ENVIRONMENTAL IMPACT STATEMENT TO REDUCE THE INCIDENTAL BYCATCH AND MORTALITY OF SEA TURTLES IN THE SOUTHEASTERN U.S. SHRIMP FISHERIES

November 29, 2016

TYPE OF STATEMENT:

(X) DRAFT ( ) FINAL

AREA OF POTENTIAL IMPACT:

Areas of tidally-influenced waters, estuaries, and substrates of the Gulf of Mexico and South Atlantic in Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina, extending out to the limit of the U.S. Exclusive Economic Zone.

ABSTRACT:

This environmental impact statement analyzes a range of potential alternatives to reduce the incidental bycatch and mortality of sea turtles in the Southeastern U.S. shrimp fisheries. The environmental impact statement contains a description of the purpose and need for evaluating the potential alternatives, the scientific methodology and data used in the analyses, background information on the physical, biological, human, and administrative environments, and a description of the effects of the potential alternatives on the aforementioned environments.

RESPONSIBLE AGENCY:

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ACRONYMS AND ABBREVIATIONS

The following are standard abbreviations for acronyms and terms found throughout this document:

ADCNR	Alabama Department of Conservation and Natural Resources
APA	Administrative Procedure Act
AS	average federally-permitted South Atlantic penaeid vessel
BIRNM	Buck Island Reef National Monument
BRD	bycatch reduction device
BSE	bays/sounds/estuaries
CCL	curved carapace length
CEA	cumulative effects analysis
CEQ	Council on Environmental Quality
CPUE	catch per unit effort
CS	consumer surplus
CZMA	Coastal Zone Management Act
DEIS	draft environmental impact statement
DNA	deoxyribonucleic acid
DTRU	Dry Tortugas Recovery Unit
DWH	DEEPWATER HORIZON (semi-submersible drilling rig)
DOC	U.S. Department of Commerce
DOI	U.S. Department of Interior
DPS	distinct population segment
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	environmental impact statement
EJ	Environmental Justice
EMS	early mortality syndrome
E.O.	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FP	fibropapillomatosis (disease)
FWC	Florida Fish and Wildlife Conservation Commission
FMP	fishery management plan
GCRU	Greater Caribbean Recovery Unit
GDNR	Georgia Department of Natural Resources
GMFMC	Gulf of Mexico Fishery Management Council
GMT	Gear Monitoring Team
GSMFC	Gulf States Marine Fisheries Commission
GRRS	Gulf of Mexico Royal Red Shrimp Endorsement
GSS	Gulf Shrimp System
HAPC	habitat area of particular concern
HMS	highly migratory species
IRFA	initial regulatory flexibility analysis

ITS	incidental take statement
LDWF	Louisiana Department of Wildlife and Fisheries
MDMR	Mississippi Department of Marine Resources
MMPA	Marine Mammal Protection Act
MPA	marine protected area
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSY	maximum sustainable yield
NCDMF	North Carolina Division of Marine Fisheries
NCWRC	North Carolina Wildlife Resources Commission
NEPA	National Environmental Policy Act
NGMRU	Northern Gulf of Mexico Recovery Unit
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NOI	notice of intent
NRDA	Natural Resources Damage Assessment
NRU	Northern Recovery Unit
OC	organochlorine (compounds)
OLE	Office of Law Enforcement
OMB	Office of Management and Budget
PBR	potential biological removal
PCB	polychlorinated biphenyls
PIM	post-interaction mortality
PRA	Paperwork Reduction Act
RFA	Regulatory Flexibility Act
RIR	regulatory impact review
RQ	regional quotient
RSCZ	South Atlantic Rock Shrimp (Carolina Zone) Permit
RSLA	South Atlantic Rock Shrimp Permit
SAFMC	South Atlantic Fishery Management Council
SAR	stock assessment report
SBA	Small Business Administration
SCDNR	South Carolina Department of Natural Resources
SCL	straight carapace length
SEFSC	Southeast Fisheries Science Center of NMFS
SERO	Southeast Regional Office of NMFS
SMZ	special management zone
SPA	South Atlantic Penaeid Shrimp Permit
SPGM	Gulf of Mexico Shrimp Permit
SST	sea surface temperature
STSSN	Sea Turtle Stranding and Salvage Network
TED	turtle excluder device
TEWG	Turtle Expert Working Group
TPWD	Texas Parks and Wildlife Department
UME	unexplained mortality event
USCG	U.S. Coast Guard

USFWS	U.S. Fish and Wildlife Service
USN	U.S. Navy
VEC	valued environmental component
VOOP	vessel of opportunity program
WTP	willingness to pay

EXECUTIVE SUMMARY

Introduction

This executive summary highlights the major components of the draft environmental impact statement (DEIS), which is being prepared to comply with the requirements of the National Environmental Policy Act of 1969 (NEPA). It provides an overview of the action, discusses the potential alternatives, and summarizes the effects of the identified preferred alternative.

All species of sea turtles are currently identified as either threatened or endangered under the Endangered Species Act of 1973 (ESA) (16 USC. 1531 et seq.). We (NMFS) share jurisdiction and legal responsibilities for the recovery and conservation of sea turtle species with the U.S. Fish and Wildlife Service (USFWS). To prevent the further decline of these species, Section 9(a)(1)(B) and 9(a)(1)(C) of the ESA prohibits the take, including incidental take, of endangered species. We also have the authority under Section 4(d) of the ESA to issue any regulations deemed necessary and advisable to provide for the conservation of threatened species.

> ***Endangered Species Act Definitions***
>
> Threatened Species: any species which is likely to become an endangered species within the foreseeable future through all or a significant portion of its range.
>
> Endangered Species: any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man.
>
> Take: means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Southeastern U.S. Shrimp Fisheries

The Southeastern U.S. shrimp fisheries use a variety of gear in both nearshore and offshore waters from Texas through North Carolina. Vessels participating in the shrimp fisheries are also diverse, ranging from small vessels (e.g., 20-25 feet [ft] in length) with a single owner/operator that generally fish close to shore, to larger vessels (e.g., 75 ft in length) with several crew able to fish in deeper waters farther offshore. While we have jurisdiction of the shrimp fisheries operating in the exclusive economic zone (EEZ), which extends from either 3 or 9 nautical miles (nmi) from the coast to 200 nmi offshore, coastal states have management authority of the shrimp fisheries occurring in their waters. The ESA, however, applies to both state and federal

(EEZ) waters. Hence, the current turtle excluder device (TED) requirements implemented by the ESA apply to both state and EEZ waters.

Other Definitions (50 CFR 222.102)

Shrimp Trawler: means any vessel that is equipped with one or more trawl nets and that is capable of, or used for, fishing for shrimp, or whose onboard or landed catch of shrimp is more than 1%, by weight, of all fish comprising its on-board or landed catch.

Skimmer Trawl: means a trawl that is fished along the side of the vessel and is held open by a rigid frame and a lead weight. On its outboard side, the trawl is held open by one side of the frame extending downward and, on its inboard side, by a lead weight attached by cable or rope to the bow of the vessel.

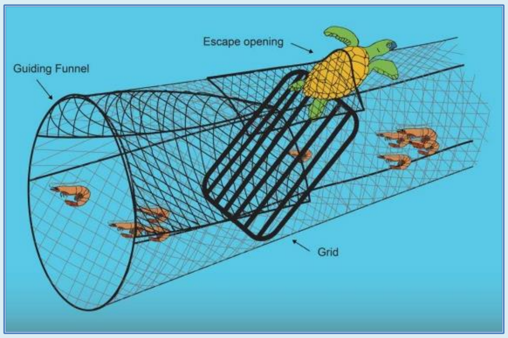
Pusher-Head Trawl (Chopsticks): means a trawl that is spread by two poles suspended from the bow of the trawler in an inverted "V" configuration.

Wing Net (Butterfly Trawl): means a trawl that is fished along the side of the vessel and that is held open by a 4-sided, rigid frame attached to the outrigger of the vessel.

Currently, any shrimp trawler in the Gulf of Mexico or South Atlantic is required to have an approved TED installed in each net rigged for fishing. Yet, there are exemptions to these requirements, which were originally implemented on the basis the exempted activities did not present a threat to sea turtle populations. Generally, vessels that have no power or mechanical-advantage trawl retrieval system; are bait shrimpers that retain all live shrimp on board with a recirculating seawater system; fish with a pusher-head trawl, skimmer trawl, or wing net; or use a single try net with a headrope 12 ft or less in length, may currently use alternative tow times in lieu of TEDs. Additionally, beam or roller trawls and shrimp trawlers fishing for royal red shrimp (a deepwater shrimp species) are also exempted entirely from the TED requirements.

Turtle Excluder Device

A turtle excluder device (TED) is a grid installed in a trawl that mechanically separates sea turtles, as well as sharks, rays, and other large bycatch species that are then excluded from the net through an escape opening, while the targeted shrimp are retained in the tail bag of the trawl.



Recent information indicates an increasing abundance of small, juvenile sea turtles interacting with the Southeastern U.S. shrimp fisheries. This abundance of small sea turtles in shallow, coastal waters is attributed to numerous ongoing conservation efforts, such as the protection of sea turtle nesting beaches and the required use of TEDs in otter trawls participating in the shrimp fisheries. These efforts have helped with the ongoing recovery and increased nesting of Kemp's ridley and other sea turtle species. But new analyses indicate alternative tow times in the skimmer trawl fisheries may not be as effective at minimizing sea turtle bycatch and mortality as originally thought. Additionally, available information reveals a significant portion of the sea turtles observed in shallow, coastal waters are sufficiently small to pass through the bars of vessels fishing with currently authorized TEDs. Due to the large number of vessels participating in the shrimp fisheries, the wide area covered by the fisheries, and the amount of effort annually exerted by the fisheries, there is concern these factors could result in elevated bycatch and mortality of sea turtles. Any significant increase in mortality could undermine ongoing conservation efforts and risk the recovery of threatened and endangered sea turtle species. As such, we are exploring several new management alternatives to reduce the incidental bycatch and mortality of sea turtles in the Southeastern U.S. shrimp fisheries.

Range of Alternatives

Alternative 1: No action

This alternative would maintain the status quo. It would not introduce any new regulations that would impact fishers or offer any new conservation measures to benefit threatened and endangered sea turtle populations.

Alternative 2: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require skimmer trawl, pusher-head trawl, and wing net vessels 26 ft in length and larger to use TEDs designed to exclude small turtles in their nets. This alternative would exclude small skimmer trawl, pusher-head trawl, and wing net vessels, as well as all vessels participating in the Biscayne Bay wing net fishery in Miami-Dade County, Florida.

Alternative 3: Amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require all skimmer trawl, pusher-head trawl, and wing net vessels to use TEDs designed to exclude small turtles in their nets. Similar to Alternative 2, this alternative would also exclude all vessels participating in the Biscayne Bay wing net fishery in Miami-Dade County, Florida.

Alternative 4: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls to use TEDs designed to exclude small turtles

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require skimmer trawl vessels 26 ft in length and larger to use TEDs designed to exclude small turtles in their nets. Other gear types included in the existing TED exemption would not be impacted by this alternative.

Alternative 5: Amend the existing TED regulations to require all vessels using skimmer trawls to use TEDs designed to exclude small turtles

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require all skimmer trawl vessels to use TEDs designed to exclude small turtles in their nets. Other gear types included in the existing TED exemption would not be impacted by this alternative.

Alternative 6: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers fishing within state waters

This alternative would amend the existing TED regulations by withdrawing the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) to require all skimmer trawl, pusher-head trawl, and wing net vessels to use TEDs designed to exclude small turtles in their nets, as well as amending the criteria for approved TEDs at 50 CFR 223.207(a)(4), 50 CFR 223.207(a)(6), and 50 CFR 223.207(d)(3) to require otter trawlers fishing in state waters to use TEDs designed to exclude small turtles in their nets. This alternative would not affect other existing TED exemptions at 50 CFR 223.206(d)(2)(ii)(A) aside from the one previously mentioned.

Alternative 7: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers

This alternative would amend the existing TED regulations by withdrawing the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) to require all skimmer trawl, pusher-head trawl, and wing net vessels to use TEDs designed to exclude small turtles in their nets, as well as amending the criteria for approved TEDs at 50 CFR 223.207(a)(4), 50 CFR 223.207(a)(6), and 50 CFR 223.207(d)(3) to require all otter trawlers to also use TEDs designed to exclude small turtles in their nets. This alternative would not affect other existing TED exemptions at 50 CFR 223.206(d)(2)(ii)(A) aside from the one previously mentioned.

Alternative Effects Summary

We estimate 5,837 non-otter trawl vessels result in 2,165-2,942 annual sea turtle mortalities due to fisheries bycatch under the status quo. In the following table, annual sea turtle conservation is based on ultimately anticipated returns; we do not expect these benefits to occur immediately following a TED requirement. Fishers will have to learn to effectively fish with TEDs in their nets and TED compliance and effectiveness rates will likely take significant time (i.e., years) to rise to the high levels (i.e., 94%) we currently see in the otter trawl fisheries. The "average adverse effect - year 1" relates to the effects encountered during the first year due to initial TED purchase; this would not be an annual economic effect, at least not to this degree (i.e., there may be annual maintenance costs associated with TEDs). The "average adverse effect - long term" relates to ongoing effects due to shrimp loss resulting from required TED use and would be an annual effect.

Table I. Summary of primary effects resulting from each alternative.

	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVES 6-7
SEA TURTLES PROTECTED	1,509 - 2,179	1,730 - 2,500	1,412 - 2,040	1,624 - 2,348	1,730 - 2,500+
TOTAL VESSELS AFFECTED	3,103	5,837	2,913	5,432	9,711
FULL-TIME VESSELS AFFECTED	973	1,103	920	1,041	2,603
PART-TIME VESSELS AFFECTED[1]	2,130	4,734	1,993	4,391	7,108
TOTAL ADVERSE EFFECT[2]	$9.4 MILLION	$13.7 MILLION	$8.9 MILLION	$12.8 MILLION	$44.0 MILLION
TOTAL REVENUE LOSS	$5.4 MILLION	$6.2 MILLION	$5.1 MILLION	$5.8 MILLION	$27.5 MILLION
TOTAL TED COSTS	$4.0 MILLION	$7.5 MILLION	$3.8 MILLION	$7.0 MILLION	$16.5 MILLION
AVERAGE ADVERSE EFFECT	$3,029	$2,347	$3,055	$2,356	$4,530
AVERAGE REVENUE LOSS	$1,740	$1,062	$1,751	$1,068	$2,830
AVERAGE TED COSTS	$1,289	$1,285	$1,304	$1,288	$1,697
AVERAGE ADVERSE EFFECT (% OF TOTAL REVENUE) - YEAR 1[3]	40% - 43%	68% - 122%	39% - 40%	70% - 120%	80% - 131%
AVERAGE ADVERSE EFFECT (% OF TOTAL REVENUE) – LONG TERM[3]	1.8% - 4.6%	1.5% - 4.6%	1.8% - 4.6%	1.5% - 4.5%	2.9% - 4.7%
NUMBER OF TEDS NEEDED	12,392	23,266	11,836	21,650	43,228
TIME TO PRODUCE TEDS	2.3 YEARS	4.3 YEARS	2.3 YEARS	4.3 YEARS	7.2 YEARS

[1] High probability that many (i.e., 50% or more) part-time vessels will stop operating due to TED costs.
[2] Does not include additional losses if part-time vessels stop operating.
[3] Low end of range is for South Atlantic and high end is for Gulf of Mexico.

Preferred Alternative

Alternative 3: Amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles.

Controversy

During scoping, significant comment was submitted from industry, as well as state representatives, on the potential impact of any additional regulations on the shrimp fisheries. Several of those who submitted comments believed that any additional burden on the shrimp fisheries could cripple the industry due to the combined effects of increased fuel prices, increased foreign imports that have depressed prices received for domestic product, the impact of the DEEPWATER HORIZON (DWH) oil spill event, and the lingering effects on infrastructure stemming from previous hurricane seasons.

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1 INTRODUCTION

This DEIS evaluates the potential environmental effects associated with a proposed rule under the ESA to reduce the incidental bycatch and mortality of sea turtles in the Southeastern U.S. shrimp fisheries. Under the ESA, we have the responsibility to implement programs to conserve marine life listed as endangered or threatened. Section 9 of the ESA prohibits the take (including harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting or attempting to engage in any such conduct), including incidental take, of endangered sea turtles. Pursuant to section 4(d) of the ESA, we have issued regulations extending the prohibition of take, with exceptions, to threatened sea turtles (50 CFR 223.205and 223.206). Section 11(f) of the ESA authorizes the issuance of regulations to enforce the take prohibitions.

We previously explored the incidental bycatch and mortality of sea turtles in the shrimp fisheries in 2011-2012, stemming from concern related to elevated sea turtle strandings in the northern Gulf of Mexico. On June 24, 2011 (76 FR 37050), we published a notice of intent to prepare an EIS and conduct scoping meetings on potential measures to reduce sea turtle bycatch in the shrimp fisheries. On May 10, 2012 (77 FR 27411), we published a proposed rule that, if implemented, would require all skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) to use TEDs in their nets. We also prepared a DEIS, which included a description of the purpose and need for evaluating the proposed action and other potential management alternatives, the scientific methodology and data used in the analyses, background information on the physical, biological, human, and administrative environments, and a description of the effects of the proposed action and other potential management alternatives on the aforementioned environments; a notice of its availability was published on May 18, 2012 (77 FR 29636). At the time the 2012 DEIS was prepared, information on the effects of the skimmer trawl fisheries on sea turtle populations was extremely limited. New information gained after the preparation of the 2012 DEIS indicates that a significant number of sea turtles observed interacting with the skimmer trawl fisheries (i.e., those found in shallow [<60 ft], state waters) have a body depth that allows them to pass between the required maximum 4-in bar spacing of a standard TED and get trapped in the back of the trawl net (i.e., they would not escape the trawl net). Therefore, the conservation benefit of expanding the TED requirement to skimmer trawls, pusher-head trawls, and wing nets was much less than originally anticipated. As a result, we determined that a final rule to withdraw the alternative tow time restriction and require all skimmer trawls, pusher-head trawls, and wing nets to use TEDs with 4-in bar spacing was not warranted (February 7, 2013; 78 FR 9024) and would cause unnecessary adverse economic effects to participants in the fisheries.

Following the withdrawal of the final rule, we initiated additional TED testing, evaluating both small sea turtle exclusion and shrimp retention within the skimmer trawl fisheries. This testing has produced several TED configurations that all utilize a TED grid with 3-in bar spacing (i.e., less than the current 4-in bar spacing maximum) and escape-opening flap specifications that would allow small turtles to effectively escape the trawl net, which could be employed by trawl vessels in areas where these small turtles occur.

Additionally, anecdotal information, limited law enforcement data, and past public comment during scoping for the 2012 DEIS indicates the alternative tow time requirements are exceeded by the skimmer trawl fleets, though the extent tow time requirements are exceeded by the skimmer trawl fleets is unclear. Tow times are inherently difficult to effectively enforce due to the time required to monitor a given vessel, as well as the ability to do so covertly to observe unbiased fishing operations. Furthermore, anecdotal information indicates skimmer trawl vessels have increased the size and amount of gear fished over time, allowing them to fish in deeper water. In some cases, vessels are rigged with both skimmer trawl frames and outriggers for use with conventional otter trawl nets. As a result of these larger skimmer trawl nets, there is a possibility that a sea turtle could be captured within the mouth of the net and not visible during a cursory cod end inspection, a scenario that is compounded by the fact that many vessels fish at night. Due to these factors, coupled with the apparent increased abundance of sea turtles in the northern Gulf of Mexico, particularly juvenile Kemp's ridley sea turtles, we are re-evaluating the efficacy of sea turtle conservation requirements associated with the skimmer trawl fisheries, as well as analyzing the effectiveness of current TED requirements in the otter trawl fisheries. On March 15, 2016 (81 FR 13772), we published a notice of intent to prepare an EIS in the *Federal Register* and conducted 5 scoping meetings in April 2016. Information and public comment gathered during that process is summarized in Section 1.3.

