



UNITED STATES DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office

263 13th Avenue South

St. Petersburg, Florida 33701-5505

<http://sero.nmfs.noaa.gov>

F/SER31:JC
SER-2017-18630

AUG 17 2017

Chief, Fort Myers Section
Jacksonville District Corps of Engineers
Department of the Army
1520 Royal Palm Square Boulevard, Suite 310
Fort Myers, Florida 33919

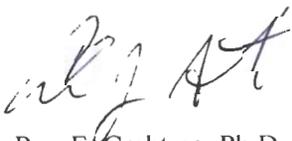
Ref.: SAJ-2017-1239 (NW-SJR), Busche Seawall Installation, Cape Coral, Lee County, Florida

Dear Sir or Madam:

The enclosed Biological Opinion (“Opinion”) was prepared by the National Marine Fisheries Service (NMFS) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA). The Opinion considers the effects of a proposal by the Jacksonville District of the U.S. Army Corps of Engineers (USACE) to authorize concrete seawall installation and mangrove removal under the authorities of Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act on the following listed species and/or critical habitat: loggerhead (Northwest Atlantic Ocean distinct population segment ([DPS]), Kemp’s ridley, and green (North and South Atlantic DPS) sea turtles; smalltooth sawfish (U.S. DPS); and smalltooth sawfish critical habitat. NMFS concludes that the proposed action is not likely to adversely affect the sea turtle species listed above and smalltooth sawfish. NMFS determined the project is likely to adversely affect, but is not likely to destroy or adversely modify, smalltooth sawfish critical habitat.

Please direct questions regarding this Opinion to Joseph Cavanaugh, Consultation Biologist, by phone at (727) 551-5097, or by email at Joseph.Cavanaugh@noaa.gov.

Sincerely,


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

Enclosures:

Biological Opinion
Sea Turtle and Smalltooth Sawfish Construction Conditions, dated March 23, 2006

File: 1514-22 F.4

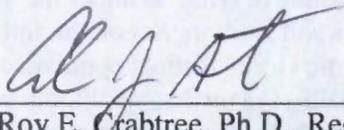


**Endangered Species Act - Section 7 Consultation
Biological Opinion**

Action Agency: U.S. Army Corps of Engineers (USACE), Jacksonville District
Applicant: Nick Busche
Activity: Shoreline stabilization installing concrete seawall with red mangrove removal within smalltooth sawfish critical habitat, Cape Coral, Lee County, Florida
Consulting Agency: National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Southeast Regional Office, Protected Resources Division, St. Petersburg, Florida

Consultation Number SER-2017-18630

Approved by:



Roy E. Crabtree, Ph.D., Regional Administrator
NMFS, Southeast Regional Office
St. Petersburg, Florida

Date Issued:

August 17, 2017

Table of Contents

1	INTRODUCTION	5
2	CONSULTATION HISTORY	5
3	DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA	5
4	STATUS OF LISTED SPECIES AND CRITICAL HABITAT	8
5	ENVIRONMENTAL BASELINE.....	20
6	EFFECTS OF THE ACTION ON CRITICAL HABITAT	22
7	CUMULATIVE EFFECTS	23
8	INTEGRATION AND SYNTHESIS	24
9	CONCLUSION.....	28
10	INCIDENTAL TAKE STATEMENT	29
11	CONSERVATION RECOMMENDATIONS.....	29
12	REINITIATION OF CONSULTATION.....	30
13	LITERATURE CITED	30

List of Figures

Figure 1. Image showing Nick Busche project site (white arrow) (©Google 2017).....	7
Figure 2. Image showing project location (white arrow) in relation to surrounding canals and the nearest outlet into the Caloosahatchee River (white rectangle) (©Google 2017)	7
Figure 3. Map of smalltooth sawfish critical habitat – Charlotte Harbor Estuary Unit (CHEU) 11	
Figure 4. Diagram A depicts a cross section of a historically-dredged channel/canal within the boundaries of the critical habitat units that has not been maintained. Diagram B depicts the typical cross section of a maintenance dredged channel/canal. Diagram C depicts a cross section of a maintained dredged channel/canal after sea level rise of > 1 ft.....	16
Figure 5. From left to right: current shoreline, + 3.5 in (+ 9 cm); + 18.5 in (+ 47 cm); and + 38.97 in (+ 99 cm) sea level rise by 2060.	18
Figure 6. Image showing the Nick Busche project site in relation to the surrounding mangrove islands that are part of the CHPSP (©Google 2017); large rectangle areas are smalltooth sawfish “hot spot” areas with high juvenile abundances	21

List of Tables

Table 1. ESA-listed Species and Critical Habitat in or Near to Action Area	8
Table 2. Effects Determinations for Designated Critical Habitat Occurring In or Near the Action Area.....	8
Table 3. Summary of Impacts to the Red Mangrove Essential Feature.....	27

Acronyms and Abbreviations

CFR	Code of Federal Regulations
CHEU	Charlotte Harbor Estuary Unit
CHPSP	Charlotte Harbor Preserve State Park
CO ₂	Carbon Dioxide
DPS	Distinct Population Segment

EFH	Essential Fish Habitat
ESA	Endangered Species Act
FWRI	Fish and Wildlife Research Institute
GMFMC	Gulf of Mexico Fishery Management Council
IPCC	Intergovernmental Panel on Climate Change
LAA	Likely to Adversely Affect
MHWL	Mean High Water Line
MLLW	Mean Low Lower Water
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NOAA	National Ocean and Atmospheric Association
Opinion	Biological Opinion
RPMs	Reasonable and Prudent Measures
USACE	U.S. Army Corps of Engineers
YOY	Young-of-the-year

Units of Measurement

Temperature

°F	degrees Fahrenheit
°C	degrees Celsius

Length and Area

ac	acre(s)
cm	centimeter(s)
ft	foot/feet
ft ²	square feet
in	inches
km	kilometer(s)
lin ft	linear feet
m	meter(s)
mi	miles
mi ²	square miles

1 INTRODUCTION

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 such 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 such species; Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary on any such action. NMFS and the U.S. Fish and Wildlife Service (USFWS) share responsibilities for administering the ESA.

Consultation is required when a federal action agency determines that a proposed action “may affect” listed species or designated critical habitat. Consultation is concluded after NMFS determines that the action is not likely to adversely affect listed species or critical habitat or issues a Biological Opinion (“Opinion”) that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat. The Opinion states the amount or extent of incidental take of the listed species that may occur, develops measures (i.e., reasonable and prudent measures - RPMs) to reduce the effect of take, and recommends conservation measures to further the recovery of the species. Notably, no incidental destruction or adverse modification of designated critical habitat can be authorized, and thus there are no RPMs—only reasonable and prudent alternatives that must avoid destruction or adverse modification.

This document represents NMFS’s Opinion based on our review of impacts associated with the proposed action to issue a permit within Lee County, Florida. This Opinion analyzes the project’s effects on threatened and endangered species and designated critical habitat, in accordance with Section 7 of the ESA. We based our Opinion on project information provided by the USACE and other sources of information, including the published literature cited herein.

2 CONSULTATION HISTORY

NMFS received a request for a formal consultation under Section 7 of the ESA from the USACE dated May 2, 2017. The USACE determined that the proposed project may affect, but is not likely to adversely affect swimming sea turtles (Kemp’s ridley, green, and loggerhead) and smalltooth sawfish, may affect smalltooth sawfish critical habitat, and requested NMFS’s concurrence. NMFS requested additional information via email on June 5, 2017, and we received a final response on the same day. We initiated formal consultation on June 5, 2017, once all necessary information was received.

3 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

3.1 Proposed Action

The project site is a single-family lot located in a residential canal that is part of an extensive Cape Coral residential canal community. The project site is located approximately 4.5 miles (mi) navigating by vessel from the project site out into the Caloosahatchee River. The applicant proposes to install 80 linear feet (lin ft) of concrete seawall at the mean high water line (MHWL) along 80 lin ft of unconsolidated shoreline necessitating the removal of approximately 55 lin ft

(approximately 425 square feet [ft²]) of red mangroves. There are 3 clumps of existing mangroves along the 80 lin ft of shorefront (25 ft + 25 ft + 5 ft = 55 lin ft total). The mangroves will be removed by mechanical equipment (e.g., excavator) and the concrete seawall will be installed by jetting; all work will be done using equipment located in uplands. There are no shallow-water impacts from the seawall installation since it will be installed at the MHWL (S. Rabney, USACE, pers. comm. to J. Cavanaugh, NMFS, June 5, 2017).

In-water construction is expected to take approximately 2 days and will be done during daylight hours only. The applicant will be required by permit condition to use turbidity controls and comply with NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006 (enclosed).

3.2 Action Area

The project is located at 26.55800°N, 82.02741°W, North American Datum 1983, within a dredged residential canal which has a mixture of consolidated shorelines (e.g., seawalls) fronting residences and unconsolidated shoreline where there are vacant lots such as the proposed action area. The entire residential canal community is bordered by extensive mangrove islands (Figures 1 and 2). The project site is located along the Hottelet Waterway within the greater residential canal system. The canal is mostly shoreline armored with either seawalls or riprap revetment. The property address is 5008 SW 26th Ave, Cape Coral, Lee County, Florida. The bottom habitat is sandy and no seagrasses in the project area. Water depths are shallow at the MHWL; however, no shallow-water area will be impacted by the proposed seawall because the seawall will be installed at MHWL (S. Rabney, USACE, pers. comm. to J. Cavanaugh, NMFS, June 5, 2017).

The action area is the shoreline immediately in front of the property. 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 includes the areas in which construction will take place, as well as the immediately surrounding water areas that may be impacted by direct (immediate) and indirect (later in time) effects of the actions.

