-58 days of embryonic development, the hatchlings emerge and swim offshore into deeper, ocean water where they feed and grow until returning at a larger size. Hatchlings generally range from 1.65-1.89 in (42-48 mm) SCL, 1.26-1.73 in (32-44 mm) in width, and 0.3-0.4 lb (15-20 g) in weight. The return to nearshore coastal habitats typically occurs around 2 years of age (Ogren 1989), although the time spent in the oceanic zone may vary from 1-4 years or perhaps more (TEWG 2000). Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April

through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops.

The average rates of growth may vary by location, but generally fall within 2.2-2.9 ± 2.4 in per year (5.5-7.5 ± 6.2 cm/year) (Schmid and Barichivich 2006; Schmid and Woodhead 2000). Age to sexual maturity ranges greatly from 5-16 years, though NMFS et al. (2011) determined the best estimate of age to maturity for Kemp's ridley sea turtles was 12 years. It is unlikely that most adults grow very much after maturity. While some sea turtles nest annually, the weighted mean remigration rate for Kemp's ridley sea turtles is approximately two years. Nesting generally occurs from April to July and females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M 1994).

Population Dynamics

Of the seven species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the beaches of Rancho Nuevo, Mexico (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the mid-1980s, however, nesting numbers from Rancho Nuevo and adjacent Mexican beaches were below 1,000 (with a low of 702 nests in 1985). Yet, nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century (Figure 8), indicating the species is recovering. It is worth noting that when the Bi-National Kemp's Ridley Sea Turtle Population Restoration Project was initiated in 1978, only Rancho Nuevo nests were recorded. In 1988, nesting data from southern beaches at Playa Dos and Barra del Tordo were added, in 1989, data from the northern beaches of Barra Ostionales and Tepehuajes were added, and, most recently in 1996, data from La Pesca and Altamira beaches were recorded. Currently, nesting at Rancho Nuevo accounts for just over 81% of all recorded Kemp's ridley nests in Mexico. Following a significant, unexplained 1-year decline in 2010, Kemp's ridley nests in Mexico reached a record high of 21,797 in 2012 (Gladys Porter Zoo nesting database 2013); in 2013 there was a second significant decline, with only 16,385 nests recorded. A small nesting population is also emerging in the United States, primarily in Texas, rising from 6 nests in 1996 to 42 in 2004, to a record high of 209 nests in 2012 (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm, http://www.nps.gov/pais/naturescience/current-season.htm).

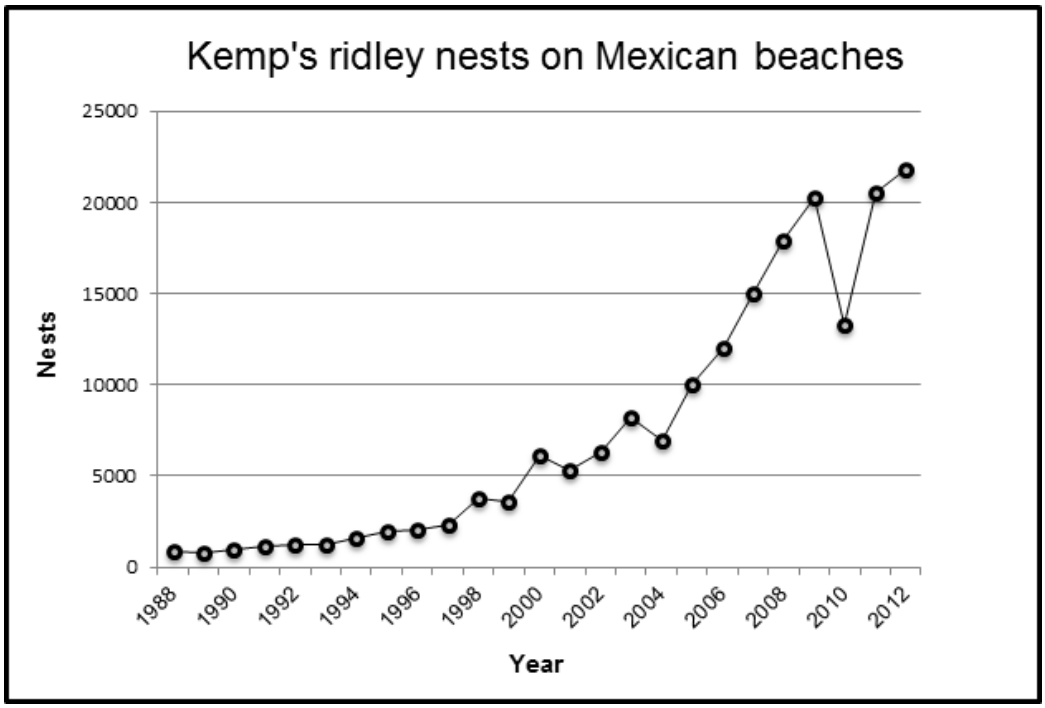

Figure 8. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2013)

Heppell et al. (2005) predicted in a population model that the population is expected to increase at least 12-16% per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011) produced an updated model that predicted the population to increase 19% per year and attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. While counts did not reach 25,000 nests by 2012, it is clear that the population is steadily increasing. The recent increases in Kemp's ridley sea turtle nesting seen in the last two decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the United States, and possibly other changes in vital rates (TEWG 1998; TEWG 2000b). While these results are encouraging, the species limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty.

Threats

Kemp's ridley sea turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 3.2.1; the remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact Kemp's ridley sea turtles.

As Kemp's ridley sea turtles continue to recover and nesting arribadas[9] are increasingly established, bacterial and fungal pathogens in nests are also likely to increase. Bacterial and fungal pathogen impacts have been well documented in the large arribadas of the olive ridley at Nancite in Costa Rica (Mo 1988). In some years, and on some sections of the beach, the hatching success can be as low as five % (Mo 1988). As the Kemp's ridley nest density at Rancho Nuevo and adjacent beaches continues to increase, appropriate monitoring of emergence success will be necessary to determine if there are any density dependent effects on emergence success.

Over the past three years, NMFS has documented (via the Sea Turtle Stranding and Salvage Network data, http://www.sefsc.noaa.gov/species/turtles/strandings.htm) elevated sea turtle strandings in the Northern Gulf of Mexico, particularly throughout the Mississippi Sound area. In the first three weeks of June 2010, over 120 sea turtle strandings were reported from Mississippi and Alabama waters, none of which exhibited any signs of external oiling to indicate effects associated with the DWH oil spill event. A total of 644 sea turtle strandings were reported in 2010 from Louisiana, Mississippi, and Alabama waters, 561 (87%) of which were Kemp's ridley sea turtles. During March through May of 2011, 267 sea turtle strandings were reported from Mississippi and Alabama waters alone. A total of 525 sea turtle strandings were reported in 2011 from Louisiana, Mississippi, and Alabama waters, with the majority (455) occurring from March through July, 390 (86%) of which were Kemp's ridley sea turtles. During 2012, a total of 428 sea turtles were reported from Louisiana, Mississippi, and Alabama waters, though the data is incomplete. Of these reported strandings, 301 (70%) were Kemp's ridley sea turtles. These stranding numbers are significantly greater than reported in past years; Louisiana, Mississippi, and Alabama waters reported 42 and 73 sea turtle strandings for 2008 and 2009, respectively; however, it should be noted that stranding coverage has increased considerably due to the DWH oil spill event. Nonetheless, considering that strandings typically represent only a small fraction of actual mortality, these stranding events potentially represent a serious impact to the recovery and survival of the local sea turtle populations. While a definitive cause for these strandings has not been identified, necropsy results indicate a significant number of stranded turtles from these events likely perished due to forced submergence, which is commonly associated with fishery interactions (B. Stacy, NMFS, pers. comm. to M. Barnette, NMFS, 2012). Yet, available information indicates fishery effort was extremely limited during the stranding events. The fact that in both 2010 and 2011 approximately 85% of all Louisiana, Mississippi, and Alabama stranded sea turtles were Kemp's ridleys is notable; however, this could simply be a function of the species' preference for shallow, inshore waters coupled with increased population abundance as reflected in recent Kemp's ridley nesting increases.

In response to these strandings, and due to speculation that fishery interactions may be the cause, fishery observer effort was shifted to evaluate the inshore skimmer trawl fishery during the summer of 2012. During May-July, observers reported 24 sea turtle interactions in the skimmer trawl fishery, all but one of which were identified as Kemp's ridleys (one sea turtle was an unidentified hardshell turtle). Encountered sea turtles were all very small, juvenile specimens ranging from 7.6-19.0 in (19.4-48.3 cm) CCL, and all sea turtles were released alive. The small average size of encountered Kemp's ridleys introduces a potential conservation issue, as over

[9] Arribada is the Spanish word for "arrival" and is the term used for massive synchronized nesting within the genus *Lepidochelys.*

50% of these reported sea turtles could potentially pass through the maximum 4-inch bar spacing of TEDs currently required in the shrimp fishery. Due to this issue, a proposed 2012 rule to require TEDs in the skimmer trawl fishery (77 FR 27411) was not implemented. Based on anecdotal information, these interactions were a relatively new issue for the inshore skimmer trawl fishery. Given the nesting trends and habitat utilization of Kemp's ridley sea turtles, it is likely that fishery interactions in the Northern Gulf of Mexico may continue to be an issue of concern for the species, and one that may potentially slow the rate of recovery for Kemp's ridley sea turtles.

4 Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area. The environmental baseline is a "snapshot" of a species' health at a specified point in time. It does not include the effects of the action under review in the consultation.

By regulation, environmental baselines for Biological Opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area. We identify the anticipated impacts of all proposed federal projects in the specific action area of the consultation at issue, that have already undergone formal or early Section 7 consultation as well as the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02, emphasis added).

Focusing on the impacts of the activities in the action area specifically, allows us to assess the prior experience and state (or condition) of the endangered and threatened individuals, and areas of designated critical habitat that occur in an action area, and that will be exposed to effects from the action under consultation. This is important because, in some phenotypic states or life history stages, listed individuals will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other states, stages, or areas within their distributions. The same is true for localized populations of endangered and threatened species: the consequences of changes in the fitness or performance of individuals on a population's status depends on the prior state of the population. Designated critical habitat is not different: under some ecological conditions, the physical and biotic features of critical habitat will exhibit responses that they would not exhibit in other conditions.

Environmental Contamination

Coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise and boat traffic can degrade marine habitats used by sea turtles (Colburn et al. 1996). The development of marinas and docks in inshore waters can negatively impact nearshore habitats. An increase in the number of docks built increases boat and vessel traffic. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Although these contaminant concentrations do not likely affect the more pelagic waters, sea turtles analyzed in this opinion travel between nearshore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles.

4.1 Factors Affecting Sea Turtles in the Action Area

As stated in Section 2.6 ("Action Area"), the proposed project includes direct impacts to all marine inshore waters in the Florida Keys with construction along ocean beaches prohibited by the PDCs. Indirect impacts from vessel traffic occur in marine inshore and nearshore waters in Florida including the Atlantic Ocean and Gulf of Mexico. However, sea turtles found in the action area are not year-round residents of the area, and may travel widely throughout the Atlantic, Gulf of Mexico, and Caribbean Sea. Therefore, individuals found in the action area can potentially be affected by activities anywhere else within their range. Numerous activities have been identified as threats and may affect sea turtles in their respective ranges, and thus the action area (see Sections 3.2 and Appendix B). The following analysis examines actions that may affect these species' environment within the action area.

4.2 Federal Actions

In addition to SAJ-82, SAJ-17 authorizes the construction of minor structures in the Florida Keys as part of a general permit programmatically consulted on by NMFS (NMFS 2012). SAJ-17 is used throughout the state of Florida but is the only other general permit that can authorize activities in Monroe County. Between 2006 and 2010, SAJ-17 was used to authorize 1,488 activities throughout Florida of which 58 activities were located in *Acropora* critical habitat (i.e., likely in Monroe County). During the latest reissuance of SAJ-17, NMFS analyzed the indirect impact of an increase in vessel traffic originating from minor structures authorized under this permit and determined that they would are likely to affect but not adversely modify sea turtles (NMFS 2012).

NMFS has also undertaken several ESA Section 7 consultations to address the effects of federally-permitted fisheries and other federal actions on threatened and endangered species. Each of those consultations sought to develop ways of reducing the probability of adverse effects of the action on sea turtles (and other species). Similarly, recovery actions NMFS has undertaken under the ESA are addressing the problem of take of sea turtles in the fishing and oil and gas industries, vessel operations, and other activities such as USACE dredging operations.

4.2.1 Construction and Operation of Public Fishing Locations

Sea turtles are known to be captured by hook-and-line at public fishing piers. Though there are no known traditional public fishing piers in the Florida Keys, there are numerous abandoned bridges that allow fishing. Many replacement bridges in the Florida Keys have retained the original bridge structures alongside the new bridge and dedicated the original bridge to public fishing and recreational use. SAJ-82 does not authorize the construction of fishing piers or other fishing structures.

4.2.2 Dredging

Marine dredging vessels are common within U.S. coastal waters. Although the underwater noises from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea

turtles. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites ("borrow areas") have been identified as sources of sea turtle mortality. Hopper dredges in the dredging mode are capable of moving relatively quickly compared to sea turtle swimming speed and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes the resting or swimming turtle. Entrained sea turtles rarely survive. NMFS completed regional opinions on the impacts of the USACE South Atlantic Division's hopper-dredging operations along the South Atlantic coast (from North Carolina through Key West, Florida) in 1991, 1995, and 1997 (NMFS 1997b), and in 1995 and 2003 for hopper dredging operations in the Gulf of Mexico (NMFS 2007). In the most recent Gulf of Mexico regional opinion, NMFS determined that (1) Gulf of Mexico hopper dredging would adversely affect Gulf sturgeon and four sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads) but would not jeopardize their continued existence and (2) dredging in the Gulf of Mexico would not adversely affect leatherback sea turtles, smalltooth sawfish, or ESA-listed large whales. An incidental take statement for those species adversely affected was issued. In the most recent South Atlantic regional Biological Opinion, NMFS determined that (1) hopper dredging in the South Atlantic would adversely affect shortnose sturgeon and four sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads), but would not jeopardize their continued existence, and (2) South Atlantic dredging would not adversely affect leatherback sea turtles or ESA-listed large whales. An incidental take statement for those species adversely affected was issued. In the Florida Keys, dredging of the Key West Harbor was completed in 2004 under this Opinion and did not result in any known take of sea turtles.

ESA Section 10 Permits

The ESA allows the issuance of permits to take ESA-listed species for the purposes of scientific research, under ESA Section 10(a)(1)(A). Authorized activities range from photographing, weighing, and tagging protected species incidentally taken in fisheries, to blood sampling, tissue sampling (biopsy), and performing laparoscopy on intentionally-captured organisms. The number of authorized takes varies widely depending upon the research and species involved, but may involve the taking of hundreds of individuals annually. Most takes authorized under these permits are expected to be (and are) nonlethal. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, issuance of the permit by NMFS must also be reviewed for compliance with Section 7(a)(2) of the ESA to ensure that issuance of the permit does not result in jeopardy to the species or adverse modification of its critical habitat.

4.3 State or Private Actions

4.3.1 Vessel Traffic

Commercial vessel traffic and recreational boating pursuits can have adverse effects on sea turtles through propeller and boat strike damage. The current extent of the impact on sea turtles in the action area is not known at this time.

4.3.2 State Fisheries

Recreational fishing from private vessels, private and public piers (described above in Section 4.1.1.1), and from shore does occur in the area. Observations of state recreational fisheries have shown that sea turtles are known to bite baited hooks, and loggerheads frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, beaches, banks, and jetties and from commercial fishermen fishing for reef fish and for sharks with both single rigs and bottom longlines (NMFS 2001). Additionally, lost fishing gear such as line cut after snagging on rocks, or discarded hooks and line, can also pose an entanglement threat to sea turtles in the area. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead sea turtles can be found in the TEWG (1998); TEWG (2000b) reports.

Although few of these state regulated fisheries are currently authorized to incidentally take listed species, several state agencies have approached NMFS to discuss applications for a Section 10(a)(1)(B) incidental take permit. Although the past and current effects of these fisheries on listed species are currently not determinable, NMFS believes that ongoing state fishing activities may be responsible for seasonally high levels of observed strandings of sea turtles on both the Atlantic and Gulf of Mexico coasts.

4.4 Other Potential Sources of Impacts in the Environmental Baseline

4.4.1 Conservation and Recovery Actions Shaping the Environment

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for Atlantic highly migratory species and Gulf of Mexico reef fish fisheries, and TED requirements for the southeastern shrimp trawl fisheries. These regulations have relieved some of the pressure on sea turtle populations.

Under Section 6 of the ESA, NMFS may enter into cooperative research and conservation agreements with states to assist in recovery actions of listed species. Prior to issuance of these agreements, the proposal must be reviewed for compliance with Section 7 of the ESA.

Outreach and Education, Sea Turtle Entanglements, and Rehabilitation

NMFS and cooperating states have established an extensive network of Sea Turtle Stranding and Salvage Network (STSSN) participants along the Atlantic and Gulf of Mexico coasts that collects data on dead sea turtles, and also rescues and rehabilitates any live stranded sea turtles. NMFS is also working to encourage placement of educational signs at public fishing and boat launch locations educating fisherman how to handle potential hook-and-line captures.

Sea Turtle Handling and Resuscitation Techniques
NMFS published a final rule (66 FR 67495, December 31, 2001) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the final rule. These measures help to prevent mortality of hard-shelled turtles caught in fishing or scientific research gear.

A final rule (70 FR 42508) published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the U.S. Coast Guard, or any other federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA [50 CFR 223.206(b)].