1.1 PURPOSE AND NEED

The purpose of the proposed action is to adequately protect, conserve, and recover sea turtle populations listed under the ESA (16 USC. 1531 et seq.) by reducing incidental bycatch and mortality of sea turtles, particularly smaller sea turtles more common in coastal waters, in the Southeastern U.S. shrimp fisheries. The need for the proposed action is to comply with the ESA's mandate to aid in the protection and recovery of listed sea turtle populations.

1.2 BACKGROUND

All sea turtle species occurring in the Atlantic Ocean are listed as either endangered or threatened under the ESA. The leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Kemp's ridley (*Lepidochelys kempii*) are listed as endangered. The Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead (*Caretta caretta*) and the North and South Atlantic DPSs of green (*Chelonia mydas*) sea turtles are listed as threatened. Sea turtles are affected by natural and human interactions on nesting beaches and in the water. Poaching, habitat loss, light pollution, marine debris, oil and gas pollution, and nesting predation by native and introduced species affect hatchlings and nesting females while on land. Fishery interactions, marine debris, marine pollution including that caused by oil and gas development and vessel operations, power plant entrainment/impingement, vessel interactions, and (non-fishery) dredging operations affect sea turtles in the neritic zone.[1] Fishery interactions, marine debris, and marine pollution also affect sea turtles when these species and the fisheries overlap in the oceanic zone.[2] Sea turtles still face many of the original threats that were the cause of their listing under the ESA.

[1] Defined as the marine environment extending from mean low water down to 200 m depths, generally corresponding to the continental shelf (Lalli and Parsons 1997).
[2] Defined as the open ocean environment where bottom depths are greater than 200 m (Lalli and Parsons 1997).

As discussed in more detail below, in the Atlantic Ocean (including the Gulf of Mexico), sea turtle populations, as determined by nesting data, remain greatly reduced from historical levels. There is cautious optimism based on the limited data available that some of the sea turtle populations in U.S. Atlantic waters appear to be stable, or in some cases, increasing. Kemp's ridley nesting in particular has experienced significant increases in the past 15 years and is trending positively overall, though significant interruptions in that trajectory in 2010 and 2013-2014 have raised concern amongst researchers and managers. Green sea turtle nesting has also been increasing in recent years. Available information indicates that these species are becoming more common in shallow, state waters of the Gulf of Mexico and the Atlantic coast. Furthermore, the skimmer trawl fisheries have been documented to interact with these sea turtle species in the times and areas the fisheries operate (e.g., Pulver et al. 2012). The primary focus of this EIS, therefore, is on assessing and reducing the incidental capture and mortality of sea turtles in the southeastern shrimp fisheries, particularly by vessels not currently using TEDs. Additional information on sea turtle recovery plans, status reviews, and interagency coordination can be found in Appendix I.

Skimmer trawls are used in Louisiana, Mississippi, Alabama, North Carolina, and to a limited extent, Florida. Wing nets (butterfly trawls) are also used in Louisiana and Florida to a much lesser extent. Most of Louisiana's wing nets are associated with fixed platforms and docks, and are not installed on a vessel. Additional information indicates there are also a small number of vessels that would be considered a type of pusher-head trawl operating in Texas, though based on a review of Texas state regulations this gear appears to be illegal in Texas waters. Skimmer trawls, as well as pusher-head (chopstick) trawls and wing nets (butterfly trawls), are currently authorized to fish without TEDs if they operate under alternative tow time restrictions.[3] These gear types were originally granted the tow time exemption under the assumption that the trawl bags were typically retrieved at intervals that would not be fatal to any sea turtles that were captured in the net. The December 2, 2002 biological opinion noted the tow time restriction was for fisheries that, "out of physical, practical, or economic necessity, require fishers to limit their tow times naturally." Florida currently requires TED use by skimmer trawlers working in state waters.

Epperly et al. (2002) stated that because skimmers are typically rigged to fish higher in the water column, the potential for turtle capture may be greater than a lower opening otter trawl. A typical 40-ft, non-bib shrimp trawl has an average headrope height of 2.8 to 3.5 ft depending on trawl design, while a skimmer trawl, with a maximum frame height of 12 ft, may have a vertical spread of approximately 9 to 10 ft. Skimmer trawl gear typically works in shallower water than an otter trawl, however, where water depth would limit the vertical profile of the net. For example, Scott-Denton et al. (2006) documented the average depth of all tows by Louisiana skimmer trawls in their study was 7.8 ft (+/- 1.2 ft s.d.). Likewise, Hines et al. (1996) recorded water depths of 1.9 to 6.0 ft (0.58 to 1.83 m) in the Newport River and 1.6 to 4.4 ft (0.5 to 1.33 m) in the North River, which were consistent with the fishing patterns of the local North Carolina fleet. In these depth ranges, skimmer trawls can fish the entire water column.

[3] Florida requires all trawls to use TEDs while fishing in Florida state waters; due to operational constraints (i.e., water depth), skimmer trawls do not operate in the EEZ.

There is a general paucity of information documenting the effects of skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) on sea turtles. Our December 2002, May 2012, and April 2014 biological opinions included some discussion on skimmer trawls. Furthermore, a non-discretionary term and condition of the opinion stated we "will monitor activities (e.g., bait shrimping) and gear (e.g., skimmer trawls) that are exempted from TED use and rely on tow time restrictions to determine their compliance with tow times and to determine if there are any effects on sea turtles from the use of these gears or the continuation of these activities that were not previously known" (NMFS 2002a).

We initiated observer effort on Gulf of Mexico skimmer trawl vessels in 2012. A total of 39 sea turtles were captured during observed trips consisting of 2,699.23 tow hours in 2012-2015. Additionally, 4 sea turtles were captured during 238 observed tows over 62 days, comprised 6.21% of the total annual skimmer trawl fishing effort, by the North Carolina Division of Marine Fisheries in 2015 (Brown 2016). The incidental capture of sea turtles in skimmer trawls has been documented in North Carolina during other studies as well (Coale et al. 1994; Price and Gearhart 2011).

The alternative tow time restrictions specify tow times are not to exceed 55 minutes from April 1 through October 31, and 75 minutes from November 1 through March 31 (50 CFR 223.206(d)(3)(i)(A) and (B)). Some publications (e.g., Price and Gearhart 2011) cite Scott-Denton et al. (2006) as evidence of observations that tow times are often exceeded within the skimmer trawl fishery. Scott-Denton et al. (2006) evaluated catch characteristics of the Louisiana skimmer trawl fishery in 2004 and 2005, and they stated "tow time ranged from 0.2 to 4.3 h, with an average tow time of 1.7 h (+/- 0.4 s.d.)." Per the TED requirements at 223.206(d)(3)(i), the tow time for a skimmer trawl is measured "from the time the codend enters the water until it is removed from the water." Tow times in the study were recorded from the time the codend entered the water to the time the codend was retrieved to dump the catch, ending the tow. The times associated with lifting the codend for periodic checking for crab traps and possibly other debris were not recorded (E. Scott-Denton, NMFS, pers. comm.). Observed skimmer trawl effort in 2012-2015 also recorded tow times based on the cod end being brought fully onboard the vessel and did not record periodic lifting to look for protected species interactions (Pulver et al. 2012, Pulver et al. 2014, Scott-Denton et al. 2014). It is unclear to what extent the average tow times reported in the aforementioned publications might represent regulatory violations of the alternative tow time restrictions. However, in 2010 and 2011, respectively, a tow time violation was documented by a state law enforcement official (R. Pittman, MDMR, pers. comm.).

These observations question the sufficiency of tow time restrictions in protecting sea turtles. If skimmer trawls can technically comply with the tow time limits without actually inspecting the entire net for potentially captured sea turtles, the conservation value of the alternative tow time restrictions may be reduced. While violations of tow times have been documented, the extent tow time restrictions are exceeded by the skimmer trawl fleet in the Gulf of Mexico and in North Carolina is unclear. Tow times restrictions are difficult to enforce. Documentation of a tow time violation requires enforcement personnel to be in close proximity of a skimmer trawl to monitor gear deployment and recovery, and to record the time when the codend enters the water until it is removed (50 CFR 223.206(d)(3)(i)). Also, enforcement personnel need to remain undetected for at least 55 minutes—practically impossible at sea—or else their presence may bias a vessel captain's operational procedure. Similarly, the presence of observers may also result in biased operational procedurals (i.e., the "observer effect"). Thus, it is likely that most tow time violations, to the extent they occur, are under-reported.

Due to the above factors, coupled with the apparent increased abundance of small sea turtles in the Northern Gulf of Mexico, particularly Kemp's ridley sea turtles, we are re-evaluating the efficacy of sea turtle conservation requirements for the Southeastern U.S. shrimp fisheries, with an emphasis on the alternative tow time restrictions used with skimmer trawl and other gear. We are also examining the effectiveness of standard TED grids (i.e., with 4-in bar spacing) on the exclusion of small sea turtles that could be encountered in shallow, coastal waters. Based on analyses of available biological information and TED testing over the past several years, we believe a TED grid with 3-in bar spacing in a top-opening configuration (and the use of lighter webbing on escape-opening flaps depending on the type of grid and angle) is effective at excluding sea turtles, particularly small sea turtles that occur in shallow, coastal waters; this issue is discussed in more detail in Section 4.

1.3 SCOPING

On March 15, 2016 (81 FR 13772), we published a notice of intent (NOI) to prepare an EIS in the *Federal Register* and conducted scoping on various approaches to address incidental bycatch and mortality of small sea turtles in the Southeastern U.S. shrimp fisheries, which were summarized in a scoping document made available to the public. Five public scoping meetings were scheduled in April to present the issues and solicit feedback on potential solutions. Estimated attendance was approximately 40 individuals at the April 13 Morehead City, North Carolina meeting; 65 at the April 19 Belle Chasse, Louisiana meeting; 40 individuals at the April 20 Biloxi, Mississippi meeting; and 7 individuals at the April 21 Bayou La Batre, Alabama meeting. A meeting scheduled for April 18 in Larose, Louisiana was cancelled due to inclement weather that impacted travel. Additional presentations were conducted on April 19 in Gretna, Louisiana for Vietnamese fishers and on April 20 in Houma, Louisiana for the Louisiana Shrimp Task Force meeting. The public scoping period ended on April 29, 2016.

In general, public comment offered at all of the scoping meetings favored the no action alternative. Fishers felt TEDs were not needed as sea turtle populations are increasing and any sea turtles captured by skimmer trawlers were released alive. Their comments also focused on the anticipated economic impacts and discussed the current hardships facing the shrimp fisheries, such as low product prices and competition from imports; many felt that any further regulations would jeopardize the fishery. Conversely, comments from environmental groups favored TED implementation in the skimmer trawl fisheries and many desired TEDs with reduced bar spacing to be required by all shrimp trawlers. Specific scoping comments are discussed in more detail below.

We received approximately 1,400 responses on the March 2016 NOI and scoping document, including approximately 36 unique comments and submitted information, 43 form letters and emails from commercial fishers, 391 signatures on a petition from the Louisiana Shrimp Association, and approximately 870 form emails from environmental groups. These responses, as well as comments received during the 4 scoping meetings and 2 additional presentations, are summarized and listed below in Table 1. The comments received during the scoping period, along with the best available information regarding the current status of listed sea turtles species and new information on the effects of the shrimp fisheries on sea turtles, as well as other factors potentially contributing to the recent sea turtle stranding events, have informed the preferred alternative and the range of alternatives considered in this DEIS.

Table 1. Summary of Public Comments Received on March 2016 NOI and Scoping Document.

COMMENT	CATEGORY
No Action; tow times are sufficient.	Proposed Alternative
Sea turtle nesting is steadily increasing and new regulations are not warranted.	Proposed Alternative
Require all shrimp trawlers fishing out to 62 miles to use TEDs with reduced bar spacing.	Proposed Alternative
Require reduced bar spacing TEDs in all shrimp trawl nets, including otter trawlers.	Proposed Alternative
Require singular TED bar spacing standard so transient vessels won't have to buy multiple TEDs for fishing in different areas.	Proposed Alternative
Require TEDs in skimmer trawls.	Proposed Alternative
Require reduced bar spacing TEDs in all inshore waters.	Proposed Alternative
Increase observer coverage on shrimp trawl vessels to 50% or greater to track improvements and collect new data.	Rejected Alternative
TED requirements for skimmer trawlers should be based on frame size versus vessel size.	Rejected Alternative
Require additional monitoring, including in-water monitoring, for the shrimp fisheries by observers and data loggers.	Rejected Alternative
Require the use of mandatory tow times in conjunction with TED use.	Rejected Alternative
Reduce the allowable head rope length on otter trawlers.	Rejected Alternative
Implement time/area closures in areas identified as sea turtle "hot spots."	Rejected Alternative
Implement a fishing closure through the month of July.	Rejected Alternative
Consider a reduction in the size of the shrimp fleet to limit the number of nets and trawl gear in the water.	Rejected Alternative
There is insufficient data to support requiring TEDs for skimmer trawls.	Analyzed
Any TED requirement for skimmer trawlers would result in a 20-30% loss of income.	Analyzed
NOAA catch retention testing results excluded bad tows and are inaccurate.	Analyzed
TEDs won't work on certain bottom types, in shallow water, and in areas with abundant abandoned crap traps.	Analyzed
Tow times are short, especially on smaller boats, due to many boats being operated by a lone fisher with no crew.	Analyzed
With the current economy, shrimping industry can't afford any more impacts.	Analyzed
Due to the lack of observed mortality of captured sea turtles in skimmer trawls TEDs are unnecessary.	Analyzed
The use of TEDs in skimmers in shallow water where the TED may lay down or stick out of the water (e.g., 3-4 ft) will result in more shrimp loss than fishing in deeper water.	Analyzed
Other impacts such as recreational fishing, beach activities, DWH oil spill event, etc. need to be considered.	Analyzed
TEDs on shrimp boats are dangerous.	Duly Noted
Ensure increased efforts to enforce proper use of required TEDs on all shrimp trawl nets over the entire shrimping season.	Duly Noted
Educate fishers on tow times and sea turtle handling.	Duly Noted
Louisiana Legislature repealed LRS 56:57.2, the state law prohibiting Louisiana Department of Wildlife and Fisheries agents from enforcing TED regulations.	Duly Noted
NOAA observers are recording tow times differently than specified at 50 CFR 223.206.	Duly Noted
More rigorous statistical studies concerning skimmer trawls should be conducted.	Duly Noted

Additional TED testing is needed.	Duly Noted
Additional enforcement is needed.	Duly Noted
Bottom-opening TEDs won't work in North Carolina based on independent testing.	Duly Noted
Require additional reporting requirements.	Duly Noted
Compliance with tow times is poor.	Duly Noted
Compliance with mandatory observer program is poor.	Duly Noted
The definition of tow times needs to be clearly stated in proposed rules.	Duly Noted
NMFS should work with states to mitigate cost of TEDs to the skimmer trawl fleet.	Duly Noted
NMFS must provide a meaningful trigger for reinitiating consultation.	Duly Noted
Skimmer fishers only catch small turtles that are likely planted by the government.	Duly Noted
Sea turtles caught during observed skimmer trawl trips were not normal and were likely sick from the DWH oil spill event.	Duly Noted
NMFS needs to translate materials such as the DEIS for the Vietnamese fishing community.	Duly Noted
NMFS's jeopardy determination must take into account the best available scientific and commercial data.	Duly Noted
Reduce shrimp fishery bycatch by 40%.	Outside of Scope
Fishers are treated like criminals and not allowed to keep species like redfish that recreational fishers keep.	Outside of Scope
If fishers don't make 60% of income from shrimp LDWF should repeal their license.	Outside of Scope
The proposed rule needs to include fisheries other than the shrimp fisheries.	Outside of Scope
NMFS must provide a numerical measure of take or otherwise valid incidental take statement.	Outside of Scope
Any TED requirement for skimmer trawls should also include wing nets, butterfly nets, chopsticks, pusher-head trawls, channel nets, try nets, and other bottom trawls.[4]	Proposed Alternative/Rejected Alternative/Outside of Scope
Impacts from the revocation of the Louisiana sales tax exemption on commercial fishing supplies need to be considered.	*Irrelevant - Louisiana reinstated sales tax exemption in July*
INFORMATION REQUESTS FOR INCLUSION IN THE DEIS	
DNA testing is needed to determine where these small turtles are coming from.	
Survey effort data, such as the number of different observers recording data, should be included when using Sea Turtle Stranding and Salvage Network information.	
Corrected tow time data, following the federal regulations at 50 CFR 223.206.	
Information on outreach events, publications, or funding dedicated to educating the skimmer trawl fisheries on tow time regulations that was provided by NOAA.	
Update on the population abundance of Kemp's ridley sea turtles.	
Clear, direct economic impact study showing cost of implementation, and suggestions from NOAA on funding sources to cover offset gear cost.	
Detailed analysis of sea turtle abundance, fishing effort, and stranding patterns to determine hotspots of sea turtle mortality in the fisheries.	
Information on funding from NOAA to support recovery projects on the Kemp's ridley sea turtle population.	

Category Key: *Analyzed* = comment is addressed in the DEIS; *Proposed Alternatives* = comment is an element in one or more of the proposed alternatives; *Rejected Alternatives* = comment relates to regulatory alternatives considered but rejected; *Outside of Scope* = comment falls outside the scope of the current regulatory action; *Duly Noted* = we acknowledge the comment, but responding is difficult because the commenter did not articulate specific concerns, did not suggest concrete alternatives, or did not substantiate the position advocated; *Contrary to Purpose and Need* = comment would impede the protection and recovery of listed sea turtle populations.

[4] This scoping comment includes portions encompassed by the range of proposed alternatives (i.e., require TEDs in skimmer, butterfly, and pusher-head trawls and channel nets), portions that are rejected (i.e., require TEDs in try nets), and portions outside the scope of the action (i.e., require TEDs in other bottom trawls beyond the Southeastern U.S. shrimp fisheries).

2 MANAGEMENT ALTERNATIVES

After consideration of the best scientific information available and comments received during the scoping process, we identified 7 alternatives including the no action alternative. These alternatives are within the scope of our authority under the ESA, are technically feasible, and meet the purpose and need of this action. The basis for each alternative considered is included under the summary of the alternative. We utilized all available scientific data to develop a preferred alternative (Alternative 3), described below. An additional 8 alternatives, also described below, were considered but rejected from further analysis.

The following alternatives only apply to vessels. As presented in the Executive Summary, the definitions of a shrimp trawler, skimmer trawl, pusher-head trawl, and wing net (per 50 CFR 222.102) all refer to gear used by vessels. As a result, single wing nets fished off a static platform or from the end of a fixed dock, which are used in Louisiana, would not be affected by this or other alternatives. We may examine the need for TEDs in this and other static gear types (e.g., channel nets) in the future, but it would also first require properly defining those gears in the Code of Federal Regulations.

2.1 ALTERNATIVE 1: NO ACTION

This alternative would allow the shrimp fisheries to be fished in the same manner as they are currently fished as described in Section 2.1.1. The current TED requirements would remain in place and no additional measures would be required to reduce potential sea turtle interactions.