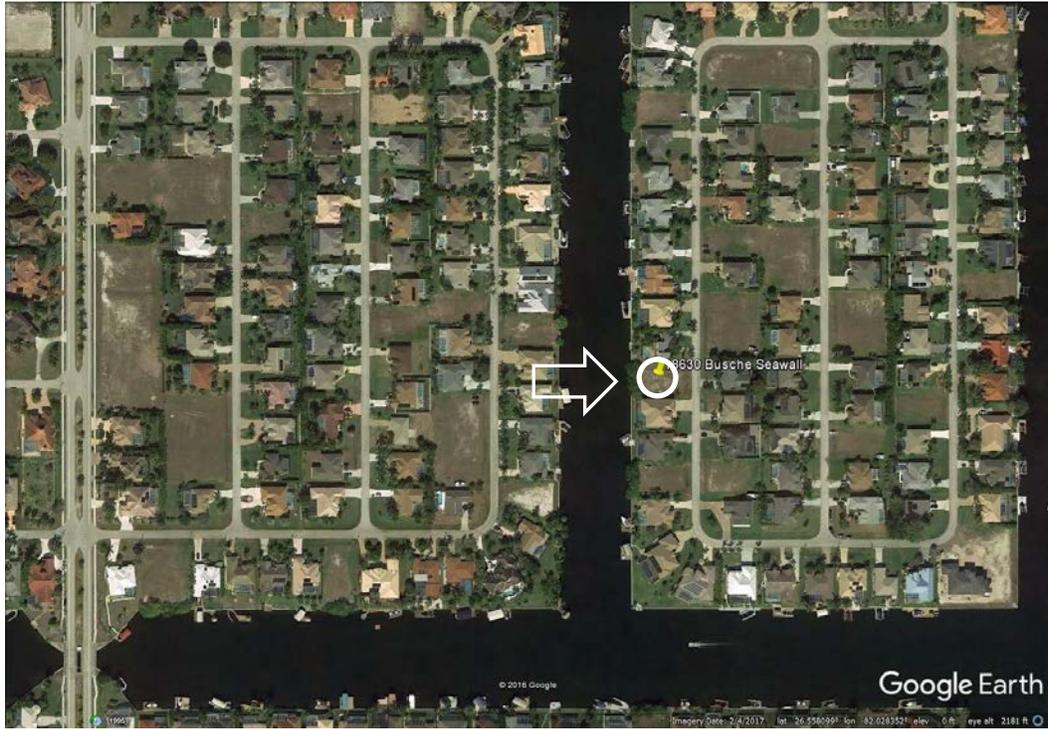


Figure 1. Image showing Nick Busche project site (white arrow) (©Google 2017)



Figure 2. Image showing project location (white arrow) in relation to surrounding canals and the nearest outlet into the Caloosahatchee River (white rectangle) (©Google 2017)

4 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

The following endangered (E) and threatened (T) species, and critical habitat under the jurisdiction of NMFS may occur in or near the action area (Tables 1-2):

Table 1. ESA-listed Species and Critical Habitat in or Near to Action Area

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Sea Turtles			
Green (North and South Atlantic distinct population segments [DPSs])	T	NLAA	NLAA
Kemp's ridley	E	NLAA	NLAA
Loggerhead (Northwest Atlantic Ocean DPS)	T	NLAA	NLAA
Fish			
Smalltooth sawfish (U.S. DPS)	E	NLAA	NLAA
E = endangered; T = threatened; NLAA = may affect, not likely to adversely affect			

Table 2. Effects Determinations for Designated Critical Habitat Occurring In or Near the Action Area

Species	Unit	USACE Effect Determination	NMFS Effect Determination
Smalltooth sawfish	Charlotte Harbor Estuary Unit (CHEU) for protection and restoration of nursery habitat	LAA	LAA, Will not destroy or adversely modify
LAA = likely to adversely affect			

In the following sections, we describe why we believe that smalltooth sawfish (U.S. DPS) and sea turtles (Kemp's ridley, green, [North Atlantic and South Atlantic DPS], and loggerhead [Northwest Atlantic Ocean DPS]) may be affected, but are not likely to be adversely affected, by the project, and why we believe that smalltooth sawfish critical habitat is likely to be adversely affected, but not destroyed or adversely modified.

4.1 Species Not Likely to be Adversely Affected

Sea Turtles and Smalltooth Sawfish

We have identified the following potential effects to sea turtles and smalltooth sawfish. We believe that the species are not likely to be adversely affected by the proposed in-water construction activities for the following reasons:

1. Sea turtles and smalltooth sawfish may be affected by avoiding or being temporarily unable to use the site due to avoidance of construction activities, related noise (e.g., mechanical removal of mangroves and seawall installation), and physical exclusion from the area blocked by turbidity curtains. These impacts will be insignificant due to the small project footprint and the project's limited duration (approximately 2 days [daylight hours only] for all in-water work), and the availability of alternative sites near the project site throughout the Cape Coral canal, some of which has unconsolidated shoreline fringed by mangroves that sawfish can use for foraging or refuge. In addition, with respect to sea turtles, because the project site is located approximately 4.5 miles inland through an extensive canal system from the Caloosahatchee River, we believe it does not provide preferred foraging or refuge habitat to sea turtles. Therefore, we believe it is unlikely that the project site is providing preferred foraging or refuge habitat to sea turtles, which further supports our conclusion that the temporary loss of habitat use (exclusion from mangroves during construction) will have insignificant effects on sea turtles. Likewise, with respect to smalltooth sawfish, given the much greater areas of red mangrove habitat available throughout the residential canal system and the extensive habitat available in the surrounding mangrove islands just outside of the canal system (4.5 mi from the project site), NMFS believes the inability to access the red mangroves during construction will have an insignificant effect on smalltooth sawfish.
2. Juvenile smalltooth sawfish may be affected by the permanent loss of red mangroves associated with the proposed action. Juvenile sawfish use the nearshore shallow water and red mangroves for foraging and refuge. The onsite red mangroves (55 lin ft) will be removed and permanently lost from the project area due to seawall installation and associated backfill. Given the much greater areas of red mangrove habitat available throughout the residential canal system and the extensive habitat available in the surrounding mangrove islands just outside of the canal system (4.5 mi), NMFS believes the permanent loss of these red mangroves within the project footprint will have an insignificant effect on smalltooth sawfish. Additionally, smalltooth sawfish will continue to be able to transit within the canal/waterway post-construction and, through extensive mangrove areas throughout the mangrove-fringed islands surrounding the residential canal system – these foraging and refuge resources will remain available to these species post-construction. Therefore, NMFS believes that effects to smalltooth from the permanent loss of red mangroves will be insignificant. Whether impacts to the red mangrove essential feature of smalltooth sawfish critical will appreciably diminish the value of critical habitat for the conservation of the species is discussed further in Section 8. Sea turtles do not have preferred foraging habitat in the project area. Although sea turtles could be found in the residential canals that include the project site, their preferred foraging habitats (species dependent) include mangrove fringed islands and natural hardbottom areas and grassbeds – all found outside of the residential canals within the adjacent Matlacha Pass Aquatic Preserve. Therefore, we believe it is unlikely that the project site is providing preferred foraging or refuge habitat to sea turtles, and thus we believe that permanent loss of habitat (e.g., mangroves) in the proposed action will have insignificant effects on sea turtles.

3. Sea turtles and smalltooth sawfish may be affected by being struck by mechanical equipment used for seawall installation and mangrove removal. Sea turtles and smalltooth sawfish are mobile species and expected to avoid the project area during seawall installation and mechanically removing mangroves which will occur over a small area and short duration (2 days during daylight hours). Therefore, NMFS believes that physical impacts directly related to in-water construction equipment are discountable. The applicant's implementation of NMFS's Sea Turtle and Smalltooth Sawfish Construction Conditions will further reduce the risk by requiring all construction workers watch for smalltooth sawfish and sea turtles. Operation of any mechanical construction equipment will cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities will not resume until the protected species has departed the project area of its own volition.

4.2 Status of Critical Habitat Likely to be Adversely Affected

Smalltooth Sawfish Critical Habitat

The U.S. Distinct Population Segment (DPS) of smalltooth sawfish was listed as endangered on April 1, 2003; however, at that time, NMFS was unable to determine critical habitat. After funding additional studies necessary for the identification of specific habitats and environmental features important for the conservation of the species, establishing a smalltooth sawfish recovery team, and reviewing the best scientific data available, NMFS issued a Final Rule (74 Federal Register [FR] 45353; see also 50 CFR § 226.218) to designate critical habitat for the U.S. DPS of smalltooth sawfish on September 2, 2009. The critical habitat consists of 2 units located along the southwestern coast of Florida: the Charlotte Harbor Estuary Unit (CHEU), which is comprised of approximately 221,459 acres (ac) (346 square miles [mi²]) of coastal habitat, and the Ten Thousand Islands/Everglades Unit (TTIU), which is comprised of approximately 619,013 ac (967 mi²) of coastal habitat.

Critical Habitat Unit Affected by this Action

This consultation focuses on an activity occurring in the CHEU, which encompasses portions of Charlotte and Lee Counties (Figure 3). The CHEU is comprised of Charlotte Harbor, Gasparilla Sound, Matlacha Pass, Pine Island Sound, San Carlos Bay, and Estero Bay. The unit is fed by the Myakka and Peace Rivers to the north and the Caloosahatchee River to the east. A series of passes between barrier islands connect the CHEU with the Gulf of Mexico. The CHEU is a relatively shallow estuary with large areas of submerged aquatic vegetation, oyster bars, saltwater marsh, freshwater wetlands, and mangroves. Freshwater flows from the Caloosahatchee River are controlled by the Franklin Lock and Dam, which periodically releases water, which thereby affects downstream salinity regimes. The CHEU boundaries are defined in detail in the Final Rule (74 FR 45353; see also 50 CFR § 226.218).

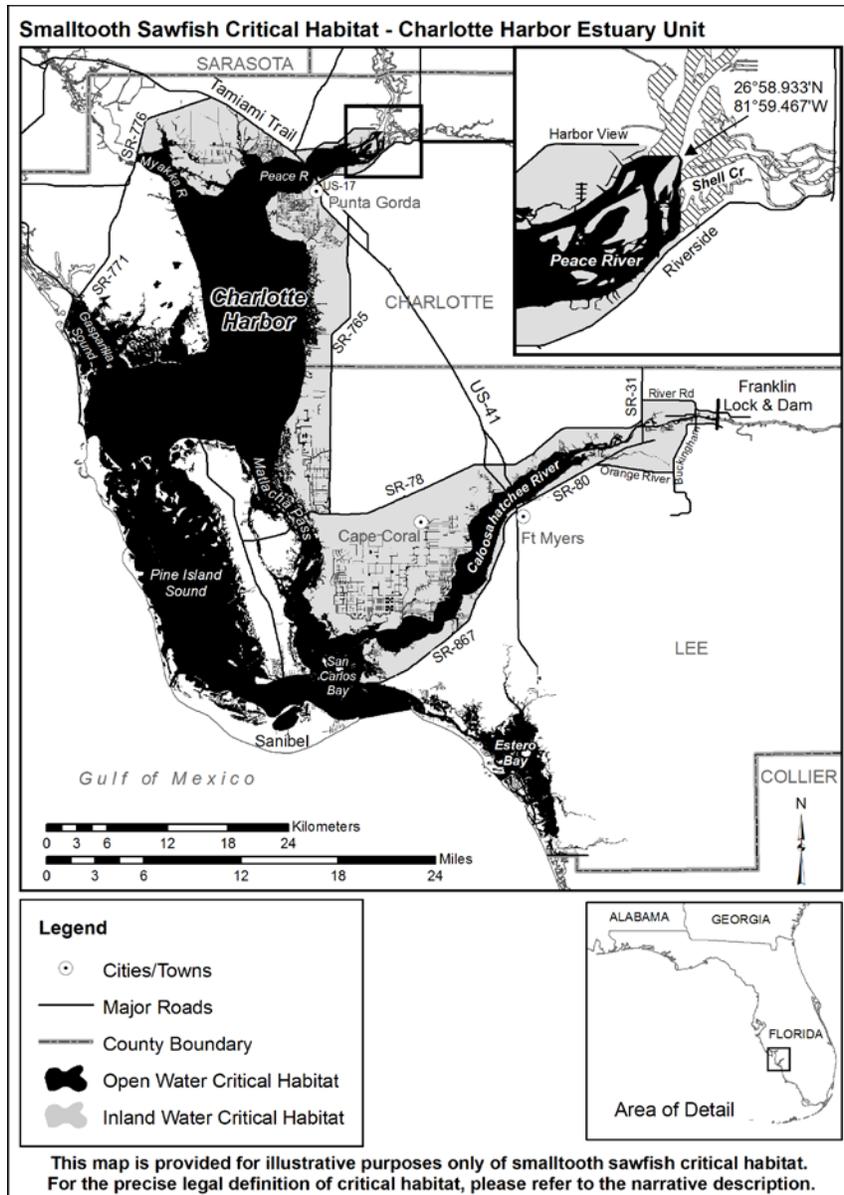


Figure 3. Map of smalltooth sawfish critical habitat – Charlotte Harbor Estuary Unit (CHEU)