On August 3, 2007, NMFS published a final rule requiring selected fishing vessels to carry observers on board to collect data on sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle takes, and to determine whether additional measures to address prohibited sea turtle takes may be necessary (72 FR 43176). This rule also extended from 30 to 180 days, the maximum period NMFS observers may be placed on vessels in response to a determination by the Assistant Administrator that the unauthorized take of sea turtles may be likely to jeopardize their continued existence under existing regulations.

Other Actions

A revised recovery plan for the loggerhead sea turtle was completed December 8, 2008 (NMFS and USFWS 2008a). An updated bi-national recovery plan for the Kemp's ridley sea turtle was completed in 2011 (NMFS et al. 2011). Recovery teams comprised of sea turtle experts have been convened and are currently working towards revising other plans based upon the latest and best available information. Five-year status reviews have recently been completed for green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. These reviews were conducted to comply with the ESA mandate for periodic evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Each review determined that no delisting or reclassification of a species status (i.e., threatened or endangered) was warranted at the time. However, further review of species data for the green, hawksbill, leatherback, and loggerhead sea turtles was recommended, to evaluate whether DPSs should be established for these species (NMFS and USFWS 2007a; NMFS and USFWS 2007b; NMFS and USFWS 2007c; NMFS and USFWS 2007d; NMFS and USFWS 2007e). The Services published a final rule on September 22, 2011, listing the global population of loggerhead sea turtles as 9 separate DPSs.

5 Effects of the Action

Sea turtles may be accidently injured or killed by the potential increase of vessels moored at docks authorized under SAJ-82 (see Section 3.1.2). Since sea turtles are known to be susceptible to vessel strikes, dock and pier construction authorized under SAJ-82 can indirectly (i.e., later in time) result in an increased risk of vessel strikes by new vessels originating from structures built under this permit. To determine the potential level of impact to sea turtles from the authorization of activities under SAJ-82, we look at the size and number of new vessels that may result from the authorization of this permit. NMFS analyzed the probability of vessel strikes to sea turtles in Florida in 2009 (Barnette 2009) and again in 2013 (Barnette 2013). This analysis was based on studies in Florida that evaluated recreational boater usage for Sarasota County (Sidman et al.

2006), Charlotte Harbor (Sidman et al. 2005)), Brevard County (Sidman et al. 2007), and Palm Beach County (Gorzelany 2013). This was compared to the vessel registration data from the Florida Department of Motor Vehicles, turtle stranding data from the STSSN, and the likelihood of turtles struck by vessels being undetected or unreported. The NMFS study estimated that 1 turtle was struck by a vessel every 149,877 trips made from recreational coastal registered vessels in the state of Florida.

Table 6, below, provides NMFS's estimate of the potential increase of vessel traffic from the construction of pile-supported structures, based on the number of activities authorized during the last 5-year authorization period and the assumed number of vessels that would be stored at these project locations. The USACE originally estimated that the authorization of SAJ-82 would result in a potential increase of 550 to 600 more vessels from activities authorized in the next 5 years. However, when asked to double check this number, they went back through their data base and looked at all of the activities permitted and came up with a different estimate for increase in vessel traffic. Their new estimate determined that boat lifts authorized separate from a single-family dock do not increase the number of vessels stored at a location. If we assume that a new dock structure can increase the potential vessel strike in the area by 2 vessels per structure, then the addition of a boat lift will not further increase this number but will just change the way the vessel is stored at the location. They also looked to see how many of the activities authorized during the last 5-year period were repairs or replacements and determined this equaled approximately 10% of the docks authorized under SAJ-82. Since these docks would already have supported vessels, repairs to them would not add to the potential vessel traffic in an area. Based on this new information, the USACE estimates that the authorization of SAJ-82 likely resulted in an increase of 178 vessels during the last five years. They then calculated the anticipated increase in construction and increase in the number of docks that would be permitted by the change in dock walkway width from 3 to 4-ft wide and came up with an estimate of 500 new vessels resulting for the authorization of SAJ-82 over the next 5-year period. For this analysis, we will use the USACE's new estimate of 500 vessels since it is based on a thorough review of the activities authorized under the previous 5-year authorization period.

Table 6. NMFS estimate of the potential increase in vessel traffic

General Permit	Assumption	Number of times issued 2007-2011	Potential 5-year increase in vessels stored at docks
Private boat ramps	1 boat per ramp	2	2
Boatlifts	1 boat per structure	211	211
Single-family docks	2 boats per structure	105	210
Total			423

Though we assume SAJ-82 will result in an increase of 500 vessels in Florida, this is likely an overestimation as many of these slips will either not have vessels stored at each individual project location or vessels stored at these locations will be relocated from an existing location (marina or previously trailered). If we assume that the average recreational boater in Florida makes 52 trips per year—an extremely conservative assumption based on the most trips per year of all of the Florida studies (Barnette 2009), this would equal 26,00 vessel trips made by recreational boaters in the Florida Keys from structures built under SAJ-82.

An increase of 26,000 vessel trips made per year from docks authorized under this permit can then be divided by the number of trips assumed to result in a vessel strike to a sea turtle (1 strike per 149,877 trips). This results in the likelihood of 1 turtle every 6 years (0.17 turtles per year) being struck by vessels stored at structures authorized under SAJ-82. However, SAJ-82 is authorized for a period of 5 years and we do not know in what year of the 6-year estimate that a turtle would potentially be struck. Therefore, we assume that 1 turtle may be struck within the 5-year authorization period for SAJ-82.

By looking at all of the sea turtles that have been reported to the STSSN in Florida during the 10-year period from 2002-2011 (see Figure 9), we see a breakdown of the percentage of each of the species that are killed in Florida waters. This is not a representation of just turtles killed by vessel strikes but provides a species composition of turtles in Florida waters in the last ten years. *Using these percentages, it is estimated that the 1 turtles that may be taken by vessel strikes from vessels stored at structures approved under SAJ-82 will be a green (42 percent), loggerhead (41 percent), or a Kemp's ridley (11 percent).* Potential vessel strikes to leatherback and hawksbill sea turtles are not being considered further because they each represented only 3 percent of the strandings in the state of Florida (see Figure 9) and because of their limited distribution in the action area it is extremely unlikely that there will be vessel interactions with these species.

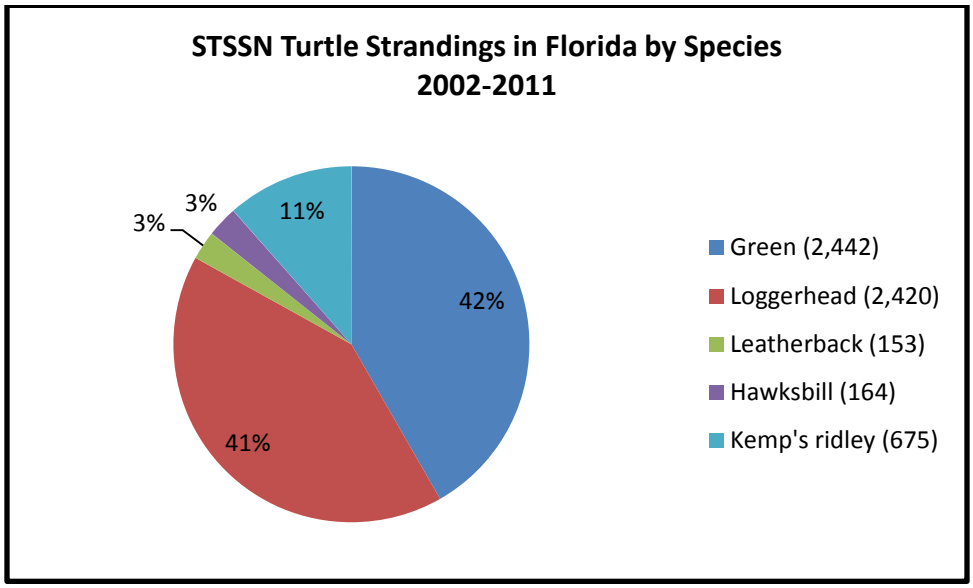

Figure 9: STSSN Turtle Strandings in Florida by Species (2002-2011).

6 Cumulative Effects

Cumulative effects include the effects of future state, tribal, or local private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Cumulative effects from unrelated, non-federal actions occurring in the action area may affect sea turtles. Stranding data indicate sea turtles in the action area die of various natural causes, including cold stunning and hurricanes, as well as human activities, such as incidental capture in state fisheries, ingestion of and/or entanglement in debris, ship strikes, and degradation of nesting habitat. The cause of death of most sea turtles recovered by the stranding network is unknown.

The authorization of dock construction in the Florida Keys under other general permits (i.e., SAJ-17 and the nationwide permit program when they are renewed) is expected to continue as described in Sections 2 and 4). An analysis of potential vessel strike interactions was also completed for the combination of 12 general permits used throughout Florida during the 5-year permit renewal review (NMFS 2012).

The fisheries described as occurring within the action area (see Sections 3 and 4, the Status of the Species and the Environmental Baseline, respectively) are expected to continue as described into the foreseeable future, concurrent with the proposed action. NMFS is not aware of any proposed or anticipated changes in these fisheries (excluding the Southeast shrimp fisheries) that would substantially change the impacts each fishery has on sea turtles covered by this opinion.

7 Jeopardy Analysis

The analyses conducted in the previous sections of this opinion serve to provide a basis to determine whether the proposed action would be likely to jeopardize the continued existence of green, loggerhead, or Kemp's ridley sea turtles. In Section 5.0, we outlined how the proposed action can affect these sea turtles. Now we turn to an assessment of the species response to these impacts, in terms of overall population effects, and whether those effects of the proposed action, when considered in the context of the status of the species (Section 3.0), the environmental baseline (Section 4.0), and the cumulative effects (Section 6.0), will jeopardize the continued existence of the affected species.

This section evaluates whether the proposed action is likely to jeopardize the continued existence of green, loggerhead, or Kemp's ridley sea turtles in the wild. To *jeopardize the continued existence of* is defined as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Section 5 ("Effects of the Action") describes the effects of the proposed action on green, loggerhead and Kemp's ridley sea turtles, and the extent of those effects in terms of an estimate of the number of sea turtles that would be captured or killed. In Section 5, we determined that 1 turtle (green, loggerhead, or Kemp's ridley) could be struck by a vessel during the 5-year authorization period for SAJ-82.

As discussed in Section 2.7, we looked at the number of vessels registered in the state of Florida over the last 10 years to determine trends. Since there was a 10% fluctuation in vessel registration (probably due to changes in the economy), we assume that the number of vessels that may occur in Florida waters over the next 5 years could increase by up to 10%. Therefore, we look at the number of turtles estimated to be captured or killed from Section 5 and add 10%.

Because the numbers are so low (1 potential strike every 6 years), this does not change our jeopardy analysis.

7.1 Loggerhead NWA DPS

The maximum potential lethal take of up to1 loggerhead sea turtles by a vessel strike is a reduction in numbers. This lethal take would also result in a reduction in reproduction as a result of lost reproductive potential, as this individual could be a female who could have survived other threats and reproduced in the future, thus eliminating a female individual's contribution to future generations. For example, an adult female loggerhead sea turtle can lay 3 or 4 clutches of eggs every 2 to 4 years, with 100 to 130 eggs per clutch. The loss of an adult female sea turtle could preclude the production of thousands of eggs and hatchlings of which a small percentage would be expected to survive to sexual maturity. Because the potential vessel strike could occur anywhere through the Keys, and sea turtles generally have large ranges in which they disperse, the distribution of loggerhead sea turtles in the action area is expected to be unaffected.

Whether the reduction of 1 loggerhead sea turtle and reproduction attributed to the proposed action would appreciably reduce the likelihood of survival for loggerheads depends on what effect this reductions in numbers and reproduction would have on overall population sizes and trends, i.e., whether the estimated reduction, when viewed within the context of the environmental baseline and status of the species, is of such an extent that adverse effects on population dynamics is appreciable. In Section 3.2, we reviewed the status of the species in terms of nesting and female population trends and several recent assessments based on population modeling (e.g., (Conant et al. 2009; NMFS-SEFSC 2009a). Below we synthesize what that information means in general terms and also in the more specific context of the proposed action and the environmental baseline.

Loggerhead sea turtles are a slow growing, late-maturing species. Because of their longevity, loggerhead sea turtles require high survival rates throughout their life to maintain a population. In other words, late-maturing species cannot tolerate much anthropogenic mortality without going into decline. Conant et al. (2009) concluded loggerhead natural growth rates are small; natural survival needs to be high; and even low to moderate mortality can drive the population into decline. Because recruitment to the adult population is slow, population modeling studies suggest even small increased mortality rates in adults and subadults could substantially impact population numbers and viability (Chaloupka and Musick 1997; Crouse et al. 1987; Crowder et al. 1994; Heppell et al. 1995).

SEFSC (2009) estimates the adult female population size for the NW Atlantic DPS is likely between approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 individuals. A more recent conservative estimate for the entire western North Atlantic population was a mean of 38,334 adult females using data from 2001-2010 (Richards et al. In Review). A much less robust estimate for total benthic females in the western North Atlantic was also obtained, with a likely range of approximately 30,000-300,000 individuals, up to less than 1 million. Further insight into the numbers of loggerhead sea turtles along the U.S. coast is available in NEFSC (2011), which reported a conservative estimate of 588,000 juvenile and adult loggerhead sea turtles present on the continental shelf from the mouth of the Gulf of St.

Lawrence to Cape Canaveral, Florida, when using only positively identified loggerhead sightings from an aerial survey. A less conservative analysis from the same study resulted in an estimate of 801,000 loggerheads in the same geographical area when a proportion of the unidentified hardshell turtles were categorized as loggerheads. This study did not include Florida's east coast south of Cape Canaveral or the Gulf of Mexico, which are areas where large numbers of loggerheads are also expected.

A detailed analysis of Florida's long-term loggerhead nesting data (1989-2012) revealed three distinct annual trends. Following a 23% increase between 1989 and 1998, nest counts declined sharply over nearly a decade. However, annual nest counts show a strong increase over the last five years. Examining only the period between the high-count nesting season in 1998 and the most recent (2012) nesting season, researchers found no demonstrable trend, indicating a reversal of the post-1998 decline. The overall change in counts from 1989 to 2012 is positive. Nest counts in 2012, corrected for subtle variation in survey effort, were slightly below the high nest count recorded in 1998. Florida accounts for more than 90% of U.S. loggerhead nesting (Florida Fish and Wildlife Conservation Commission (FWC) data, http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/).

The increasing trends on Florida core nesting beaches includes the most recent nesting season (2012), which had 58,172 loggerhead nests counted – the second highest count in 24 years. Index beaches in the Florida Panhandle, which are not part of the set of core beaches, also had high loggerhead nest counts in 2012. Following a general decline in counts since 1997 when surveys of Panhandle index beaches began, the 2012 season had the highest number recorded in 16 years of nest counts.

We believe that the incidental take and resulting mortality of loggerhead sea turtles associated with the proposed action is not reasonably expected to cause an appreciable reduction in the likelihood of survival of the NWA DPS of loggerhead sea turtles. We believe the current population is large (i.e., several hundred thousand individuals) and is showing encouraging signs of stabilizing and possibly increasing. Over at least the next several decades, we expect the western North Atlantic population to remain large (i.e., hundreds of thousands of individuals) and to retain the potential for recovery, and that the proposed action will not cause the population to lose genetic heterogeneity, broad demographic representation, or successful reproduction, nor affect loggerheads' ability to meet their lifecycle requirements, including reproduction, sustenance, and shelter.

The recovery plan anticipates that, with implementation of the plan, the western North Atlantic population will recover within 50 to 150 years, but notes that reaching recovery in only 50 years would require a rapid reversal of the then declining trends of the Northern, Peninsular Florida, and Northern Gulf of Mexico Recovery Units. The recovery plan includes 8 different recovery actions directly related to the proposed action of this opinion.

The Services' recovery plan for the NWA population of the loggerhead turtle (NMFS and USFWS 2008) which is the same population of turtles as the NWA DPS, provides additional explanation of the goals and vision for recovery for this population. The objectives of the recovery plan most pertinent to the threats posed by the proposed action are numbers 1 and 2:

- Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
- Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.

Recovery objective 1, "Ensure that the number of nests in each recovery unit is increasing…," is the plan's overarching objective and has associated demographic criteria. Currently, none of the plan's criteria are being met, but the plan acknowledges that it will take 50-150 years to do so. Further reduction of multiple threats throughout the North Atlantic, Gulf of Mexico, and Greater Caribbean will be needed for strong, positive population growth, following implementation of more of the plan's actions. Although any continuing mortality in what might be an already declining population can affect the potential for population growth, we believe the effects of the proposed action would not impede or prevent achieving this recovery objective over the anticipated 50-150 year time frame.

Recovery objective 2, "Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes." Currently, there are not enough data to determine if this objective is being met. The NWA DPS nesting trend for loggerhead sea turtles remains slightly negative, although as mentioned above the trend has likely stabilized. Overall, loggerhead populations have a long way to go before the population decline is reversed and numerical increases in population meet the goals of the recovery plan. As with recovery objective 1 above, continuing mortality in what might still be a declining population resulting from the proposed action would not impede or prevent achieving this recovery objective over the anticipated 50-150 year time frame.

We believe that the proposed action is not reasonably expected to cause an appreciable reduction in the likelihood of recovery of the NWA DPS of loggerheads. Recovery is the process of removing threats so self-sustaining populations persist in the wild. The proposed action would not impede progress on achieving the identified relevant recovery objectives or achieving the overall recovery strategy.