2.2 ALTERNATIVE 2: AMEND THE EXISTING TED REGULATIONS TO REQUIRE VESSELS 26 FT AND GREATER IN LENGTH USING SKIMMER TRAWLS, PUSHER-HEAD TRAWLS, AND WING NETS (BUTTERFLY TRAWLS)—WITH THE EXCEPTION OF THE BISCAYNE BAY WING NET FISHERY PROSECUTED IN MIAMI-DADE COUNTY, FLORIDA—TO USE TEDS DESIGNED TO EXCLUDE SMALL TURTLES

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) regarding skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls), and require vessels 26 ft and greater in length fishing these gears to use TEDs designed to exclude small turtles in their nets. The TED exemption would be amended to allow small vessels (i.e., less than 26 ft in length) to continue to use alternative tow times in lieu of TEDs for several reasons. We currently do not have any observer data on vessels less than 26 ft in length due to logistics; these small vessels lack available space to accommodate fishery observers safely. We also do not have any TED testing data on skimmer trawl vessels less than 27 ft in length and, therefore, cannot definitely conclude if a TED would have a differential effect on catch of small vessels compared to larger vessels. Because of these data limitations, we decided to use 26 ft as the delineation point for the TED requirement in this alternative.

This alternative also considers safety at sea issues, as public comment during the scoping process indicated small vessels are usually operated by a single individual and have obvious limited deck space. Therefore, potential issues related to TED use (e.g., TED clogging by debris, net getting entangled in the motor due to a lengthened net to accommodate TED extension, etc.) could potentially contribute to a safety at sea issue (e.g., man overboard). Due to the fact most small skimmer vessels are operated by a single individual, we also believe these vessels more regularly comply with the alternative tow time restrictions. Because of the lack of crew, an operator is more likely to periodically check and recover his catch to keep the gear manageable; longer, uninspected tows could result in heavier catches that could present recovery and sorting issues to the single operator working with limited deck space. These points were also made in public comment during scoping. Available information also indicates that smaller vessels fish less compared to larger vessels, likely due to weather considerations, and that some of these small skimmer vessels may be operated by recreational fishers (LDWF 2016). While LDWF does not permit the recreational use of skimmer trawls, recreational fishers may purchase a commercial shrimp gear license to enhance their catch for personal consumption or other recreational purposes. As a result, we do not believe these vessels operate as often or as long as true commercial vessels. This alternative takes into consideration differential economic effects on smaller versus larger vessels. The potential costs from TED purchase and maintenance, as well as potential shrimp loss associated with TED use, would be more significant for a small vessel compared to a larger vessel that lands more shrimp on average. That is to say a larger vessel will produce more shrimp and, therefore, be more able to defray the additional costs. These issues are discussed in more detail in Section 4.

Alternative 2 would not affect other TED exemptions, such as the existing exemption for vessels operating without any power or mechanical-advantage trawl retrieval system (i.e., any device used to haul any part of the net aboard) at 50 CFR 223.206(d)(2)(ii)(A)(*1*). Due to the lack of any power or mechanical-advantage trawl retrieval system, nets have to be pulled in by hand. This would require retrievals at short, regular intervals to prevent heavy catches that would otherwise prevent or hinder recovery. As such, we believe trawl intervals would be short enough to prevent bycatch mortality of any captured sea turtles.

This alternative would make an exception for vessels in the Biscayne Bay wing net fishery that operate in Miami-Dade County, Florida. These vessels use small, light-mesh monofilament nets that operate on the surface of the water in winter months in channels of Biscayne Bay near Miami. There is little bycatch in this fishery as it is predominately sight fishing using lights to reveal an abundance of shrimp that is then targeted by the wing nets. Any bycatch such as large fish (e.g., tarpon, barracuda) or palm fronds is immediately noticeable due a dramatic increase in drag and potential to blow-out the light monofilament webbing of the net. Furthermore, there currently is no information indicating this fishery interacts with sea turtles or could result in bycatch mortality of a captured sea turtle. As such, given the available information, we do not believe the Biscayne Bay wing net fishery presents a threat to sea turtle populations at this time.

2.3 ALTERNATIVE 3 (PREFERRED ALTERNATIVE): AMEND THE EXISTING TED REGULATIONS TO REQUIRE ALL VESSELS USING SKIMMER TRAWLS, PUSHER-HEAD TRAWLS, AND WING NETS (BUTTERFLY TRAWLS)—WITH THE EXCEPTION OF THE BISCAYNE BAY WING NET FISHERY PROSECUTED IN MIAMI-DADE COUNTY, FLORIDA—TO USE TEDS DESIGNED TO EXCLUDE SMALL TURTLES

Alternative 3 (Preferred Alternative) would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*), thereby requiring all vessels employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs designed to exclude small turtles in their nets. Similar to Alternative 2, however, an exemption for the Biscayne Bay wing net fishery would be retained. Furthermore, small trawlers that operate without any power or mechanical-advantage trawl retrieval system (i.e., any device used to haul any part of the net aboard) would still be allowed to employ alternative tow times per the exemption at 50 CFR 223.206(d)(2)(ii)(A)(*1*).

This alternative would address equity concerns expressed from other sectors of the shrimp fisheries. Specifically, some fishers using otter trawls that are currently required to use TEDs in their nets have believe the TED exemption for skimmer trawls, pusher-head trawls, and wing nets results in an unfair advantage to those gear types. This alternative would also prevent fishers from potentially switching gears under another altenative (e.g., Alternatives 4-5) to circumvent any new TED requirments.

2.4 ALTERNATIVE 4: AMEND THE EXISTING TED REGULATIONS TO REQUIRE VESSELS 26 FT AND GREATER IN LENGTH USING SKIMMER TRAWLS TO USE TEDS DESIGNED TO EXCLUDE SMALL TURTLES

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require all skimmer trawl vessels 26 ft and greater in length to use TEDs designed to exclude small turtles in their nets. While similar to Alternative 2, this alternative is specific only to skimmer trawls. We do not currently have information from direct observation on TED installation/operation, sea turtle exclusion, and potential catch loss related to TED use on pusher-head trawls or wing nets. Therefore, this alternative would only affect the portion of the fisheries that we have previously examined. For the reasons discussed in Alternative 2, we would also continue to exempt small vessels (i.e., less than 26 ft in length). Alternative 4 would also not impact the existing exemption for vessels operating without any power or mechanical-advantage trawl retrieval system at 50 CFR 223.206(d)(2)(ii)(A)(*1*). Due to a lack of specific information on the skimmer trawl fisheries, we are unable to quantify the number of vessels 26 ft and greater in length that may operate under this latter exemption.

2.5 ALTERNATIVE 5: AMEND THE EXISTING TED REGULATIONS TO REQUIRE ALL VESSELS USING SKIMMER TRAWLS TO USE TEDS DESIGNED TO EXCLUDE SMALL TURTLES

Alternative 5 would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require the use of TEDs designed to exclude small turtles in all skimmer trawl nets. Small skimmer trawls that operate without any power or mechanical-advantage trawl retrieval system (i.e., any device used to haul any part of the net aboard) would still be allowed to employ alternative tow times per the exemption at 50 CFR 223.206(d)(2)(ii)(A)(*1*).

2.6 ALTERNATIVE 6: AMEND THE EXISTING TED REGULATIONS AND REQUIRE THE USE OF TEDS DESIGNED TO EXCLUDE SMALL TURTLES BY ALL SHRIMP TRAWLERS FISHING WITHIN STATE WATERS

This alternative would remove the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*), thereby requiring all vessels employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs designed to exclude small turtles in their nets. Additionally, all otter trawlers operating in state waters would also have to utilize TEDs designed to exclude small turtles in their nets. Trawlers operating under other existing exemptions from the TED requirements (e.g., trawlers that operate without any power or mechanical-advantage trawl retrieval system under 50 CFR 223.206(d)(2)(ii)(A)(*1*) or trawlers using a single try net under 50 CFR 223.206(d)(2)(ii)(A)(*5*)), however, would not be affected by this alternative.

2.7 ALTERNATIVE 7: AMEND THE EXISTING TED REGULATIONS AND REQUIRE THE USE OF TEDS DESIGNED TO EXCLUDE SMALL TURTLES BY ALL SHRIMP TRAWLERS

This alternative would remove the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*), thereby requiring all vessels employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs designed to exclude small turtles in their nets. Additionally, all otter trawlers would also have to utilize TEDs designed to exclude small turtles in their nets. Trawlers operating under other existing exemptions from the TED requirements (e.g., trawlers that operate without any power or mechanical-advantage trawl retrieval system under 50 CFR 223.206(d)(2)(ii)(A)(*1*) or trawlers fishing for royal red shrimp under 50 CFR 223.206(d)(2)(ii)(B)(*2*)), however, would not be affected by this alternative.

2.8 ALTERNATIVES ELIMINATED FROM FURTHER DETAILED STUDY

We also considered a number of other alternatives to minimize the bycatch and mortality of small sea turtles in trawl fisheries. For the reasons described below, these alternatives were eliminated from further analysis in this DEIS.

Expand Observer Coverage

Several comments received during the scoping process recommended increasing observer coverage on shrimp trawl vessels to 50% or greater, in order to track improvements in TED compliance and collect new data. Specifics of the regionally managed observer programs can be found on our National Observer Program's website (http://www.st.nmfs.gov/st4/nop/), which has links to each regional observer program and in the 2012 National Observer Program Annual Report (NMFS 2013). The Southeast Regional Observer Program observes the shrimp fisheries; Atlantic, Gulf of Mexico, and Caribbean pelagic longline fisheries; Gulf of Mexico reef fish fishery; directed large coastal shark bottom longline fisheries; and the Southeast shark gillnet fishery. Fisheries that are not federally managed, such as those that occur exclusively in state waters, are currently unlikely to be monitored regularly by observers.

The Gulf of Mexico and South Atlantic shrimp fisheries currently have approximately 2% and 1% observer coverage, respectively. While additional observer coverage may provide beneficial information, given the size of the shrimp fisheries (i.e., >5,000 total vessels), the need for observer coverage in other fisheries in both the Gulf of Mexico and South Atlantic, and current budgets and budget projections, we are not in a position to increase observer coverage in the shrimp fisheries at this time. Fishery observers typically collect data on species composition of the catch, weights of fish caught, and disposition of landed species, though they may also collect information on protected species interactions. It is unlikely, however, that the fishery observer program would be able to provide definitive information on sea turtle bycatch in the shrimp fisheries, in of itself, due to the nature of sea turtle interactions with TEDs. Observers can document small turtles passing through TED bars and turtles captured in try nets. Yet, they would not typically see interactions between sea turtles and deployed TEDs, nor would they be able to quantify sea turtle bycatch as turtles may fall out of the net during recovery and before an observer could see or document the event. Even without a dedicated observer program, sea turtle mortalities in state and nearshore waters may be detected as elevated sea turtle strandings. The Sea Turtle Stranding and Salvage Network (STSSN) has become an important sentinel of nearshore sea turtle mortalities. The detection of sea turtle mortalities by the STSSN provided the first indications of sea turtle-fishery interactions in the summer flounder, large-mesh gillnet, and pound net fisheries in inshore and nearshore waters of the Mid-Atlantic. Subsequently, the observations and data collected by the STSSN supported the sea turtle conservation measures implemented to reduce bycatch in many of these fisheries.

In summary, an expanded observer program would not, in and of itself, reduce incidental sea turtle bycatch and mortality of small sea turtles. Therefore, this alternative was not deemed to be practicable or effective in addressing the purpose and need of the DEIS.

Require TEDs for Skimmer Trawlers Based on Frame Size Versus Vessel Size

During the scoping process, we received comments suggesting that management alternatives should be based on skimmer trawl frame size versus vessel size when considering exceptions to a TED requirement. That is, rather than exempting vessels less than 26 ft in length, for example, it might be more prudent to base any exemptions based on frame size. Skimmer trawls, however, are a state-managed segment of the southeastern shrimp fisheries. In some instances, state shrimp licenses do not differentiate by gear (i.e., otter versus skimmer trawl), nor do they include specific information on gear characteristics. Due to this lack of information, it is not possible to sort or classify the population of fishers in an alternative based on skimmer trawl frame size.

Require Data Loggers for the Shrimp Fisheries

While data loggers may help provide information on fishery effort both in time and space (depending on the data loggers used), they would not directly help reduce incidental fishery bycatch and mortality of small sea turtles. Therefore, we opted not to explore this alternative further.

Require Mandatory Tow Times in Conjunction with TEDs

As noted elsewhere in this document, tow times are difficult to enforce and we have documented compliance issues with them in the past. These issues are—in part—what originally prompted us to explore the mandatory use of TEDs in the skimmer trawl fisheries. TEDs have been demonstrated to be effective at reducing incidental bycatch and mortality of sea turtles. Significant measures have been taken to explore modification of the TED requirements to effectively exclude small sea turtles. We don't believe mandatory tow times in addition to the required use of TEDs would provide any significant benefit to sea turtle populations, but would introduce an unnecessary burden to industry. As this alternative would not appreciably assist our conservation objectives, we excluded this alternative from additional consideration.

Reduce the Allowable Size of Shrimp Nets

The reduction in the allowable size of shrimp nets was offered as an alternative during the scoping period (e.g., maximum combined headrope length of 90 ft in North Carolina waters). While a reduction in the size (e.g., maximum allowable footrope length) of a shrimp trawl net may reduce sea turtle interactions, it would not prevent sea turtle mortality of those turtles that would still invariably be captured in nets that are not equipped with TEDs, such as skimmer trawls. Additionally, an increase in effort could negate any reduction in sea turtle interactions occurring due to a reduction in net size. Therefore, we have determined this alternative would not be effective in protecting and recovering listed sea turtle populations.

Implement Time/Area Closures

Time/area closures can be an effective fisheries management action depending on the circumstances and intended objectives. Closing areas to fishing on a seasonal or periodic basis may introduce significant socio-economic effects to industry and administrative effects. While these consequences may be necessary to achieve particular goals, it does not appear to be a practical solution to address the needed reduction of bycatch and incidental mortality of small sea turtles in the southeastern shrimp fisheries. Time/area closures were explored in the 2012 DEIS (77 FR 29636). All of the time/area closure alternatives were determined to be less beneficial to sea turtles than the required use of TEDs due to the potential for effort shift, the presence of turtles outside of the closure areas, and other reasons discussed in the 2012 DEIS. As a result, we believe there are technical solutions that achieve better conservation results, introduce much less significant socio-economic effects to industry, and are easier to enforce than time/area closures that potentially span multiple jurisdictions.

Reduce the Size of the Southeastern Shrimp Fisheries Fleet

The Southeastern U.S. shrimp fisheries have witnessed a significant amount of attrition over the past 10-15 years. The federal shrimp fishery in the Gulf of Mexico has declined from 2,385 permitted vessels in March 2007 to 1,441 vessels eligible for permits in October 2016 (NMFS statistics). Likewise, participants and effort in state fisheries have also declined. For example, shrimp gear license sales in Louisiana has declined from 22,218 licenses in 2000 to 15,174 licenses in 2013, while the number of licensed resident and non-resident shrimp fishers in

Louisiana has declined from 10,006 in 2000 to an average of 5,600 in recent years; fishing effort has experienced similar declines (LDWF statistics). Given the improving trends of sea turtle populations, we do not feel further reductions in the shrimp fleet is warranted or needed.

Require the Use of TEDs in All Try Nets

Current TED regulations at CFR 223.206(d)(2)(ii) exempt a single test or try net with a headrope length of 12 ft (3.6 m) or less and with a footrope length of 15 ft (4.6 m) or less and if it is pulled immediately in front of another (primary) net. Vessels fishing with try nets larger than the exempted specifications, or with multiple try nets, are currently required to have TEDs installed in those nets. Try nets with a headrope length less than 12 ft are required to abide by alternative tow time requirements. Past work has indicated that smaller try nets are less likely to capture turtles compared to the larger try nets currently required to use TEDs. Specifically, in 24,834 hours of observed try net effort in the Gulf of Mexico from 2011-2015 there were 28 sea turtle interactions documented (E. Scott-Denton, NFMS, pers. comm., August 4, 2016). This yields a catch per unit of effort (CPUE) of 0.00113, which is an order of magnitude less than that calculated for Kemp's ridley sea turtle captures in the skimmer trawl fisheries discussed later in this document. Try net captures in the South Atlantic over the same time period occurred more often, with 13 interactions in 3,680 hours of observed try net effort (E. Scott-Denton, NFMS, pers. comm., August 4, 2016), but the resulting CPUE of 0.00353 is still significantly lower than that documented in the skimmer trawl fisheries presented herein. Regardless, we have conducted some initial and limited TED testing on try nets with a headrope length of 11.75 ft (3.58 m), but have yet to initiate testing on smaller try nets used in the fisheries (e.g., 6-8 ft [1.8-2.4 m] headrope length). This preliminary work indicated that some of these try nets will require TED grid frames smaller than the current 32 in (81 cm) horizontal and vertical measurements, which will require additional testing. Without examining effective TED designs in a range of try net sizes, we do not believe requiring TEDs in all try nets to be practical at this time. Alternative 4, however, would require all shrimp trawlers fishing in state waters to use modified TEDs to exclude small sea turtles, which would include TED use in try nets by these vessels.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This section describes the baseline conditions of important components of the environment in which the proposed action and alternatives would take place. As the proposed action is designed to reduce the incidental bycatch and mortality of small sea turtles in the Southeastern U.S. shrimp fisheries, the following sections are focused on the shrimp fisheries in the Gulf of Mexico and South Atlantic, as well as the environments associated with or impacted by those fisheries, particularly sea turtle populations.

3.1 DESCRIPTION OF THE FISHERIES

A complete description of the federal shrimp fisheries can be found in the Gulf of Mexico Fishery Management Council's (GMFMC) Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters (GMFMC 1981) and its subsequent plan amendments, as well as the South Atlantic Fishery Management Council's (SAFMC) Fishery Management Plan for the Shrimp Fishery of the South Atlantic Region (SAFMC 1993) and its subsequent plan amendments. As the scope of the action affects state shrimp fisheries, we have also compiled data from coastal states resource agencies (see Section 3.6, Description of the Administrative Environment) and reviewed available information such as that presented in published state shrimp fishery management plans (FMPs) (e.g., 2015 Louisiana Shrimp FMP).

The Northern Gulf of Mexico (and North Carolina) shrimp fisheries are based primarily on 2 species, brown shrimp (*Farfantepenaeus aztecus*) and white shrimp (*Litopenaeus setiferus*). The management unit in the GMFMC Shrimp FMP also includes pink shrimp (*Farfantepenaeus duorarum*) and royal red shrimp (*Hymenopenaeus robustus*). Seabobs (*Xiphopenaeus kroyeri*) and rock shrimp (*Sicyonia brevirostris*) occur as incidental catch in the fisheries.

Brown shrimp is the most important species in the U.S. Gulf of Mexico fisheries, with principal catches made from June through October. Annual commercial landings from 2003 through 2014 have ranged from approximately 45 to 88 million pounds (lb) of tails depending on environmental factors that influence natural mortality. The fisheries extend offshore to about 40 fathoms. Brown shrimp is also the most abundant shrimp species in North Carolina, and accounts for 67% of North Carolina's shrimp landings. The brown shrimp fisheries occur primarily at night in offshore (i.e., EEZ) waters, but a significant portion of brown shrimp effort in inshore waters occurs in daylight hours.

White shrimp, second in value, are found in near shore waters to about 20 fathoms from Texas through Alabama; Louisiana is the center of abundance for white shrimp. There is a small spring and summer fishery for overwintering individuals, but the majority is taken from August through December. Annual commercial landings from 2003 through 2014 have ranged from approximately 56 to 87 million lb of tails. In North Carolina white shrimp is harvested primarily in the fall, and accounts for 28% of North Carolina shrimp landings. A good portion of the white shrimp fisheries occur during daylight hours.

Pink shrimp are found off all Gulf of Mexico states but are most abundant off Florida's west coast and particularly in the Tortugas grounds off the Florida Keys. Most landings are made from October through May with annual commercial landings ranging from approximately 3 to 11 million lb of tails. In the Northern and Western Gulf of Mexico states, pink shrimp are landed mixed with brown shrimp and are usually counted as browns. Most catches are made within 30 fathoms. Pink shrimp are harvested in the spring and the fall in North Carolina, and account for 5% of North Carolina's shrimp landings.