Essential Features of Critical Habitat

The recovery plan developed for the smalltooth sawfish, which represents NMFS’s best judgment about the objectives and actions necessary for the species’ recovery, identified a need to increase the number of juvenile smalltooth sawfish developing into adulthood by protecting or restoring nursery habitat. NMFS determined that without sufficient habitat, the population was unlikely to increase to a level associated with low extinction risk and de-listing. Therefore, NMFS identified 2 habitat features essential for the conservation of this species: (1) red mangroves, and (2) shallow, euryhaline habitats (shallow, euryhaline habitats) characterized by water depths between the mean high water line (MHWL) and -3 ft (-0.9 meters [m]) measured at mean lower low water (MLLW) (Final Rule, 74 FR 45353). These essential features of critical

habitat provide juveniles refuge from predation and forage opportunities within their nursery habitat. One or both of these essential features must be present in an action area for it to function as critical habitat for smalltooth sawfish.

Habitat Use

Juvenile smalltooth sawfish, identified as those up to 3 years of age or approximately 8 ft (2.4 meters [m]) in length (Simpfendorfer et al. 2008), inhabit the shallow waters of estuaries and can be found in sheltered bays, dredged canals, along banks and sandbars, and in rivers (NMFS 2000). Juvenile smalltooth sawfish occur in euryhaline waters (i.e., waters with a wide range of salinities) and are often closely associated with muddy or sandy substrates, and shorelines containing red mangroves (Simpfendorfer 2001; 2003). The structural complexity of red mangrove prop roots creates a unique habitat used by a variety of fish, invertebrates, and birds. Juvenile smalltooth sawfish, particularly young-of-the-year (YOY) (measuring less than 39.4 inches (in) [100 centimeters (cm)] in length), use these areas as both refuge from predators and forage grounds; taking advantage of the large number of fish and invertebrates found there.

Tracking data from the Caloosahatchee River in Florida indicate very shallow depths and specific salinity ranges are important abiotic factors influencing juvenile smalltooth sawfish movement patterns, habitat use, and distribution (Simpfendorfer et al. 2011). An acoustic tagging study in a developed region of Charlotte Harbor, Florida, identified the importance of mangroves in close proximity to shallow-water habitat for juvenile smalltooth sawfish, stating that juveniles generally occur in shallow water within 328 ft (100 m) of mangrove shorelines (Simpfendorfer et al. 2010). Juvenile smalltooth sawfish spend the majority of their time in waters shallower than -13 ft (-4 m) deep (Simpfendorfer et al. 2010) and are seldom found deeper than -32 ft (-10 m) (Poulakis and Seitz 2004). Simpfendorfer et al. (2010) also indicated the following developmental differences in habitat use: the smallest YOY juveniles generally used water shallower than -1.6 ft (-0.5 m), had small home ranges, and exhibited high levels of site fidelity. Although small juveniles exhibit high levels of site fidelity for specific nursery habitats for periods of time lasting up to 3 months (Wiley and Simpfendorfer 2007), they undergo small movements coinciding with changing tidal stages. These movements often involve moving from shallow sandbars at low tide and among red mangrove prop roots at higher tides (Simpfendorfer et al. 2010), behavior likely to reduce the risk of predation (Simpfendorfer 2006). As juveniles increase in size, they begin to expand their home ranges (Simpfendorfer et al. 2010; Simpfendorfer et al. 2011), eventually moving to more offshore habitats where they likely feed on larger prey and eventually reach sexual maturity.

Researchers have identified several areas within the Charlotte Harbor Estuary that are disproportionately more important to juvenile smalltooth sawfish, based on intra- or inter-annual capture rates during random sampling events within the estuary (Poulakis 2012; Poulakis et al. 2011). The areas, termed “hot spots,” correspond with areas where public encounters are most frequently reported. Use of these hot spots can be variable within and among years based on the amount and timing of freshwater inflow. Smalltooth sawfish use hot spots further upriver during drought (i.e., high salinity) conditions and areas closer to the mouth of the Caloosahatchee River during times of high freshwater inflow (Poulakis et al. 2011). At this time, researchers are unsure what specific biotic (e.g., presence or absence of predators and prey) or abiotic factors (e.g., salinity) influence this habitat selection. Still, they believe a variety of conditions in

addition to salinity, such as temperature, dissolved oxygen, water depth, shoreline vegetation, and food availability, may influence smalltooth sawfish habitat selection (Poulakis et al. 2011).

Status and Threats to Critical Habitat

Modification and loss of smalltooth sawfish critical habitat is an ongoing threat contributing to the current status of the species. Activities such as agricultural and urban development, commercial activities, dredge-and-fill operations, boating, erosion, and diversions of freshwater runoff contribute to these losses (SAFMC 1998). Large areas of coastal habitat were modified or lost between the mid-1970s and mid-1980s within the United States (Dahl and Johnson 1991; USFWS 1999). Since then, rates of loss have decreased even though habitat loss continues. Between 1998 and 2004, approximately 2,450 ac (3.8 mi²) of intertidal wetlands consisting of mangroves or other estuarine shrubs were lost along the Atlantic and Gulf coasts of the United States (Stedman and Dahl 2008). In another study, Orlando et al. (1994) analyzed 18 major southeastern estuaries and recorded over 703 mi (1,131 kilometers [km]) of navigation channels and 9,844 mi (15,842 km) of shoreline with modifications. Additionally, changes to the natural freshwater flows into estuarine and marine waters through construction of canals and other water-control devices have altered the temperature, salinity, and nutrient regimes, reduced both wetlands and submerged aquatic vegetation coverage, and degraded vast areas of coastal habitat utilized by smalltooth sawfish (Gilmore 1995; Quigley and Flannery 2002; Reddering 1988; Whitfield and Bruton 1989). Juvenile sawfish and their critical habitat are particularly vulnerable to these kinds of habitat losses or alterations due to the juveniles' affinity for (and developmental need of) shallow, estuarine systems. Although many forms of habitat modification are currently regulated, some permitted direct and/or indirect damage to habitat from increased urbanization still occurs and is expected to continue in the future.

In Florida, coastal development often involves the removal of mangroves, the armoring of shorelines through seawall construction, and the dredging of canals. This is especially apparent in master plan communities such as Cape Coral and Punta Gorda which are located within the Charlotte Harbor Estuary. These communities were created through dredge-and-fill projects to increase the amount of waterfront property available for development, but in doing so, developers removed the majority of red mangrove habitat from the area. The canals created by these communities require periodic dredging for boat access, further affecting the shallow, euryhaline essential feature of critical habitat (See Figure 3, Diagrams A and B). Development continues along the shorelines of Charlotte Harbor in the form of docks, boat ramps, shoreline armoring, utility projects, and navigation channel dredging.

To protect critical habitat, federal agencies must ensure that their activities are not likely to result in the destruction or adverse modification of the physical and biological features that are essential to the conservation of sawfish, or the species' ability to access and use these features (ESA Section 7(a)(2); see also 50 CFR 424.12(b) (discussing essential features)). Therefore, proposed actions that may impact critical habitat require an analysis of potential impacts to each essential feature. As mentioned previously, there are 2 essential features of smalltooth sawfish critical habitat: (1) red mangroves; and (2) shallow, euryhaline habitats characterized by water depths between the MHWL and -3 ft (-0.9 m) measured at MLLW. The USACE oversees the permitting process for residential and commercial marine development in the CHEU. The Florida Department of Environmental Protection (FDEP) and their designated authorities also

regulate mangrove removal in Florida. All red mangrove removal permit requests with a federal nexus within smalltooth sawfish critical habitat necessitate ESA Section 7 consultation. NMFS Protected Resources Division tracks the loss of these essential features of smalltooth sawfish critical habitat.

Threats to Critical Habitat

Dock and Boat Ramp Construction

The USACE attempts to persuade applicants to construct docks in accordance with the NMFS-USACE *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation (SAV), Marsh, or Mangrove Habitat* (“Dock Construction Guidelines”) when possible. The current dock construction guidelines allow for some amount of mangrove removal; however, it is typically restricted to either (1) trimming to facilitate a dock, or (2) complete removal up to the width of the dock extending toward open water, which the guidelines define as a width of 4 ft.

Installation or replacement of boat ramps is often part of larger projects such as marinas, bridge approaches, and causeways where natural and previously created deepwater habitat access channels already exist. Boat ramps can result in the permanent loss of both the red mangrove and the shallow, euryhaline habitat features of critical habitat for smalltooth sawfish.

Marina Construction

Marinas have the potential to adversely affect aquatic habitats. Marinas are typically designed to be deeper than -3 ft MLLW to accommodate vessel traffic; therefore, most existing marinas lacking essential features are unlikely to function as critical habitat for smalltooth sawfish. The expansion of existing marinas and creation of new marinas can result in the permanent loss of large areas of this nursery habitat.

Bulkhead and Seawall Construction

Bulkheads and other shoreline stabilization structures are used to protect adjacent shorelines from wave and current action and to enhance water access. These projects may adversely impact critical habitat for smalltooth sawfish by removal of the essential features through direct filling and dredging to construct vertical or riprap seawalls. Generally, vegetation plantings, sloping riprap, or gabions are environmentally-preferred shoreline stabilization methods instead of vertical seawalls because they provide better quality fish and wildlife habitat. Nevertheless, placement of riprap material removes more of the shallow euryhaline essential feature than a vertical seawall. Also, many seawalls built along unconsolidated shorelines require the removal of red mangroves to accommodate the seawalls.

Cable, Pipeline, and Transmission Line Construction

While not as common as other activities, excavation of submerged lands is sometimes required for installing cables, pipelines, and transmission lines. Construction may also require temporary or permanent filling of submerged habitats. Open-cut trenching and installation of aerial transmission line footers are activities that have the ability to temporarily or permanently impact critical habitat for smalltooth sawfish.

Transportation Infrastructure Construction

Potential adverse effects from federal transportation projects in smalltooth sawfish critical habitat (CHEU) include operations of the Federal Highway Administration, USACE, and the Federal Emergency Management Agency. Construction of road improvement projects typically follow the existing alignments and expand to compensate for the increase in public use.