7.2 Green Sea Turtles

The potential lethal take of up to 1 green sea turtle is a reduction in numbers. This take would also result in a potential reduction in future reproduction, assuming the individual would be a female and would have survived otherwise to reproduce. For example, an adult green sea turtle can lay 1-7 clutches (usually 2-3) of eggs every 2 to 4 years, with 110-115 eggs/nest of which a small percentage is expected to survive to sexual maturity. Green sea turtles are highly migratory, and individuals from all Atlantic nesting populations may range throughout the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. While the potential lethal take would result in a displacement of an individual from the action area, the loss is not significant in terms of local, regional, or global distribution as a whole. The majority of reproductive effort for green sea turtles comes from Florida and the Florida population distribution would be expected to remain the same. Therefore, we believe the anticipated impact will not affect the species' distribution.

Whether the reduction in numbers and reproduction of green sea turtles species would appreciably reduce the species' likelihood of survival depends on the probable effect the changes in numbers and reproduction would have on current population sizes and trends.

The 5-year status review for green sea turtles states that of the 7 green sea turtle nesting concentrations in the Atlantic Basin for which abundance trend information is available, all were determined to be either stable or increasing (NMFS and USFWS 2007a). That review also states that the annual nesting female population in the Atlantic basin ranges from 29,243-50,539 individuals. Additionally, the pattern of green sea turtle nesting shows biennial peaks in abundance, with a generally positive trend during the 10 years of regular monitoring since establishment of index beaches in Florida in 1989. An average of 5,039 green turtle nests were laid annually in Florida between 2001 and 2006 with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS 2007a). Data from the index nesting beaches program in Florida substantiate the dramatic increase in nesting. In 2007, there were 9,455 green turtle nests found just on index nesting beaches, the highest since index beach monitoring began in 1989. The number fell back to 6,385 in 2008, further dropping under 3,000 in 2009, but that consecutive drop was a temporary deviation from the normal biennial nesting cycle for green turtles, as 2010 saw an increase back to 8,426 nests on the index nesting beaches (FWC Index Nesting Beach Survey Database). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica, population growing at 4.9% annually.

For a population to remain stable, sea turtles must replace themselves through successful reproduction at least once over the course of their reproductive lives, and at least one offspring must survive to reproduce itself. If the hatchling survival rate to maturity is greater than the mortality rate of the population, the loss of breeding individuals would be exceeded through recruitment of new breeding individuals from successful reproduction of non-taken sea turtles. Since the abundance trend information for green sea turtles is clearly increasing, we believe the lethal interactions attributed to the proposed action will not have any measurable effect on that trend. Therefore, we conclude the proposed action is not likely to appreciably reduce the likelihood of survival of green sea turtles in the wild.

The Recovery plan for the population of Atlantic green sea turtles (NMFS and USFWS 1991) lists the following relevant recovery objectives over a period of 25 continuous years:

- The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years;
    - Status: Green sea turtle nesting in Florida between 2001-2006 was documented as follows: 2001 – 581 nests, 2002 – 9,201 nests, 2003 – 2,622, 2004 – 3,577 nests, 2005 – 9,644 nests, 2006 – 4,970 nests. This averages 5,039 nests annually over those 6 years (2001-2006) (NMFS and USFWS 2007a). Subsequent nesting has shown even higher average numbers (i.e., 2007 – 9,455 nest, 2008 – 6,385, 2009 – 3, 000, 2010 – 8,426 nests, 2011 – 10,701). In 2013, the number reached 25,553, thus, this recovery criterion continues to be met.
- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.

- Status: Several actions are being taken to address this objective; however, there are currently no estimates available specifically addressing changes in abundance of individuals on foraging grounds. Given the clear increases in nesting, however, it is likely that numbers on foraging grounds have increased by at least the same amount. This opinion's effects analysis assumes that in-water abundance has increased at the same rate as Tortuguero nesting.

The lethal interactions of a green sea turtle attributed to the proposed action is not likely to reduce population numbers over time due to current population sizes, nesting increases and expected recruitment. Thus, the proposed action is not likely to impede the recovery objectives above and will not result in an appreciable reduction in the likelihood of green sea turtles' recovery in the wild.

7.3 Kemp's Ridley Sea Turtles

The potential lethal take of 1 Kemp's ridley sea turtle is a reduction in numbers. This lethal take would also result in a potential reduction in future reproduction, assuming this individual would be a female and would have survived otherwise to reproduce. For example, females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs, though only a small percentage are expected to survive to sexual maturity. Kemp's ridleys are wide ranging throughout the Gulf of Mexico and along the Atlantic coast, and while the potential lethal take would result in a loss, it is not significant in terms of the species' rangewide distribution as a whole.

The proposed action's reduction in numbers and reproduction would reduce the species' population compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Whether the reduction in numbers and reproduction of Kemp's ridley sea turtles species would appreciably reduce this species' likelihood of survival depends on the probable effect the changes in numbers and reproduction would have on current population sizes and trends.

Heppell et al. (2005) predicted in a population model that the Kemp's ridley sea turtle population is expected to increase at least 12-16% per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011b) contains an updated model which predicts that the population is expected to increase 19% per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. In 2009 the population was on track with 21,144 nests, but an unexpected and as yet unexplained drop in nesting occurred in 2010 (13,302), deviating from the NMFS et al. (2011b) model prediction. A subsequent increase to 20,570 nests in 2011 occurred and then a record high of 21,797 occurred in 2012, but in 2013 there was a second significant decline, with only 16,385 nests recorded (Gladys Porter Zoo nesting database 2013. We will not know if the population is continuing the general trajectory predicted by the model until future nesting data are available. Of course, this updated model assumes that current survival rates within each life stage remain constant. The recent increases in Kemp's ridley sea turtle nesting seen in the last two decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced

trawling effort in Mexico and the U.S., and possibly other changes in vital rates (TEWG 1998; TEWG 2000a). While these results are encouraging, the species' limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental stochasticity, all of which are often difficult to predict with any certainty.

The loss of 1 Kemp's ridley sea turtles from the proposed action is not likely to measurably affect overall population numbers due to current large population sizes, expected recruitment, and continuing strong nesting numbers. Thus, we believe the proposed action will not result in an appreciable reduction in the likelihood of Kemp's ridley sea turtles' survival in the wild.

The recovery plan for the Kemp's ridley sea turtle (NMFS et al. 2011a) lists the following relevant recovery objectives:

- A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

The recovery plan states average nests per female is 2.5 and sets a recovery goal of 10,000 nesting females that would be represented by 25,000 nests in a season. As discussed above, nesting levels had been steadily increasing to a high of 21,144 nests in 2009, exhibited a substantial decline in 2010, but rebounded markedly in 2011 to 20,570 nests and again in 2012 with 21,797 nests. The lethal take of 1 Kemp's ridleys by the proposed action will not affect the overall level or trend in adult female nesting population numbers or number of nests per nesting season. Thus, the proposed action will not result in an appreciable reduction in the likelihood of Kemp's ridley sea turtle recovery in the wild.

8 Conclusion

We have analyzed the best available data, the current status of the species, environmental baseline, effects of the proposed action, and cumulative effects and determined that the proposed action is not likely to jeopardize the continued existence of sea turtles.

It is important to note that the conclusions drawn in this Opinion are based on a series of assumptions (see Section 2.7). Because a programmatic by nature covers future actions that have not been specifically identified, the analysis is based on the actions that occurred during the last 5 years and a prediction that actions in the next 5 years will be the same plus a potential increase of 10%, as discussed in the assumptions and the jeopardy analysis (see Section 8). A series of assumptions are made based on the best available data, PDCs are in place to define the limits of the action (see Section 2.3), and reporting described in the programmatic review (Section 2.4) is required to evaluate that the activities authorized meet the assumptions made and that the effects are consistent with the analysis in this opinion. If the assumptions are inaccurate or the effects are outside of the scope of this opinion, that consultation must be reinitiated. This determination will be made at the programmatic review between the USACE and NMFS.

9 Incidental Take Statement

NMFS acknowledges that 1 sea turtle (green, loggerhead, or Kemp's ridley) may be injured or killed through an increase in vessel traffic from the authorization of SAJ-82. Construction of docks and boat authorized under these general permits is under the jurisdiction of the USACE but the vessel traffic resulting from this construction is not under the jurisdiction of the USACE. Therefore, no take is authorized. If any takes of species under NMFS's purview occur during in-water construction authorized under this general permit, it shall be immediately reported to *takereport.nmfsser@noaa.gov*, refer to the present Biological Opinion by title, issue date, NMFS Public Consultation Tracking System identifier number (SER-2008-2958), the USACE permit number that authorized the activity, and consultation must be reinitiated.

10 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

NMFS believes the following conservation recommendations are reasonable, necessary, and appropriate to conserve and recover sea turtles. NMFS strongly recommends that these measures be considered and adopted. In order for us to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

Noise:

1. Determine ambient noise levels in a variety of in-water settings throughout the state of Florida. For instance, determine the ambient noise level in a man-made residential canal compared to the open-water environments.

2. Pile Driving: To better understand the cumulative effects of noise from pile-driving activities, the USACE should conduct an independent study to characterize all aspects of noise-producing construction activities (such as pile driving) in the state of Florida. The study should characterize both specific sources of noise, as well as ambient noise measurements in various areas throughout Florida. Major noise-producing activities should be identified and measurements of noise from these activities should be recorded and reported in appropriate units of measurement (peak levels, SEL, CUM, RMS, etc.) to estimate the acoustic footprint of the activities, duration, frequency, and relative contribution to ambient noise levels in the state of Florida. Methodologies of field measurements should be should be coordinated with NMFS personnel. Such data would help quantify the relative contribution of pile driving on ambient noise levels, compared to other known sources, and conduct cumulative impact analyses in the Florida waters. Following completion of such a study, the USACE should hold a joint USACE/NMFS workshop with industry representatives to cooperatively discuss the results of the study and identify any technology- or method-based recommendations to reduce ambient noise in the marine environment, and

any other future actions that may be necessary to reduce noise impacts from in-water construction activities in Florida.

Sea Turtles

1. Provide all applicants applying for a USACE permit involving docks or boat ramps with information about the risk of vessel strikes to turtles. This should also include contact information for the sea turtle stranding network.

11 Reinitiation of Consultation

As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) 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, (2) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the Biological Opinion, or (3) a new species is listed or critical habitat designated that may be affected by the identified action.

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Appendix A: USACE Jacksonville District General Permits

Included below is a list of general permits that the USACE uses to authorize activities in the state of Florida.

The 12 general permits were reviewed by NMFS under a programmatic consultation (NMFS tracking number SER-2011-1939 dated December 19, 2012).

General permits and actions excluded from all critical habitat:

SAJ-5: ***Maintenance dredging activities in residential (man-made) canals*** in navigable waters of the United States.

- A residential canal is defined as a man-made waterway, historically dug from uplands, and surrounded on both sides by uplands adjacent to principally residential properties.
- Federally-maintained navigation and/or flood control projects are not considered to be residential canals and SAJ-5 is not authorized for use within them.
- No additional dredging or excavation is allowed under this permit other than is necessary to restore the canal to its original excavated depth; however, in no case shall the depth of canal be greater than -5 ft mean low water.
- The material dredged/excavated under each authorization shall not exceed 4,000 yd^3 per project per year.
- SAJ-5 does not authorize the removal of plugs or the connection of any canal or other non-connected waterbody to navigable waters of the United States or to any other waters of the United States.

SAJ-12: Installation and maintenance of ***private single-family boat ramps***, including appurtenant structures (bulkheads, rub-rails, and tie-up piers) requiring less that 100 $yd^3$of fill material.

- The boat ramp should extend no further than 1 to 2 ft waterward of the MHWL or the ordinary high water line (OHWL), but in no case shall they exceed 5 ft waterward of the MHWL or the OHWL.
- Tie-up piers shall not exceed the length of the boat ramp or a width of 4 ft; and may have a single catwalk or terminal platform not to exceed 20 ft in length and 4 ft in width.
- Navigational access to navigable waters of the United States must already exist. No dredging of navigational access channels is permitted.

SAJ-13: Installation, construction, maintenance, replacement, and/or repair of ***aerial transmission lines, electrical substations, and access roads*** for construction and maintenance of overhead power lines and electrical substations.

- Foundations for overhead transmission line towers, poles, and anchors that provided the foundations shall be the minimum size necessary and have separate footings for each tower leg (rather than a larger single pad) where feasible.
- Access roads are limited to the minimum effects as stated in the special conditions of SAJ-13 including minimizing the width and length of access roads as necessary, that raised access roads be properly bridged or culverted to maintain surface water flows, to minimize surface discharge, and that roads used only for construction be removed upon completion of work and restored to pre-construction conditions.

SAJ-14: Installation, construction, maintenance, replacement, and repair of ***subaqueous utility and transmission lines, outfall and intake structures associated with the utility line, substations, and access roads*** for the construction and maintenance of same.

- All subaqueous utility and/or transmission lines shall be installed a minimum of 4 ft below the bottom contour except in federal channels which have deeper criteria as described in special condition #15.
- No utility and/or transmission lines will be embedded in the bottom of state Class I or II waters or aquatic preserves.
- Discharge of dredged or fill material is authorized by this general permit as described in special condition #13.
- Dredged or fill materials must not change the pre-construction bottom contours as described in special condition #17.
- Materials resulting from trench excavation may be temporarily side-cast according to the requirements in special conditions #16 and #17.

SAJ-46: Installation of ***bulkheads and backfill from single-family lots*** in residential (man-made) canals in the state of Florida.

- A residential canal is defined as a man-made waterway, historically dug from uplands, and surrounded on both sides by uplands adjacent to principally residential property. Open water areas on bays and lagoons are not considered residential canals, nor are federally-maintained navigational and/or flood control projects, and SAJ-46 is not authorized for use within them.
- The bulkhead and backfill shall not exceed 300 ft in length, and shall not extend waterward of the MHWL or the OHWL, unless necessary to align with existing adjacent seawalls.
- Seawall and/or riprap restoration may be permitted at its previous location, upland of, or within 1 ft waterward of its previous location.
- New riprap will not be placed more than 4 ft waterward of the MHWL or the OHWL.
- This permit does not authorize fill activities other than placement of riprap previously specified and backfill behind seawalls or bulkhead.
- At no time should this permit be construed to allow filling of waters of the United States for additional development, to impede navigation, or affect flood control.

SAJ-72: Installation of ***residential docks in Citrus County, Florida***.

- In-water work is limited to pile placement only. Additional associated structures such as boatlifts, stairway, walkway, or floating platforms shall be constructed out of water.
- All construction shall conform to the Citrus County Comprehensive Plan which limits residential dock construction to 1 slip per 100 ft of shoreline that the applicant controls as part of the lot where his or her residence is located. Therefore, most docks cannot accommodate more than 1 vessel.
- Expansion of existing marinas or other commercial facilities is not authorized under SAJ-72.

General permits allowed in critical habitat:

SAJ-17: Installation of ***minor structures***

- Minor structures include single mooring piles, small mooring dolphins (not to exceed a cluster of 4), non-commercial information signage, boatlifts, hoists, davits, or other minor structure that would have less environmental impact than a small dock.

SAJ-20: Repair, replacement, or installation of ***single-family docks/piers***

- Docks are to accommodate not more than 4 vessels and normal appurtenances such as boat hoists, boat shelters with open sides, stairways, walkways, mooring piles, and dolphins.

SAJ-33: Installation of ***private multi-family docks/piers or government docks/piers***

- Dock must be less than 1,000 ft^2 in surface area and are designed to accommodate not more than 5 vessels, including dry storage, unless a Florida Fish and Wildlife Conservation Commission approved Manatee Protection Plan is more restrictive.
- This general permit includes normal appurtenances such as boat hoists, boat shelters with open sides, stairways, walkways, mooring piles, and maintenance of the same.

SAJ-34: Installation of ***private commercial piers***

- Piers must be 1,000 ft^2 or less in surface area and accommodate 5 or fewer boat slips (including dry storage), unless a Florida Fish and Wildlife Conservation Commission approved Manatee Protection Plan is more restrictive.
- This general permit includes normal appurtenances such as boat hoists, boat shelters with open sides, stairways, walkways, mooring piles, and maintenance of the same. Associated mooring piles are not included in this surface area.
- The expansion of existing marinas or other commercial facilities is not authorized under this general permit.

PGPs:

SAJ-91: ***Minor structures and bulkheads within the man-made canals in Cape Coral***.

- The work authorized is limited to existing canals within the City of Cape Coral and does not include the Caloosahatchee River, Matlacha Pass Aquatic Preserve, and the Cape Coral Spreader Canal.
- The removal of red mangroves is prohibited.
- All residential lots along the canals in the City of Cape Coral have 125 ft to 140 ft of shoreline. The city code requires all properties maintain a bulkheads along the canals if the property has a swimming pool. The City of Cape Coral no longer requires the placement of riprap in front of bulkheads along the canals.
- The City of Cape Coral has stated that they have not used SAJ-91 for the authorization of aerial transmission lines, sub-aqueous transmission lines, or for new stormwater outfalls and do not anticipate the need to use this permit for these activities in the future. They may continue to use this permit for the maintenance of existing stormwater outfalls.

Aerial Transmission Lines and associated structures

- No dredging or filling of navigable waters or waters of the United States is permitted.

Subaqueous and Transmission Lines

- This includes the installation and maintenance of subaqueous utility and transmission lines placed on, under, or embedded in the bottom of navigable waters of the United Sates within the City of Cape Coral. The installation of utility and transmission lines by direction boring is authorized.
- Dredged or till material placed in backfill or bedding for subaqueous utility and transmission lines must not change the preconstruction bottom contours. Excess material must be removed to an upland disposal area.