The commercial fishery for royal red shrimp is most common on the continental shelf from about 140 to 2300 fathoms, and east of the Mississippi River. Landings have varied 2003 through 2014, ranging from approximately 130,000 to 353,000 lbs of tails. In 2013, 74% of landings were from federal waters off Alabama, 24% were from off Florida, and 2% were from off Louisiana (GMFMC 2016a).

The 3 principal species (penaeids) are short-lived and provide annual crops; however, royal red shrimp live longer, and several year classes may occur on the grounds at one time. The condition of each shrimp stock is monitored annually, and none has been classified as being overfished for over 40 years.

Brown, white, and pink shrimp are subjected to fishing from inland waters and estuaries, through the state-regulated territorial seas, and into federal waters of the EEZ. Royal red shrimp occur only in the EEZ. Management measures implemented under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) apply only to federal waters in the EEZ. Cooperative management occurs when state and federal regulations are consistent. Examples are the seasonal closure off Texas, the Tortugas Shrimp Sanctuary, and the shrimp/stone crab seasonally closed zones off Florida.

More than half of the commercial shrimp vessels fall into a size range from 56 to 75 ft (GMFMC 2016a). Federal permits for shrimp vessels are currently required, and state license requirements vary. A moratorium on federal shrimp permits was approved by the GMFMC in 2005. Many vessels maintain licenses in several states because of their migratory fishing strategy. The number of vessels in the shrimp fisheries at any one time varies due to economic factors such as the price and availability of shrimp and cost of fuel.

As of October 18, 2016, there were 1,441 valid or renewable moratorium permits for the federal Gulf of Mexico shrimp fishery (SPGM), which is a significant decline from the 2,385 permits encompassed by a previously open-access Gulf of Mexico federal shrimp fishery, which sunset on March 25, 2007 (NMFS statistics). Additionally, there are 285 current Gulf of Mexico royal red shrimp endorsements (GRRS), which must be accompanied by a valid SPGM permit. In the South Atlantic, there were 467 federally-permitted (open-access) vessels in the penaeid shrimp fishery (SPA), 106 (open-access) permits for the Carolina Zone rock shrimp fishery (RSCZ), and 97 valid (limited-access) permits for the South Atlantic EEZ rock shrimp fishery (RSLA).

Various types of gear are used to capture shrimp, including but not limited to: cast nets, dip nets, haul seines, otter trawls, stationary butterfly nets, wing nets (butterfly trawls), skimmer nets, traps, and beam trawls. The otter trawl, with various modifications, is the dominant gear used in offshore waters. A basic otter trawl consists of a heavy mesh bag with wings on each side designed to funnel the shrimp into the "cod end" or "tail bag." A pair of otter boards or trawl doors positioned at the end of each wing hold the mouth of the net open by exerting a downward and outward force at towing speed. A lead line or footrope extends from door to door on the bottom of the trawl, while a cork line or headrope is similarly attached at the top of the net. A "tickler chain" is also attached between the trawl doors that runs just ahead of the net, and is used to spook shrimp off the bottom and into the trawl net. The lead lines of larger nets are weighted with a 1/4-to 3/8-in loop chain attached at about 1-ft intervals with a 14- to 16-in drop. Many larger nets are also equipped with rollers on the lead line that keeps the lead line from digging into muddy bottom.

Shrimp trawl nets are usually constructed of nylon or polyethylene mesh webbing, with individual mesh sizes ranging from as small as 1-1/4 in to 2 in. The sections of webbing are assembled according to the size and design (usually flat, balloon, or semi-balloon) of trawl desired, which affects the width and height of the trawl's opening and its bottom-tending characteristics. The tongue or "mongoose" design incorporates a triangular tongue of additional webbing attached to the middle of the headrope pulled by a center towing cable, in addition to the 2 cables pulling the doors. This configuration allows the net to spread wider and higher than conventional nets and as a result has gained much popularity for white shrimp fishing.

Until the late 1950s, most shrimp vessels pulled single otter trawls, ranging from 80 to 100 ft in width, directly astern of the boat. Double-rig trawling was introduced into the shrimp fleet during the late 1950s. The single large trawl was replaced by 2 smaller trawls, each 40 to 50 ft in width, towed simultaneously from stoutly constructed outriggers located on the port and starboard sides of the vessels. The advantages of double-rig trawling include: (1) increased catch per unit of effort, (2) fewer handling problems with the smaller nets, (3) lower initial gear costs, (4) a reduction in costs associated with damage or loss of the nets, and (5) greater crew safety.

In 1972, the quad rig was introduced in the shrimp fisheries, and by 1976 it became widely used in the EEZ of the western Gulf of Mexico. The quad rig consists of a twin trawl pulled from each outrigger (i.e., 4 trawl nets). One twin trawl typically consists of two 40- or 50-ft trawls connected to a center sled and spread by 2 outside trawl doors. Thus, the quad rig with 2 twin trawls has a total spread of 160-200 ft versus the total spread of 110 ft in the old double rig of two 55-ft trawls. The quad rig has less drag and is more fuel efficient. The quad rig is the primary gear used in federal waters by larger vessels. Smaller boats and inshore trawlers often still use single- or double-rigged nets.

TED requirements for shrimp trawlers originally appeared in 1987, but were not fully implemented for the fisheries until December 1994 (57 FR 57348). A primary modification to the TED requirements occurred in 2003 (68 FR 8456), when we implemented larger escape opening sizes that would allow the exclusion of leatherback and large loggerhead and green sea turtles. A summary of the TED requirements is included in Appendix II. Based on evaluation and testing of various TED designs, we have determined that a well installed and maintained TED will result in an approximate 95 to 98% turtle exclusion efficiency rate (J. Gearhart memorandum to S. Epperly, NMFS, March 29, 2011); the lower efficiency rate was documented for smaller turtles used in our small turtle testing protocol between 2001-2010, which relies on 2- to 3-year old juvenile turtles. The higher efficiency rate was documented in our wild turtle testing protocol from 2002-2007, which typically witnesses larger turtles on average as compared to the small turtle testing protocol. That is, even a fully-compliant TED may experience incidental catch of sea turtles due to a variety of factors including environmental conditions, individual turtle behavior, etc.

Try nets are small otter trawls about 12 to 16 ft in width that are used to test areas for shrimp concentrations. These nets are towed during regular trawling operations and lifted periodically to allow the fishers to assess the amount of shrimp and other fish and shellfish being caught. These amounts in turn determine the length of time the large trawls will remain set or whether more favorable locations will be selected. Try nets with a headrope length greater than 12 ft are required to use TEDs, while try nets 12 ft or less are required to comply with alternative tow times if no TED is installed (per 50 CFR 223.206(d)(2)(ii)(A)(*5*)).

Wing nets (butterfly trawls or "paupiers") were introduced in the 1950s and used on shrimp boats either under power or while anchored. A butterfly trawl consists of square metal frame which forms the mouth of the net. Webbing is attached to the frame and tapers back to a cod end on either side of the vessel. The vessel is then anchored in tidal current or the nets are "pushed" through the water by the vessel. Louisiana also licenses the use of stationary wing nets, which typically consist of a single net attached to a platform and is tended while it fishes, similar to a channel net used in North and South Carolina; the majority of licensed wing nets in Louisiana are associated with stationary platforms or docks. There is also a unique wing net fishery that primarily operates in Biscayne Bay, Miami-Dade County, Florida, sight-targeting pink shrimp at night. These vessels use light monofilament webbing that fish the surface when shrimp are abundant, typically around the full moon (Johnson et al. 2012).

Vietnamese fishers began moving into Louisiana in the early 1980s and introduced a gear called the “xipe” or “chopstick” net around 1983. The chopstick was attached to a rigid or flexible frame similar to the wing net; however, the frame mounted on the bow of the boat was attached to a pair of skids and fished by pushing the net along the bottom. As with wing nets, the contents of the net could be picked up and dumped without raising the entire net out of the water as is necessary with an otter trawl.

The skimmer trawl was developed for use in some areas primarily to catch white shrimp, which has the ability to jump over the cork line of standard trawls while being towed in shallow water. The skimmer net frame allows the net to be elevated above the water while the net is fishing, thus preventing shrimp from escaping over the top. Owing to increased shrimp catch rates, less debris or bycatch, and lower fuel consumption than otter trawlers, the use of skimmer nets quickly spread in several coastal states. Within the Gulf of Mexico, Louisiana, Mississippi, Alabama, and Florida include skimmer trawls as an allowable gear. In the South Atlantic, North Carolina is the only state that permits skimmer trawl gear.

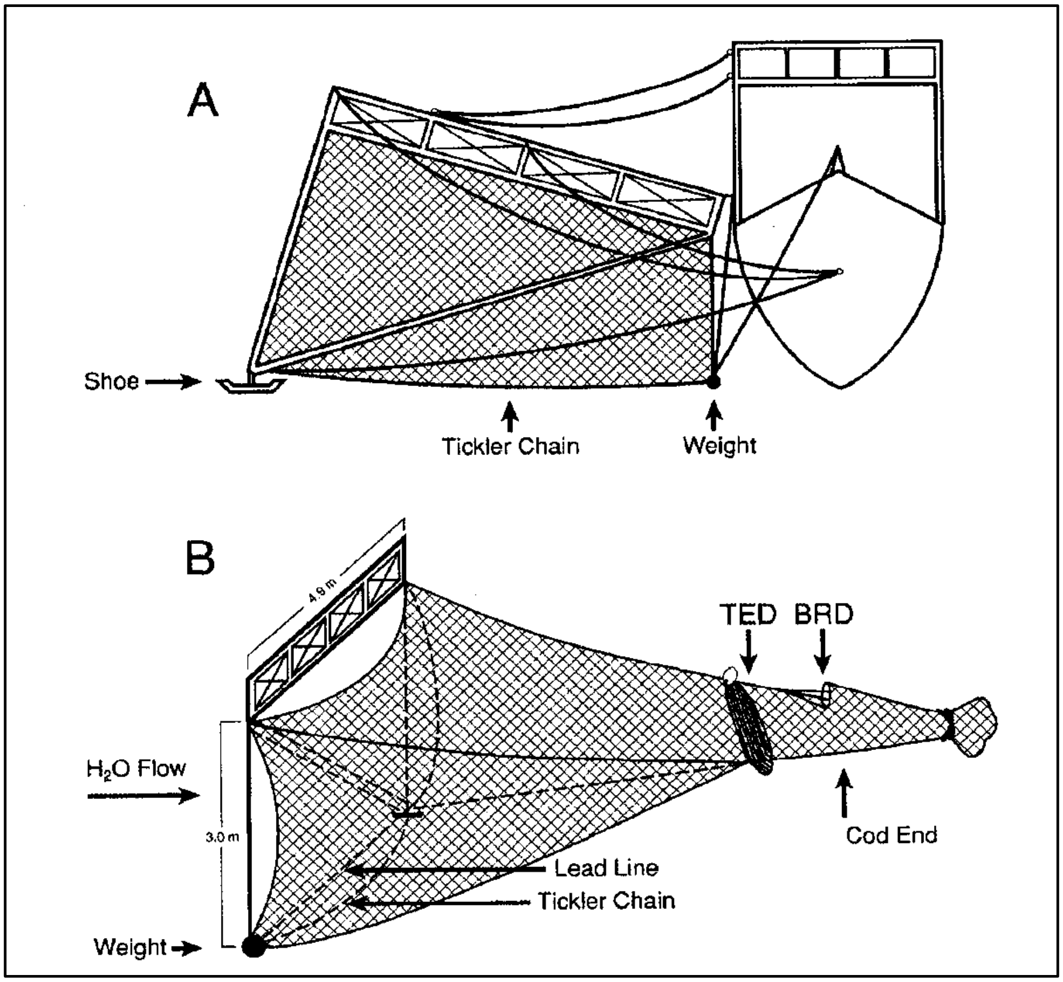

Figure 1. Skimmer trawl diagram showing (A) the skimmer trawl frame and (B) the components of the net, including an installed TED and BRD (from Warner et al. 2004).

The basic components of a skimmer trawl (Figure 1) include a frame, the net, heavy weights, skids or "shoes," and tickler chains. The net frame is usually constructed of schedule 80 steel or aluminum pipe or tubing and is either L-shaped (with an additional stiff leg) or a trapezoid design. When net frames are deployed, they are aligned perpendicularly to the vessel and cocked or tilted forward and slightly upward. This position allows the net to fish better and reduces the chance of the leading edge of the skid digging into the bottom and subsequently damaging the gear. The frames are maintained in this position by 2 or more stays or cables to the bow. The outer leg of the frame is held in position with a "stiff leg" to the horizontal pipe and determines the maximum depth at which each net is capable of working. To the bottom of the outer leg is attached the skid or "shoe," which allows the frame to ride along the bottom, rising and falling with the bottom contour. Tickler chains and lead lines comprise the bottom of this gear.

Fishers are required to comply with state and/or federal regulations, depending on where they fish. Some states have specific regulations for the different fisheries, which are briefly summarized below.

The Texas Parks and Wildlife Department (TPWD) manages the commercial shrimp fishery in 3 segments within its waters: the bay food shrimp fishery, the Gulf of Mexico (i.e., offshore) food shrimp fishery, and the bait shrimp fishery. There has been a limited entry program in effect for the Texas bay and bait shrimp fisheries since 1996, and since 2005 for the Gulf of Mexico shrimp fishery. Because TPWD allows licensed bait shrimp vessels to participate in the bay and Gulf of Mexico shrimp fisheries, bait shrimp trawlers are required to use TEDs in their nets (per 50 CFR 223.206(d)(2)(ii)(A)(*2*)). According to Texas Administrative Code, only beam and otter trawls are permitted to harvest shrimp from Texas waters.

The Louisiana Department of Wildlife and Fisheries (LDWF) issues commercial otter trawl, skimmer net, and butterfly net gear licenses to harvest shrimp in Louisiana waters. In Louisiana, butterfly net gear can be associated with vessels or affixed to platforms or docks adjacent to tidal passes. Regulations specific to Louisiana state waters specify that no person on a vessel shall use a double skimmer net having an individual net frame more than 16 ft measured horizontally or 12 ft measured vertically, or 20 ft measured diagonally, or with a lead line measuring more than 28 ft for each net in Louisiana waters. Additionally, reinforcement framing attached to the net frame shall not be considered in determining the dimensions of a double skimmer. A skimmer or butterfly net may be mounted no more than 24 in from the side of the vessel and individual nets cannot be tied together in Louisiana waters. Lastly, Louisiana fishing regulations state that no person shall use sweeper devices, leads, extensions, wings or other attachments in conjunction with or attached to butterfly nets or skimmer nets. In Louisiana, fishers use paired skimmer nets primarily in inshore waters and tidal passes; they also use them extensively in shallow nearshore Gulf of Mexico waters (LDWF 2016). Skimmer trawls in Louisiana account for a significant amount of shrimp landings, averaging approximately 41% of total landings from 2000-2013 (LDWF 2016). Skimmer trawls ranging from 30-49 ft in length accounted for the highest proportion of shrimp landings among all vessel size classes (77.1% of total shrimp within the category and 28.4% of total shrimp amongst all vessel categories).

The Mississippi shrimp fishery is managed by the Mississippi Department of Marine Resources (MDMR), and the opening of the annual shrimp season is determined by the average size of shrimp documented in surveys conducted by the MDMR. Regulations specific to skimmer trawls in Mississippi specify that it shall be unlawful to use skimmer trawls or wing nets with a maximum size greater than 25 ft on the headrope and 32 ft on the footrope. Shrimp licenses issued by MDMR do not differentiate by gear type and MDMR does not have accurate data on the number of skimmer trawls operating in Mississippi waters; they estimate to be 150 vessels that utilize only skimmer gear and approximately 50 other vessels that are rigged with both skimmer and otter trawl gear (T. Floyd, MDMR, pers. comm.). Additionally, MDMR issues 274 shrimp licenses on average that indicate otter trawl gear only, with another 128 that do not specify gear type.

The Alabama Department of Conservation and Natural Resources (ADCNR) manages the Alabama shrimp fishery, and the Alabama Administrative Code (Chapter 220-3-.01) states that, "It shall be illegal for any person, firm or corporation to take or attempt to take shrimp or other seafoods in or from the inside waters of the State of Alabama by trawl or trawls used together the total width of which exceeds fifty (50) feet as measured in a straight distance along the cork line, which is the main top line containing corks. The use of more than two trawls is prohibited in the inside waters; provided however, that one “try trawl” not to exceed ten (10) feet as measured across the cork line may be used for sampling in addition to the above. In addition, wings shall be cut and tied to the wing line only on points and it shall be illegal to use a trawl or trawls on which the length of the top leg line exceeds the length of the bottom leg line, the length of the leg line being defined as the distance from the rear of the trawl door to the beginning of the wing.” Alabama does not specify gear type for its commercial shrimp license. During 2011-2014, Alabama issued 621 resident shrimp licenses on average, with approximately 60% of the licenses issued to vessels less than 30 ft in length.

Managed by the Florida Fish and Wildlife Conservation Commission (FWC), the Florida state food and bait shrimp fisheries employ otter trawls, skimmer trawls, roller frame trawls, and wing nets. The use of skimmer trawls is allowable in Florida state waters, and much of the historical effort occurred in the Florida Panhandle, specifically in Apalachicola Bay (Warner et al. 2004). While skimmer trawls are an authorized gear, Florida Administrative Code 68B-31.004 states that TEDs are required on all otter and skimmer trawls, except for a single try net or rectangular rigid roller frame trawl that has an opening shielded with a grid of vertical bars spaced no more than 3 in apart. Recent information indicates there is very little skimmer trawl activity in Florida.

The Georgia Department of Natural Resources (GDNR) manages separate food shrimp and bait shrimp fisheries in its waters. Unlike most other states, Georgia prohibits night-time trawling in its waters. The maximum footrope length for a single trawl or trawls combined for food shrimp is 220 ft, not including a try net up to 16 ft in length. Nets used in the bait shrimp fishery may not be larger than 20 ft at the widest part of its mouth.

The South Carolina food and bait shrimp fisheries are managed by the South Carolina Department of Natural Resources (SCDNR). Similar to Georgia, South Carolina prohibits night-time trawling for shrimp in state waters and limits the footrope length to 220 ft, excluding a maximum 16-ft try net. For the food shrimp fishery, otter trawls are the primary gear, though static channel nets are also used in state bays to harvest shrimp. TED use is required in some areas when fishing with channel nets in South Carolina.

In North Carolina, otter trawls harvest the bulk of landed shrimp, with skimmer trawls and channel nets each accounting for approximately 3% of the total catch. An increasing number of vessels in Carteret, Onslow, and Pender Counties are switching from otter trawls to skimmers as their efficiency on brown shrimp harvest is improved. According to Brown (2016), skimmer vessels in North Carolina average approximately 30 ft in length and operate with crews of 1 or 2 fishers. They typically operate in the estuarine waters of North Carolina in late summer and fall when white shrimp are most abundant. Skimmer trawls in North Carolina are limited to 26 ft in total combined width per North Carolina state rule 15A NCAC 03O .0302.