Transportation projects may impact critical habitat for smalltooth sawfish through installation of bridge footers, fenders, piles, and abutment armoring, or through removal of existing bridge materials by blasting or mechanical efforts.

Dredging

Riverine, nearshore, and offshore areas are dredged for navigation, construction of infrastructure, and marine mining. An analysis of 18 major southeastern estuaries conducted in 1993-94 demonstrated that over 7,000 km of navigation channels have already been dredged (Orlando et al. 1994). Habitat effects of dredging include the loss of submerged habitats by disposal of excavated materials, turbidity and siltation effects, contaminant release, alteration of hydrodynamic regimes, and fragmentation of physical habitats (GMFMC 1998; GMFMC 2005; SAFMC 1998). In the CHEU, dredging to maintain canals and channels constructed prior to the critical habitat designation, limits the amount of available shallow, euryhaline habitat essential feature to the edges of waterways and these dredging activities can disturb juveniles that are using these areas. At the time of critical habitat designation, many previously dredged channels and canals existed within the boundaries of the critical habitat units; however, we are unsure which of those contained the shallow-water essential feature at that time. It is likely that many of these channels and canals were originally dredged deeper than 3 ft MLLW, but they have since shoaled in and now contain the essential feature of shallow, euryhaline habitat. Therefore, maintenance dredging impacts are counted as a loss to this essential feature, even though the areas may or may not have contained the essential feature at time of designation (see Figure 4, Diagrams A and B)

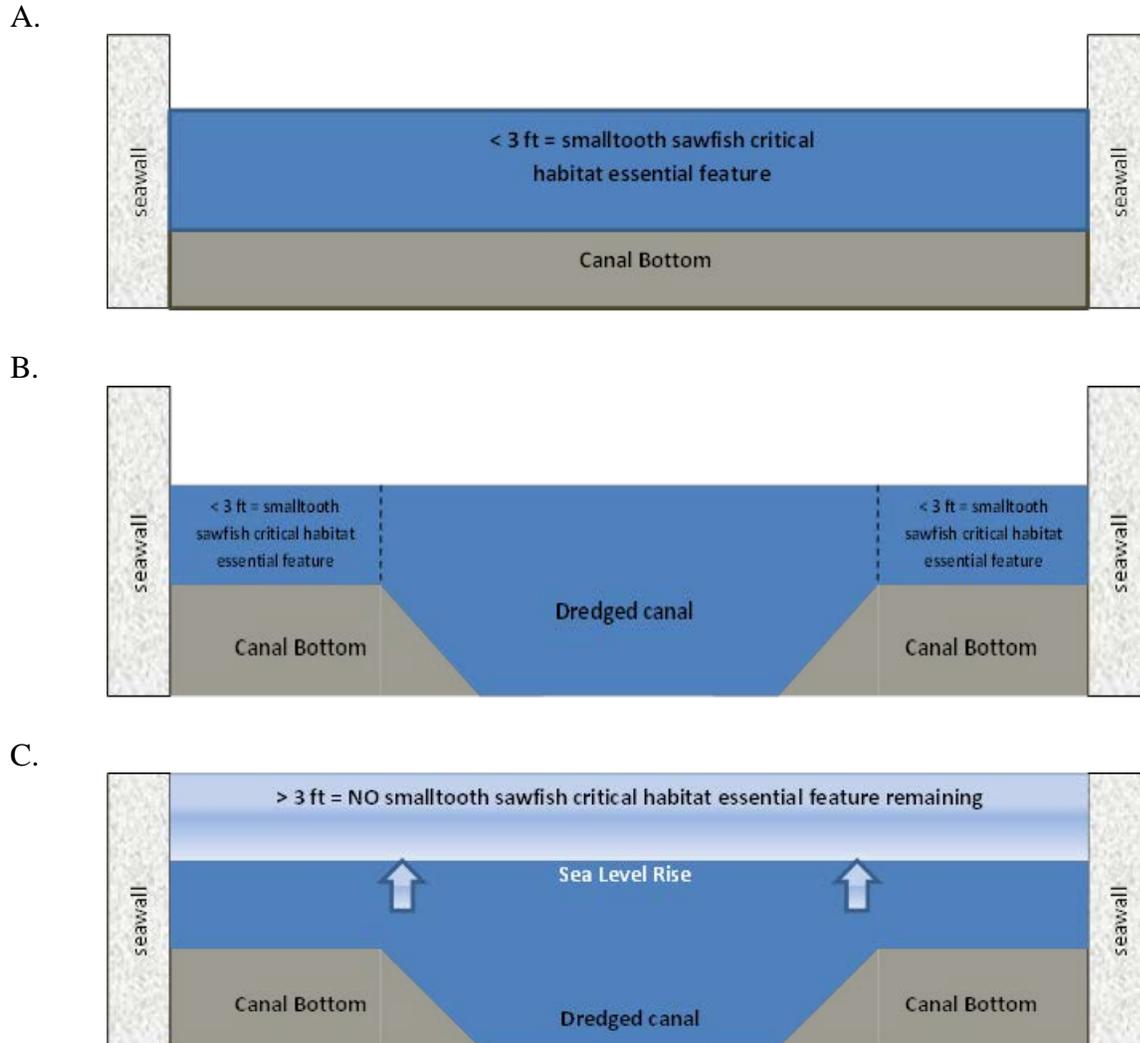


Figure 4. Diagram A depicts a cross section of a historically-dredged channel/canal within the boundaries of the critical habitat units that has not been maintained. Diagram B depicts the typical cross section of a maintenance dredged channel/canal. Diagram C depicts a cross section of a maintained dredged channel/canal after sea level rise of > 1 ft.

Construction, Operations and Maintenance of Impoundments and Other Water Level Controls

Federal agencies such as the USACE have historically been involved in large water control projects in Florida. Agencies sometimes propose impounding rivers and tributaries for such purposes as flood control, salt water intrusion prevention, or creation of industrial, municipal, and agricultural water supplies. Projects to repair or replace water control structures may affect smalltooth sawfish critical habitat by limiting sufficient freshwater discharge which could alter the salinity of estuaries. The ability of an estuary to function as a nursery depends upon the quantity, timing, and input location of freshwater inflows (Garmestani and Percival 2005; Norton et al. 2012; USEPA 1994). Estuarine ecosystems are vulnerable to the following human-induced disturbances: (1) decreases in seasonal inflow caused by the removal of freshwater upstream for agricultural, industrial, and domestic purposes; (2) contamination by industrial and sewage discharges; (3) agricultural runoff carrying pesticides, herbicides, and other toxic pollutants; and (4) eutrophication (e.g., influx of nutrients such as nitrates and phosphates most often from

fertilizer runoff and sewage) caused by excessive nutrient inputs from a variety of nonpoint and point sources. Additionally, rivers and their tributaries are susceptible to natural disturbances, such as floods and droughts, whose effects can be exacerbated by these man-made disturbances.

As stated above, smalltooth sawfish show an affinity for a particular salinity range, moving downriver during wetter months and upriver during drier months to remain within that range (Simpfendorfer et al. 2011). Therefore, water management decisions that affect salinity regimes may impact the functionality of critical habitat. This may result in smalltooth sawfish following specific salinity gradients into less advantageous habitats (e.g., areas with less shallow-water or red mangrove habitat). Furthermore, large changes in water flow over short durations would likely escalate movement patterns for smalltooth sawfish, thereby increasing predation risk and energy output. Researchers are currently looking into the effects of large-scale freshwater discharges on smalltooth sawfish and their designated critical habitat. The most vulnerable portion of the juvenile sawfish population to water management projects appears to be smalltooth sawfish in their first year of life. Newborn smalltooth sawfish remain in smaller areas irrespective of salinity, which potentially exposes them to greater osmotic stress (a sudden change in the solute concentration around a cell, causing a rapid change in the movement of water across its cell membrane), and impacts the nursery functions of sawfish critical habitat (Poulakis et al. 2013; Simpfendorfer et al. 2011).

Climate Change Threats

The Intergovernmental Panel on Climate Change has stated that global climate change is unequivocal and its impacts to coastal resources may be significant (IPCC 2007). There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities (i.e., global warming mostly driven by the burning of fossil fuels). The latest report by the IPCC (2013) is more explicit, stating that, “science now shows with 95% certainty that human activity is the dominant cause of observed warming since the mid-twentieth century.” Some of the anticipated outcomes are sea level rise, increased frequency of severe weather events, and changes in air and water temperatures. NOAA’s climate change web portal provides information on the climate-related variability and changes that are exacerbated by human activities (<http://www.climate.gov/#understandingClimate>). The EPA’s climate change webpage also provides basic background information on these and other measured or anticipated effects (<http://www.epa.gov/climatechange/index.html>).

Though the impacts on smalltooth sawfish cannot, for the most part, be predicted with any degree of certainty, we can project some effects to sawfish critical habitat. We know that both essential features (red mangroves and shallow, euryhaline waters less than 3 ft deep at MLLW) will be impacted by climate change. Sea level rise is expected to exceed 3.3 ft (1 m) globally by 2100, according to the most recent publications, exceeding the estimates of the Fourth Assessment of the IPCC (Meehl et al. 2007; Pfeffer et al. 2008; Rahmstorf et al. 2009). Mean sea level rise projections have increased since the Fourth Assessment because of the improved physical understanding of the components of sea level, the improved agreement of process-based models with observations, and the inclusion of ice-sheet dynamical changes (IPCC 2013). A 1-m sea level rise in the state of Florida is within the range of recent estimates by 2080 (Pfeffer et al. 2008; Rahmstorf et al. 2009).

Sea level increases would affect the shallow-water essential feature of smalltooth sawfish critical habitat within the CHEU. A 2010 climate change study by the Massachusetts Institute of Technology forecasted sea level rise in a study area with significant overlap with the CHEU (Vargas-Moreno and Flaxman 2010). The study investigated possible trajectories of future transformation in Florida's Greater Everglades landscape relative to 4 main drivers: climate change, shifts in planning approaches and regulations, population change, and variations in financial resources. MIT used (IPCC 2007) sea level modeling data to forecast a range of sea level rise trajectories from low, to moderate, to high predictions (Figure 5). The effects of sea level rise on available shallow-water habitat for smalltooth sawfish would be exacerbated in areas where there is shoreline armoring (e.g., seawalls). This is especially true in canals where the centerlines are maintenance-dredged deeper than -3 ft (0.9 m) for boat accessibility. In these areas, the areas that currently contain the essential feature depth (less than -3 ft at MLLW) will be reduced along the edges of the canals as sea level rises (see previous Figure 4).