Private Single-Family Docks and Appurtenances

- Structures authorized under this PGP are private single-family docks not to exceed 4 slips. This would include normal appurtenances such as boat hoists, boat shelters with open sides, stairways, walkways, mooring piles, dolphins, and maintenance of these appurtenances. Construction of upland cut boat slips is not authorized.
- No living (i.e., residential structure), fueling, or storage facilities over navigable waters of the United States are authorized.
- A structure which by its size or location may adversely affect water quality, fish and wildlife habitat, wetlands or SAV shall not be authorized. Impacts to SAV cannot be authorized.

Minor Structures associations with Single-Family Docks

- Minor structures include single mooring piles; small mooring dolphins (limited to 1 cluster of 4 or fewer piles); non-commercial information signage, boat lifts, hoists, davits, etc.; and other minor structure that would have less environmental impacts than a small dock.

Stormwater Outfalls

- Structures authorized under SAJ-91 are stormwater outfalls and appurtenances.
- Dredging is authorized at stormwater outfalls. Maintenance dredging shall be limited to a depth of no more than 5 ft below MHWL or OHWL. No additional dredging is authorized under this general permit other than that which would be necessary to restore the discharge structure to its original permitted excavated depth.
- Excavated spoil material shall be deposited at self-contained upland areas that will prevent spoil material and/or return water from reentering any water of the United States (including wetlands) or interfering with natural drainage.

Bulkheads and Backfill in Residential Canals

- The work herein authorized includes the construction, repair or maintenance of seawalls (bulkheads) and associated backfill in residential canals.
- The seawall shall not exceed 300 ft in length and not extend any farther waterward than 18 inches from the existing seawall or MHWL.
- The backfill must be from upland sources and consist of suitable material free from toxic pollutants in other than trace quantities. The amount of backfill shall not exceed 1 yd^3 per running ft below the plane of the MHWL.
- This permit does not authorize any filling, except for backfill behind the seawall. New riprap may be placed at the toe of the existing or replacement seawall when the

toe of the seawall is deeper than 3 ft at mean lower low water. Also, replacement riprap can only be added within the same footprint of existing riprap (i.e., no waterward extension or lateral expansion of riprap beyond the previous footprint) in depths less than or equal to 3 ft at mean lower low water.

SAJ-96: ***Single-family piers in Pinellas County***

- Single-family piers are not to exceed 2 slips, including personal watercraft lifts and seawall mounted davits.
- This would include normal appurtenances considered minor structures such as boat hoists, boat shelters with open sides, stairways, walkways, lower landings, mooring piles, dolphins, and maintenance of same, including pier reconfiguration.
- Maintenance dredging around the single family dock.

General Permits covered under separate consultations with NMFS: Table 2 provides a list of general permits used by the USACE to permit in-water activities in Florida that were not covered by the programmatic opinion issued by NMFS in December 2012 (NMFS tracking number SER-2011-1939).

Table 2: USACE General Permits reviewed individually by NMFS

USACE General Permit No.	Description	Date NMFS Completed Consultation	NMFS Consultation No. and Type
SPGP IV-R1	Variety of activities throughout the state of Florida under FDEP	December 21, 2011	SER-2009-5980 Formal
SAJ-42	Variety of activities in Miami-Dade County	February 10, 2011	SER-2008-1790 Formal
SAJ-71	Live rock aquaculture	October 13, 2010	SER-2010-1366 Informal
SAJ-82	Variety of activities in Florida Keys	Ongoing	SER-2008-2958 Formal
SAJ-93	Maintenance dredging in the Intracoastal Waterway on the east coast of Florida	No consultation on record	No consultation on record
SAJ-99	Live rock and marine bivalve aquaculture	August 29, 2012	SER-2012-1303 Informal

SPGP IV-RI: This PGP gives limited general authority to the FDEP for several in-water construction activities in all of the counties in the state of Florida, except for Miami-Dade County. In-water construction activities covered by this SPGP are: shoreline stabilization projects; construction of boat ramps, boat launch areas and structures associated with such ramps or launch areas; docks, piers associated facilities, and other minor pile-supported structures, and; maintenance dredging of canals and channels. NMFS completed a programmatic consultation for SPGP IV-R1 on December 21, 2011.

SAJ-42: This PGP gives limited general authority to Miami-Dade County for several in-water construction activities and serves as an operating agreement between Miami-Dade County's Department of Environmental Resource Management (DERM) and the USACE to administer SAJ-42. Specifically, SAJ-42 covers the majority of Johnson's seagrass critical habitat, located in Biscayne Bay within Miami-Dade County. For the intent of the present programmatic consultation, only those areas of Johnson's seagrass critical habitat outside of Miami-Dade County will be discussed in terms of effects analyses to both the species and its critical habitat. NMFS completed a programmatic consultation for SAJ-42 on February 10, 2011.

SAJ-71: This PGP will authorize the deposition of materials for live rock aquaculture within federal waters off the state of Florida. PGP SAJ-71 will be administered by NMFS through an operating agreement between the USACE and NMFS that gives general authority to NMFS to administer SAJ-71 for the purposes of live rock aquaculture, in navigable waters of the United States which are within federal waters off the state of Florida. NMFS completed a programmatic consultation for SAJ-71 on October 10, 2010.

SAJ-82: This RGP is for single-family residential projects in the Florida Keys, Monroe County, including lot fills; construction of minor structures, minor pile-supported structures and marginal docks, including repair or replacement of said structures; boat ramps; and riprap revetments, bulkheads and backfill in residential canals. Activities will be located in waters of the United States on, or within existing wetland lots in platted subdivisions within the Florida Keys, Monroe County, Florida, excluding federally-maintained navigation channels, flood control projects, and the Marvin D. Adams Waterway (Adam's Cut). NMFS is currently working on a programmatic consultation for SAJ-82 and its effects on corals and *Acropora* critical habitat.

SAJ-93: This RGP gives limited general authority to the Florida Inland Navigation District for maintenance dredging activities along the east coast of Florida. Dredging is authorized in federal channels located in the Atlantic Intracoastal Waterway, the Intracoastal Waterway, the Okeechobee Waterway, and along the east coast of Florida.

SAJ-99: This PGP gives limited general authority to the Florida Department of Agriculture and Consumer Services to authorize the deposition of materials for live rock aquaculture within the jurisdictional waters of the State of Florida. Additionally, this permit also authorizes discharges of dredged or fill material (i.e., shell hash, bags seeded with clams, rock, etc.) necessary for shellfish and live rock aquaculture such as seeding, rearing, cultivating, relaying, transplanting, and harvesting activities. NMFS completed a programmatic consultation for SAJ-99 on August 29, 2012.

Nationwide Permits (NWP) used by the USACE in Florida
These NWPs were reissued and published under the federal registry dated February 12, 2012, and became effective March 19, 2012. These are currently under review by NMFS.

NWP-2 Structures in Artificial Canals: Structures constructed in artificial (i.e., man-made) canals within principally residential developments where the connection of the canal to a navigable water of the United States has been previously authorized (see 33 CFR 322.5(g)). (Section 10)

NWP-3 Maintenance: (a) The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure, or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification. (b) This NWP also authorizes the removal of accumulated sediments and debris in the vicinity of existing structures (e.g., bridges, culverted road crossings, water intake structures, etc.) and/or the placement of new or additional riprap to protect the structure. The removal of sediment is limited to the minimum necessary to restore the waterway in the vicinity of the structure to the approximate dimensions that existed when the structure was built, but cannot extend farther than 200 ft in any direction from the structure. (c) This NWP also authorizes temporary structures, fills, and work necessary to conduct the maintenance activity. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. (d) This NWP does not authorize maintenance dredging for the primary purpose of navigation. This NWP does not authorize beach restoration. This NWP does not authorize new stream channelization or stream relocation projects. (Sections 10 of the Clean Water Act and Section 404 of the Rivers and Harbors Act)

NWP-9 Structures in Fleeting and Anchorage Areas: Structures, buoys, floats and other devices placed within anchorage or fleeting areas to facilitate moorage of vessels where the U.S. Coast Guard has established such areas for that purpose. (Section 10)

NWP-10 Mooring Buoys: Non-commercial, single-boat, mooring buoys. (Section 10)

NWP-13 Bank Stabilization: Bank stabilization activities necessary for erosion prevention, provided the activity meets all of the following criteria (a) No material is placed in excess of the minimum needed for erosion protection; (b) The activity is no more than 500 ft in length along the bank, unless the district engineer waives this criterion by making a written determination concluding that the discharge will result in minimal adverse effects; (c) The activity will not exceed an average of 1 yd^3 per running foot placed along the bank below the plane of the ordinary high water mark or the high tide line, unless the district engineer waives this criterion by making a written determination concluding that the discharge will result in minimal adverse effects; (d) The activity does not involve discharges of dredged or fill material into special aquatic sites, unless the district engineer waives this criterion by making a written determination concluding that the discharge will result in minimal adverse effects; (e) No material is of a type,

or is placed in any location, or in any manner, that will impair surface water flow into or out of any waters of the United States; (f) No material is placed in a manner that will be eroded by normal or expected high flows (properly anchored trees and treetops may be used in low energy areas); and, (g) The activity is not a stream channelization activity. This NWP also authorizes temporary structures, fills, and work necessary to construct the bank stabilization activity. (Sections 10 of the Clean Water Act and 404 of the Rivers and Harbors Act)

NWP-19 Minor Dredging: Dredging of no more than 25 yd^3below the plane of the ordinary high water mark or the mean high water mark from navigable waters of the United States (i.e., Section 10 waters). This NWP does not authorize the dredging or degradation through siltation of coral reefs, sites that support submerged aquatic vegetation (including sites where submerged aquatic vegetation is documented to exist but may not be present in a given year), anadromous fish spawning areas, or wetlands, or the connection of canals or other artificial waterways to navigable waters of the United States (see 33 CFR 322.5(g)). (Sections 10 of the Rivers and Harbors Act and 404 of the Clean Water Act)

NWP-28 Modifications of Existing Marinas: Reconfiguration of existing docking facilities within an authorized marina area. No dredging, additional slips, dock spaces, or expansion of any kind within waters of the United States is authorized by this NWP. (Section 10)

NWP-35 Maintenance Dredging of Existing Basins: Excavation and removal of accumulated sediment for maintenance of existing marina basins, access channels to marinas or boat slips, and boat slips to previously authorized depths or controlling depths for ingress/ egress, whichever is less, provided the dredged material is deposited at an area that has no waters of the United States site and proper siltation controls are used. (Section 10)

NWP-36 Boat Ramps: Activities required for the construction of boat ramps, provided the activity meets all of the following criteria (a) The discharge into waters of the United States does not exceed 50 $yd^3$of concrete, rock, crushed stone or gravel into forms, or in the form of precast concrete planks or slabs, unless the district engineer waives the 50 yd^3limit by making a written determination concluding that the discharge will result in minimal adverse effects; (b) The boat ramp does not exceed 20 ft in width, unless the district engineer waives this criterion by making a written determination concluding that the discharge will result in minimal adverse effects; (c) The base material is crushed stone, gravel or other suitable material; (d) The excavation is limited to the area necessary for site preparation and all excavated material is removed to an area that has no waters of the United States; and, (e) No material is placed in special aquatic sites, including wetlands. (Sections 10 of the Rivers and Harbors Act and 404 of the Clean Water Act).

Appendix B: Pile-Driving Noise Assessment for SAJ-82

1 Glossary of Acoustic Terms

Abandonment – Long-term discontinued utilization of resources in areas such as resting, feeding, mating, or nursing areas that are important for the species.

Avoidance – Individuals may avoid an area for the duration a noise is present.

Behavioral Zone – The distance from pile driving within which potentially adverse behavioral reactions may occur.

Cumulative Sound Exposure Level (cSEL) – A sound measurement associated with a series of pile strike events. cSEL can be estimated from the single-strike SEL and the number of strikes that likely would be required to place the pile at its final depth by using the following equation:

cSEL = sSEL + 10 log(# of pile strikes) for impact pile driving
cSEL = sSEL + 10 log(time in seconds) for vibratory pile driving.

Cylindrical Spreading – Sound that spreads away from a source in the shape of a cylinder. In some environments, sound will not propagate uniformly in all directions from a source. A simple approximation for spreading loss in a medium with upper and lower boundaries can be obtained by assuming that the sound is distributed uniformly over the surface of a cylinder having a radius equal to the range r and a height H equal to the depth of the ocean. Beyond some range the sound will hit the sea surface or sea floor, or other reflective surfaces.

Dry Firing – A method of raising and dropping the pile-driving hammer with no compression of the pistons, producing a lower-intensity sound than the full power of the hammer.

Effective Quiet – The level at which a sound becomes too quiet to contribute to hearing loss from cumulative noise exposure.

Habituation – Becoming accustomed to noise through repeated or prolonged exposure. Habituation can occur even when negative consequences result.

Harassment Zone – The distance from a noise within which behavioral reactions or temporary threshold shift may occur.

Impact Zone – The distance from the pile encompassing the effects of interest (i.e., the injury zone and/or the behavior zone).

Injury Zone – The distance from a noise source within which non-lethal injury may occur, but mortality is not expected. Onset of injury should be considered as permanent threshold shift (PTS or non-recoverable hearing loss), but includes other effects such as swim bladder damage.

Masking – Obscuring of softer sounds of interest by louder sounds at similar frequencies. Masking of the vocalizations of conspecifics, mates, predators, and other important signals may

have consequences on marine mammals. An analogous effect in humans would be the experience of having difficulty discerning an individual person's speech at loud parties.

Mortality Zone – The distance from a noise source within which mortality may occur.

No response – Some species may exhibit no apparent response to a noise while other species exhibit strong responses. No apparent response may indicate undetectable effects (e.g., habituation, PTS, and stress).

Peak Pressure – Peak pressure is the maximum positive pressure between zero and the greatest pressure of signals in units of dB re 1 µPa peak or 0-peak for impulsive pile-driving noise. 0-p values are not to be confused with peak-to-peak measurements (p-p).

Permanent Threshold Shift (PTS) – Permanent hearing loss caused by exposure to loud noise over a period of time. PTS is considered permanent hearing loss may affect foraging success, mate acquisition, and other biologically important activities.

Physical Injury – Some sounds such as pressure waves or intense noise sources create pressure waves or high-energy sound waves resulting in tissue damage.

Physiological Stress – Noise is a potential environmental stressor that can affect the health of animals that may include immune system responses.

Ramp-Up – A method that involves slowly increasing the power of the hammer and noise produced over a period of time prior to beginning work.

Root Mean Square (RMS) – Decibel measure of the square root of the mean square pressure. For impulses, the average of the squared pressures over the time that comprise that portion of the waveform containing 90% of the sound energy of the impulse.

Sensitization – Increased behavioral response over time as animals learn that a repeating or ongoing noise has significant consequences.

Sound Exposure Level (SEL) – Sound energy associated with a pile-driving pulse (sSEL), or series of pulses (cSEL), is characterized by the SEL. SEL is calculated by summing the cumulative pressure squared over the time of the event.

Spherical Spreading – Spherical spreading describes the decrease in level when a sound wave propagates away from a source uniformly in all directions from a sound source in the shape of a sphere.

Temporary Threshold Shift (TTS) – Temporary hearing loss caused by a decreased sensitivity in hearing. The analogous effect in humans is ringing in the ears and loss of hearing experienced after a loud concert. TTS is generally fully recoverable within hours or days and results in short-term effects.

Watch Zone – A protective buffer zone that may be monitored to detect animals that are heading towards the impacted area. The watch zone radius may vary depending on the type of project and species potentially occurring in the project area.

2 Purpose and Scope

The purpose of the SAJ-82 Opinion is to provide a programmatic review of the underwater noise produced during the construction of small-scale docks and seawalls in the Florida Keys. The scope of this review is limited to the construction of small-scale docks and seawalls permitted by the U.S. Army Corps of Engineers (USACE) and does not cover the noise and potential effects associated with large marina, transportation, or offshore energy construction projects which use different types of piles and construction equipment. The acoustic effects that the construction of small-scale docks and seawalls may have on the underwater marine soundscape were assessed to ascertain the potential effects to fish and sea turtles. When looking at the effects of noise, smalltooth sawfish are categorized under the effects to fish. The results of this analysis were then applied to the development of BMPs to be used during consultations under Section 7 of the Endangered Species Act (ESA) (16 U.S.C. § 1536). Although several different types of activities produce underwater sound, the analysis shows that the loudest noises of concern that may harm listed species result from impact pile-driving activities. Many other underwater noises are produced by construction activities that increase ambient noise levels, but are generally not harmful to sea turtles and fish.

Sea turtles and smalltooth sawfish are low-frequency hearing generalists (Table 1) and are able to detect the vibrations and lower frequency sound components associated with construction noise.

Table 1. Hearing ranges of listed species

Species or Group	Hearing Range	References
sea turtles	100-2,000 Hz	Ketten and Bartol (2006); Lenhardt et al. (1996); Lenhardt (1994); McCauley et al. (2000a); McCauley et al. (2000b); Moein et al. (1994); O'Hara and Wilcox (1990)
smalltooth sawfish	<1,000 Hz	Hearing in the species has not been measured, but is based on assumed lower-frequency hearing for fish without swim bladders (e.g., (Casper et al. 2003).

During impact pile-driving, noise is produced when the energy from the hammer is transferred to the pile and released into the surrounding water and sediment. We have characterized these construction activities and associated noise levels using the best available information provided by the USACE, the Florida Marine Contractors Association, and published literature. Depending on the type and location of pile-driving activity, noise can result in a spectrum of responses ranging from minor to those that can disturb or injure vulnerable animals (Figure 1).