Obtaining an accurate estimate of active vessels in the Southeastern U.S. shrimp fisheries is difficult due to the number of permitting agencies involved, differences in management, and artifacts with available data sets (e.g., trip reports, landings data). As mentioned, some states do not specify vessel/gear type (e.g., otter or skimmer trawl). In other cases, licenses may be issued to individual vessels or it may be issued to individual nets (with some vessels using multiple nets). In some instances, individual vessels may use multiple gear types (e.g., otter and skimmer trawls). Additionally, license information is but one metric for describing the fisheries; there may be significant latent effort from year to year, so license information does not necessarily reflect actual participation or effort. Nonetheless, it does help describe the potential universe of vessels involved in the fisheries. Table 2 summarizes available information on residential state-licensed commercial vessels in the Southeastern U.S. shrimp fisheries. States also issue shrimp licenses to non-residential vessels, but these are not included as it would result in double-counting. That is, as the shrimp fisheries are highly transient, vessels based (and residentially-licensed) in Texas, for example, could also be (non-residentially) licensed to fish in Louisiana or Mississippi state waters during various times of the year. Likewise, the aforementioned 1,364 and 467 federally-permitted shrimp vessels in the Gulf of Mexico (SPGM) and South Atlantic (SPA), respectively, are also likely licensed to fish in one or more states' territorial waters.

Table 2. Summary of residential state-licensed commercial vessels in the Southeastern U.S. shrimp trawl fisheries. Texas statistics via TPWD; Louisiana statistics via LDWF; Mississippi statistics via MDMR (T. Floyd, pers. comm.); Alabama statistics via AMRD (C. Blankenship, pers. comm.); Florida statistics via FWC; Georgia statistics via GDNR; South Carolina statistics via SCDNR (A. Brown, pers. comm.); North Carolina statistics via NCDMF (2015). Skimmer and otter trawl totals are underestimates due to lack of shrimp gear identification in Alabama and the unclassified trawl gear category in Florida.

STATE	YEAR	SKIMMER	OTTER	SKIMMER - OTTER	WING NET	ROLLER FRAME	UNCLASSIFIED	TOTAL[1]
TEXAS	2015	-	995	-	-	-	-	995
LOUISIANA	2015	3,651	2,576	-	960[2]	-	-	7,187[2]
MISSISSIPPI	2015	150	274	50	-	-	-	474
ALABAMA	2014	N/A	N/A	-	-	-	-	552
FLORIDA[3]	2015	1	407	-	103	103	51	665
GEORGIA	2015	-	208	-	-	-	-	208
SOUTH CAROLINA	2015	-	292	-	-	-	-	292
NORTH CAROLINA	2014	75	376	-	-	-	-	451
TOTAL		**3,877**	**4,948**	**50**	**1,063[2]**	**103**	**51**	**10,824[1,2]**

[1] Aggregating all vessels across gear types may overestimate total vessels as individuals may hold multiple licenses (e.g., otter and skimmer in Louisiana).
[2] The majority of Louisiana wing nets are associated with a fixed structure rather than a vessel; 680 unique individuals purchased the 960 wing net gear licenses. As vessels would typically purchase 2 licenses, this preponderance of single licenses indicate that most of the wing nets are associated with fixed structures.
[3] Florida does not have a unique shrimp license but a general saltwater product license, so these numbers are based on landings.

Recreational shrimp trawl fisheries also occur seasonally inside state waters. However, not all states have a permitting system for recreational shrimping in state waters. Furthermore, some recreational fishers may purchase commercial licenses in order to use skimmer trawl or other commercial gears, but do not participate at the same level as commercial fishers. In 2014, there were more than 750 recreational shrimp permits for Texas, Louisiana, Mississippi, and Alabama; it should be noted that Florida and Alabama do not require special recreational shrimp permits for state waters.

3.2 DESCRIPTION OF THE PHYSICAL ENVIRONMENT

The physical environment of the Gulf of Mexico region has been described in detail in the EIS for the Generic Essential Fish Habitat (EFH) Amendment, and is incorporated herein by reference (GMFMC 2004). The Gulf of Mexico has a total area of approximately 600,000 square miles (1.5 million km^2), including state waters (Gore 1992). It is a semi-enclosed, oceanic basin connected to the Atlantic Ocean by the Straits of Florida and to the Caribbean Sea by the Yucatan Channel. Oceanic conditions are primarily affected by the Loop Current, the discharge of freshwater into the Northern Gulf of Mexico, and a semi-permanent, anticyclonic gyre in the western Gulf of Mexico. Gulf of Mexico water temperatures range from 12°C to 29°C (54°F to 84°F) depending on time of year and depth of water. In the Gulf of Mexico, adult penaeid shrimp are found in nearshore and offshore silt, mud, and sand bottoms while juveniles are found inhabiting estuaries.

The 2005 hurricane season, particularly Hurricane Katrina in late August 2005, resulted in significant effects to the physical environment in the Northern Gulf of Mexico. Hurricane Katrina's storm surge resulted in massive flooding throughout the region, which in turn led to significant oil spills (i.e., millions of gallons) and the release of toxic materials such as raw sewage, pesticides, heavy metals, and a variety of other harmful chemicals. Debris from coastal communities littered marshes, estuaries, and other nearshore waters, potentially impacting nursery habitat such as oyster reefs. While hurricanes have historically altered the physical environment in the Northern Gulf of Mexico, due to the widespread and intense effects to heavily-industrialized areas, the effects of Hurricane Katrina extend beyond natural storm effects and may have a longer-lasting influence on the regional environment.

On April, 20, 2010, while drilling approximately 50 miles (mi) east-southeast of the Mississippi River Delta, Louisiana and 100 mi south of Dauphin Island, Alabama, the DWH semi-submersible drilling rig experienced a catastrophic explosion due to a blowout. The fire burned out of control until the rig sank on April 22, 2010, which allowed the compromised well to release oil directly into the Gulf of Mexico. The well was temporarily capped on July 15, 2010, which significantly reduced the amount of leaking oil, but the well was not ultimately sealed and declared "effectively dead" until September 19, 2010. Estimates on the amount of released oil varied widely and over time, but final official estimates indicated 53,000-62,000 barrels were released per day as a result of the event; the total amount of oil released into the Gulf of Mexico was estimated at 4.9 million barrels (780,000m^3) (McNutt et al. 2011).

In the wake of the explosion and spill, approximately 2.1 million gallons of chemical dispersant were applied to surface waters (1.4 million gallons) and directly at the wellhead (0.77 million gallons) between May 15 and July 12, 2010.[5] COREXIT is a product line of solvents primarily used as a dispersant for breaking up oil slicks, and it (i.e., COREXIT 9527 and COREXIT 9500) was the most-used dispersant in the DWH oil spill event. COREXIT 9527 was replaced by COREXIT 9500 after the former was deemed too toxic; Unified Command records indicate that the last date of use of the COREXIT 9527 was May 22, 2010. According to the manufacturer, "When the COREXIT dispersants are deployed on the spilled oil, the oil is broken up into tiny bio-degradable droplets that immediately sink below the surface where they continue to disperse and bio-degrade. This quickly removes the spilled oil from surface drift and reducing direct exposure to birds, fish, and sea animals in the spill environment."

[5] www.whitehouse.gov/blog/issues/Deepwater-BP-oil-spill (accessed November 3, 2010); from Kujawinski et al. 2011.

COREXIT 9527, considered by the Environmental Protection Agency (EPA) to be an acute health hazard, is stated by its manufacturer to be potentially harmful to red blood cells, the kidneys and the liver, and may irritate eyes and skin. The chemical 2-butoxyethanol, found in COREXIT 9527, was identified as having caused lasting health problems in workers involved in the cleanup of the EXXON VALDEZ oil spill. In contrast, COREXIT 9500, a combination of propylene glycol, is deemed to have low human and environmental risk according to the Materials Safety Data Sheet for the chemical. Its ingredients are not considered carcinogens, although no long-term exposure studies have been conducted on the solution. Furthermore, there is no information currently available on the effects of the dispersant on sea turtles, either by direct exposure or other avenues, such as bioaccumulation through foraging on prey species.

The physical environment for the South Atlantic region potentially affected by the alternatives considered in this DEIS has been described in detail in the Fishery Ecosystem Plan of the South Atlantic Region, and is incorporated herein by reference (SAFMC 2009). The South Atlantic region is defined by the inshore, coastal, and offshore waters of the Atlantic Ocean encompassed by the boundary between the states of Virginia and North Carolina, extending southward and westward to the line of demarcation between the Atlantic Ocean and Gulf of Mexico off the Florida coast (83° 00'W longitude).

3.3 DESCRIPTION OF THE BIOLOGICAL ENVIRONMENT

3.3.1 Gulf of Mexico and South Atlantic Shrimp (Including EFH)

In the southeastern United States, the shrimp industry is based mostly on 3 shallow-water species of the family Penaeidae: white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), and pink shrimp (*Farfantepenaeus duorarum*). Rock shrimp (*Sicyonia brevirostris*) and royal red shrimp (*Pleoticus robustus*) are also fished in both regions, but occur in deeper water than the 3 penaeid species. White, brown, and pink shrimp use a variety of habitats as they grow from planktonic larvae to spawning adults (GMFMC 1981).

White shrimp are offshore and estuarine dwellers and are pelagic or demersal, depending on life stage. They range from Fire Island, New York, to St. Lucie Inlet on the Atlantic coast of Florida, and from the Ochlockonee River on the Gulf of Mexico coast of Florida to Ciudad Campeche, Mexico. Along the Atlantic coast of the U.S., the white shrimp is more common off South Carolina, Georgia, and northeast Florida. White shrimp are generally concentrated on the continental shelf where water depths are 89 ft (27 m) or less, although occasionally they are found much deeper (up to 270 ft) (SAFMC 1998). The eggs are demersal and larval stages are planktonic; both occur in nearshore marine waters. Postlarvae migrate through passes mainly from May-November with peaks in June and September. Juveniles are common to highly abundant in all Gulf of Mexico estuaries from Texas to about the Suwannee River in Florida. Postlarvae and juveniles inhabit mostly mud or peat bottoms with large quantities of decaying organic matter or vegetative cover. Migration from estuaries occurs in late August and September and appears to be related to size and environmental conditions (e.g., sharp temperature drops in fall and winter). Adult white shrimp are demersal and generally inhabit nearshore Gulf of Mexico waters to depths less than 30 m on bottoms of soft mud or silt. See

Nelson (1992) and Pattillo et al. (1997) for more detailed information on habitat associations of white shrimp.

Pink shrimp occupy a variety of habitats, depending on their life stage. Eggs and early planktonic larval stages occur in marine waters. Eggs are demersal, whereas larvae are planktonic until the postlarval stage when they become demersal. Juveniles inhabit almost every U.S. estuary in the Gulf of Mexico but are most abundant in Florida. Juveniles are commonly found in estuarine areas with seagrass where they burrow into the substrate by day and emerge at night. Adults inhabit offshore marine waters with the highest concentrations in depths of 9 to 44 m.

Brown shrimp occur from Martha's Vineyard, Massachusetts to the Florida Keys and northward into the Gulf of Mexico to the Sanibel Grounds. The species reappears near Apalachicola Bay and occurs around the Gulf of Mexico coast to northwestern Yucatan. Although brown shrimp may occur seasonally along the Mid-Atlantic States, breeding populations apparently do not occur north of North Carolina. The species may occur in commercial quantities in areas where water depth is as great as 361 ft (110 m), but they are most abundant in areas where the water depth is less than 180 ft (55 m) (SAFMC 1998). Brown shrimp eggs are demersal and occur offshore. The larvae occur offshore and begin to migrate to estuaries as postlarvae. Postlarvae migrate through passes on flood tides at night mainly from February-April with a minor peak in the fall. Postlarvae and juveniles are common to highly abundant in all U.S. estuaries from Apalachicola Bay in the Florida Panhandle to the Mexican border. In estuaries, brown shrimp postlarvae and juveniles are associated with shallow vegetated habitats but also are found over silty sand and non-vegetated mud bottoms. Adult brown shrimp occur in neritic Gulf of Mexico waters (i.e., marine waters extending from mean low tide to the edge of the continental shelf) and are associated with silt, muddy sand, and sandy substrates. More detailed discussion on habitat associations of brown shrimp is provided in Nelson (1992) and Pattillo et al. (1997).

Pink shrimp occur from southern Chesapeake Bay to the Florida Keys and around the coast of the Gulf of Mexico to Yucatan south of Cabo Catoche. Maximum abundance is reached off southwestern Florida and the southeastern Gulf of Campeche. Along the Atlantic coast of the U.S. pink shrimp are of major commercial significance only in North Carolina and the Florida Keys. Pink shrimp are most abundant in areas where water depth is 36-121 ft (11-37 m) although in some areas they may be abundant where water depth is as much as 213 ft (65 m) (SAFMC 1998).

Royal red shrimp is a deep-water species most abundant on the continental shelf from about 140 to 275 fathoms east of the Mississippi River. Unlike penaeid shrimp, which are short-lived and provide annual crops, royal reds live longer and several year classes may occur on the shrimping grounds at one time.

EFH for shrimp consists of Gulf of Mexico waters and substrates extending from the U.S./Mexico border to Fort Walton Beach, Florida from estuarine waters out to depths of 183 m; waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 183 and 595 m; waters and substrates extending from Pensacola Bay, Florida to the boundary between the areas covered by the GMFMC and the SAFMC out to depths of 64 m, with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 18 and 46 m; and in Florida Bay between depths of 9 and 18 m (GMFMC 2004).

For penaeid shrimp in the South Atlantic, EFH includes inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity, and all interconnecting water bodies as described in the Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region (SAFMC 1998). Inshore nursery areas include tidal freshwater, estuarine, and marine emergent wetlands (e.g., intertidal marshes); tidal freshwater forested areas; mangroves; tidal freshwater, estuarine, and marine submerged aquatic vegetation (e.g., seagrass); and subtidal and intertidal non-vegetated flats. This habitat is found from North Carolina through the Florida Keys.

In North Carolina, habitat areas of particular concern (HAPC) for penaeid shrimp include estuarine shoreline habitats where juvenile shrimp congregate. Seagrass beds, prevalent in the sounds and bays of North Carolina and Florida, are particularly critical areas. South Carolina and Georgia lack substantial amounts of seagrass beds. Here, the shrimp nursery habitat is the high marsh areas that offer shell hash and mud bottoms. In addition, juvenile shrimp move seasonally out of the marsh into deep holes and creek channels adjoining the marsh system during winter. Therefore, the area of particular concern for early growth and development encompasses the entire estuarine system from the lower salinity portions of the river systems through the inlet mouths.

3.3.2 Other Gulf of Mexico and South Atlantic Marine Harvested Species (Including EFH)

Information on other Gulf of Mexico species can be found in the 6 other GMFMC FMPs and their subsequent amendments, and are incorporated herein by reference: Fishery Management Plan for the Red Drum Fishery of the Gulf of Mexico (GMFMC 1986); Fishery Management Plan for the Reef Fish Fishery of the Gulf of Mexico (GMFMC 1982); Fishery Management Plan for Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic (GMFMC and SAFMC 1985); Fishery Management Plan for the Stone Crab Fishery of the Gulf of Mexico (GMFMC 1979); Fishery Management Plan for Spiny Lobster in the Gulf of Mexico and South Atlantic (GMFMC and SAFMC 1982a); and the Fishery Management Plan for Coral and Coral Reefs of the Gulf of Mexico and South Atlantic (GMFMC and SAFMC 1982b).

Likewise, information on other South Atlantic species can be found in the 7 other FMPs (and their subsequent amendments) of the SAFMC, and are incorporated herein by reference: Fishery Management Plan for Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic (GMFMC and SAFMC 1985); Fishery Management Plan for Spiny Lobster in the Gulf of Mexico and South Atlantic (GMFMC and SAFMC 1982a); Fishery Management Plan for Coral and Coral Reefs of the Gulf of Mexico (GMFMC and SAFMC 1982b); Fishery Management Plan for the Dolphin and Wahoo Fishery of the Atlantic (SAFMC 2003); Fishery Management Plan for the Golden Crab Fishery of the South Atlantic Region (SAFMC 1995); Fishery Management Plan for Pelagic *Sargassum* Habitat in the South Atlantic Region (SAFMC 2002); and the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region (SAFMC 1983).

The 1996 reauthorization of the MSA mandated that FMPs be amended to include the description and identification of EFH for all managed species. The MSA defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." EFH for species managed by the GMFMC and SAFMC have been identified and described in their respective FMP amendments (GMFMC 1998, 2004, 2005; SAFMC 1998), and are incorporated herein by reference. Maps of EFH, and links to source documents can be found on the EFH mapping website, at http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/map.aspx.

EFH for a number of highly migratory species (HMS), including tuna, sharks, swordfish and billfish, also occur within the area considered within the scope of this DEIS. According to the 2006 Final Consolidated Atlantic HMS FMP, we have not detected adverse effects from non-HMS fishing gears on HMS EFH. HMS EFHs occur primarily in the water column or are dependent on open-water conditions such as fronts and temperature gradients. Bottom trawling may affect nearshore and estuarine shark pupping areas, however these effects are currently undocumented and at this point are considered to be temporary and minimal (NMFS 2006a).

Effects of Bottom Trawling on Benthic Habitat

All fishing has an effect on the marine environment, and therefore the associated habitat. Fishing has been identified as the most widespread human exploitative activity in the marine environment (Jennings and Kaiser 1998), as well as the major anthropogenic threat to demersal fisheries habitat on the continental shelf (Cappo et al. 1998). Fishing effects range from the extraction of a species which skews community composition and diversity to reduction of habitat complexity through direct physical effects of fishing gear. As the most extensively utilized towed bottom-fishing gear (Watling and Norse 1998), trawls have been identified as the most wide-spread form of disturbance to marine systems below depths affected by storms (Watling and Norse 1998; Friedlander et al. 1999). Jones (1992) broadly classified the way a trawl can affect the seabed as: scraping and ploughing; sediment resuspension; and physical habitat destruction, and removal or scattering of non-target benthos. The specific effects of otter and skimmer trawls were evaluated by Barnette (2001), and the discussion of those gear types is incorporated herein by reference.

3.3.3 Sea Turtles

All sea turtle species occurring in the Atlantic Ocean are listed as either endangered or threatened under the ESA. The alternatives discussed in this DEIS may potentially affect 5 sea turtle species: the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Kemp's ridley (*Lepidochelys kempii*), which are listed as endangered, and the Northwest Atlantic Ocean DPS for loggerhead (*Caretta caretta*) and the North and South Atlantic DPSs of green (*Chelonia mydas*), which are listed as threatened.

The species discussions in this section will focus primarily on the Atlantic Ocean populations of these species, since these are the populations that may be affected by the proposed action. The following subsections are synopses of the best available information on the life history, distribution, population trends, and current status of the 5 species of sea turtles that are likely to be adversely affected by one or more components of the proposed action. 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 1991a), hawksbill sea turtle (NMFS and USFWS 1993), leatherback sea turtle (NMFS and USFWS 1992), and loggerhead sea turtle (NMFS and USFWS 2008e), and sea turtle status reviews and biological reports (Conant et al. 2009; NMFS and USFWS 1995, 2013a, 2013b; TEWG 1998, 2000, 2007, 2009; Seminoff et al. 2015).

3.3.3.1 Status of U.S. Atlantic Sea Turtle Populations

Thorough life history and status assessments of populations of sea turtles found in U.S. Atlantic waters can be found in the sea turtle recovery plans (NMFS and USFWS 1991a, 1991b, 1992, 1993, 1998a, 1998b, 2008; USFWS and NMFS 1992), and 5-year reviews (NMFS and USFWS 1995, 2007a, 2007b, 2007c, 2007d, 2007e, 2013a, 2013b; Seminoff et al. 2015) and the loggerhead status review (Conant et al. 2009), which are incorporated herein by reference. A brief summary of the status of the species within U.S. Atlantic waters is given below.

3.3.3.2 Green Sea Turtle

The green sea turtle was originally 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. On April 6, 2016, the original listing was replaced with the listing of 11 distinct population segments (DPSs) (81 FR 20057 2016). The Mediterranean, Central West Pacific, and Central South Pacific DPSs were listed as endangered. The North Atlantic, South Atlantic, Southwest Indian, North Indian, East Indian-West Pacific, Southwest Pacific, Central North Pacific, and East Pacific were listed as threatened. For the purposes of this document, only the South Atlantic DPS (SA DPS) and North Atlantic DPS (NA DPS) will be considered, as they are the only 2 DPSs with individuals occurring in the Atlantic and Gulf of Mexico waters of the United States.