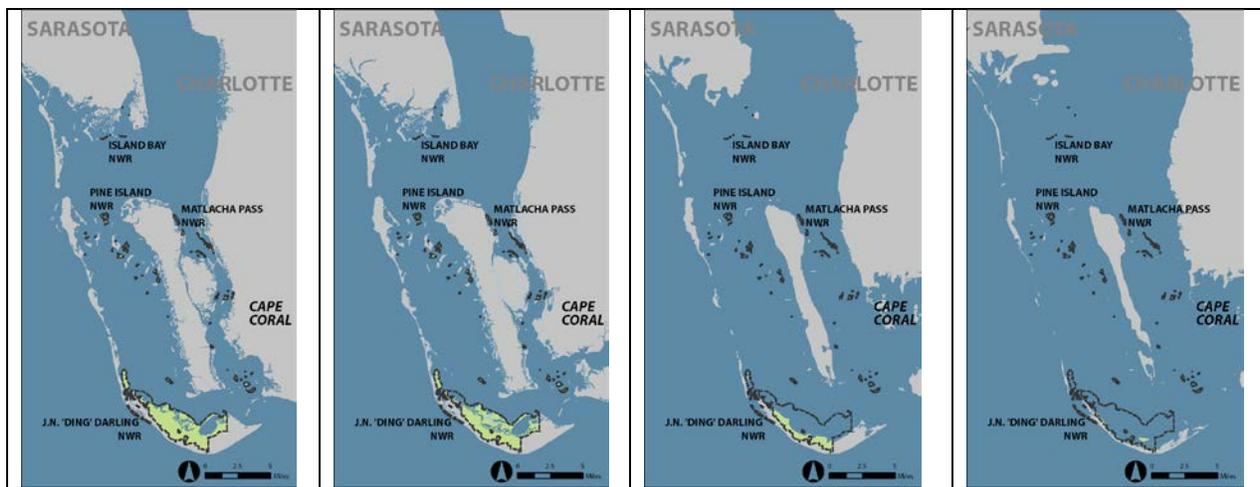


Figure 5. From left to right: current shoreline, + 3.5 in (+ 9 cm); + 18.5 in (+ 47 cm); and + 38.97 in (+ 99 cm) sea level rise by 2060¹.

Along the Gulf Coast of Florida, and south Florida in particular, rises in sea level will impact mangrove resources. As sea levels rise, mangroves will be forced landward in order to remain at a preferred water inundation level and sediment surface elevation, which is necessary for successful growth. This retreat landward will not keep pace with conservative projected rates of elevation in sea level (Gilman et al. 2008). This forced landward progression poses the greatest threat to mangroves in areas where there is limited or no room for landward or lateral migration (Semenuk 1994). Such is the case in areas of the CHEU where landward mangrove growth is restricted by shoreline armoring and coastal development. This man-made barrier will prohibit mangroves from moving landward and will result in the loss of the mangrove essential feature.

Other threats to mangroves result from climate change: fluctuations in precipitation amounts and distribution, seawater temperature, CO₂ levels, and damage to mangroves from increasingly severe storms and hurricanes (McLeod and Salm 2006). A 25% increase in precipitation

¹ Adapted from (Vargas-Moreno and Flaxman), M. Addressing the Challenges of Climate Change in the Greater Everglades Landscape. Project Sheet. November, 2010. Department of Urban Planning, MIT.

globally is predicted by 2050 (McLeod and Salm 2006), but the specific geographic distribution will vary, leading to increases and decreases in precipitation at the regional level. Changes in precipitation patterns caused by climate change may adversely affect the growth of mangroves and their distribution (Field 1995; Snedaker 1995). Decreases in precipitation will increase salinity and inhibit mangrove productivity, growth, seedling survival, and spatial coverage (Burchett et al. 1984). Decreases in precipitation may also change mangrove species composition, favoring more salt-tolerant types (Ellison 2010). Increases in precipitation may benefit some species of mangroves, increasing spatial coverage and allowing them to out-compete other salt marsh vegetation (Harty 2004). Even so, potential mangrove expansion requires suitable habitat for mangroves to increase their range, which depends to a great extent on patterns and intensity of coastal development (i.e., bulkhead and seawall construction).

Seawater temperature changes will have potential adverse effects on mangroves as well. Many species of mangroves show an optimal shoot density in sediment temperatures between 59°-77°F (15°-25°C) (Hutchings and Saenger 1987). Yet, at temperatures between 77°-95°F (25°-35°C), many species begin to show a decline in leaf structure and root and leaf formation rates (Saenger and Moverley 1985). Temperatures above 95°F lead to adverse effects on root structure and survivability of seedlings (UNESCO 1992) and temperatures above 100.4°F (38°C) lead to a cessation of photosynthesis and mangrove mortality (Andrews et al. 1984). Although impossible to forecast precisely, sea surface ocean temperatures are predicted to increase 1.8°-3.6°F (1°-2°C) by 2060 (Chapter 11 (IPCC 2013)), which will in turn impact underlying sediment temperatures along the coast. If mangroves shift pole-ward in response to temperature increases, they will at some point be limited by temperatures at the lower end of their optimal range and available recruitment area. This is especially true when considering already armored shorelines in residential communities such as those within and surrounding the CHEU of critical habitat for smalltooth sawfish.

As atmospheric CO₂ levels increase, mostly resulting from human-induced causes (e.g., burning of fossil fuels), the world's oceans will absorb much of this CO₂, causing potential increases in photosynthesis and mangrove growth rates. This increase in growth rate, however, would be limited by lower salinities expected from CO₂ absorption in the oceans (Ball et al. 1997), and by the availability of undeveloped coastline for mangroves to expand their range. A secondary effect of increased CO₂ concentrations in the oceans is the deleterious effect on coral reefs' ability to absorb calcium carbonate (Hoegh-Guldberg et al. 2007), and subsequent reef erosion. Eroded reefs may not be able to buffer mangrove habitats from waves, especially during storm/hurricane events, causing additional physical effects.

Finally, the anticipated increase in the severity of storms and hurricanes may also impact mangroves. Tropical storms are expected to increase in intensity and/or frequency, which will directly impact existing mangroves that are already adversely impacted by increased seawater temperatures, CO₂, and changes in precipitation (Cahoon et al. 2003; Trenberth 2005). The combination of all of these factors may lead to reduced mangrove height (Ning et al. 2003). Further, intense storms could result in more severe storm surges and lead to potential changes in mangrove community composition, mortality, and recruitment (Gilman et al. 2006). Increased storm surges and flooding events could also affect mangroves' ability to photosynthesize (Gilman et al. 2006) and reduce oxygen concentrations in the mangrove lenticels (Ellison 2010).

5 ENVIRONMENTAL BASELINE

This section describes the effects of past and ongoing human and natural factors contributing to the current status of the affected smalltooth sawfish critical habitat in the action area. The environmental baseline describes the critical habitat's health based on information available at the time of this consultation.

By regulation (50 CFR 402.02), environmental baselines for Biological Opinions include the past and present impacts of all state, federal, or private actions and other human activities in, or having effects 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 defined in 50 CFR 402.11), as well as the impact of state or private actions, or the impacts of natural phenomena, which are concurrent with the consultation in process (50 CFR 402.02).

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 critical habitat. We can focus on areas of designated critical habitat that occur in an action area that may be exposed to effects from the action under consultation. This is important because in some areas, critical habitat features will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other areas. These localized stress responses or stressed baseline conditions may increase the severity of the adverse effects expected from the proposed action.

5.1 Status of Critical Habitat within the Action Area

The project site is a single-family lot, located approximately 4.5 miles from the Caloosahatchee heading southeast out through the nearest vessel channel outlet (Figure 6). The benthos (water bottom) at the site is described as sandy bottom. There are 55 lin ft of red mangroves along the property shorefront and all mangroves are slated for removal in order to install 80 lin ft of seawall and associated backfill. The extensive residential, manmade canal system in Cape Coral is adjacent to the Charlotte Harbor Preserve State Park (CHPSP). The CHPSP is comprised of 43,000 acres and protects 80 miles of shoreline habitat along the Charlotte Harbor estuaries in Charlotte and Lee Counties, providing a buffer between the aquatic preserves and urban development and agriculture (Charlotte Harbor Aquatic Preserves Management Plan, 2016).



Figure 6. Image showing the Nick Busche project site in relation to the surrounding mangrove islands that are part of the CHPSP (©Google 2017); large rectangle areas are smalltooth sawfish “hot spot” areas with high juvenile abundances

5.2 Factors Affecting Critical Habitat within the Action Area

Federal Actions

Since the designation of smalltooth sawfish critical habitat on September 2, 2009, we have consulted on several shoreline stabilization (shoreline armoring necessitating red mangrove and shallow-water habitat removal) projects in the greater residential canal system where the project is located; however, no other federal permitted projects are known to have occurred within the action area as defined in Section 3, as per a review of the NMFS PRD’s completed consultation database (June 21, 2017).

USACE Authorized Marine Construction Permitting

The USACE issues permits under the Clean Water Act and Rivers and Harbors Act for coastal in-water marine construction, including actions to consolidate shoreline abutting residential properties for new home construction. Consolidation of shoreline usually involves shoreline armoring, such as seawall and riprap revetment, which often necessitates the removal of mangroves and disturbance of submerged aquatic vegetation (e.g., seagrasses that are covered by riprap). In the action area, state and county ordinances often require shoreline armoring before building on vacant lots is allowed. Although individual shoreline armoring projects may be small in scale, cumulatively, these required armoring projects could have a potentially large effect on smalltooth sawfish critical habitat. This is particularly true given the limited options available under the ordinances for shoreline armoring. For example, alternatives to vertical

seawalls such as living shorelines are only an option for the required pre-construction shoreline armoring in limited instances.

State or Private Actions

Nonfederal activities that may adversely affect designated critical habitat for smalltooth sawfish in the action area include impacts from residential shoreline stabilization activities that do not require federal permits or otherwise have a federal nexus. The direct and indirect impacts from some of these activities are difficult to quantify. NMFS does not have any knowledge of state or private actions occurring in or near to the action area that would not also require a federal permit; the likelihood of a shoreline armoring project occurring in or near to the action area that does not require a federal permit for in-water construction work, for instance, is very small. Where possible, conservation actions in ESA Section 10 permits, ESA Section 6 cooperative agreements, and state permitting programs are being implemented or investigated to monitor or study impacts from these sources.

Other Potential Sources of Impacts to the Environmental Baseline

Stochastic events, such as hurricanes, are common throughout the range of smalltooth sawfish, especially in the current core of its range (i.e., south and southwest Florida). These events are by nature unpredictable, and their effect on the recovery of the species and on critical habitat is unknown; however, they have the potential to impede recovery directly if animals die as a result of them, or indirectly if critical habitat is damaged as a result of these disturbances. In 2005, Hurricane Charley likely damaged habitat, including mangroves, and around the action area.

Conservation and Recovery Actions Shaping the Environmental Baseline

Federal Essential Fish Habitat (EFH) consultation requirements pursuant to the Magnuson-Stevens Fishery Conservation and Management Act minimize and mitigate for losses of wetland and preserve valuable foraging and developmental habitat that is used by juvenile smalltooth sawfish, including areas that has been designated as smalltooth sawfish critical habitat. NMFS has designated mangrove and estuarine habitats as EFH as recommended by the Gulf of Mexico Fishery Management Council (GMFMC). Both essential features (shallow, euryhaline water less than 3 ft MLLW and red mangroves) are critical components of areas designated as EFH and receive a basic level of protection under the Magnuson-Stevens Act to the extent that the Act requires minimization of impacts to EFH resources.