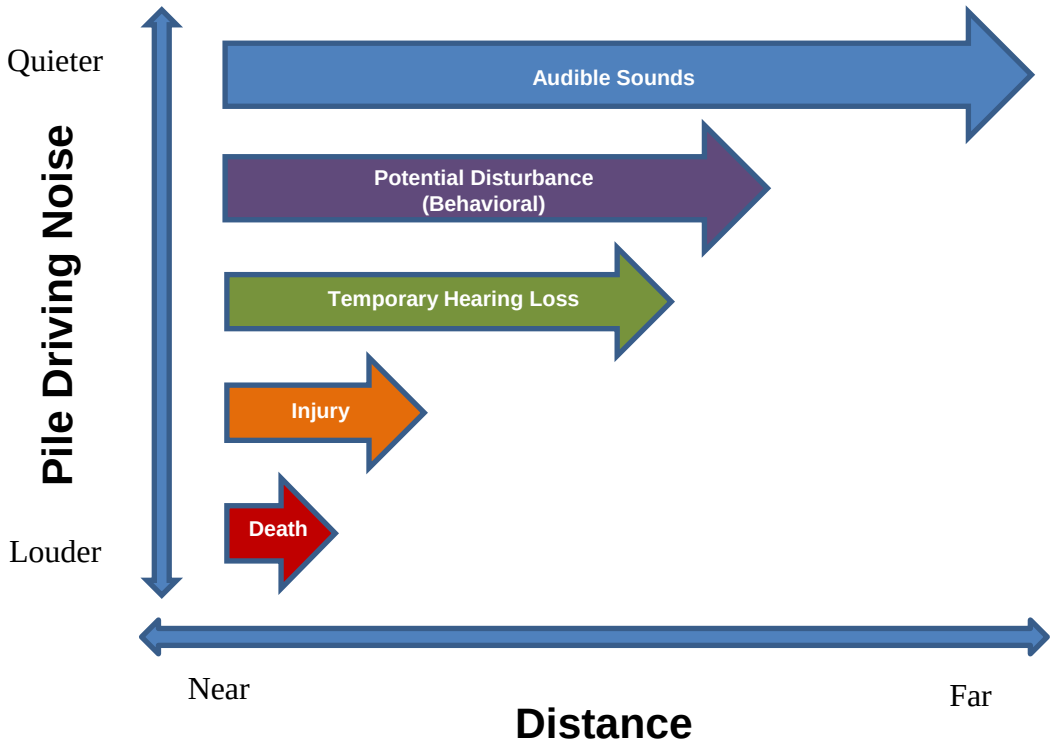

Figure 1. The relative effects to animals: distance to/from a noise source

2.1 Effects to Listed Species from Noise

Animals may have varied behavioral responses to noises. Species have different lifestyles, sound-detection capabilities, and behavioral responses that must be considered in addition to the season, location, habitat, and life stage that may be affected. Evasive behaviors are advantageous responses to avoid the threat of harm or annoyance from noise. Behavioral responses could also have some negative consequences on animals. Effects on the behavior of fish or sea turtles may be important if they disrupt feeding, migrating, mating, or sheltering. Behavioral reactions of sea turtles (DeRuiter and Doukara 2010; McCauley et al. 2000a; McCauley et al. 2000b) have been reported in response to airgun noise, another loud impulsive noise source in the ocean. No studies have been completed for sawfish; however, Krebs et al. (2012) reported that most tagged Atlantic sturgeon are not likely to remain in areas with injurious noise levels. Their study found that Atlantic sturgeon likely avoid these areas during periods of high construction noise. Myrberg (2001) reported that sudden increases in sound beginning at 20 decibels above ambient caused sharks to move away from a sound source. Halvorsen et al. (2012a); (2012b) show that the organ systems (liver, kidneys, and intestines) vulnerable to tissue damage from noise pressure waves in ray-finned fish are also very prominent in the elasmobranch body plan (such as sawfish have). Another consideration for bottom-dwelling elasmobranchs is that they are often in contact with the substrate (Casper et al. 2012). The vibrations within the sediment from pile driving could also be damaging, especially when considering the body shape of sawfish. Many of the organs of these dorsoventrally flattened fishes are in close proximity to the bottom surface of the body, providing little protection from

pile-driving vibrations. Sawfish may be attracted to man-made structures and there is documentation that elasmobranchs tend to aggregate around coastal and offshore structures (Stanley and Wilson 1991). Hearing-related effects may include temporary threshold shift (TTS, or recoverable hearing loss), permanent threshold shift (PTS, or non-recoverable hearing loss), or masking of important sounds (important acoustic signals obscured by underwater noise) used to detect others of the same species, prey, or threats. Behavioral responses to underwater noise may be important depending on the location, habitat, or life stage of a species.

Pile-driving noise upwards of 150 decibels is well above ambient noise levels and is expected to elicit an avoidance response from smalltooth sawfish. Although avoidance responses are advantageous at preventing direct injury, we must consider the potential consequences of the avoidance behavior on individuals from noise exposure because this may disrupt feeding, mating, migration, sheltering, or indirectly increase the risk to individuals (e.g., via predation). Some individuals may be biologically motivated to remain in a habitat for feeding, sheltering, mating, and other biologically important reasons, or may temporarily use the area as an established pathway between habitats. Other individuals may abandon use of the area altogether. Habituation and sensitization to noise is of concern from repeated noise exposures, after which an animal may no longer react to it, or the exposures may desensitize animals to the potential risks that may result from loud noise.

For sea turtles and fish, hearing injury can result in decreased predator detection and avoidance, decreased ability for passive listening to detect prey species, interfere with the detection of conspecifics (in vocal species), and an overall inhibited ability to detect cues in the acoustic soundscape. Permanent hearing loss or permanent threshold shift (PTS) is the irreversible loss of hearing abilities. Other non-auditory tissue injury such as hematomas, bruising, and bleeding could result from exposure to very loud noise. Both PTS and tissue injury could have negative consequences for an animal. Temporary hearing loss or temporary threshold shift (TTS) is a temporary hearing impairment from exposure to loud noises that is recoverable with time (hours to days). Temporary hearing loss is not considered physical injury, but could have some temporary effects to the auditory sense of an animal. Mortality is the lethal injury to an animal. This is the worst case outcome from exposure to the loudest sound sources. For the types of docks and sea walls covered in this review, we would only expect mortality from impact driving of metal sheet piles that could result in ruptures of swim bladders, lungs, or intestines at close distances. However, installing metal sheet piles by impact hammer is excluded by the PDCs in Section 2.5.

2.2 Exposure Criteria Used to Determine Potential Effects

Exposure criteria should be used to assess whether noise from construction projects may affect a listed species. Assessing potential injury is fairly straightforward. If an animal is likely to be exposed to noise levels that exceed the injury threshold levels, injury is expected and measures to avoid or minimize the potential for harmful exposure should be required. Assessing the potential for harm from behavioral responses to noise exposure requires further qualitative analysis. The injury and behavioral thresholds in Table 2 and Table 3 were used to establish the potential for effects from exposure to pile-driving noise. Injurious decibel (dB) levels are expressed in units of peak pressure or sound exposure level. Sound exposure level can be further expressed as

single strike SEL (sSEL) or cumulative SEL (cSEL) for exposure to pile-driving noise over time. Animal hearing is characterized by the root mean square (RMS) dB level and is used as the criteria for the auditory detection and resulting behavioral reactions to a noise.

Table 2. Impact pile-driving threshold noise levels for fish and sea turtles

Effect	Animal	Threshold Level (dB re 1 µPa)[e]
Injury	Fish[a,b] and Sea Turtles	206 (peak pressure) or 187 (sSEL), whichever is larger
Behavior	Fish[c]	150 (RMS)
	Sea Turtles[d]	160 (RMS)

[a] FHA (2012). Fish are considered more sensitive to physical injury than sea turtles; therefore, fish thresholds are used as conservative interim criteria.
[b] (Halvorsen et al. 2012a; Halvorsen et al. 2012b)
[c] (McCauley et al. 2000b)
[d] Skalski et al. (1992)
[e] See glossary for definitions of different decibel (dB) levels.

Table 3. Continuous noise threshold levels for fish and turtles from exposure to vibratory pile-driving noise

Effect	Animal	Threshold Level (dB re 1 µPa)
Injury [a]	Sturgeon, Sawfish, and Sea Turtles	206 (peak pressure) or 234 (cSEL), whichever is larger
Behavior	Fish	150 (RMS)
	Sea Turtles	160 (RMS)

[a] Injury criteria from Hastings (2010). There are no SEL criteria for sea turtles for continuous noises.

3 Calculations of Noise Thresholds for Pile Driving

Assumptions of the Analyses

The calculations in this document and the resulting BMPs are based on a series of assumptions. These assumptions and resulting key points are provided in the list below and discussed further in this section:

- The number of piles necessary to complete construction of a residential dock varies by the size and design of the structure. A typical dock with 15 piles requires approximately 10 hours of pile driving, including placement of piles and equipment, and can take 2 or more days to complete. Some larger residential docks can use up to 70 piles and noise could be produced over a period of 2 weeks. After pile installation, it takes approximately 26 hours of additional work for above-water carpentry (framing and decking), and up to 3 more hours to install a boatlift. Pile driving for residential docks does not occur at night.
- Pile types considered below include wood (round timber), vinyl sheet piles, concrete (in a variety of shapes including round and square), metal boat lift I-beams (steel or marine-grade aluminum), metal piles used for docks and seawalls, and metal sheet piles (steel or marine-grade aluminum). As discussed further below and stated in the PDCs, metal piles and metal sheet piles are prohibited from installation by impact hammer under SAJ-82 due to their potential for single-strike injury, injury impact zone, and daily cumulative

noise exposure zone. Metal piles and sheet piles can only be installed by hand or by vibratory hammer.

- Noise spreads cylindrically in coastal waters and noise transmission is characterized by 15 logR spreading loss.
- Strike rates for dock construction with wood piles have been reported to occur once or twice per minute (CALTRANS 2007). The average number of strikes per pile is estimated as 45, calculated as an average of 1.5 times per minute for 30 minutes.
- Concrete pile installation is estimated to take 160 strikes per pile.
- Sheet piles and I-beams can be installed in no more than 12 to 15 minutes, with pile strikes about once every 1.4 seconds or 43 to 44 strikes per minute (660 strikes per pile) (CALTRANS 2007).
- Daily exposure limits are based on the installation of 10 wood or concrete piles per day.
- Vibratory pile driving may take up to 30 minutes per pile.
- Although no noise measurements exist for vinyl sheet piles, the material construction of vinyl piles is expected to produce noise similar to that produced by the installation of wood piles. Although specific measurements are needed, we have used the available measurements for wood piles to estimate vinyl pile noise until additional information is available.
- For this analysis, we considered an impact pile driver as a combustion driven device used to install piles. There are 2 main classes of impact hammers: external combustion and internal combustion. External combustion hammers use cables, steam, compressed air or pressurized hydraulic fluid to raise the ram which is then dropped by gravity (e.g., a drop hammer). Internal combustion hammers do not rely on gravity and force the ram into the pile (e.g., a diesel hammer). During impact pile driving, noise is produced when the energy from the hammer is transferred to the pile and released into the surrounding water and sediment. By contrast, hand installation of any type of pile was determined to not result in injurious or behavioral noise impacts and does not require mitigation.
- The location of the project in a confined space versus open water was considered. If a project occurred in a confined space, the animal may be afraid to move through or past the noise source to escape it. This could result in a daily cumulative impact to the species remaining. In an open water environment, the species would be able to move away from the noise without passing through or by the noise source. For this consultation, we have defined a confined space as any area that has another object or structure within 150 ft of pile installation such as a project located across from islands/keys or within an inland canal, small coves or inlets along the shoreline. A 150-ft radius was chosen because it is twice the distance of the daily cumulative noise exposure level generated by the installation of 10 concrete piles. According to the FMCA, 10 piles is the maximum number of piles that contractors stated could be installed in 1 day. Therefore, even if all 10 piles were installed resulting in the largest daily cumulative exposure distance, species in an open water project location could escape the area without further noise exposure. This allows the animal at least twice the distance of the impact zone to be able to escape.

3.1 Impact Pile-Driving Noise Calculations

Tables 4 through 16 in this section are the results of noise calculations for each of the pile types installed by each of the pile installation methods. All calculations were completed using the formulas and methods described in Appendix B, Section 4.

Table 4. Impact hammer source levels and threshold distances for dock and seawall construction projects

Maximum Diameter and Pile Type	Source Level (dB re 1 µPa)	Fish Radius (m)	Turtle Radius (m)
12- to14-inch wood pile and vinyl sheet			
Injury (peak pressure)	195 dB	NA	NA
Injury (sSEL)	175 dB	NA	NA
Behavior (RMS)	185 dB	215	46
24-inch concrete pile			
Injury (peak pressure)	200 dB	NA	NA
Injury (sSEL)	175 dB	NA	NA
Behavior (RMS)	185 dB	215	46
12-inch metal boat lift I-beam (H-pile)			
Injury (peak pressure)	205 dB	NA	NA
Injury (sSEL)	175 dB	NA	NA
Behavior (RMS)	190 dB	465	100
24-inch metal sheet pile			
Injury (peak pressure)	220 dB	9	9
Injury (sSEL)	194 dB	3	3
Behavior (RMS)	204 dB	858	185

[a] Pile-driving data derived from CALTRANS (2009). Source levels were back-calculated from the reported measurement distance to the pile using 15 logR cylindrical spreading loss.

The peak pressure threshold of 206 db (Table 2) is not exceeded from single strikes for wood or concrete, but is exceeded for metal sheet piles. Therefore, peak pressure is not considered further in the analysis for wood and concrete piles.

Table 5. The daily cumulative exposure (cSEL) of animals to continuous noise from impact pile driving of wood, concrete, and I-beam or metal sheet piles based on strikes per pile

Piles/Day	Strikes/ Wood Pile	10Log(strikes)	Strikes/ Concrete Pile	10Log(strikes)	Strikes/ I-Beam, Metal Sheet Pile	10Log(strikes)
1	45	16.53	160	22.04	660	28.20
2	90	19.54	320	25.05	1,320	31.21
3	135	21.30	480	26.81	1,980	32.97
4	180	22.55	640	28.06	2,640	34.22
5	225	23.52	800	29.03	3,300	35.19
6	270	24.31	960	29.82	3,960	35.98
7	315	24.98	1,120	30.49	4,620	36.65
8	360	25.56	1,280	31.07	5,280	37.23
9	405	26.07	1,440	31.58	5,940	37.74
10	450	26.53	1,600	32.04	6,600	38.20

Table 6. Impact hammer daily cumulative impact zone ranges for injury based on the number of *wood piles* driven per day

Piles/Day	cSEL	Fish and Sea Turtles	
		dB Above Threshold	Impact Radius (m)
1	191.5	4.5	2
2	194.5	7.5	3
3	196.3	9.0	4
4	197.5	10.5	5
5	198.5	11.5	6
6	199.3	12.3	7
7	200.0	13.0	7
8	200.6	13.6	8
9	201.1	14.1	9
10	201.5	14.5	9

The peak pressure threshold is not exceeded from single wood pile strikes. The effective quiet level of 47 m is not exceeded.

Table 7. Impact hammer daily cumulative impact zone ranges for injury based on the number of *concrete piles* driven per day

Piles/Day	cSEL (dB re 1 µPa)	Fish and Sea Turtles	
		dB Above Threshold	Impact Radius (m)
1	197.04	10.04	4.7
2	200.05	13.05	7.5
3	201.81	14.81	9.7
4	203.06	16.06	11.8
5	204.03	17.03	13.7
6	204.82	17.82	15.4
7	205.49	18.49	17.1
8	206.07	19.07	18.7
9	206.58	19.58	20.2
10	207.04	20.04	21.7

The peak pressure threshold is not exceeded from single concrete pile strikes. The effective quiet level of 47 m is not exceeded.

Table 8. Impact hammer daily cumulative impact zone ranges for injury based on the number of *I-beams* driven per day

Piles/Day	cSEL	Fish and Sea Turtles	
		dB Above Threshold	Impact Radius (m)
1	203.2	16.20	13
2	206.2	19.21	20

The effective quiet (EQ) distance of 858 m is not exceeded.

Table 9. Impact hammer daily cumulative impact zone ranges for injury based on the number of *metal sheet piles* driven per day

Piles/Day	cSEL (dB re 1 µPa)	Fish ≥ 2 grams and Turtles	
		dB Above Threshold	Impact Radius (m)
1	222.20	35.20	223
2	225.21	38.21	353
3	226.97	39.97	462
4	228.22	41.22	560
5	229.19	42.19	650
6	229.98	42.98	734
7	230.65	43.65	813
8	231.23	44.23	858
9	231.74	44.74	858
10	232.20	45.20	858

The effective quiet (EQ) distance of 858 m is exceeded after 8 piles per day for larger fish.

Table 10. Impact pile driving behavioral impact zone ranges for wood, vinyl, concrete, and metal sheet piles

Pile Type	dB Above Fish Threshold	Fish Behavior Radius (m)	dB Above Sea Turtle Threshold	Sea Turtle Behavior Radius (m)
wood/vinyl	35 dB	215	25 dB	46
concrete	35 dB	215	25 dB	46
I-beam	40 dB	465	30 dB	100
metal sheet pile	44 dB	858	34 dB	185

3.2 Vibratory Pile-Driving Noise Calculations

Table 11. Vibratory pile-driving source levels and impact distances for wood, vinyl, and concrete piles used for small docks

Effect/Pile Type	Source Level (dB re 1 µPa)	Fish Radius (m)	Turtle Radius (m)
8- to 10-inch wood or vinyl sheet			
Injury (peak pressure)	186 dB	0	0
Injury (sSEL)	170 dB	0	0
Behavior (RMS)	170 dB	22	5
10-inch concrete			
Injury (peak pressure)	186 dB	0	0
Injury (sSEL)	170 dB	0	0
Behavior (RMS)	170 dB	22	5
24-inch AZ metal sheet pile			
Injury (peak pressure)	192 dB	0	0
Injury (sSEL)	178 dB	0	0
Behavior (RMS)	178 dB	74	16
12-inch metal I-beams (H-pile)			
Injury (peak pressure)	165 dB	0	0
Injury (sSEL)	150 dB	0	0
Behavior (RMS)	150 dB	0	0

[*] Vibratory pile driving of wood and concrete is not common and no measurements are yet available. We used source levels from vibratory pile driving of a 13-inch steel pipe as a conservative upper limit of potential noise for wood and concrete.