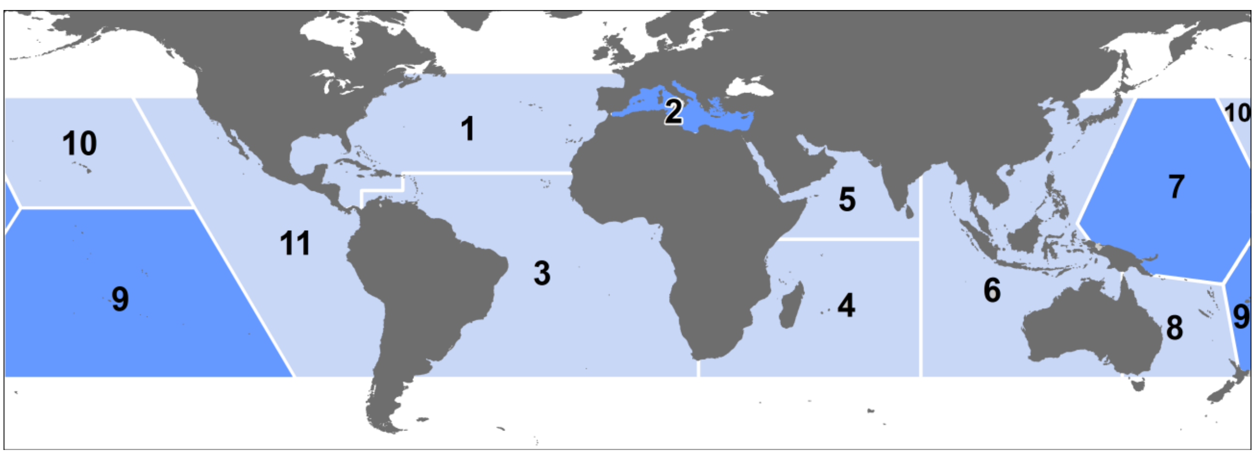

Figure 2. Threatened (light) and endangered (dark) green turtle DPSs: 1. North Atlantic, 2. Mediterranean, 3. South Atlantic, 4. Southwest Indian, 5. North Indian, 6. East Indian-West Pacific, 7. Central West Pacific, 8. Southwest Pacific, 9. Central South Pacific, 10. Central North Pacific, and 11.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

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) with a straight carapace length of greater than 3.3 ft (1 m). Green sea turtles have a smooth carapace with 4 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 1997). The 2 largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica (part of the NA DPS), and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef.

Differences in mitochondrial deoxyribonucleic acid (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. Within U.S. waters individuals from both the NA and SA DPSs can be found on foraging grounds. While there are currently no in-depth studies available to determine the percent of NA and SA DPS individuals in any given location, 2 small-scale studies provide an insight into the degree of mixing on the foraging grounds. An analysis of cold-stunned green turtles in St. Joseph Bay, Florida (Northern Gulf of Mexico) found approximately 4% of individuals came from nesting stocks in the SA DPS (specifically Suriname, Aves Island, Brazil, Ascension Island, and Guinea Bissau) (Foley et al. 2007). On the Atlantic coast of Florida, a study on the foraging grounds off Hutchinson Island found that approximately 5% of the turtles sampled came from the Aves Island/Suriname nesting assemblage, which is part of the SA DPS (Bass and Witzell 2000). All of the individuals in both studies were benthic juveniles. Available information on green turtle migratory behavior indicates that long distance dispersal is only seen for juvenile turtles. This suggests that larger adult-sized turtles return to forage within the region of their natal rookeries, thereby limiting the potential for gene flow across larger scales (Monzón-Argüello et al. 2010). While all of the mainland U.S. nesting individuals are part of the NA DPS, the U.S. Caribbean nesting assemblages are split between the NA and SA DPS. Nesters in Puerto Rico are part of the NA DPS, while those in the U.S. Virgin Islands are part of the SA DPS. We do not currently have information on what percent of individuals on the U.S. Caribbean foraging grounds come from which DPS.

<u>North Atlantic DPS Distribution</u>

The NA DPS boundary is illustrated in Figure 2. Four regions support nesting concentrations of particular interest in the NA DPS: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), U.S. (Florida), and Cuba. By far the most important nesting concentration for green turtles in this DPS is Tortuguero, Costa Rica. Nesting also occurs in the Bahamas, Belize, Cayman Islands, Dominican Republic, Haiti, Honduras, Jamaica, Nicaragua, Panama, Puerto Rico, Turks and Caicos Islands, and North Carolina, South Carolina, Georgia, and Texas, U.S.A. In the eastern North Atlantic, nesting has been reported in Mauritania (Fretey 2001).

The complete nesting range of NA DPS green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as Puerto Rico (Dow et al. 2007; NMFS and USFWS 1991a). 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 south through Broward counties.

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), 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 Yucatán Peninsula.

South Atlantic DPS Distribution

The SA DPS boundary is shown in Figure 2, and includes the U.S. Virgin Islands in the Caribbean. The SA DPS nesting sites can be roughly divided into four regions: western Africa, Ascension Island, Brazil, and the South Atlantic Caribbean (including Colombia, the Guianas, and Aves Island in addition to the numerous small, island nesting sites).

The in-water range of the SA DPS is widespread. In the eastern South Atlantic, significant sea turtle habitats have been identified, including green turtle feeding grounds in Corisco Bay, Equatorial Guinea/Gabon (Formia 1999); Congo; Mussulo Bay, Angola (Carr and Carr 1991); as well as Principe Island. Juvenile and adult green turtles utilize foraging areas throughout the Caribbean areas of the South Atlantic, often resulting in interactions with fisheries occurring in those same waters (Dow et al. 2007). Juvenile green turtles from multiple rookeries also frequently utilize the nearshore waters off Brazil as foraging grounds as evidenced from the frequent captures by fisheries (Lima et al. 2010; López-Barrera et al. 2012; Marcovaldi et al. 2009). Genetic analysis of green turtles on the foraging grounds off Ubatuba and Almofala, Brazil show mixed stocks coming primarily from Ascension, Suriname and Trindade as a secondary source, but also Aves, and even sometimes Costa Rica (NA DPS) (Naro-Maciel et al. 2007; Naro-Maciel et al. 2012). While no nesting occurs as far south as Uruguay and Argentina, both have important foraging grounds for South Atlantic green turtles (Gonzalez Carman et al.

2011; Lezama 2009; López-Mendilaharsu et al. 2006; Prosdocimi et al. 2012; Rivas-Zinno 2012).

*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 2-week intervals, laying an average of 3-4 clutches (Johnson and Ehrhart 1996). Clutch size often varies among subpopulations, but mean clutch size is approximately 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart 1989). Eggs incubate for approximately 2 months before hatching. Hatchling green sea turtles are approximately 2 in (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 2007a). Green sea turtles exhibit particularly slow growth rates of about 0.4-2 in (1-5 cm) per year (Green 1993), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately 8-10 in (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 mature slowly, requiring 20-50 years to reach sexual maturity (Chaloupka and Musick 1997; Hirth 1997).

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 2007a).

Status and Population Dynamics

Accurate population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. Nonetheless, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends and nester abundance is provided in the most recent status review for the species (Seminoff et al. 2015), with information for each of the DPSs.

<u>North Atlantic DPS</u>

The NA DPS is the largest of the 11 green turtle DPSs, with an estimated nester abundance of over 167,000 adult females from 73 nesting sites. Overall this DPS is also the most data rich. Eight of the sites have high levels of abundance (i.e., <1000 nesters), located in Costa Rica, Cuba, Mexico, and Florida. All major nesting populations demonstrate long-term increases in abundance (Seminoff et al. 2015).

Tortuguero, Costa Rica is by far the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al. 2015). Nesting at Tortuguero appears to have been increasing since the 1970's, when monitoring began. 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's 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). Green sea turtle nesting is documented annually on beaches of North Carolina, South Carolina, and Georgia, though nesting is found in low quantities (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 10 years of regular monitoring (Figure 3). According to data collected from Florida's index nesting beach survey from 1989-2015, 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 27,975 in 2015. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in 2010 and 2011, and a return to the trend of biennial peaks in abundance thereafter (Figure 3). 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%.

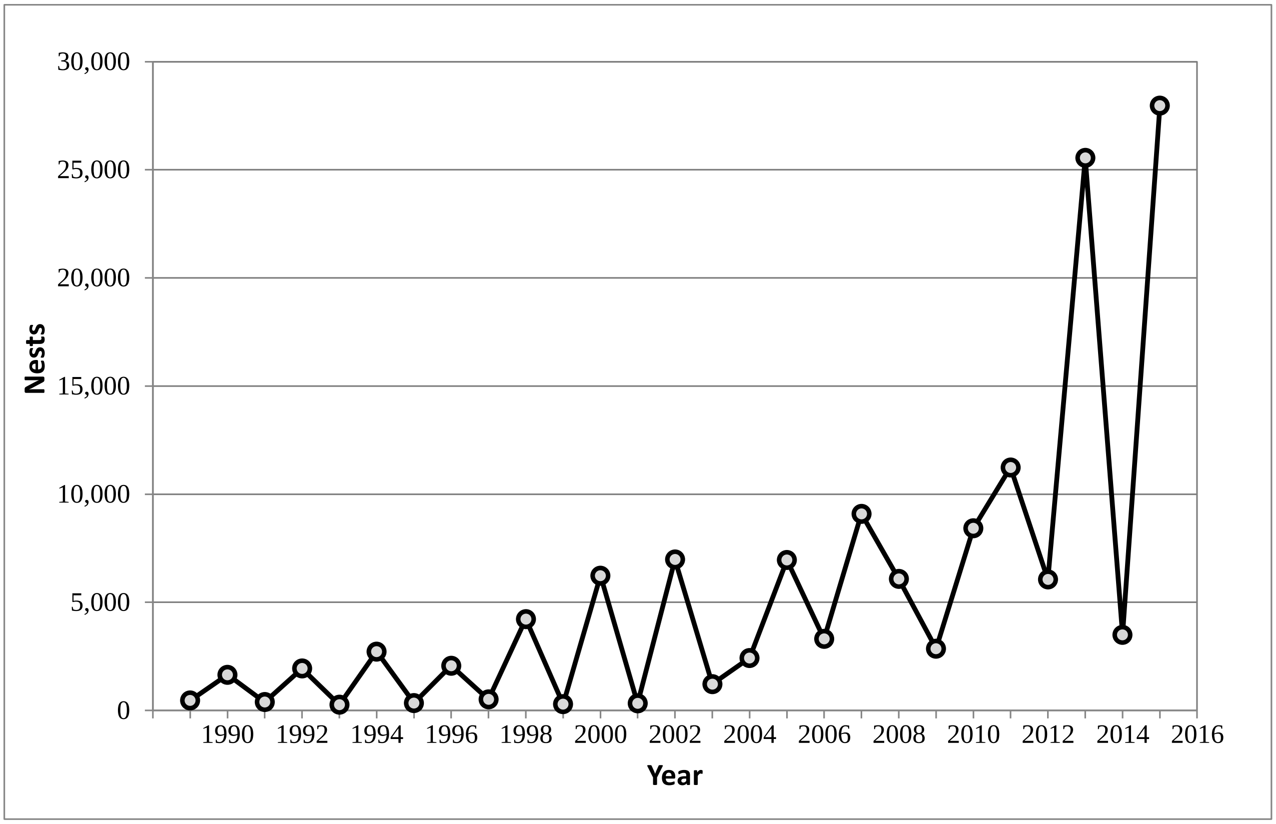

Figure 3. Green sea turtle nesting at Florida index beaches since 1989.

Similar to the nesting trend found in Florida, in-water studies in Florida have also recorded increases in green turtle captures at the Indian River Lagoon site, with a 661 percent increase over 24 years (Ehrhart et al. 2007), and the St Lucie Power Plant site, with a significant increase in the annual rate of capture of immature green turtles (SCL<90 cm) from 1977 to 2002 or 26 years (3,557 green turtles total; M. Bressette, Inwater Research Group, unpublished data; Witherington et al. 2006).

<u>South Atlantic DPS</u>

The SA DPS is large, estimated at over 63,000 nesters, but data availability is poor. More than half of the 51 identified nesting sites (37) did not have sufficient data to estimate number of nesters or trends (Seminoff et al. 2015). This includes some sites, such as beaches in French Guiana, which are suspected to have large numbers of nesters. Therefore, while the estimated number of nesters may be substantially underestimated, we also do not know the population trends at those data-poor beaches. However, while the lack of data was a concern due to increased uncertainty, the overall trend of the SA DPS was not considered to be a major concern as some of the largest nesting beaches such as Ascension Island, Aves Island (Venezuela), and Galibi (Suriname) appear to be increasing. Others such as Trindade (Brazil), Atol das Rocas (Brazil), and Poilão and the rest of Guinea-Bissau seem to be stable or do not have sufficient data to make a determination. Bioko (Equatorial Guinea) appears to be in decline but has less nesting than the other primary sites (Seminoff et al. 2015).

In the U.S., nesting of SA DPS green turtles occurs on the beaches of the U.S. Virgin Islands, primarily on Buck Island. There is insufficient data to determine a trend for Buck Island nesting, and it is a smaller rookery, with approximately 63 total nesters utilizing the beach (Seminoff et al. 2015).

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), ecosystem alterations (e.g., nesting beach development, beach nourishment and shoreline stabilization, vegetation changes), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 3.3.3.7.

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 0.04 in (0.1 cm) to greater than 11.81 in (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). FP is cosmopolitan, but it 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 46.4°F-50°F (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 found cold-stunned in Texas. Of these, approximately 620 were found dead or died after stranding, while approximately 1,030 turtles 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.

Whereas oil spill impacts are discussed generally for all species in Section 3.3.3.7, specific impacts of the DWH spill on green sea turtles are considered here. Impacts to green sea turtles occurred to offshore small juveniles only. A total of 154,000 small juvenile greens (36.6% of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. A large number of small juveniles were removed from the population, as 57,300 small juveniles greens are estimated to have died as a result of the exposure. A total of 4 nests (580 eggs) were also translocated during response efforts, with 455 hatchlings released (the fate of which is unknown) (DWH Trustees 2016). Additional unquantified effects may have included inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred.

While green turtles regularly use the Northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean, and Atlantic, and the proportion of the population using the Northern Gulf of Mexico at any given time is relatively low. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of Mexico were reduced as a result of the DWH oil spill of 2010, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, as well as the impacts being primarily to smaller juveniles (lower reproductive value than adults and large juveniles), reduces the impact to the overall population. It is unclear what impact these losses may have caused on a population level, but it is not expected to have had a large impact on the population trajectory moving forward. However, recovery of green turtle numbers equivalent to what was lost in the Northern Gulf of Mexico as a result of the spill will likely take decades of sustained efforts to reduce the existing threats and enhance survivorship of multiple life stages (DWH Trustees 2016).

3.3.3.3 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

Hawksbill sea turtles are small- to medium-sized (99-150 lb on average [45-68 kg]) although females nesting in the Caribbean are known to weigh up to 176 lb (80 kg) (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 adult food source, and other invertebrates. The shells of hatchlings are 1.7 in (42 mm) long, are mostly brown, and are 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 1993; Plotkin and Amos 1990; Plotkin and Amos 1988). 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) off St. Croix was later identified 1,160 mi (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 that of 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 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 decimated, 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 (Diez and Van Dam 2002; León and Diez 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 2002; 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 Jr. 1994; Diez and Van 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 the beaches where they were born (natal 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 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 in (2.5-5 cm) in length and weigh approximately 0.5 oz (15 g).

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 Diez 1997), although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (León and Diez 2000; Mayor et al. 1998; Van Dam and Diez 1997).

Reproductive females undertake periodic (usually non-annual) migrations to their natal beaches 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 Diez 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 Diez 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 6,000-8,000 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, hawksbills typically laid about 500-1,000 nests on Mona Island, Puerto Rico in the past (Diez and Van Dam 2007), but the numbers appear to be increasing, as the Puerto Rico Department of Natural and Environmental Resources counted nearly 1,600 nests 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, U.S. Virgin Islands.

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). They determined historic trends (i.e., 20-100 years ago) for 58 of the 83 sites, and also determined recent abundance trends (i.e., within the past 20 years) 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 (past 20 years) 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 2 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. The conservation measures implemented when BIRNM was expanded in 2001 most likely explains this increase.

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). 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 5-year status review for the species (NMFS and USFWS 2013a).

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) as discussed in Section 3.3.3.7. There are also specific threats that are of special emphasis, or are unique, for hawksbill sea turtles discussed in further detail below.

While oil spill effects are discussed generally for all species in Section 3.3.3.7, specific effects of the DWH spill on hawksbill turtles have been estimated. Hawksbills made up 2.2% (8,850) of small juvenile sea turtle (of those that could be identified to species) exposures to oil in offshore areas, with an estimate of 615 to 3,090 individuals dying as a result of the direct exposure (DWH Trustees 2016). No quantification of large benthic juveniles or adults was made. Additional unquantified effects may have included inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those effects, if they occurred. Although adverse effects occurred to hawksbills, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event is relatively low, and thus a population-level impact is not believed to have occurred due to the widespread distribution and nesting location outside of the Gulf of Mexico for this species.

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 nineteenth and early twentieth centuries (Parsons 1972). Additionally, 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 Brautigam and Eckert (2006).

The continuing demand for the hawksbills' shells as well as other products derived from the species (e.g., leather, oil, perfume, and cosmetics) represents an ongoing threat to its recovery. The British Virgin Islands, Cayman Islands, Cuba, Haiti, and the Turks and Caicos Islands (United Kingdom) 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. Hawksbill sea turtle products are openly available in the Dominican Republic and Jamaica, despite a prohibition on harvesting hawksbills and their eggs (Fleming 2001). Up to 500 hawksbills per year from 2 harvest sites within Cuba were legally captured each year until 2008 when the Cuban government placed a voluntary moratorium on the sea-turtle fishery (Carillo et al. 1999; Mortimer and Donnelly 2008). 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, but illegal trade still occurs 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) and are also highly sensitive to the effects of climate change (e.g., higher incidences of disease and coral bleaching) (Crabbe 2008; Wilkinson 2004). Because continued loss of coral reef communities (especially in the greater Caribbean region) is expected to impact hawksbill foraging, it represents a major threat to the recovery of the species.

3.3.3.4 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 2000; 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 4 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 records indicate a nesting 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 had been exponentially increasing prior to the recent low nesting years, which may indicate that the population had been experiencing a similar increase. Additional nesting data in the coming years will be required to determine what the recent nesting decline means for the population trajectory.

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) straight carapace length (SCL), 1.26-1.73 in (32-44 mm) in width, and 0.3-0.4 lb (15-20 g) in weight. Their 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 they 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 2 years. Nesting generally occurs from April to July. Females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M. 1994).

Population Dynamics

Of the 7 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 twenty-first century (Figure 4), which indicates 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 2013). From 2013 through 2014, there was a second significant decline, as only 16,385 and 11,279 nests were recorded, respectively. In 2015, nesting in Mexico improved to 14,006 recorded nests (Gladys Porter Zoo 2015). Nesting numbers appear to be increasing 3 years in a row, as preliminary numbers for the 2016 nesting season recorded approximately 18,000 registered nests (J. Pena, Gladys Porter Zoo, pers. comm. to M. Barnette, NMFS, August 2, 2016). At this time, it is unclear if future nesting will steadily and continuously increase, similar to what occurred from 1990-2009, or if nesting will continue to exhibit sporadic declines and increases as recorded in the past 5 years.