6 EFFECTS OF THE ACTION ON CRITICAL HABITAT

6.1 Shallow-water Essential Feature Impacts

The shallow, euryhaline essential feature of designated critical habitat is present adjacent to the unconsolidated shoreline; however, the seawall will be placed at the MHWL and this feature is outside of the footprint of the proposed seawall and will not be affected by the proposed action.

6.2 Red Mangrove Essential Feature Impacts

The red mangrove essential feature found within the CHEU of designated critical habitat for the U.S. DPS of smalltooth sawfish is present and is likely to be adversely affected by the seawall installation necessitating the removal of these mangroves. This will result in a permanent loss of approximately 55 lin ft of shoreline of the red mangrove habitat, which is potential forage and shelter area for juvenile smalltooth sawfish. Using remote sensing data acquired from the FWRI,

we were able to compile information relating to the total area of this essential feature within smalltooth sawfish critical habitat. Based on that information, we estimated that the total amount of red mangrove shoreline for the CHEU was approximately 5,512,320 lin ft (1,044 mi) at the time that smalltooth sawfish were listed under the ESA in 2003. While the available red mangrove essential feature in the CHEU will be diminished by 55 lin ft of shoreline, the project is not severing or preventing access to alternate refuge or forage areas at the site or in the surrounding area, for juvenile smalltooth sawfish. Still, some ecological function provided to juvenile smalltooth sawfish in terms of the red mangrove essential feature will be lost. Thus we believe the proposed removal of 55 lin ft of red mangroves is likely to adversely affect the red mangrove essential feature of smalltooth sawfish critical habitat.

7 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 (50 CFR 402.02).

Many threats to smalltooth sawfish critical habitat are expected to be exacerbated by the effects of global climate change (see Threats to Critical Habitat section). Potential increases in sea level may impact the availability of nursery habitat, particularly shallow euryhaline and red mangrove lined, low-lying coastal habitats (IPCC 2014; Wanless et al. 2005). Red mangroves could be negatively affected by increased temperatures, salinities, and acidification of coastal waters (Snedaker 1995), Wanless et al. 2005 (Scavia et al. 2002), as well as increased runoff and erosion due to the expected increase in extreme storm events (IPCC 2014; Wanless et al. 2005). These alterations of the marine environment due to global climate change could ultimately affect the distribution, physiology, and growth rates of red mangroves, potentially eliminating them from particular areas. The magnitude of these effects on smalltooth sawfish critical habitat are difficult to predict, yet the cyclical loss of habitat from extreme storm events combined with sea level rise may result in a decrease in areal coverage of red mangrove essential feature of smalltooth sawfish critical habitat (Norton et al. 2012; Scavia et al. 2002). However, this proposed action is of such a small scale, scope, and limited time frame that is not very likely to contribute to, or be affected cumulatively by climate change. Smalltooth sawfish habitat has been degraded or modified throughout the southeastern United States, including areas designated as critical habitat, from agriculture, urban development, commercial activities, channel dredging, boating activities, and the diversion of freshwater runoff.

No future actions with effects beyond those already described are reasonably certain to occur in the action area, and no other future state, tribal, or local private actions are reasonably certain to occur in the action area. The man-made canals within the CHEU will likely continue to experience the same types of actions described in the status of critical habitat in Section 3. These threats include shoreline armoring (e.g., seawall and/or riprap installation and associated red mangrove removal), canal dredging, and dock construction.

8 INTEGRATION AND SYNTHESIS

8.1 Critical Habitat Destruction/Adverse Modification Analysis

NMFS's regulations define *Destruction or adverse modification* to mean "a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (50 CFR § 402.02). Other alterations that may destroy or adversely modify critical habitat may include impacts to the area itself, such as those that would impede access to or use of the essential features. We intend the phrase "significantly delay" in development of essential features to encompass a delay that interrupts the likely natural trajectory of the development of physical and biological features in the designated critical habitat to support the species' recovery. NMFS will generally conclude that a Federal action is likely to "destroy or adversely modify" designated critical habitat if the action results in an alteration of the quantity or quality of the essential physical or biological features of designated critical habitat, or that precludes or significantly delays the capacity of that habitat to develop those features over time, and if the effect of the alteration is to appreciably diminish the value of critical habitat for the conservation of the species.

This analysis takes into account the geographic and temporal scope of the proposed action, recognizing that "functionality" of critical habitat necessarily means that it must now and must continue in the future to support the conservation of the species and progress toward recovery. The analysis must take into account any changes in amount, distribution, or characteristics of the critical habitat that will be required over time to support the successful recovery of the species. Destruction or adverse modification does not depend strictly on the size or proportion of the area adversely affected, but rather on the role the action area and the affected critical habitat serves with regard to the function of the overall critical habitat designation, and how that role is affected by the action.

In designating critical habitat for the smalltooth sawfish, we explained that the key conservation objective for the species is to facilitate recruitment of juveniles into the adult population by protecting juvenile areas. We determined that the habitat features essential to achieving that conservation objective are (1) shallow, euryhaline habitats characterized by water depths between the MHWL and 3 ft (0.9 m) measured at MLLW and (2) red mangrove shorelines. These essential features are necessary to facilitate recruitment of juveniles into the adult population because they provide for predator avoidance and habitat for prey. Impacts to designated critical habitat, thus, have the potential to destabilize recovery efforts and impede chances for recovery. The critical habitat designation for smalltooth sawfish is divided into 2 units in southwest Florida where the physical features essential to the species' conservation can be protected from destruction or adverse modification: the Charlotte Harbor Estuary Unit (CHEU) and the Ten Thousand Islands/Everglades Unit (TTIU). The proposed action is located within CHEU.

The smalltooth sawfish recovery plan identifies 3 recovery objectives (NMFS 2009). Recovery Objective #1 is to minimize human interactions and associated injury and mortality; this objective is not relevant to critical habitat. Recovery Objective #2 is to protect and/or restore

smalltooth sawfish habitats. Recovery Objective #3 is to ensure smalltooth sawfish abundance increases substantially and the species reoccupies areas from which it had previously been extirpated. Our analysis evaluates whether the anticipated impacts to critical habitat associated with the proposed action would interfere with the conservation objective behind the designated critical habitat—that is, facilitation of juvenile recruitment into a recovering adult population.

8.2 Protect and Restore Smalltooth Sawfish Habitat (Recovery Objective #2)

In establishing Recovery Objective #2, we recognized that recovery and conservation of smalltooth sawfish depends on the availability and quality of nursery habitats. Historically, juvenile sawfish were documented in mangrove and non-mangrove habitat in the southeastern United States. Due to the protections provided by the Ten Thousand Islands National Wildlife Refuge, Everglades National Park, and the Florida Keys National Marine Sanctuary, much of the historic juvenile smalltooth sawfish habitat in southwest Florida has remained high-quality juvenile habitat. Recovery Regions G, H, and I in southwest Florida extend from the Manatee River on the west coast of Florida south through Everglades National Park and the Florida Keys to Caesar Creek on the southeast coast of Florida. The CHEU is in Recovery Region G. While much of the CHEU is protected by the Charlotte Harbor Preserve State Park (CHPSP) system, it is also highly anthropomorphically influenced (See Section 5 “Environmental Baseline”).

The recovery plan states that for the three recovery regions with remaining high-quality habitats (i.e., Recovery Regions G, H, and I), juvenile habitats “must be maintained over the long term at or above 95% of the acreage available at the time of listing” (NMFS, 2009). To ensure that a proposed action will not impede Recovery Objective #2, we determine whether the critical habitat unit will be able to maintain 95% of its area after taking into account project impacts in the context of the status of the critical habitat, the environmental baseline, and cumulative effects. Although the CHEU is only part of the larger Recovery Region G, and the 95% protection requirement applies across not just Recovery Region G, but also Recovery Regions H and I, we believe it is appropriate to consider whether 95% of the habitat in the CHEU is maintained as that threshold seeks to protect nursery areas and the CHEU contains the only protected nursery areas within Recovery Region G. Below we estimate the percent impact the proposed action will have on the red mangrove shoreline essential feature of critical habitat within the CHEU.

Red Mangrove Essential Feature Impacts

Remote sensing data from FWRI indicated that approximately 5,512,320 lin feet of red mangrove shoreline (abbreviated RMS throughout this section) was available in the CHEU at the time of species listing in April 2003 (Table 3 Line 1). As described above, in our analysis we must determine whether project impacts will interfere with long-term maintenance of designated juvenile nursery habitat in the CHEU at or above 95% of the acreage available at the time of listing; however, loss of habitat was not formally monitored until critical habitat was designated in September 2009. Therefore, we must estimate habitat loss that occurred during the period between species listing and the designation of critical habitat.

To do this, first we need to calculate an annual loss rate of RMS in CHEU. We used a 7-year dataset of completed Section 7 consultations (September 2009 – September 2016) to generate an annual rate of loss that can then be used as a proxy to back-calculate the loss of RMS between

species listing and the time of critical habitat designation. We are relying on this 7-year dataset because using 7 complete years of information helps avoid over- or under-estimating the rate of habitat loss due to any potential inter-annual variability associated with economic growth and contraction that may have occurred in that time. During that time, NMFS completed 107 Section 7 consultations on projects within the CHEU that resulted in the total loss of 12,302 lin ft of RMS. Based on these losses, we can estimate an annual loss rate of RMS using the following equation:

$$\begin{aligned} \text{Annual loss rate of RMS} &= \text{RMS loss via Section 7 Consultations} \div 7 \text{ years} \\ \text{Annual loss rate of RMS} &= 12,302 \text{ lin ft} \div 7 \text{ years} \\ \text{Annual loss rate of RMS} &= 1,757.43 \text{ lin ft per year} \end{aligned}$$

This annual loss rate of RMS is equal to a monthly RMS loss rate of:

$$\begin{aligned} \text{Monthly loss rate of RMS} &= 1,757.43 \text{ lin ft} \div 12 \text{ months} \\ \text{Monthly loss rate of RMS} &= 146.45 \text{ lin ft per month} \end{aligned}$$

Assuming the same monthly loss rate, we can then back-calculate the loss of RMS in the 77 months between when the species was listed and the time of critical habitat designation (beginning of April 2003 – end of August 2009) using the following equation:

$$\begin{aligned} \text{RMS loss prior to critical habitat designation} &= 77 \text{ months} \times \text{Annual loss rate of RMS} \\ \text{RMS loss prior to critical habitat designation} &= 77 \text{ months} \times 146.45 \text{ lin ft per month} \\ \text{RMS loss prior to critical habitat designation} &= 11,276.65 \text{ lin ft (Table 3 Line 2)} \end{aligned}$$

Next, we need to determine the loss of RMS since the designation of critical habitat. From the time of critical habitat designation until March 31, 2017², NMFS completed 123 Section 7 consultations on projects within the CHEU that have resulted in the additional loss of approximately 13,282 lin ft of RMS (Table 3 Line 3). Using this information, we can calculate the RMS currently available for juvenile smalltooth sawfish in CHEU using the following equation:

$$\begin{aligned} \text{RMS currently available in CHEU} &= \text{RMS in CHEU at time of species listing} \\ &\quad - (\text{RMS loss prior to critical habitat designation} \\ &\quad + \text{RMS loss since critical habitat designation}) \\ \text{RMS currently available in CHEU} &= 5,512,320 \text{ lin ft} - (11,276.65 \text{ lin ft} + 13,282 \text{ lin ft}) \\ \text{RMS currently available in CHEU} &= 5,512,320 \text{ lin ft} - 24,558.65 \text{ lin ft} \\ \text{RMS currently available in CHEU} &= 5,487,761.35 \text{ lin ft (Table 3 Line 4)} \end{aligned}$$

² Due to the small number of monthly projects affecting smalltooth sawfish critical habitat and the limited adverse effect from typical seawall/dock projects to critical habitat, NMFS updates red mangrove shoreline loss quarterly.