The peak pressure threshold is not exceeded for vibratory pile driving and is not considered further in the calculations. Although the SEL level is not exceeded, the cSEL is considered further for exposure of animals over time.

Table 12. Estimated cumulative exposure (cSEL) values over time from continuous noise associated with the vibratory hammer installation piles

Number of Piles	Average Time to Drive a Pile (seconds)	10 Log(time in seconds) Cumulative dB
1	1,800	32.55
2	3,600	35.56
3	5,400	37.32
4	7,200	38.57
5	9,000	39.54
6	10,800	40.33
7	12,600	41.00
8	14,400	41.58
9	16,200	42.10
10	18,000	42.55

Table 13. Vibratory hammer daily cumulative impact zone ranges for injury based on the number of *wood, vinyl, or concrete piles* driven per day

Piles/Day	cSEL (dB re 1 µPa)	Fish and Sea Turtles -	
		dB Above Threshold	Impact Radius (m)
1	202.5	0	0
2	205.6	0	0
3	207.3	0	0
4	208.5	0	0
5	209.5	0	0
6	210.3	0	0
7	211.0	0	0
8	211.6	0	0
9	212.1	0	0
10	212.6	0	0

The effective quiet (EQ) level of 22 m is exceeded at 8 piles.

Table 14. Vibratory hammer daily cumulative impact zone ranges for injury based on the number of I-beams driven per day

Piles/Day	cSEL (dB re 1 µPa)	Fish and Sea Turtles	
		dB Above Threshold	Impact Radius (m)
1	**182.55**	**0**	**0**
2	**185.56**	**0**	**0**

The effective quiet level is not exceeded.

Table 15. Vibratory hammer daily cumulative impact zone ranges for injury based on the number of metal *sheet piles* driven per day

Piles/Day	cSEL (dB re 1 µPa)	Fish and Sea Turtles	
		dB Above Threshold	Impact Radius (m)
1	210.55	0	0
2	213.56	0	0
3	215.32	0	0
4	216.57	0	0
5	217.54	0	0
6	218.33	0	0
7	219.00	0	0
8	220.10	0	0
9	220.55	0	0
10	220.97	0	0

The effective quiet (EQ) level is not exceeded..

Although no noise measurements exist for vinyl sheet piles, the material construction of vinyl piles is expected to produce noise similar to that produced by the installation of wood piles. Although specific measurements are needed, we have used the available measurements for wood pile to estimate vinyl pile noise until additional information is available.

Table 16. Vibratory pile driving behavioral impact zone ranges for wood/vinyl, concrete, and all sheet piles

Piles Type	dB Above Fish Threshold	Fish Radius (m)	dB Above Sea Turtle Threshold	Sea Turtle Radius (m)
wood/vinyl	20 dB	22	10 dB	4.6
concrete	20 dB	22	10 dB	4.6
metal I-beam	0	0	0	0
metal sheet pile	28 dB	74	18 dB	16

3.3 Noise Control Measures to Reduce Injury

There has been a fair amount of work performed in reducing noise from pile driving, which is summarized in Table 17. For coastal waters, 'bubble curtains' have been the primary focus of noise control efforts based on their sound attenuation capabilities (when properly designed) and cost effectiveness. Recently confined bubble curtains and temporary noise attenuation piles (TNAP) have shown consistently good results as noise-reducing measures. This section evaluates the effectiveness of the noise abatement measures.

Table 17. Effectiveness and cost of noise control measures for pile driving

Sound Treatment	Description	Effectiveness		Cost
		Reduction	Metric	
Bubble curtain or bubble tree	Air bubbles used to block sound	5-20+ dB	RMS, Peak, SEL	$50-200
Confined bubble curtain	A fabric, solid, or tubular curtain is used to confine bubbles	9-22 dB	RMS, Peak, Particle velocity	$100-200
Pile caps	Micarta caps used between the impact piling head and the pile to reduce noise	1-8 dB	RMS, Peak, SEL	Low material cost. May increase time to install pile.
Temporary Noise Attenuation Pile	A physical barrier lined with foam or other materials	8-14 dB	RMS, Peak, SEL	Unknown. May be similar to bubble curtain
Dewatered cofferdam	Removal of water around pile	15 dB 3-35 dB	RMS, Peak	Unknown. Assumed more than bubble curtains
Vibratory hammers	Alternative to impact hammers	10-20+ dB	RMS, Peak, SEL	2-3 times cost of impact hammers
Suction piles	Replacement for existing techniques	Very large reduction	All	Potential cost savings
Press-in piles	Piles are pressed into place	Very large reduction	All	Unknown

Table modified from Pile Driving Treatments table found in Spence et al. (2007) and updated with data by Laughlin (2010).

The USACE and FMCA have indicated the preferred noise abatement method for impact driving of concrete piles is a temporary noise attenuation pile. These piles or "sleeves" consist of a steel casing lined with noise insulating foam that is placed over the pile during installment. For smaller piles associated with docks, use of polyvinyl chloride (PVC) piles may be a viable alternative to steel piles, but they have not yet been tested. A TNAP design is a hollow walled (air-filled) metal pile casing or foam-lined metal casing placed around the pile being driven. This method is best applied to vertical, non-interlocking piles. Noise levels with a TNAP can be reduced by an average of 11 dB (8 to 14 dB) (Laughlin 2010), but have been reported in previous studies to have an even greater capacity to reduce noise. In the latest report (Laughlin 2010), a double-wall TNAP was constructed using 2 concentric pipes with outside diameters of 60 inches and 48 inches with and a wall thickness of 1 inch. The 5-inch space between the inner and outer steel tubes was partially filled with a 4-inch-thick, sound-absorbing material. Tests were conducted both with and without bubbles between the pile and the hollow tube via a bubble ring at the bottom of the TNAP. Bubbles resulted in a slightly greater reduction of 1-3 dB than TNAPs without bubbles. Laughlin (2010) recommended that TNAPs could be used as an alternative to the bubble curtain as an underwater noise mitigation device since the average noise

reduction is about the same. New designs of TNAPs and confined bubble curtain designs are still being investigated to improve noise reduction capabilities.

To compare the effectiveness of noise abatement measures with all pile types, we calculated the potential noise levels associated with impact pile driving with and without noise abatement (Table 18). In each example, the injury distance is reduced to zero for wood and vinyl piles, and to less than 50 ft for concrete piles and marine-grade aluminum I-beams. Based on our analysis, TNAPs will reduce the distance of injurious noise propagation to less than 50 ft. The risk of injury can be reduced to discountable levels if noise abatement measures are implemented that reduce the risk of cumulative injury to less than 50 ft. Distances less than 50 ft can be effectively observed by an onsite workers monitoring for listed species. The observer can shut down a pile-driving hammer to avoid exposing protected species to harmful noise levels when they are sighted.

Table 18. Estimated injury distances for sawfish and sea turtles exposed to daily cumulative noise exposure levels from wood, concrete, and I-beam pile driving without noise abatement and with an average 11 dB reduction with TNAPs or bubble curtains

Daily Injury Distance (m) With No Noise Abatement			Daily Injury Distance (m) With Noise Abatement		
Wood	Concrete	I-beam	Wood	Concrete	I-beam
9	22	20	None	4	10

For sheet pile types for which TNAPs cannot be used, a confined bubble curtain may be used to reduce noise levels. Confined bubble curtains consists of some type of aquatic barrier around a pile that is filled with bubbles. The bubbles are created by forcing compressed air through small holes drilled in PVC pipe. The bubble curtain disrupts the sound waves as they passes through, thereby reducing noise levels transmitted beyond the curtain. In order to be effective, the bubble curtain must fully enclose the pile through the entire water column; the ring emitting the bubbles must be seated properly on the sea floor to avoid suspension of sinking on the PVC pipe. Reductions in peak pressure, RMS pressure, and energy are typically on the order of 5-20 dB or more. Although the effectiveness of confined bubble curtains is more variable than TNAPs, the average noise reduction is about the same. Based on the best case scenario of a 20 dB reduction in noise, our estimates of the amount of noise reduction required to reduce the injury distance to less than 50 ft indicate that steel sheet piles may still have an associated injury zone even when confined bubble curtains are used (Table 19). Yet, the actual noise levels will be largely dependent upon the type of sheet pile, the power of the impact hammer, the substrate hardness, and water depth. Because noise abatement measures cannot adequately reduce the injury potential for the installation of metal sheet pile with an impact hammer, this installation type and method is not authorized under SAJ-82. These activities will require separate Section 7 consultation to address the increased risk of injury from noise. Projects requiring sheet piles that produce injurious noise levels will likely need to consider confined bubble curtain designs, as well as additional mitigation measures when possible, such as working at low tide to reduce the amount of noise transmitted into the water.

Table 19. The reduction in noise levels needed to reduce the daily cumulative noise exposure distances for sheet piles to less than 50 ft

Distance from Pile (m)	dB Reduction Needed	Target Source Level (SEL)
5	35	159
10	30	164
15	28	166

The FMCA has indicated that the use of steel sheet piles in Monroe County for marine and property armoring is uncommon. Vinyl sheet piles are the preferred construction material of choice due to their resistance to corrosion in salt water.

It is important to note that vibratory piling methods may be a reasonable solution for reducing the peak noise levels and removing impulsive sounds in certain applications. Vibratory methods have been measured to be significantly quieter than impact pile driving methods. In many cases, the reduction in noise levels can eliminate any risk of injury and minimize the area of behavioral disturbance. For use as a standard industry practice, the use of vibratory hammers must be a viable construction method for a variety of application or for a particular pile type. The FMCA has indicated that vibratory hammers are a viable option for the installation of I-beam used for in some boatlift designs; however, flexibility is needed for using a variety of pile driver types depending on the location and sediment layers encountered during pile driving.

Other Alternatives Considered, but Not Currently Implemented

The effects of 'pile caps' on underwater sound generation have also been measured by Laughlin (2006). Pile caps are circular discs that are placed between the impact head of the piling hammer and the pile. For practical materials, peak level reductions of 1-8 dB were measured. A negative effect on piling efficiency may result, but has not been investigated. Pile caps are not a recommended noise treatment method.

Alternatives to impact or vibratory pile driving that significantly reduce underwater sound levels could replace these conventional methods. One of these, suction piling, presents a good opportunity to greatly reduce noise while potentially increasing installation speed (Mather 2000). A suction pile is a large drum with the bottom face removed. The drum is located on the ocean floor, and air and water are sucked out thereby sinking the pile into the ground. Grout ballast can also be added for supplemental strength; if ballast is not used, then the pile can easily be completely removed by reversing the installation process. It is believed that the noise of this procedure will be negligible relative to existing methods since the only noise source is the suction pump.

Another alternative to conventional piling methods is the use of a 'press-in piling machine' (Goh et al. 2005). Press-in piling machines are unique, self-contained units that use static forces to install piles. The machine uses other piles that have already been installed as leverage to install new piles. All impulsive types of noise are removed by using this technique. This approach has been used extensively on land and in shallow waters where noise and vibration is of concern.

4 How to Calculate Noise Impacts

4.1 Calculation Steps for Pile Driving

a. Review the Project for Needed Information

The basic information on the pile driving activity required to conduct an effects analysis is:

- the material composition of the piles (metal, concrete, wood, composite)
- the type of piles (e.g., sheet, H, tubular, square, etc.)
- the diameter of the piles
- the number of piles driven
- the number of hammer strikes per pile
- the duration to drive a single pile
- the number of piles driven per day
- the time of year of the activity
- the type of pile-driving method (e.g., hydraulic, diesel, vibratory hammer)
- other pile driving methods (e.g., drilling, jetting)
- vessels required
- the total duration of the project
- depth, bottom, type, and habitat characteristics
- a map of the project area

b. Choose a Spreading Loss Model

The decrease in noise level with distance from the source (also called attenuation or spreading loss) can be estimated using a spreading loss model. A general equation to be used for planning and assessment purposes to predict noise at some distance from a pile is:

$TL(R) = SL - N \log R$*;* where

TL is the threshold level in Table 1 at a distance R from the pile in meters,
SL is the source level,
N is a coefficient for geometric spreading (e.g., spherical or cylindrical), and
R is a distance from the source.

For pile-driving projects, geometric spreading (N) can range between 10 and 20, but usually takes the form of 2 equations based on water depth.

Spherical spreading in deep water is expressed as: $TL(R) = SL - 20 \log R$
Intermediate spreading in shallower water is expressed as: $TL(R) = SL - 15 \log R$

A general assessment rule in determining which spreading loss model to use is to compare your impact zone distance to the water depth in the project area. Use spherical spreading (20 logR) if your impact zone is shorter than the water depth, and cylindrical (10 logR) or intermediate spreading (15 logR) if your impact zone is longer than the water depth. This is explained by the fact a sound wave will not generally travel further than the depth of the water column before being reflected. In deep water, surface reflections does not occur as quickly. Pile driving in

deeper water is best modeled using spherical spreading where there are few reflections of the sound waves off hard surfaces such as the sea bottom. In shallow water, surface reflections result in non-uniform or cylindrical spreading of the sound waves (see Figure 2).

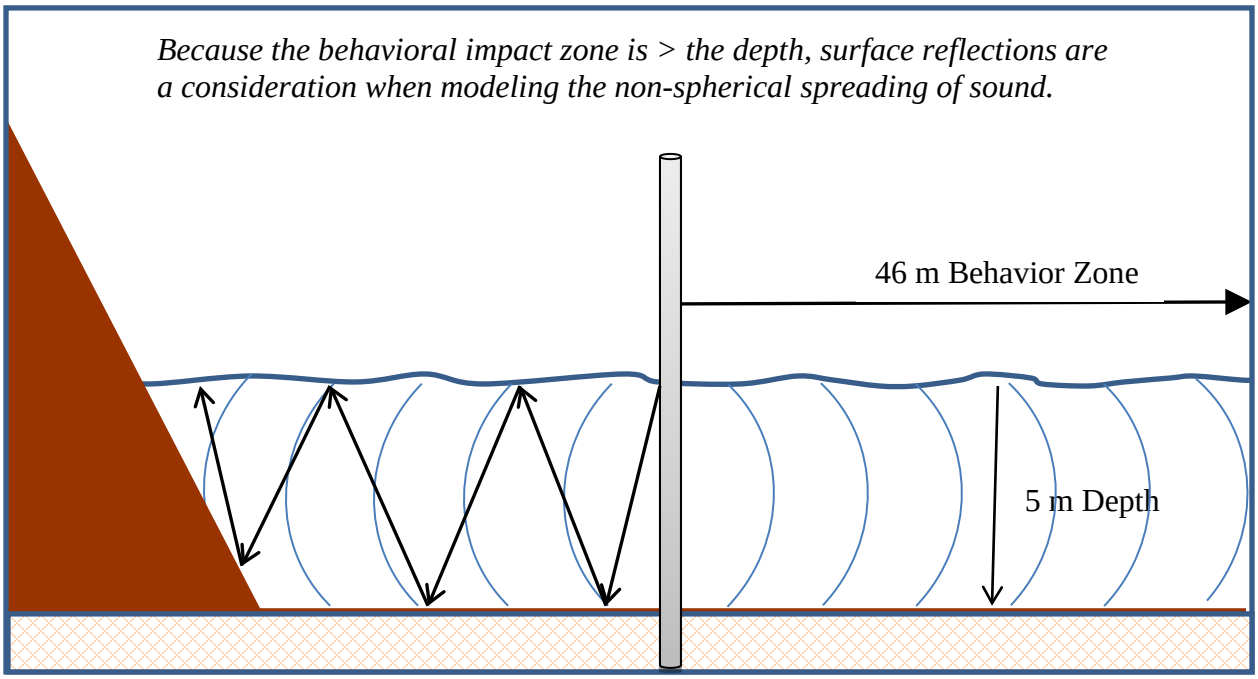

Figure 2. An example of intermediate spreading loss where surface reflections result in non-uniform spreading of sound waves

Sound propagation can range between 10 logR and 15 logR in shallow water. For planning purposes, the use of the 15 logR spreading loss model is recommended unless other documentation is provided. Aside from offshore energy projects, most pile driving occurs in shallow, coastal areas so intermediate spreading loss is the most common model used for coastal areas. To find the distance of the threshold level TL(R) to determine your impact zone use the Spreading Loss Calculator explained below in Step f. More detailed examples and discussion of determining impact zones using spreading loss equations can be found in the FHA (2012).

c. Determine the Noise Reference Levels

Noise levels produced from pile-driving noise can be estimated from similar projects reported in technical papers and peer reviewed literature. Typically, the pile size, type, and pile-driving method are used to characterize noise levels. A particularly useful reference is CALTRANS (2009). The source level will need to be determined on a project-by-project basis through information provided by the applicant or through reference levels reported in the literature. Report the noise levels in the Effects Analysis. The noise levels used in the effects analysis should be tabulated for easy reference.