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). It is worth noting that nesting in Texas has paralleled the trends observed in Mexico, with a significant decline in 2010 followed by a second decline in 2013-2014. Nesting rebounded in 2015, as 159 nests were documented along the Texas coast (National Park Service data) and preliminary information for 2016 indicates 186 documented nests (D. Shaver, National Park Service, pers. comm. to M. Barnette, NMFS, August 2, 2016).

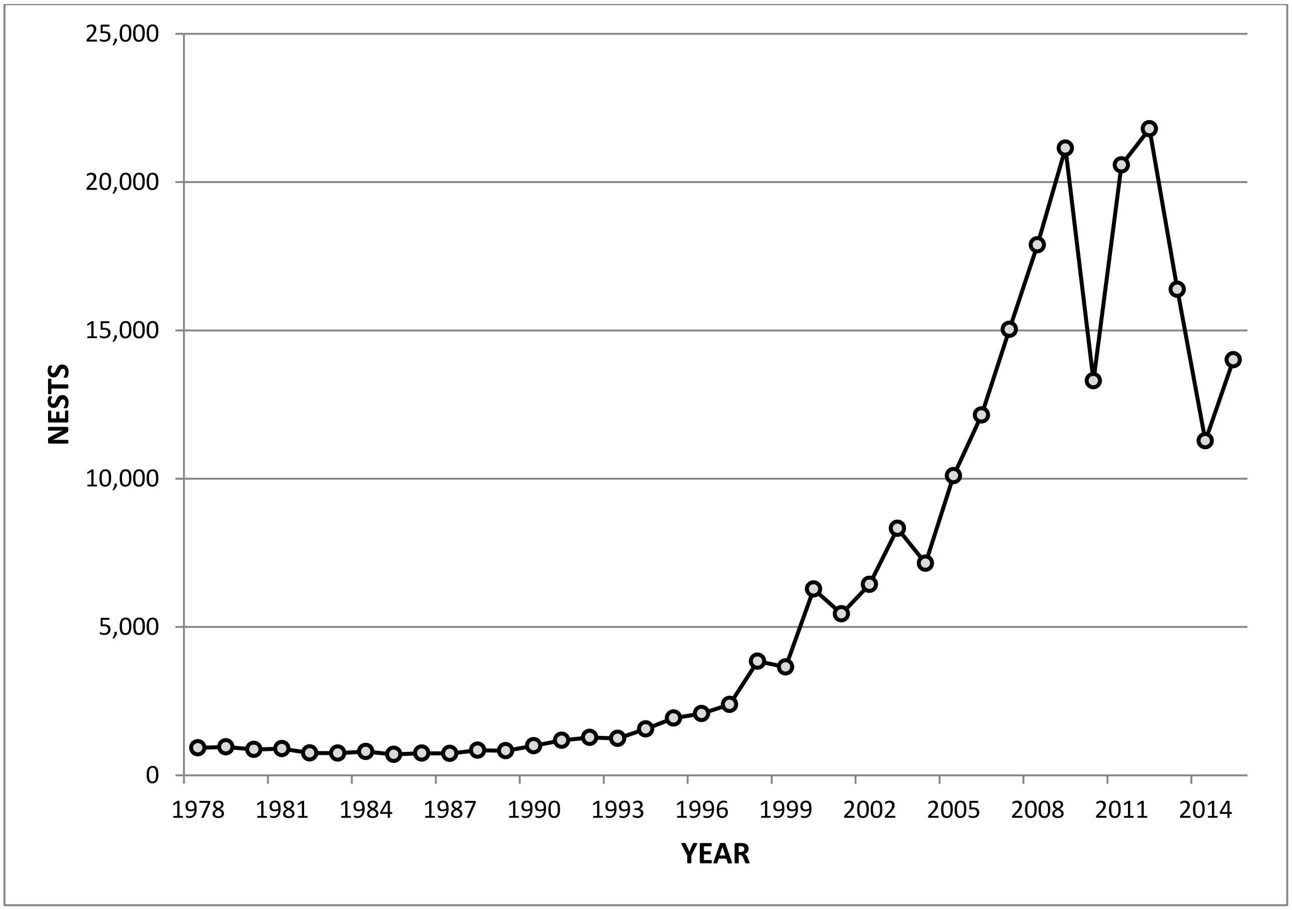

Figure 4. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2015).

Through modelling, Heppell et al. (2005) predicted the population is expected to increase at least 12-16% per year and could reach 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 to 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 2015, it is clear that the population has increased over the long term. The increases in Kemp's ridley sea turtle nesting over the last 2 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 2000). 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 factors which are often difficult to predict with any certainty. Additionally, the significant nesting declines observed in 2010 and 2013-2014 potentially indicate a serious population-level impact, and there is cause for concern regarding the ongoing recovery trajectory.

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 3.3.3.7; 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[6] 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 5% (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.

Over the past 6 years, we have 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 3 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) having occurred from March through July, 390 (86%) of which were Kemp's ridley sea turtles. During 2012, a total of 384 sea turtles were reported from Louisiana, Mississippi, and Alabama waters. Of these reported strandings, 343 (89%) were Kemp's ridley sea turtles. During 2014, a total of 285 sea turtles were reported from Louisiana, Mississippi, and Alabama waters, though the data is incomplete. Of these reported strandings, 229 (80%) 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. It should be noted that stranding coverage has increased considerably due to the DWH oil spill event.

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

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, March 2012). Yet, available information indicates fishery effort was extremely limited during the stranding events. The fact that 80% or more of all Louisiana, Mississippi, and Alabama stranded sea turtles in the past 5 years were Kemp's ridleys is notable; however, this could simply be a function of the species' preference for shallow, state 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 skimmer trawl fisheries during the summer of 2012. During May-July of that year, observers reported 24 sea turtle interactions in the skimmer trawl fisheries. All but a single sea turtle were identified as Kemp's ridleys (1 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) curved carapace length (CCL). All sea turtles were released alive. The small average size of encountered Kemp's ridleys introduces a potential conservation issue, as over 50% of these reported sea turtles could potentially pass through the maximum 4-in bar spacing of TEDs currently required in the shrimp fisheries. Due to this issue, a proposed 2012 rule to require TEDs in the skimmer trawl fisheries (77 FR 27411) was not implemented. Based on anecdotal information, these interactions were a relatively new issue for the skimmer trawl fisheries. Given the nesting trends and habitat utilization of Kemp's ridley sea turtles, it is likely that fisheries 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.

While oil spill effects are discussed generally for all species in Section 3.3.3.7, specific effects of the DWH oil spill event on Kemp's ridley sea turtles are considered here. Kemp's ridleys experienced the greatest negative impact stemming from the DWH oil spill event of any sea turtle species. Impacts to Kemp's ridley sea turtles occurred to offshore small juveniles, as well as large juveniles and adults. Loss of hatchling production resulting from injury to adult turtles was also estimated for this species. Injuries to adult turtles of other species, such as loggerheads, certainly would have resulted in unrealized nests and hatchlings to those species as well. Yet, the calculation of unrealized nests and hatchlings was limited to Kemp's ridleys for several reasons. All Kemp's ridleys in the Gulf of Mexico belong to the same population (NMFS et al. 2011), so total population abundance could be calculated based on numbers of hatchlings because all individuals that enter the population could reasonably be expected to inhabit the northern Gulf of Mexico throughout their lives (DWH Trustees 2016).

A total of 217,000 small juvenile Kemp's ridleys (51.5% of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. That means approximately half of all small juvenile Kemp's ridleys from the total population estimate of 430,000 oceanic small juveniles were exposed to oil. Furthermore, a large number of small juveniles were removed from the population, as up to 90,300 small juveniles Kemp's ridleys are estimated to have died as a direct result of the exposure. Therefore, as much as 20% of the small oceanic juveniles of this species were killed during that year. Impacts to large juveniles (>3 years old) and adults were also high. An estimated 21,990 such individuals were exposed to oil (about 22% of the total estimated population for those age classes); of those, 3,110 mortalities were estimated (or 3% of the population for those age classes). The loss of near-reproductive and reproductive-stage females would have contributed to some extent to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley nests is between 1,300 and 2,000, which translates to between approximately 65,000 and 95,000 unrealized hatchlings (DWH Trustees 2016). This is a minimum estimate, however, because the sublethal effects of the DWH oil spill event on turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years, which may have contributed substantially to additional nesting deficits observed following the DWH oil spill event. These sublethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season). The nature of the DWH oil spill event effect on reduced Kemp's ridley nesting abundance and associated hatchling production after 2010 requires further evaluation. It is clear that the DWH oil spill event resulted in large losses to the Kemp's ridley population across various age classes, and likely had an important population-level effect on the species. Still, we do not have a clear understanding of those impacts on the population trajectory for the species into the future.

3.3.3.5 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 CCL that often exceeds 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). The leatherback does not have a bony shell. Instead, its shell is approximately 1.5 in (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 its long-distance trips in search of food.

Unlike other sea turtles, leatherbacks have several unique traits that enable them to live in cold water. For example, leatherbacks have a countercurrent circulatory system (Greer et al. 1973),[7] a thick layer of insulating fat (Davenport et al. 1990; Goff and Lien 1988), gigantothermy (Paladino et al. 1990),[8] and they can increase their body temperature through increased metabolic

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

activity (Bostrom and Jones 2007; Southwood et al. 2005). These adaptations allow leatherbacks to be comfortable in a wide range of temperatures, which helps them to travel further than any other sea turtle species (NMFS and USFWS 1995). For example, a leatherback may swim more than 6,000 mi (10,000 km) in a single year (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; 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 2001).

While leatherbacks will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003a). Leatherbacks have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey such as jellyfish and salps. A leatherback's mouth and throat also have backward-pointing spines that help retain jelly-like prey. Leatherbacks' favorite prey are jellies (e.g., medusae, siphonophores, and salps), which commonly occur in temperate and northern or sub-arctic latitudes and likely has a strong influence on leatherback distribution in these areas (Plotkin 2003). Leatherbacks are known to be deep divers, with recorded depths in excess of a half-mile (Eckert et al. 1989), but they 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 7 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 7 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) subadult, 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 subadult and adult life stages (Chaloupka 2002; Crouse 1999; Heppell et al. 1999; Heppell et al. 2003a; Spotila et al. 1996; Spotila et al. 2000). 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 of 2-3 years by Pritchard and Trebbau (1984), of 3-6 years by Rhodin (1985), of 13-14 years for females by Zug and Parham (1996), and 12-14 years for leatherbacks nesting in the U.S. Virgin Islands by Dutton et al. (2005). 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). Still, 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 2-4 years (Garcia 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 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). Females usually lay up to 10 nests during the 3-6 month nesting season (March through July in the United States), typically 8-12 days apart, with 100 eggs or more per nest (Eckert et al. 2012; Eckert 1989; Maharaj 2004; Matos 1986; Stewart and Johnson 2006; Tucker 1988). Yet, up to approximately 30% of the eggs may be infertile (Maharaj 2004; Stewart and Johnson 2006). 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 weigh approximately 1.5-2 oz (40-50 g), and have lengths of approximately 2-3 in (51-76 mm), with fore flippers as long as their bodies. Hatchlings grow rapidly, with reported growth rates for leatherbacks from 2.5-27.6 in (6-70 cm) in length, estimated at 12.6 in (32 cm) per year (Jones et al. 2011).

In the Atlantic, the sex ratio appears to be skewed toward females. The Turtle Expert Working Group (TEWG) reports that nearshore and onshore strandings data from the U.S. Atlantic and Gulf of Mexico coasts indicate that 60% of strandings were females (TEWG 2007). 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 subadult 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 9-13 years (Eguchi et al. 2006). Spotila et al. (1996) 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 2006). Leatherbacks nesting in Central America and Mexico travel thousands of miles through 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; Graham 2009).

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. Coordinated efforts of data collection and analyses by the leatherback TEWG 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 a single 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. TEWG (2007) observed positive growth within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana. More specifically, Tiwari et al. (2013) report an estimated 3-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 2001). This increase 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 (Schulz 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,[9] while the number of nests was declining at beaches in Guiana (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 is most prevalent in Costa Rica, Panama, and the Gulf of Uraba in Colombia (Duque et al. 2000). The Caribbean coastline 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

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

indicates a possible 67.8% decline between 1995 and 2006 (Troëng et al. 2007). Tiwari et al. (2013) report an estimated 3-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 (U.S. Virgin Islands), 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). Tiwari et al. (2013) report an estimated 3-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, Tiwari et al. (2013) report an annual growth rate of +7.5% in St. Croix and a 3-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 (FWC, unpublished data). Using data from the index nesting beach surveys, the TEWG (2007) estimated a significant annual nesting growth rate of 1.17% between 1989 and 2005. FWC Index Nesting Beach Survey Data generally indicates biennial peaks in nesting abundance beginning in 2007 (Figure 5 and Table 3). A similar pattern was also observed statewide (Table 3). 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. Tiwari et al. (2013) report an annual growth rate of 9.7% and a 3-generation abundance change of +1,863%.

Table 3. Number of Leatherback Sea Turtle Nests in Florida.

NESTS RECORDED	2011	2012	2013	2014	2015
INDEX NESTING BEACHES	625	515	322	641	489
STATEWIDE	1,653	1,712	896	1,604	N/A

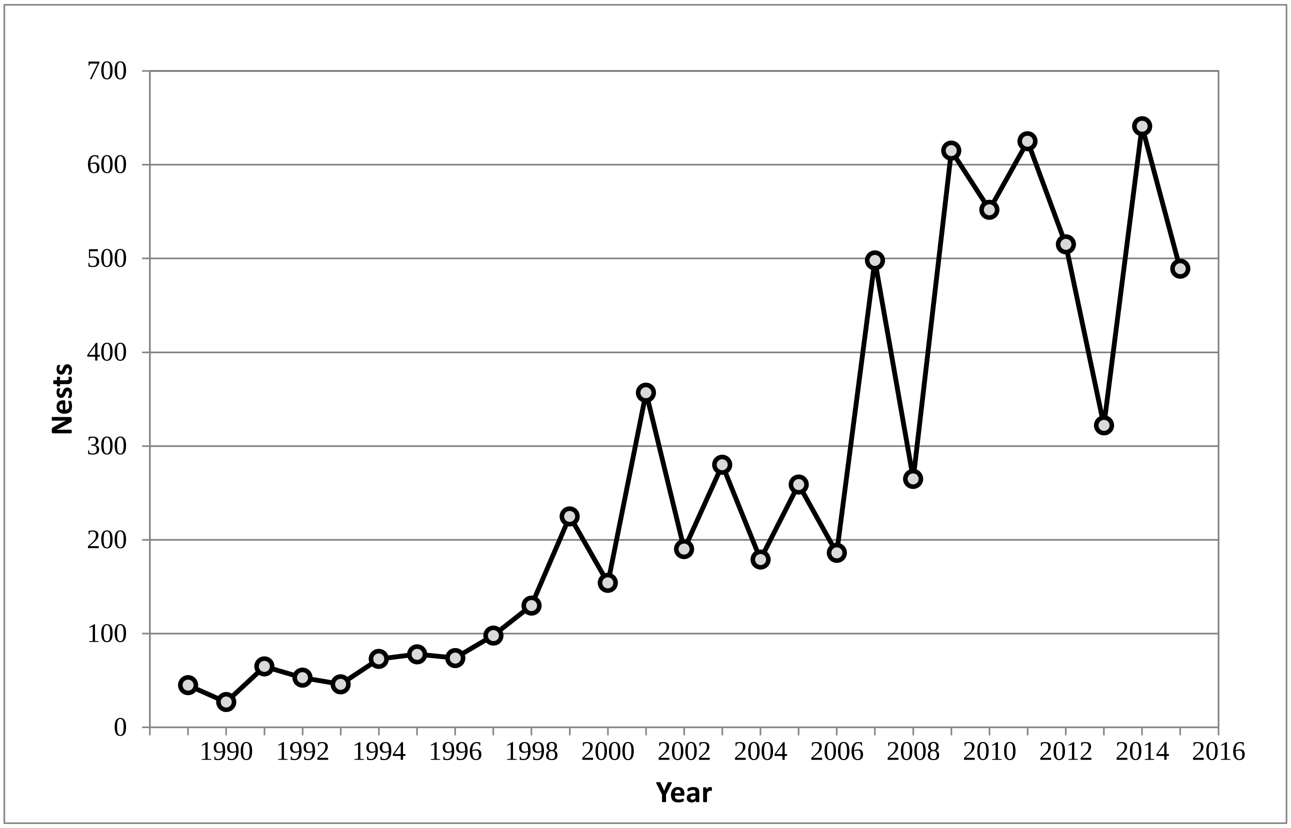

Figure 5. Leatherback sea turtle nesting at Florida index beaches since 1989.

The West African nesting stock of leatherbacks is large and important, but it 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 a single season (Fretey et al. 2007). Fretey et al. (2007) 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. (1996) characterized the entire Western Atlantic population as stable at best and estimated a population of 18,800 nesting females. Spotila et al. (1996) further 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). The TEWG (2007) also determined that at of the time of their publication, leatherback sea turtle populations in the Atlantic were all stable or increasing with the exception of the Western Caribbean and West Africa populations. The latest review by NMFS and USFWS (2013) suggests the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean.

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 3.3.3.7; 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 vulnerability 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 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. 2003). 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. This 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% or 138 of 408 cases examined) contained some form of plastic debris (Mrosovsky et al. 2009). Blocking of the gut by plastic 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.—factors 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 plastic object might resemble a food item by its shape, color, size, or even movement as it drifts about, and therefore induce a feeding response in leatherbacks.

As discussed in Section 3.3.3.7, global climate change can be expected to have various effects 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 (Houghton et al. 2006; Witt et al. 2007); however, more studies need to be done to monitor how changes to prey items affect distribution and foraging success of leatherbacks so population-level effects can be determined.

While oil spill effects are discussed generally for all species in Section 3.3.3.7, specific effects of the DWH oil spill on leatherback sea turtles are considered here. Available information indicates leatherback sea turtles (along with hawksbill turtles) were least directly affected by the oil spill. Leatherbacks were documented in the spill area, but the number of affected leatherbacks was not estimated due to a lack of information compared to other species. But given that the northern Gulf of Mexico is important habitat for leatherback migration and foraging (TEWG 2007), and documentation of leatherbacks in the DWH oil spill zone during the spill period, it was concluded that leatherbacks were exposed to DWH oil, and some portion of those exposed leatherbacks likely died. Potential DWH-related impacts to leatherback sea turtles include direct oiling or contact with dispersants from surface and subsurface oil and dispersants, inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred. Although adverse impacts likely occurred to leatherbacks, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event may be relatively low. Thus, a population-level impact may not have occurred due to the widespread distribution and nesting location outside of the Gulf of Mexico for this species.

3.3.3.6 Loggerhead Sea Turtle (Northwest 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 9 DPSs for loggerhead sea turtles (76 FR 58868, September 22, 2011; effective October 24, 2011). This rule listed the following DPSs: (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 Ocean DPS is the only one that occurs within the action area and therefore is the only one considered in this document.

Species Description and Distribution

Loggerheads are large sea turtles. Adults in the southeast United States average about 3 ft (92 cm) long, measured as a SCL, and weigh approximately 255 lb (116 kilogram [kg]) (Ehrhart and Yoder 1978). Adult and subadult 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, 5 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). Subadult and adult loggerheads are primarily found in coastal waters and eat 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). For the Northwest Atlantic Ocean DPS, most nesting occurs along the coast of the United States, from southern Virginia to Alabama. Additional nesting beaches for this DPS 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 U.S. Atlantic, Gulf of Mexico, and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches. Aerial surveys suggest that loggerheads as a whole are distributed in U.S. waters as follows: 54% off the southeast U.S. coast, 29% off the northeast U.S. coast, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Within the Northwest Atlantic Ocean DPS, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf of Mexico coast of Florida. Previous Section 7 analyses have recognized at least 5 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 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS 2001).