While this number only takes into account projects with a federal nexus requiring ESA Section 7 consultation, there are very few projects without a federal nexus that could impact RMS in the CHEU as most in-water construction projects require federal authorization.

We calculated the amount of RMS that must be maintained in the CHEU using the following equation:

$$\begin{aligned} \text{RMS that must be maintained in CHEU} &= \\ \text{Total RMS in CHEU at time of critical habitat designation} &\times 95\% \\ \text{RMS that must be maintained in CHEU} &= 5,512,320 \text{ lin ft} \times 0.95 \\ \text{RMS that must be maintained in CHEU} &= 5,236,704 \text{ lin ft (Table 4 Line 5)} \end{aligned}$$

The proposed project would result in the loss of 55 lin ft of the estimated 5,512,320 lin ft of RMS in the CHEU at the time of species listing (Table 3 Line 6). Using the above results, we can estimate the impact of the proposed project in addition to the RMS lost in CHEU since the species was listed using the following equation:

$$\begin{aligned} \% \text{ RMS lost in CHEU since species listing} &= \\ &= [(RMS \text{ loss due to this project} \\ &+ RMS \text{ lost prior to critical habitat designation} \\ &+ RMS \text{ lost since critical habitat designation}) \\ &\div \text{Total RMS in CHEU at time of species listing}] \times 100 \\ \% \text{ RMS lost in CHEU since species listing} &= \\ &= [(55 \text{ lin ft} + 11,276.65 \text{ lin ft} + 13,282 \text{ lin ft}) \div 5,512,320 \text{ lin ft}] \times 100 \\ \% \text{ RMS lost in CHEU since species listing} &= (24,613.65 \text{ lin ft} \div 5,512,320 \text{ lin ft}) \times 100 \\ \% \text{ RMS lost in CHEU since species listing} &= 0.446521 \% \text{ (Table 3 Line 7)} \end{aligned}$$

Table 3. Summary of Impacts to the Red Mangrove Essential Feature

Red Mangrove Shoreline in the CHEU		Linear Feet
1.	Available at the time of species listing	5,512,320
2.	Losses prior to critical habitat designation	11,276.65
3.	Losses since critical habitat designation (through federal agency actions)*	13,282
4.	Available as of March 31, 2017*	5,487,761.35
5.	Acreage that must be maintained per Recovery Plan	5,236,704 (95% of 5,512,320)
6.	Affected by this project	55.0
7.	Affected since species listing* (lines 2+3+6)	24,613.65 (0.446521% of 5,512,320)
*Due to the small number of monthly projects affecting smalltooth sawfish critical habitat and the limited adverse impact from typical seawall/dock projects to critical habitat, NMFS updates red mangrove shoreline losses quarterly.		

Summary of Impacts to the Essential Features

Including this project, 0.446521% of the RMS essential feature (Table 3) in CHEU have been affected by in-water construction projects requiring a federal authorization since smalltooth sawfish was listed in 2003. Thus, the loss of essential feature associated with the proposed project, in combination with losses since we listed the species, does not provide any impediment to effectively protecting 95% of designated juvenile nursery habitat in the CHEU available at the time the species was listed, and therefore will not be an impediment to Recovery Objective #2.

8.3 Ensure Smalltooth Sawfish Abundance Increases (Recovery Objective #3)

In establishing Recovery Objective #3, we recognized that it was important that sufficient numbers of juvenile sawfish inhabit several nursery areas across a diverse geographic area to ensure survivorship and growth and to protect against the negative effects of stochastic events within parts of their range. To meet this objective, Recovery Region G (i.e., CHEU) must support sufficiently large numbers of juvenile sawfish to ensure that the species is viable in the long-term and can maintain genetic diversity. For this region, the recovery objective requires that the relative abundance of small juvenile sawfish (< 200 cm) either increases at an average annual rate of at least 5% over a 27-year period, or juvenile abundance is at greater than 80% of the carrying capacity of the recovery region.

Assessing the effect of the proposed action on small juvenile abundance is made difficult by the state of available data. Since the designation of critical habitat and the release of the recovery plan in 2009, ongoing studies have been in place to monitor the US DPS of smalltooth sawfish. FWRI is conducting a study in the CHEU that is supported primarily under funding provided by NMFS through the Section 6 Species Recovery Grants Program, while NOAA Fisheries SEFSC Panama City Laboratory and Florida State University have focused studies in the TTIU. The intent of these studies is to determine the abundance, distribution, habitat use, and movement of juvenile sawfish. Given the limited duration of the study in CHEU (September 2009-current]), there is not yet enough data to discern the trend in juvenile abundance within that Unit. Early indications are that juvenile sawfish are at least stable and likely increasing in the CHEU, due in large part to ESA-listing of the species and designation of critical habitat. While it may be too early to state definitively that juveniles within CHEU are surviving to adulthood, researchers consistently capture newborn smalltooth sawfish, particularly within “hot spots,” indicating adult smalltooth sawfish are pupping within Recovery Region G. Available data from the adjacent Recovery Region H (i.e., TTIU) indicate that adult smalltooth sawfish are also reproducing within this recovery region and that the juvenile population trend is at least stable and possibly increasing—though variability is high (Carlson et al. 2007)(Carlson and Osborne 2012). With no other data to consider, the abundance trend in TTIU represents the best data available for assessing the population trends in the CHEU. Therefore, we do not believe the loss of habitat associated with this project, in combination with the losses to date, will impede the 5% annual growth objective for the juvenile population within Recovery Region G.

9 CONCLUSION

After reviewing the current status of smalltooth sawfish critical habitat, the environmental baseline, and the cumulative effects, it is our Opinion that the loss of 55 lin ft of red mangrove essential feature from the proposed seawall installation will not interfere with achieving the

relevant habitat-based Recovery Objectives for smalltooth sawfish. Therefore, we conclude the project will not impede the critical habitat's ability to support the smalltooth sawfish's conservation, despite permanent adverse effects. Given the nature of the project and the information provided above, we conclude that the action, as proposed, is likely to adversely affect, but is not likely to destroy or adversely modify, smalltooth sawfish critical habitat.

10 INCIDENTAL TAKE STATEMENT

NMFS does not anticipate that the proposed action will incidentally take any species and no take is authorized. Nonetheless, any takes of smalltooth sawfish or sea turtles shall be immediately reported to takereport.nmfs@noaa.gov. Refer to the present Biological Opinion by title (Busche Seawall), issuance date, NMFS PCTS identifier number (SER-2017-18630), and USACE permit number (SAJ-2017-1239). At that time, consultation must be reinitiated.

11 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authority to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations identified in Biological Opinions can assist action agencies in implementing their responsibilities under Section 7(a)(1). Conservation recommendations are discretionary activities designed 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. The following conservation recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the federal action agency:

1. Continue public outreach and education on smalltooth sawfish and smalltooth sawfish critical habitat, in an effort to minimize interactions, injury, and mortality.
2. Provide funding to conduct directed research on smalltooth sawfish that will help further our understanding about the species (e.g., implement a relative abundance monitoring program which will help define how spatial and temporal variability in the physical and biological environment influence smalltooth sawfish) in an effort to predict long-term changes in smalltooth sawfish distribution, abundance, extent, and timing of movements.
3. Fund surveys of detailed bathymetry and mangrove coverage within smalltooth sawfish critical habitat. Lee County and the USACE recently funded such surveys within the Cape Coral municipality. Data is needed from other municipalities within the CHEU to establish a more accurate baseline assessment of both critical habitat features (red mangroves and shallow-water areas).
4. Fund and support restoration efforts that rehabilitate and create shallow, euryhaline and mangrove fringe habitats within the range of smalltooth sawfish.

To stay abreast of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

12 REINITIATION OF CONSULTATION

This concludes NMFS's formal consultation on the proposed action. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal action agency involvement or control over the action has been retained, or is authorized by law, and if (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

13 LITERATURE CITED

- Andrews, T. J., B. F. Clough, and G. J. Muller. 1984. Photosynthetic gas exchange properties and carbon isotope ratios of some mangroves in North Queensland. Pages 15-23 in H. J. Teas, editor. *Physiology and Management of Mangroves* volume 9. Dr. W. Junk Publishers.
- Ball, M. C., M. J. Cochrane, and H. M. Rawson. 1997. Growth and water use of the mangroves *Rhizophora apiculata* and *R. stylosa* in response to salinity and humidity under ambient and elevated concentrations of atmospheric CO₂. *Plant, Cell & Environment* 20(9):1158-1166.
- Burchett, M. D., S. Meredith, A. Pulkownik, and S. Pulkownik. 1984. Short term influences affecting growth and distribution of mangrove communities in the Sydney region. *Wetlands (Australia)* 4(2):10.
- Cahoon, D. R., P. Hensel, J. Rybczyk, K. L. McKee, C. E. Proffitt, and B. C. Perez. 2003. Mass tree mortality leads to mangrove peat collapse at Bay Islands, Honduras after Hurricane Mitch. *Journal of Ecology* 91(6):1093-1105.
- Carlson, J. K., J. Osborne, and T. W. Schmidt. 2007. Monitoring the recovery of smalltooth sawfish, *Pristis pectinata*, using standardized relative indices of abundance. *Biological Conservation* 136(2):195-202.
- Dahl, T. E., and C. E. Johnson. 1991. Status and trends of wetlands in the conterminous United States, mid-1970s to mid-1980s. U.S. Fish and Wildlife Service, Washington, D.C.
- Ellison, J. 2010. Vulnerability of Fiji's mangroves and associated coral reefs to climate change. A review., Suva, Fiji, WWF South Pacific Office.