It is important to note the distance of the reported noise level. Many reference levels are reported at 10 m from the pile. We can back-calculate noise levels from 10 m to the pile by adding 10 dB for 10 logR cylindrical loss, 15 dB for 15 log intermediate spreading loss, and 20

dB for 20 logR spherical spreading loss. Other reference level distances can easily be back-calculated by determining the dB loss for the distance using the Spreading Loss Calculator.

d. Determine Source Level: Cumulative Sound Exposure Level

Cumulative exposure is based on the amount of time an animal may be exposed to noise from repeated strikes of impact hammers (or the amount of time for vibratory piling). For any given set of conditions (source level, type of transmission loss, strikes/pile) over some period of time, cumulative exposure (cSEL) may result in some risk of hearing loss even if the sSEL (single exposure level) is below the threshold for injury. This calculation is important if animals may be expected to be repeatedly exposed to noise over time (e.g., nursery or developmental areas, preferred feeding or resting areas, or semi-enclosed areas in which animals may remain).

NOTE: cSEL assumes constant exposure, and does not account for the movement of fish and sea turtles. Movements must be monitored during the activity, modeled, or considered qualitatively in the analysis.

For dock and seawall construction which only occurs during daylight hours in residential areas, the cSEL can be calculated on a daily basis:

Daily cSEL Source Level = sSEL Source Level + 10 log(# of strikes/ pile)(# of piles/day)

As a general guideline, consider the cumulative effects of noise exposure over a 24-hr period, as long as there is sufficient "quiet" recovery time between exposures. The effects of repeated daily exposures over days, weeks, or months may be considered qualitatively or quantitatively if the different noise sources and exposure levels are present over time. Note: This exposure level is realized from constant exposure to the noise, but does not account for animal movement.

Another important consideration in calculating cSEL in the context of pile driving is the "effective quiet" level. For fish, the effective quiet level has been set at 150 dB (CALTRANS 2009). For sea turtles, we are applying the same level. For animals exposed to levels at or less than the effective quiet level, noise impacts will not accumulate to cause injury. Therefore, we need to calculate the distance from the source at which noise levels will attenuate below this effective quiet level. Only within this range will potentially injurious cSEL accumulate.

For example, if a pile has a 180 dB sSEL source level, the maximum cumulative strike exposure injury range is at 100 m from the pile. This is determined by finding the difference between the single-strike source level and effective quiet (180 dB – 150 dB = 30 dB). A 30 dB loss occurs at 100 m from a pile using the 15 logR spreading loss. Therefore, animals beyond 100 m would not accumulate potentially injurious cSEL and 100m would be the limit of the cSEL injury zone.

e. Determine the Impact Zones by Calculating Threshold Distances

Using the Spreading Loss Calculator

In previous steps you will have already calculated the source level for both a single strike and for cumulative daily strikes. In Step 4, you have chosen the spreading loss model appropriate for a project. A quick and effective method to calculate impact zone distances with the model is to

first calculate the difference in dB (-dB) between the source level and threshold level, then determine what distance that dB difference occurs with the Spreading Loss Calculator.

For example, to determine the distance of the daily cumulative level of injury, first subtract the threshold levels for each animal group in Table 2 from the cSEL source level.

<u>Calculate the Difference (-dB) Between Source Level and Injury Threshold Levels</u>
fish ≥ 2 grams and sea turtles = Source Level (cSEL) – 187 dB
fish < 2 grams = Source Level (cSEL) – 183 dB

<u>Calculate the Difference (-dB) Between Source Level and Behavioral Threshold Levels</u>
for all fish sizes = Source Level (RMS) – 150 dB
sea turtles = Source Level (RMS) – 160 dB

After determining the dB difference between source level and threshold level, use the Spreading Loss Calculator to input different ranges in the first column (Range) to find the distance that the -dB difference would occur. The calculator uses 3 spreading loss formulas to allow for quick calculations of several ranges (see Figure 3). The equations solve for any range input by the user by automatically calculating noise reduction at those distances from a pile (-dB) using 3 spreading loss equations for any range input by the user.

Spherical (20 logR) and Cylindrical (10 and 15 logR) Spreading Loss

Instructions: Input range from source to obtain spherical and cylindrical spreading loss (- dB)

Range (m)	log (R)	20 logR Spherical Spreading Loss (- dB)	10 log R Cylindrical Spreading Loss (- dB)	15 log R Cylindrical Spreading Loss (- dB)
1	0	0	0	0
2	0.301029996	6.020599913	3.010299957	4.515449935
4	0.602059991	12.04119983	6.020599913	9.03089987
8	0.903089987	18.06179974	9.03089987	13.5463498
10	1	20	10	15
25	1.397940009	27.95880017	13.97940009	20.96910013
50	1.698970004	33.97940009	16.98970004	25.48455007
100	2	40	20	30
1000	3	60	30	45
2000	3.301029996	66.02059991	33.01029996	49.51544993
10000	4	80	40	60
100000	5	100	50	75
500000	5.698970004	113.9794001	56.98970004	85.48455007
1000000	6	120	60	90

Figure 3. Screenshot of the Spreading Loss Calculator. The dB loss over any range can be determined for 3 types spreading loss models (10 logR, 15 logR, and 20 logR). For example, at 50 m, there is a 25.5 dB reduction in noise from a pile due to intermediate transmission loss (15 logR).

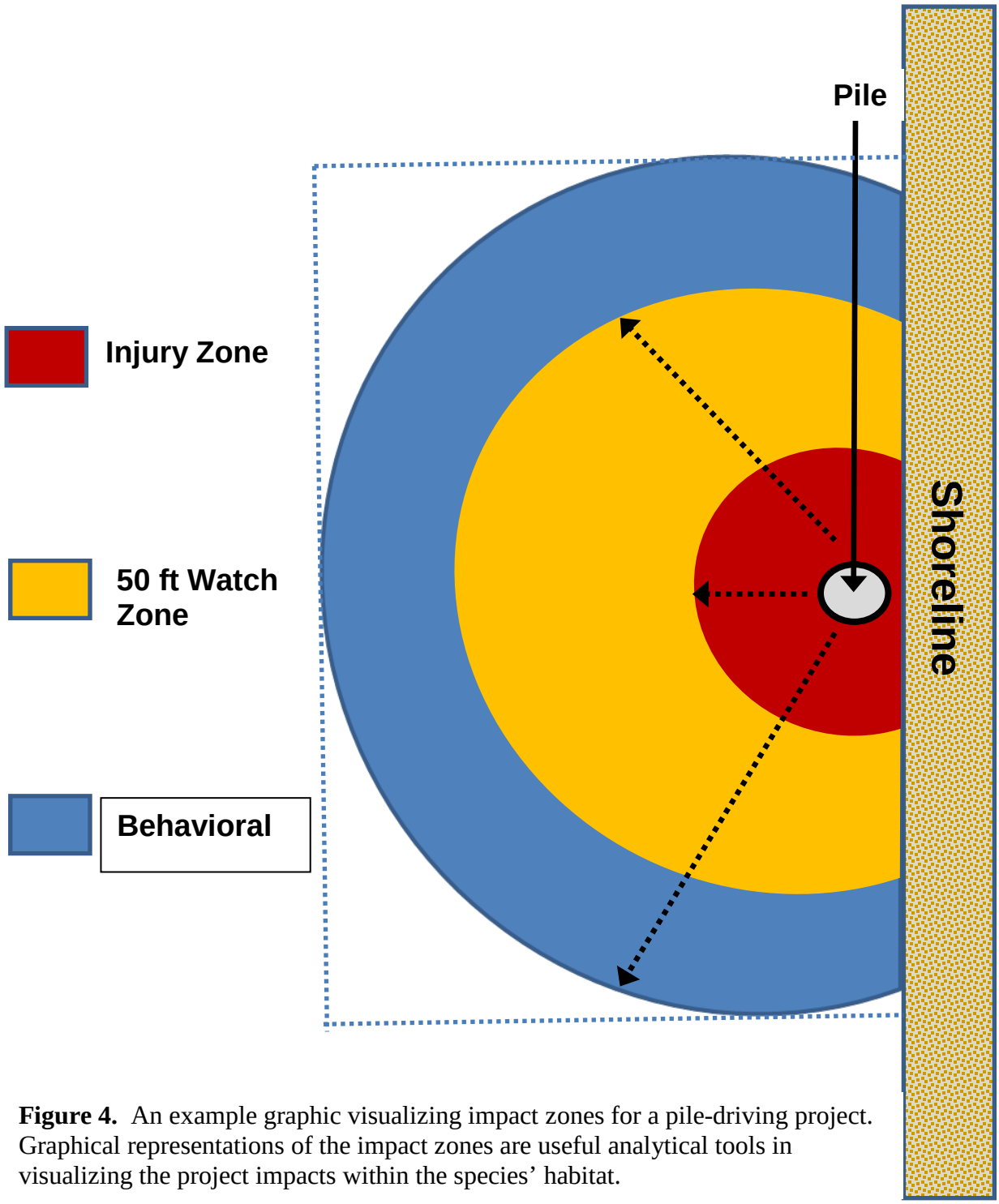

Figure 4. An example graphic visualizing impact zones for a pile-driving project. Graphical representations of the impact zones are useful analytical tools in visualizing the project impacts within the species' habitat.

4.2 Example Noise Calculation for a Single Family Dock

Step 1. Gather project details.
In the following example, a federal agency is proposing to issue a permit for the construction of a single family dock in Florida.

The applicant provided project details including the following:

- 16 piles will be driven by impact hammer
- all piles are 12-inch-diameter wood piles
- each pile takes 30 minutes to install
- plan to install 10 piles per day
- pile installation is continuous, but only during daylight hours
- the hammer strikes at an average rate of 1.5 strikes per minute (45 strikes per pile)
- water depth ranges from 0-5 m
- sea turtles and smalltooth sawfish may be in the project area

Step 2. Determine noise reference levels and choose a spreading loss model.
Referencing the noise levels reported for a 12-in wood pile in CALTRANS (2009), the source level is estimated to be 180 dB Peak Pressure, 160 dB sSEL, and 170 dB RMS at a distance of 10 m from the pile. Because the project is in shallow water, the 15 logR intermediate spreading loss model will be used. To back-calculate the source level from the reported level measured 10 m from the pile, we added 15 dB to each of the literature values (Table 20).

Table 20. Back-Calculation of Source Levels

Type of Noise Impact	Measured Source Level (10 m from Source)	Back-Calculation to Source (15 logR)	Final Source Level
Peak Pressure	180	15	195
Single strike (sSEL)	160	15	175
RMS (behavioral)	170	15	185

Step 3. Calculate the cumulative exposure level (cSEL).
To address the sound exposure level over the course of a day, the SEL from exposure to a single pile strike (sSEL) was converted to cSEL for exposure to the total pile strikes per day. This is calculated using the following formula:

Daily cSEL Source Level = sSEL Source Level + 10 log(# of strikes/ pile)(# of piles/day)
= 175 + 10 log(45)(10)
= 175 + 26.5
= 201.5 (rounded to 202)

Step 4. Calculate the difference between project noise levels and threshold values.
Determine if noise associated with pile installation reaches a level loud enough to disturb or injure protected species we compare project source levels to the literature threshold values (Table 21)

Table 21. Calculations of Threshold Exceedances

Effect	Animal	Threshold Level (dB re 1 µPa)	Project Levels (dB re 1 µPa)	Difference in dB
Injury	All fish and turtles	206 (peak pressure)	195 (peak pressure)	Not exceeded
	Fish ≥ 2 grams	187 (SEL)	175 (sSEL)	Not exceeded
			202 (cSEL)	15
Behavior	Fish	150 (RMS)	185 (RMS)	35
	Sea turtles	160 (RMS)	185 (RMS)	25

Step 5. Use the Spreading Loss Calculator to determine the zone of impact in cases where source levels exceed threshold values.

Change the values in column 1 (Range) of the Spreading Loss Calculator (Figure 5) to calculate noise attenuation over specific distances. Alter the values in column 1 as necessary to find dB levels in the last column (15 logR model) that most closely match those calculated in Step 4 above (Table 21 "Difference in dB"). We demonstrate this in Figure 6 below where the arrows represent the ranges that we modified in column 1 and the resulting changes in dB loss calculated in the last column. By changing the values in column 1 (10, 46, and 215 m) we were able to match the dB of loss calculated in Table 21 above (15, 25, and 35 dB respectively). The ranges (i.e., distances) associated with the arrows correspond with the radii to which noise source levels exceed threshold levels at the project site (impact radius, Table 22).

Spherical (20 logR) and Cylindrical (10 and 15 logR) Spreading Loss

Instructions: Input range from source to obtain spherical and cylindrical spreading loss (- dB)

Range (m)	log (R)	20 logR Spherical Spreading Loss (- dB)	10 log R Cylindrical Spreading Loss (- dB)	15 log R Cylindrical Spreading Loss (- dB)
1	0	0	0	0
2	0.301029996	6.020599913	3.010299957	4.515449935
4	0.602059991	12.04119983	6.020599913	9.03089987
8	0.903089987	18.06179974	9.03089987	13.5463498
10	1	20	10	15
25	1.397940009	27.95880017	13.97940009	20.96910013
50	1.698970004	33.97940009	16.98970004	25.48455007
100	2	40	20	30
1000	3	60	30	45
2000	3.301029996	66.02059991	33.01029996	49.51544993
10000	4	80	40	60
100000	5	100	50	75
500000	5.698970004	113.9794001	56.98970004	85.48455007
1000000	6	120	60	90

Figure 5. Screenshot of original Spreading Loss Calculator prior to any modifications

Spherical (20 logR) and Cylindrical (10 and 15 logR) Spreading Loss				
Instructions: Input range from source to obtain spherical and cylindrical spreading loss (- dB)				
Range (m)	log (R)	20 logR Spherical Spreading Loss (- dB)	10 log R Cylindrical Spreading Loss (- dB)	15 log R Cylindrical Spreading Loss (- dB)
1	0	0	0	0
2	0.301029996	6.020599913	3.010299957	4.515449935
4	0.602059991	12.04119983	6.020599913	9.03089987
8	0.903089987	18.06179974	9.03089987	13.5463498
10	1	20	10	15
25	1.397940009	27.95880017	13.97940009	20.96910013
46	1.662757832	33.25515663	16.62757832	24.94136748
100	2	40	20	30
215	2.33243846	46.6487692	23.3243846	34.9865769
2000	3.301029996	66.02059991	33.01029996	49.51544993
10000	4	80	40	60
100000	5	100	50	75
500000	5.698970004	113.9794001	56.98970004	85.48455007
1000000	6	120	60	90

Figure 6. Screenshot of the Spreading Loss Calculator after the first column was modified

Table 22. Calculations of Impact Zones Based on Source Levels for the Project

Effect	Animal	Threshold Level (dB re 1 µPa)	Project Levels (dB re 1 µPa)	Difference in dB	Impact Zone Radius (m)
Injury	All fish and turtles	206 (peak pressure)	195 (peak pressure)	Not exceeded	0
	Fish ≥ 2 grams	187 (SEL)	175 (sSEL)	Not exceeded	0
			202 (cSEL)	15	10
Behavior	Fish	150 (RMS)	185 (RMS)	35	215
	Sea turtles	160 (RMS)	185 (RMS)	25	46

Step 6. Compare the calculated cSEL impact zone to the maximum impact zone limited by effective quiet.

Now we need to determine whether the amount of accumulated noise exposure and the corresponding cSEL impact zone would be limited by the noise reaching effective quiet. First, calculate the difference between the source level (sSEL) and the effective quiet level (150 dB sSEL).

In this example:
175 dB sSEL (source level) – 150 dB sSEL (effective quiet level) = 25 dB

Next, consult the Spreading Loss Calculator to find the distance over which sound would attenuate by that amount.

25 dB spreading loss occurs at 46 m using 15 logR (see Figure 6)
46 m is the maximum range of the cSEL injury zone before reaching effective quiet

Last, compare the calculated cSEL impact zone radius from Step 5 (10 m) to the maximum impact zone limited by effective quiet, calculated in this step (46 m). Use the smaller of the two values as the cumulative injury impact radius. In this case, the originally calculated 10 m is the impact zone radius for daily cumulative exposure.

Summary

Interpretations of the noise impact zones associated with the project shown in Table 22 are as follows:

- Potential injury for fish and sea turtles from single pile strikes (sSEL) is not measurable as the source levels do not exceed the threshold values for injury.
- Potential injury to fish from cumulative sound exposure (cSEL) each day is possible within 10 m from the pile. For the purpose of this example, fish includes sturgeon and smalltooth sawfish. Since threshold values for sea turtles are not currently known we assume the thresholds used for fish also apply to sea turtles. Therefore we assume the 10 m cumulative injury zone also applies to sea turtles.
- Behavioral responses of sea turtles may occur up to 46 m (150 ft) from the project.
- Behavioral responses of fish may occur up to 215 m (705 ft) from the project.