- Field, C. D. 1995. Impact of expected climate change on mangroves. *Hydrobiologia* 295(1-3):75-81.
- Garmestani, A. S., and H. F. Percival. 2005. Raccoon removal reduces sea turtle nest depredation in the ten thousand islands of Florida. *Southeastern Naturalist* 4(3):469-472.
- Gilman, E. L., J. Ellison, N. C. Duke, and C. Field. 2008. Threats to mangroves from climate change and adaptation options: A review. *Aquatic Botany* 89(2):237-250.
- Gilman, E. L., J. Ellison, V. Jungblut, H. Van Lavieren, L. Wilson, F. Areki, G. Brighthouse, J. Bungitak, E. Dus, and M. Henry. 2006. Adapting to Pacific Island mangrove responses to sea level rise and climate change. *Climate Research* 32:161-176.
- Gilmore, G. R. 1995. Environmental and Biogeographic Factors Influencing Ichthyofaunal Diversity: Indian River Lagoon. *Bulletin of Marine Science* 57(1):153-170.
- GMFMC. 1998. Generic amendment for addressing essential fish habitat requirements in the following Fishery Management plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, United States waters; Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf of Mexico, Coastal Migratory Pelagic Resources (Mackerel) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery of the Gulf of Mexico; Spiny Lobster Fishery of the Gulf of Mexico; Coral and Coral Reefs of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida.
- GMFMC. 2005. Generic Amendment 3 for addressing EFH requirements, HAPCs , and adverse effects of fishing in the following FMPs of the Gulf of Mexico: Shrimp, Red Drum, Reef Fish, Stone Crab, Coral and Coral Reefs in the GOM and Spiny Lobster and the Coastal Migratory Pelagic resources of the GOM and South Atlantic. Gulf of Mexico Fishery Management Council, Tampa, FL.
- Harty, C. 2004. Planning strategies for mangrove and saltmarsh changes in southeast Australia. *Coastal Management* 32(4):405-415.
- Hoegh-Guldberg, O., P. J. Mumby, A. J. Hooten, R. S. Steneck, P. Greenfield, E. Gomez, C. D. Harvell, P. F. Sale, A. J. Edwards, K. Caldeira, N. Knowlton, C. M. Eakin, R. Iglesias-Prieto, N. Muthiga, R. H. Bradbury, A. Dubi, and M. E. Hatzioles. 2007. Coral reefs under rapid climate change and ocean acidification. *Science* 318(5857):1737-1742.
- Hutchings, P. A., and P. Saenger. 1987. *Ecology of Mangroves*. St. Lucia, Queensland, Australia; New York: University of Queensland Press.
- IPCC. 2007. *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Summary for Policymakers*. S. Solomon, and coeditors, editors. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change)*. Cambridge University Press, Cambridge, UK and New York, NY.

- IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Pages 1535 *in* T. F. Stocker, and coeditors, editors. Cambridge University Press, Cambridge, United Kingdom; New York, NY.
- IPCC. 2014. Climate change 2014: Impacts, adaptation, and vulnerability. IPCC Working Group II contribution to AR5. Intergovernmental Panel on Climate Change.
- McLeod, E., and R. V. Salm. 2006. Managing mangroves for resilience to climate change. IUCN, Gland, Switzerland.
- Meehl, G. A., T. F. Stocker, W. D. Collins, P. Friedlingstein, A. T. Gaye, J. M. Gregory, A. Kitoh, R. Knutti, J. M. Murphy, A. Noda, S. C. B. Raper, I. G. Watterson, A. J. Weaver, and Z. C. Zhao. 2007. Global climate projections. Pages 747-846 *in* S. Solomon, and coeditors, editors. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY.
- Ning, Z. H., R. E. Turner, T. Doyle, and K. K. Abdollahi. 2003. Integrated assessment of the climate change impacts on the Gulf Coast Region: findings of the Gulf Coast Regional Assessment. LSU Graphic Services, Baton Rouge, Louisiana.
- NMFS. 2000. Smalltooth Sawfish Status Review. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Saint Petersburg, FL.
- NMFS. 2009. Smalltooth Sawfish Recovery Plan, Silver Spring, MD.
- NMFS. 2010. Smalltooth Sawfish 5-Year Review: Summary and Evaluation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Protected Resources Division, St. Petersburg, FL.
- Norton, S. L., T. R. Wiley, J. K. Carlson, A. L. Frick, G. R. Poulakis, and C. A. Simpfendorfer. 2012. Designating critical habitat for juvenile endangered smalltooth sawfish in the United States. *Marine and Coastal Fisheries* 4(1):473-480.
- Orlando, S. P., Jr. , P. H. Wendt, C. J. Klein, M. E. Patillo, K. C. Dennis, and H. G. Ward. 1994. Salinity Characteristics of South Atlantic Estuaries. NOAA, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD.
- Pfeffer, W. T., J. T. Harper, and S. O'Neel. 2008. Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise. *Science* 321(5894):1340-1343.

- Poulakis, G. R. 2012. Distribution, Habitat Use, and Movements of Juvenile Smalltooth Sawfish, *Pristis pectinata*, in the Charlotte Harbor Estuarine System, Florida. Florida Institute of Technology, Melbourne, FL.
- Poulakis, G. R., and J. C. Seitz. 2004. Recent occurrence of the smalltooth sawfish, *Pristis pectinata* (Elasmobranchiomorpha: Pristidae), in Florida Bay and the Florida Keys, with comments on sawfish ecology. *Florida Scientist* 67(27):27-35.
- Poulakis, G. R., P. W. Stevens, A. A. Timmers, C. J. Stafford, and C. A. Simpfendorfer. 2013. Movements of juvenile endangered smalltooth sawfish, *Pristis pectinata*, in an estuarine river system: use of non-main-stem river habitats and lagged responses to freshwater inflow-related changes. *Environmental Biology of Fishes* 96(6):763-778.
- Poulakis, G. R., P. W. Stevens, A. A. Timmers, T. R. Wiley, and C. A. Simpfendorfer. 2011. Abiotic affinities and spatiotemporal distribution of the endangered smalltooth sawfish, *Pristis pectinata*, in a south-western Florida nursery. *Marine and Freshwater Research* 62(10):1165-1177.
- Quigley, D. T. G., and K. Flannery. 2002. Leucoptic harbour porpoise *Phocoena phocoena* (L.). *Irish Naturalists' Journal* 27(4):170.
- Rahmstorf, S., A. Cazenave, J. A. Church, J. E. Hansen, R. F. Keeling, D. E. Parker, and R. C. J. Somerville. 2009. Recent climate observations compared to projections. *Science* 316(5825):709.
- Reddering, J. S. V. 1988. Prediction of the effects of reduced river discharge on estuaries of the south-eastern Cape Province, South Africa. *South African Journal of Science* 84:726-730.
- Saenger, P., and J. Moverley. 1985. Vegetative phenology of mangroves along the Queensland coastline. Pages 9 in M. G. Ridpath, and L. K. Corbett, editors. *Ecology of the wet-dry tropics: Proceedings of a joint symposium with the Australian Mammal Society in association with the Darwin Institute of Technology*. Blackwell Scientific Book Distributors, Melbourne.
- SAFMC. 1998. Final Plan for the South Atlantic Region: Essential Fish Habitat Requirements for the Fishery Management Plan of the South Atlantic Fishery Management Council. South Atlantic Fishery Management Council, Charleston, SC.
- Scavia, D., J. C. Field, D. F. Boesch, R. W. Buddemeier, V. Burkett, D. R. Cayan, M. Fogarty, M. A. Harwell, R. W. Howarth, C. Mason, D. J. Reed, T. C. Royer, A. H. Sallenger, and J. G. Titus. 2002. Climate change impacts on US coastal and marine ecosystems. *Estuaries* 25(2):149-164.
- Semeniuk, V. 1994. Predicting the effect of sea-level rise on mangroves in northwestern Australia. *Journal of Coastal Research* 10(4):1050-1076.

- Simpfendorfer, C. A. 2001. Essential habitat of the smalltooth sawfish (*Pristis pectinata*). Report to the National Fisheries Service's Protected Resources Division. Mote Marine Laboratory Technical Report.
- Simpfendorfer, C. A. 2003. Abundance, movement and habitat use of the smalltooth sawfish. Final Report. Mote Marine Laboratory Mote Technical Report No. 929, Sarasota, FL.
- Simpfendorfer, C. A. 2006. Movement and habitat use of smalltooth sawfish. Final Report. Mote Marine Laboratory, Mote Marine Laboratory Technical Report 1070, Sarasota, FL.
- Simpfendorfer, C. A., G. R. Poulakis, P. M. O'Donnell, and T. R. Wiley. 2008. Growth rates of juvenile smalltooth sawfish, *Pristis pectinata* (Latham), in the western Atlantic. *Journal of Fish Biology* 72(3):711-723.
- Simpfendorfer, C. A., T. R. Wiley, and B. G. Yeiser. 2010. Improving conservation planning for an endangered sawfish using data from acoustic telemetry. *Biological Conservation* 143:1460-1469.
- Simpfendorfer, C. A., B. G. Yeiser, T. R. Wiley, G. R. Poulakis, P. W. Stevens, and M. R. Heupel. 2011. Environmental Influences on the Spatial Ecology of Juvenile Smalltooth Sawfish (*Pristis pectinata*): Results from Acoustic Monitoring. *PLoS ONE* 6(2):e16918.
- Snedaker, S. 1995. Mangroves and climate change in the Florida and Caribbean region: scenarios and hypotheses. *Hydrobiologia* 295(1-3):43-49.
- Stedman, S., and T. E. Dahl. 2008. Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998-2004. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and U.S. Department of the Interior, U.S. Fish and Wildlife Service.
- Trenberth, K. 2005. Uncertainty in Hurricanes and Global Warming. *Science* 308(5729):1753-1754.
- UNESCO. 1992. Coastal systems studies and sustainable development. . Pages 276 in *COMAR Interregional Scientific Conference*. UNESCO, Paris, 21-25 May, 1991.
- USEPA. 1994. Freshwater Inflow Action Agenda For The Gulf of Mexico; First Generation-Management Committee Report. U.S. Environmental Protection Agency.
- USFWS. 1999. South Florida Multi-Species Recovery Plan Atlanta, Georgia. 2172p.
- Vargas-Moreno, J. C., and M. Flaxman. 2010. Addressing the challenges of climate change in the greater everglades landscape. Massachusetts Institute of Technology, Cambridge, Massachusetts.

- Wanless, H. R., B. M. Vlaswinkel, and K. L. Jackson. 2005. Coastal Landscape and Channel Evolution Affecting Critical Habitats at Cape Sable, Everglades National Park, Florida. University of Miami.
- Whitfield, A. K., and M. N. Bruton. 1989. Some biological implications of reduced freshwater inflow into eastern Cape estuaries: a preliminary assessment. *South African Journal of Science* 85:691-694.
- Wiley, T. R., and C. A. Simpfendorfer. 2007. The ecology of elasmobranchs occurring in the Everglades National Park, Florida: implications for conservation and management. *Bulletin of Marine Science* 80(1):171-189.