Appendix C: SAJ-82 Noise Effects Matrix and BMPs

This Appendix summarizes the potential noise effects to sea turtles and smalltooth sawfish from activities covered under SAJ-82 in the Florida Keys. The information in the tables below is explained in more detail in this Opinion for SAJ-82 including a glossary of terms (Appendix B), explanation of sound attenuation calculations (Appendix B), analysis of potential effects (Section 3.1.4), and required BMPs following the tables in this Appendix. The tables are formatted as described below:

1. Species: We first consider which species may be affected (sea turtles and smalltooth sawfish).
2. Noise Metric: In order to understand how noise affects species, it is important to know how noise is measured and what noise levels effect species. Noise is measured in 3 different ways and each is expressed in its own units of measurement.
    a. **Single Strike Injury**- This measurement is used to determine if injury would occur from impact hammer installation. This is measured in units of sSEL or peak pressure. If either peak pressure or sSEL are exceeded, then injury occurs.
    b. **One Second Injury Exposure**- This measurement is used to determine if injury would occur from one second of exposure to non-impact hammer source like vibratory or augur installation. This is measured in units of peak pressure.
    c. **Daily Cumulative Noise Exposure**- This measurement (cSEL) determines if the noise produced over the course of the day of construction can cause injury. Note that the source level and calculations for cumulative noise exposure are adjusted with each pile strike or with time for vibratory installation to account for accumulated exposure, as described in Appendix B.
    d. **Behavioral Response**- This measurement (RMS) determines if the noise will result in a behavioral response such as a change in feeding or sheltering.
3. Source Levels: For each construction activity, we provide the noise levels provided in literature of the noise produced during the installation of the pile, back-calculated to the actual source using the 15 logR spreading model, if the literature values are reported at some greater distance from the source, as explained in Appendix B.
4. Threshold: For each noise metric, we provide the noise level from the literature at which the onset of impacts to species occurs.
5. Impact Radius: The distance from the source at which species are effected by noise above the corresponding threshold level. Because the daily cumulative noise exposure source levels change with every strike/over time, the impact radius also changes. The table shows the change as more piles are installed (e.g., the impact radius for 1 pile versus 10 piles), as described in more detail in Appendix B.
6. Possible Species Responses: If species can be affected within a given impact radius, we then consider all of the possible species responses (both injurious and behavioral) that may occur within that radius from the pile.
7. Required BMPs: This column directs you to the BMP Plan required under SAJ-82 based on the type of pile and installation method used. The BMP Plans are provided immediately following the tables.
8. Effects Determination: This is the determination that NMFS made on what effect we believe the noise generated from the pile installation will have on sea turtle and smalltooth sawfish from projects authorized under SAJ-82. The effects determinations include:

a. NE: No Effect means that we do not believe the pile type and installation method will result in an effect to the species.
b. NLAA: Not likely to Adversely Affect means that we believe the effect will be discountable or insignificant, as described in more detail in Section 3.1.4.
c. LAA: Likely to Adversely Affect means that we believe the pile type and installation method is likely to have detrimental effects to the species. Activities that are LAA are not authorized under SAJ-82.

Jetting: High- pressure water is used to create the piling hole and sometimes to simultaneously install the pile.

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	One-second Injury Exposure	Jetting source levels are unknown, but result in much lower noise levels than either impact or vibratory pile driving alone while minimizing the amount of hammering necessary. Noise measurements taken with water jetting turned on or off during pile driving resulted in no additional noise recorded above that of the pile-driving noise (CALTRANS 2007).	206 (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure		Threshold levels for noise sources ≤ 167 dB SEL were not calculated	0	N/A		NE
	Behavioral Response		160 dB (RMS)	0	N/A		NE
Smalltooth Sawfish	One-second Injury Exposure		206 (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure		Threshold levels for noise sources ≤ 167 dB SEL were not calculated	0	N/A		NE
	Behavioral Response		150 dB (RMS)	0	N/A		NE

Drop punch: Drop punching is a method that uses a 12- to 24-inch-diameter steel punch dropped repeatedly from a barge-mounted crane. After the pilot hole is created, the pile is driven to resistance using an impact hammer.

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	Single-Strike Injury	The best available information on a drop punch is a bucket dredge striking the sea bottom. The noise produced from the heavy bucket dropped onto the channel bottom was measured to be 124 dB re 1 µPa (RMS) at 150 m from the work site (Dickerson et al. 2001). Back-calculating the noise attenuation 150 m results in a potential source level of 156 dB re 1 µPa (RMS).	206 dB (peak pressure) or 187 dB (sSEL)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure		Threshold levels for noise sources ≤ 167 dB SEL were not calculated	0	N/A		NE
	Behavioral Response		160 dB (RMS)	0	N/A		NE
Smalltooth Sawfish	Single-Strike Injury		206 dB (peak pressure) or 187 dB (sSEL).	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure		Threshold levels for noise sources ≤ 167 dB SEL were not calculated	0	N/A		NE
	Behavioral Response		150 dB (RMS)	2.5 m (8 ft)	Disrupted feeding, sheltering, pupping, or potential increase in risk to predation		NE, impact radius is so small that adverse effects are implausible

Auger: An auger is used to create the hole to install a pile.

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	One-second Exposure Injury	Noise levels from small-scale drilling operations that are representative of dock construction methods such as auguring have been measured to be no more than 107 dB re 1 µPa (0-peak) at 7.5 m from the source (Willis et al. 2010). Our back-calculation resulted in an approximate source level no greater than 120 dB re 1 µPa (0-peak).	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure		Threshold levels for noise sources ≤ 167 dB SEL were not calculated	0	N/A		NE
	Behavioral Response		160 dB (RMS)	0	N/A		NE
Smalltooth Sawfish	One-second Injury Exposure		206 dB (peak pressure))	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure		Threshold levels for noise sources ≤ 167 dB SEL were not calculated	0	N/A		NE
	Behavioral Response		150 dB (RMS)	0	N/A		NE

Vibratory Hammer for installation of wood, vinyl, or concrete pile 10 inches in diameter or less

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius (m)	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	One-second Injury Exposure	186 dB (peak pressure), 170 dB (SEL)	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted over time to reflect accumulated exposure.	234 dB (cSEL)	0	N/A		NE
	Behavioral Response	170 dB (RMS)	160 dB (RMS)	5 m (16 ft)	Disrupted feeding, sheltering		NLAA
Smalltooth Sawfish	One-second Injury Exposure	186 dB (peak pressure), 170 dB (SEL)	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted over time to reflect accumulated exposure.	234 dB (cSEL).	0	N/A		NE
	Behavioral Response	170 dB (RMS)	150 dB (RMS)	22 m (72 ft)	Disrupted feeding, sheltering, pupping, or potential increase in risk to predation		NLAA

Vibratory Hammer for installation of 2 metal boat lift I-beams

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	One-second Injury Exposure	165 dB (peak pressure), 150 dB (SEL)	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted over time to reflect accumulated exposure.	or 234 dB (cSEL)	0	N/A		NE
	Behavioral Response	150 dB (RMS)	160 dB (RMS)	0	N/A		NE
Smalltooth Sawfish	One-second Injury Exposure	165 dB (peak pressure), 150 dB (SEL)	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted over time to reflect accumulated exposure.	234 dB (cSEL)	0	N/A		NE
	Behavioral Response	150 dB (RMS)	150 dB (RMS)	0	N/A		NE

Vibratory Hammer for installation of 24-inch wide metal sheet pile

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	One-second Injury Exposure	192 dB (peak pressure), 178 dB (SEL)	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted over time to reflect accumulated exposure.	234 dB (cSEL)	0	N/A		NE
	Behavioral Response	178 dB (RMS)	160 dB (RMS)	16 m (52 ft)	Disrupted feeding, sheltering		NLAA
Smalltooth Sawfish	One-second Injury Exposure	192 dB (peak pressure), 178 dB (SEL)	206 dB (peak pressure)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted over time to reflect accumulated exposure.	or 234 dB (cSEL)	0	N/A		NE
	Behavioral Response	178 dB (RMS)	150 dB (RMS)	74 m (243 ft)	Disrupted feeding, sheltering, pupping, or potential increase in risk to predation		NLAA

Impact Hammer installation of up to a 14-inch-diameter wood piles or vinyl piles

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	Single-Strike Injury	195 dB (peak pressure), 175 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 2 m (7 ft), 10 piles = 9 m (30 ft)	Onset of auditory injury		NLAA
	Behavioral Response	185 dB (RMS)	160 dB (RMS)	46 m (150 ft)	Disrupted feeding, sheltering		NLAA
Smalltooth Sawfish	Single-Strike Injury	195 dB (peak pressure), 175 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL).	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 2 m (7 ft), 10 piles = 9 m (30 ft)	Onset of auditory injury		NLAA
	Behavioral Response	185 dB (RMS)	150 dB (RMS)	215 m (705 ft)	Disrupted feeding, sheltering, pupping, or potential increase in risk to predation		NLAA

Impact Hammer installation of up to a 24-inch-diameter concrete pile

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	Single-Strike Injury	200 dB (peak pressure), 175 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL)	0	N/A	BMP Plan A if a maximum of 5 piles per day will be driven. BMP Plan B if a total of 6 or more piles per day will be driven.	NE
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.	206 dB (peak pressure) or 187 dB (cSEL) 234 dB (cSEL)	1 pile = 5 m (15 ft) 5 piles = 14 m (50 ft) 10 piles = 22 m (71 ft)	Onset of auditory injury		NLAA
	Behavioral Response	185 dB (RMS)	160 dB (RMS)	46 m (150 ft)	Disrupted feeding, sheltering		NLAA

Impact Hammer installation of up to a 24-inch-diameter concrete pile

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Smalltooth Sawfish	Single-Strike Injury	200 dB (peak pressure), 175 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL).	0	N/A	BMP Plan A if a maximum of 5 piles per day will be driven. BMP Plan B if a total of 6 or more piles per day will be driven.	NE
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 5 m (15 ft) 5 piles = 14 m (50 ft) 10 piles = 22 m (71 ft)	Onset of auditory injury		NLAA
	Behavioral Response	185 dB (RMS)	150 dB (RMS)	215 m (705 ft)	Disrupted feeding, sheltering, pupping, or potential increase in risk to predation		NLAA

Impact Hammer installation of 2 boat lift I-beams

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	Single-Strike Injury	205 dB (peak pressure), 175 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL)	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.*	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 13 m (43 ft) 2 piles = 20 m (66 ft) *	Onset of auditory injury		NLAA
	Behavioral Response	190 dB (RMS)*	160 dB (RMS)	100 m (328 ft)	Disrupted feeding, sheltering		NLAA
Smalltooth Sawfish	Single-Strike Injury	205 dB (peak pressure), 175 dB (sSEL)*	206 dB (peak pressure) or 187 dB (sSEL).	0	N/A	BMP Plan A	NE
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.*	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 13 m (43 ft) 2 piles = 20 m (66 ft)*	Onset of auditory injury		NLAA
	Behavioral Response	190 dB (RMS)*	150 dB (RMS)	465 m (1,525 ft)*	Disrupted feeding, sheltering, pupping, or potential increase in risk to predation		NLAA

* Noise levels not believed to be accurate based on the installation method used. Boatlift I-beams only penetrate loose sediment until they reach the top of, or first few inches of, hard substrate to stabilize the structure on the hard substrate versus penetrating it.

Impact Hammer installation of 24-inch-wide metal sheet pile (Not authorized under SAJ-82)

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Required BMPs under SAJ-82	Effects Determination
Sea Turtles	Single-Strike Injury	220 dB (peak pressure), 194 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL)	9 m (30 ft)	Physical or auditory injury	Not Authorized under SAJ-82	LAA
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 223 m (731 ft) 10 piles = 858 m (2,815 ft)	Onset of auditory injury		LAA
	Behavioral Response	204 dB (RMS)	160 dB (RMS)	185 m (607 ft)	Disrupted feeding or sheltering, potential increase in risk to predation, potential altered reproduction (mating and access to nesting beaches), potential for noise-related injury if species remains in impact radius		NLAA or LAA depending on the location and time of year

Impact Hammer installation of 24-inch-wide metal sheet pile (Not authorized under SAJ-82)

Species	Route of Effect	Source Level (Noise generated by activity)	Threshold (Noise level that causes a response)	Impact Radius	Possible Species Response	Effect to Individual	Required BMPs under SAJ-82	Effects Determination
Smalltooth Sawfish	Single-Strike Injury	220 dB (peak pressure), 194 dB (sSEL)	206 dB (peak pressure) or 187 dB (sSEL)	9 m (30 ft)	Physical or auditory injury	Temporary avoidance of area and potential noise-related injuries	Not Authorized under SAJ-82	LAA
	Daily Cumulative Noise Exposure	The source level is adjusted for total pile strikes to reflect accumulated exposure.	206 dB (peak pressure) or 187 dB (cSEL)	1 pile = 223 m (731 ft) 10 piles = 858 m (2,815 ft)	Onset of auditory injury	Temporary avoidance of area and potential noise-related injuries		LAA
	Behavioral Response	204 dB (RMS)	150 dB (RMS)	858 m (2,8215 ft)	Disrupted feeding or sheltering, pupping, potential increase in risk to predation, potential for noise-related injury if species remains in impact radius	Temporary avoidance of area and potential noise-related injuries		NLAA or LAA depending on the location and time of year.

4.3 Noise Best Management Practices (BMPs) for SAJ-82

The following best management practices key is for reducing the exposure sea turtles and smalltooth sawfish to potential harmful daily noise exposure levels associated with pile driving during dock and seawall construction activities.

4.3.1 Noise BMP Plan A: Sea Turtle and Smalltooth Sawfish Construction Conditions

The permittee shall comply with the following protected species construction conditions:

a. All construction personnel are responsible for observing water-related activities to detect the presence of these species.

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species' entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d. If a sea turtle or smalltooth sawfish is seen within 100 yd of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 ft of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

e. Any injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

4.3.2 Noise BMP Plan B: Impact Pile-Driving Construction Conditions for the installation of 6 or more concrete piles per day.

1. The permittee shall follow all conditions defined in the Noise BMP Plan A above plus the conditions provided below:

2. Noise Abatement Measures: A temporary noise attenuation pile (TNAP) and/or a bubble curtain must be used if a given construction day will result in the installation of 6 or more concrete piles installed by impact hammer in a confined space. These measures must be

used for the installation of all of the piles that day, not just for piles 6-10. The TNAP design must be constructed of a double-walled tubular casing (a casing within a larger casing), with at least a 5-inch-wide hollow space completely filled with closed-cell foam or other noise dampening material between the walls. The TNAP must be long enough to be seated firmly on the sea bottom, fit over the pile being driven, and extend at least 3 ft above the surface of the water. The bubble curtain design must adhere to the guidelines for unconfined and confined bubble curtains defined below, and be followed as detailed in the USACE permit application. The use of *any* other alternative noise control method must receive prior approval by NMFS and the USACE.

If the required noise abatement measured defined in number 2 above cannot be used, then the pile must be installed by a different method using the appropriate noise BMPs defined in this Opinion (e.g., concrete piles may be installed by vibratory hammer instead, following BMP Plan A).

Bubble Curtain Specifications for Pile Driving

When using an impact hammer to drive or proof concrete or metal piles, use 1 of the following sound attenuation methods:

1) If water velocity is equal to or less than 1.6 ft per second (1.1 miles per hour) for the entire installation period, surround the pile being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100% of the pile perimeter for the full depth of the water column.
    a) General - An unconfined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe, and a frame. The frame facilitates transport and placement of the system, keeps the aeration pipes stable, and provides ballast to counteract the buoyancy of the aeration pipes in operation.
    b) The aeration pipe system shall consist of multiple layers of perforated pipe rings, stacked vertically in accordance with the following:

Water Depth (m)	No. of Layers
0 to less than 5	2
5 to less than 10	4
10 to less than 15	7
15 to less than 20	10
20 to less than 25	13

    c) The pipes in all layers shall be arranged in a geometric pattern which shall allow for the pile being driven to be completely enclosed by bubbles for the full depth of the water column and with a radial dimension such that the rings are no more than 0.5 m from the outside surface of the pile.

        i. The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without burial and shall accommodate sloped conditions.
        ii. Air holes shall be 1.6 mm (1/16-in) in diameter and shall be spaced approximately 20 mm (3/4 in) apart. Air holes with this size and

spacing shall be placed in 4 adjacent rows along the pipe to provide uniform bubble flux.

iii. The system shall provide a bubble flux 3.0 m^3 per minute per linear meter of pipe in each layer (32.91 ft^3 per minute per lin ft of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

$$V_t = 3.0\ m^3/min/m * \text{Circumference of the aeration ring in m}$$

or

$$V_t = 32.91\ ft^3/min/ft * \text{Circumference of the aeration ring in ft}$$

iv. Meters shall be provided as follows:

- Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
- Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet, the flow meter at the compressor can be eliminated.
- Flow meters shall be installed according to the manufactures recommendation based on either laminar flow or non-laminar flow.

2) If water velocity is greater than 1.6 ft per second (1.1 miles per hour) at any point during installation or you are constructing a seawall, surround the pile or area being driven by a confined bubble curtain (e.g., a bubble ring surrounded by a fabric or non-metallic sleeve). The confined bubble curtain will distribute air bubbles around 100% of the pile perimeter for the full depth of the water column, according to specifications below.

   a) General - A confined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe(s), and a means of confining the bubbles.
   b) The confinement shall extend from the substrate to a sufficient elevation above the maximum water level expected during pile installation such that when the air delivery system is adjusted properly, the bubble curtain does not act as a water pump (i.e., little or no water should be pumped out of the top of the confinement system).
   c) The confinement shall contain resilient pile guides that prevent the pile and the confinement from coming into contact with each other and do not transmit vibrations to the confinement sleeve and into the water column (e.g., rubber spacers, air filled cushions).
   d) In water less than 15 m deep, the system shall have a single aeration ring at the substrate level. In waters greater than 15 m deep, the system shall have at least 2 rings: 1 at the substrate level and the other at mid-depth.

e) The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without sinking into the substrate and shall accommodate for sloped conditions.

f) Air holes shall be 1.6 mm (1/16-inch) in diameter and shall be spaced approximately 20 mm (3/4 inch) apart. Air holes with this size and spacing shall be placed in 4 adjacent rows along the pipe to provide uniform bubble flux.

g) The system shall provide a bubble flux of 2.0 m^3 per minute per linear meter of pipe in each layer (21.53 ft^3 per minute per lin ft of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

Vt = 2.0 m3/min/m * Circumference of the aeration ring in m

or

Vt = 21.53 ft3/min/ft * Circumference of the aeration ring in ft

(h) Flow meters shall be provided as follows:

i. Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.

ii. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet, the flow meter at the compressor can be eliminated.

iii. Flow meters shall be installed according to the manufacturer's recommendation based on either laminar flow or non-laminar flow.