The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula. It also concluded that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the recovery 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 2008e). 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 Northwest Atlantic Ocean DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the Northwest Atlantic Ocean DPS.

Life History Information

The Northwest Atlantic Loggerhead Recovery Team defined the following 8 life stages for the loggerhead life cycle, which include the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[10]), (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 2008e). Loggerheads are long-lived animals. They reach sexual maturity between 20-38 years of age, although age of maturity varies widely among populations (Frazer and Ehrhart 1985; NMFS 2001). The annual mating season occurs from late March to early June, and female turtles lay eggs throughout the summer months. Females 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). Each nest contains an average of 100-126 eggs (Dodd 1988) which incubate for 42-75 days before hatching (NMFS and USFWS 2008e). Loggerhead hatchlings are 1.5-2 in long and weigh about 0.7 ounces (20 grams).

As post-hatchlings, loggerheads hatched on U.S. beaches enter the "oceanic juvenile" life stage, migrating offshore and becoming associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986; Conant et al. 2009; Witherington 2002). Oceanic juveniles grow at rates of 1-2 in (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. 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 oceanic habitat in the North Atlantic longer than hypothesized, or they move back and forth between oceanic and coastal habitats interchangeably (Witzell 2002). Stranding records indicate that when immature loggerheads reach 15-24 in (40-60 cm) SCL, they begin to reside 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 (Conant et al. 2009).

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads do not use the relatively enclosed shallow-water estuarine habitats with limited ocean access as frequently as juveniles. Areas such as Pamlico Sound, North Carolina, and the

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

Indian River Lagoon, Florida, are regularly used by juveniles but not by adult loggerheads. Adult loggerheads do tend to use estuarine areas with more open ocean access, such as the 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 (Conant et al. 2009).

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; GDNR, unpublished data; SCDNR, 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. They also reside in Florida Bay in the United States, and along 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 5 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. 2009; Heppell et al. 2003b; NMFS 2001; NMFS 2009a; NMFS and USFWS 2008e; TEWG 1998; TEWG 2000; 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 survey effort and methods are standardized (e.g., NMFS and USFWS 2008e). NMFS and USFWS (2008e) concluded that the lack of change in 2 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.

<u>Peninsular Florida Recovery Unit</u>
The Peninsular Florida Recovery Unit is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989-2007 showed an average of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (NMFS and USFWS 2008e). The statewide estimated total for 2013 was 77,975 nests (FWC nesting database).

In addition to the total nest count estimates, FWC 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 6). FWC performed a detailed analysis of the long-term loggerhead index nesting data (1989-2015) (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/). Over that time period, 3 distinct trends were identified. From 1989-1998 there was a 24% increase that was then followed by a sharp decline over the subsequent 9 years. A large increase in loggerhead nesting has occurred since, as indicated by the 74% increase in nesting between 2008 and 2015. FWC examined the trend from the 1998 nesting high through 2015 and found that the decade-long post-1998 decline was replaced with a slight but nonsignificant increasing trend. Looking at the data from 1989 through 2015 (an increase of over 38%), FWC concluded that there was an overall positive change in the nest counts (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/).

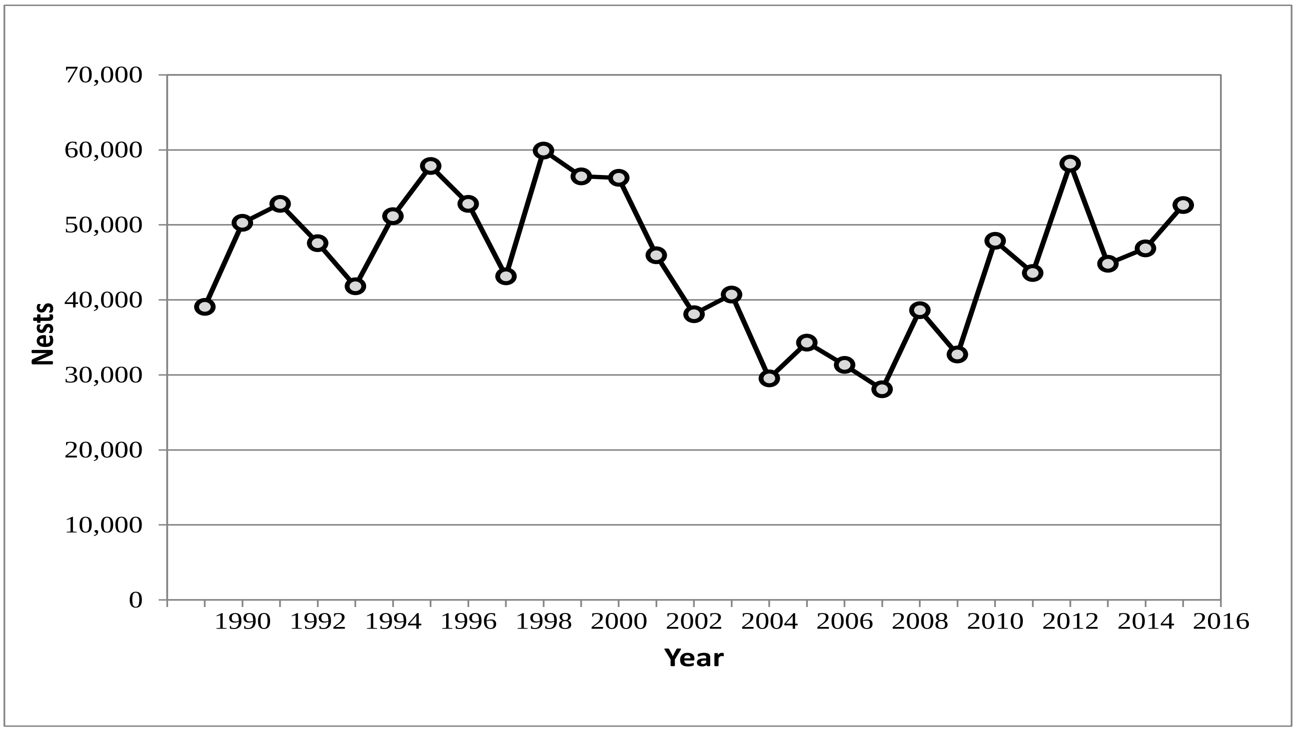

Figure 6. Loggerhead sea turtle nesting at Florida index beaches since 1989.

<u>Northern Recovery Unit</u>

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 (GDNR unpublished data, North Carolina Wildlife Resources Commission (NCWRC) unpublished data, 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 1980-2008. Overall, there are strong statistical data to suggest the NRU had experienced a long-term decline over that period of time.

Data since that analysis (Table 4) 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, GDNR press release, http://www.georgiawildlife.com/node/3139). South Carolina and North Carolina nesting have also begun to show a shift away from the declining trend of the past.

Table 4. Total Number of NRU Loggerhead Nests (GDNR, SCDNR, and NCWRC nesting datasets).

NESTS RECORDED	2008	2009	2010	2011	2012	2013	2014
GEORGIA	1,649	998	1,760	1,992	2,241	2,289	1,196
SOUTH CAROLINA	4,500	2,182	3,141	4,015	4,615	5,193	2,083
NORTH CAROLINA	841	302	856	950	1,074	1,260	542
TOTAL	**6,990**	**3,472**	**5,757**	**6,957**	**7,930**	**8,742**	**3,821**

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 7).

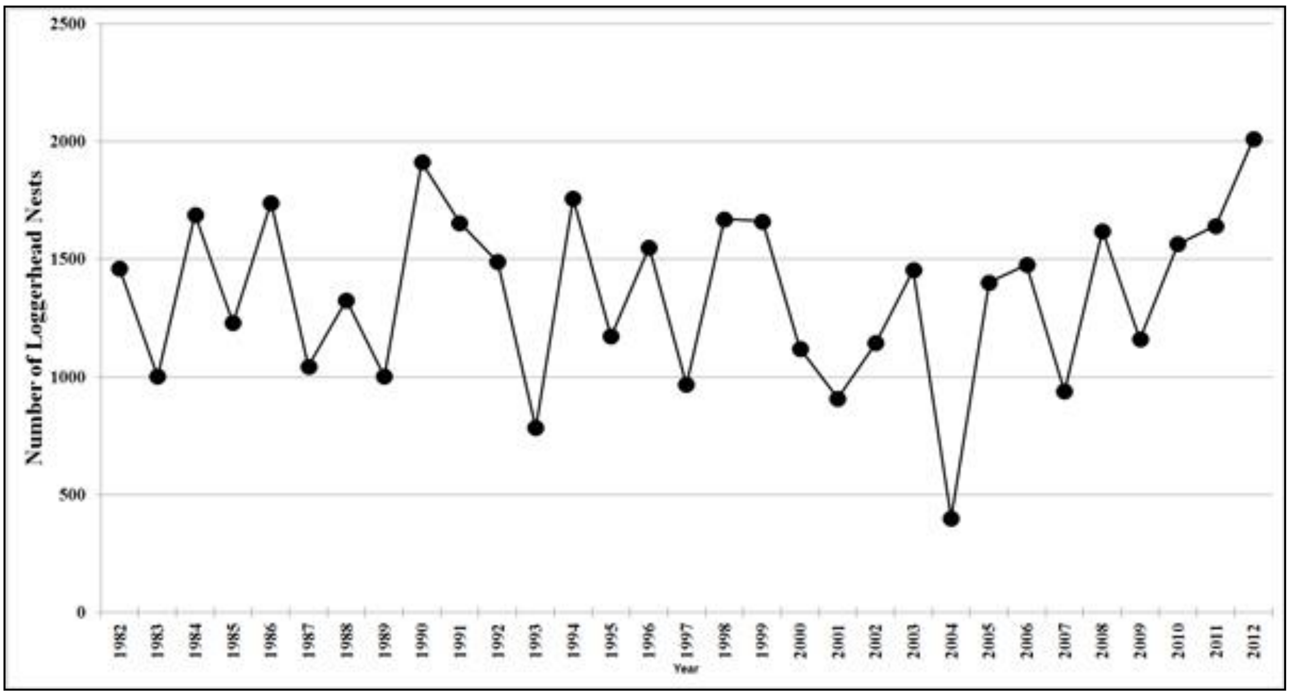

Figure 7. South Carolina index nesting beach counts for loggerhead sea turtles (from the SCDNR website, http://www.dnr.sc.gov/seaturtle/nest.htm).

<u>Other Northwest Atlantic DPS Recovery Units</u>

The remaining 3 recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages, but they are 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 there was no detectable trend during this period (NMFS and USFWS 2008e). 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. 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 (NMFS and USFWS 2008e). 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 2008e).

In-Water Trends

Nesting data are the best current indicator of sea turtle population trends, but in-water data also provide some insight. In-water 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 CPUE (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, although 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. (2003), cited in NMFS and USFWS (2008e), 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). In-water studies throughout the eastern United States, however, indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG 2009).

Population Estimate

Our Southeast Fisheries Science Center (SEFSC) developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS 2009a). 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, and 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), suggest the adult female population size is approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS 2009a). 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 2009a). A preliminary regional abundance survey of loggerheads within the northwestern Atlantic continental shelf for positively identified loggerhead in all strata estimated about 588,000 loggerheads (interquartile range of 382,000-817,000). When correcting for unidentified turtles in proportion to the ratio of identified turtles, the estimate increased to about 801,000 loggerheads (interquartile range of 521,000-1,111,000) (NMFS 2011).

Threats (Specific to Loggerhead Sea Turtles)

The threats faced by loggerhead sea turtles are well summarized in the general discussion of threats in Section 3.3.3.7. Yet the impact of fishery interactions is a point of further emphasis for this species. The joint NMFS and USFWS Loggerhead Biological Review Team determined that the greatest threats to the Northwest Atlantic Ocean DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009).

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants; they have the highest organochlorine concentrations (Storelli et al. 2008) and metal loads (D'Ilio et al. 2011) in sampled tissues among the sea turtle species. It is thought that dietary preferences were likely to be the main differentiating factor among sea turtle 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 nests, leading to egg mortality (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), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

3.3.3.7 Sources of Sea Turtle Mortality

Threats to the recovery of listed sea turtles are reviewed and documented extensively in the sea turtle recovery plans (NMFS and USFWS 1991a, 1991b, 1992, 1993, 1998a, 1998b, 2008; USFWS and NMFS 1992), the 5-year reviews (NMFS and USFWS 1995, 2007a, 2007b, 2007c, 2007d, 2007e), and the loggerhead status review (Conant et al. 2009) which are incorporated by reference. These documents are summarized here and are discussed in more detail for specific species previously in this section. Recovery of sea turtle populations to historical levels requires a reduction in anthropogenic mortality on all fronts and for all life phases—both on nesting beaches and in the marine environment.

Sea turtles face many sources of natural mortality, some of which are exacerbated by humans. Hurricanes and other severe weather events are known to be destructive to sea turtle nests and hatchlings. Sand accretion, rainfall, and wave action that result from these storms can appreciably reduce hatching success. Other sources of natural mortality include cold stunning, biotoxin exposure, and native species predation.

Anthropogenic factors that impact hatchlings and adult females on land, or the success of nesting and hatching include: beach armoring and nourishment; artificial lighting; beach cleaning; beach pollution; increased human presence; recreational beach equipment; vehicular and pedestrian traffic; coastal development/construction; exotic dune and beach vegetation; removal of native vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (e.g., raccoons, armadillos, and opossums) which raid nests and feed on turtle eggs (NMFS and USFWS 2007a, 2008). Although primary sea turtle nesting beaches are protected along large expanses of the Northwest Atlantic Coast (e.g., Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges); Tortuguero, Costa Rica; Rancho Nuevo, Mexico; and other important beaches, many Northwest Atlantic sea turtle nesting beaches have limited or no protection. Sea turtle nesting and hatching success on unprotected high density beaches, such as those in East Florida from Indian River to Broward County, are particularly affected by all of the above threats.

Many threats to sea turtles on land are expected to be exacerbated by the effects of global climate change (NMFS and USFWS 2007a, 2007b, 2007c, 2007d, 2007e). Potential increases in sea level of approximately 4.2 mm (1.65 in) per year until 2080 might remove available nesting beaches, particularly on narrow low-lying coastal and inland beaches and on beaches where coastal development has occurred (Church et al. 2001; IPCC 2007; Mazaris et al. 2009). Additionally, global climate change may affect the severity of extreme weather (e.g., hurricanes), potentially generating more intense storms and associated erosion or damage to sea turtle nests and/or nesting sites (Goldenburg et al. 2001; Webster et al. 2005; IPCC 2007). The cyclical loss of nesting beaches resulting from extreme storm events may then result in a decrease in hatching success and hatchling emergence (Martins 1996; Ross 2005; Pike and Stiner 2007). However, there is evidence that, depending on the species, those species with lower nest site fidelity (e.g., leatherbacks) would be less vulnerable to storm related threats than those with higher site fidelity (e.g., loggerheads). In Guiana, leatherbacks have continued to nest despite the loss of beaches between nesting years (Pike and Stiner 2007; Witt et al. 2007; Girondot and Fretey 1996).

Changes in air and beach temperatures can affect sea turtles at the population level. The sex of hatchlings is determined by temperatures 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). Based on modeling, a 2°C increase in air temperature is expected to result in a loggerhead sea turtle sex ratio of over 80% female offspring for loggerhead nesting beaches in the vicinity of Southport, North Carolina. Farther to the south at Cape Canaveral, Florida, a 2°C increase in air temperature would likely result in production of 100% females, while a 3°C increase in air temperature would likely exceed the thermal threshold of turtle clutches (i.e., greater than 35°C) resulting in death (Hawkes et al. 2007). Glenn et al. (2003) also reported that, for green sea turtles, incubation temperatures also appeared to affect hatchling size with smaller turtles produced at higher incubation temperatures; however, it is unknown whether this effect is species specific and what impact it has on the survival of the offspring. Changes in air temperature as a result of global climate change may alter sex ratios and may reduce hatchling production in the most southern nesting areas of the United States (Hawkes et al. 2007). Given that the south Florida nesting group is the largest loggerhead nesting group in the Atlantic (in terms of numbers of nests laid), a decline in the success of nesting as a result of global climate change could have profound effects on the abundance and distribution of the loggerhead species in the Atlantic, including the action area. However; variation of sex ratios to incubation temperature between individuals and populations is not fully understood. Therefore, it is unclear whether sea turtles will (or can) adapt behaviorally to altered incubation conditions to counter potential feminization or death of clutches associated with incubation temperatures, such as choosing nest sites that are located in cooler areas, such as shaded areas of vegetation or higher latitudes or nesting earlier or later during cooler periods of the year (Hawkes et al. 2007).

Sea turtles are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; underwater explosions; hopper dredging; offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching; and fishery interactions.

As mentioned in Section 3.2, the DWH explosion and subsequent oil spill event released an estimated 4.9 million barrels of oil into the Gulf of Mexico off Louisiana from April-September 2010. Additionally, approximately 2.1 million gallons of COREXIT chemical dispersant was applied to surface waters and directly at the wellhead. This event resulted in significant immediate and potential long-term effects on Gulf of Mexico sea turtle populations. There is no information currently available on the effects of the dispersant on sea turtles, however, either by direct exposure or other avenues, such as bioaccumulation through foraging on prey species.

Global climate change effects in the marine environment are anticipated to affect sea turtles in the Northwest Atlantic. Changes in water circulation may occur. Changes in the Gulf Stream would have profound effects on every aspect of Northwest Atlantic sea turtle life history from hatching success, oceanic migrations at all life stages, foraging, and nesting (Gagosian 2003; NMFS and USFWS 2007a, 2007b, 2007c, 2007d, 2007e). Thermocline circulation patterns are expected to change in intensity and direction with changes in temperature and freshwater input at the poles (Rahmstorf 1997; Stocker and Schmittner 1997). This will potentially affect not only hatchlings that rely on passive transport in surface currents for migration and dispersal but also pelagic adults (i.e., leatherbacks) and juveniles that depend on current patterns and major frontal zones in obtaining suitable prey, such as jellyfish (Hawkes et al. 2007).

Prey availability may also be affected by changes in water temperatures and currents. Seagrasses could ultimately be negatively affected by increased temperatures, salinities, and acidification of coastal waters (Short and Neckles 1999; Bjork et al. 2008), as well as increased runoff due to the expected increase in extreme storm events as a result of global climate change. These alterations of the marine environment due to global climate change could ultimately affect the distribution, physiology, and growth rates of seagrasses, potentially eliminating them from particular areas. The magnitude of these effects on seagrass beds, and on the herbivorous green sea turtles that forage on them, however, are difficult to predict. Some populations of green sea turtles appear to specialize in the consumption of algae (Bjorndal 1997) and mangroves (Limpus and Limpus 2000), suggesting they may be able to substitute other available forage species. Changes to benthic communities as a result of changes to water temperature may affect omnivorous species such as Kemp’s ridley and loggerhead sea turtles; however, these species are less likely to suffer shortages of prey than species with more specific diets such as green sea turtles (Hawkes et al. 2007).

Several studies have also investigated the effects of changes in sea surface temperature (SST) and air temperatures on turtle reproductive behavior. For loggerhead sea turtles, warmer SSTs in the spring have been correlated to an earlier onset of nesting (Weishampel et al. 2004; Hawkes et al. 2007), shorter internesting intervals (Hays et al. 2002), and a decrease in the length of the nesting season (Pike et al. 2006). Green sea turtles also exhibited shorter internesting intervals in response to warming water temperatures (Hays et al. 2002).

Ocean acidification related to global climate change would also reasonably be expected to negatively affect sea turtles. The term "ocean acidification" describes the process of ocean water becoming corrosive as a result of carbon dioxide (CO_2) absorption from the atmosphere. The absorption of atmospheric CO_2 into the ocean lowers the pH of the waters, decreasing the effects of global climate change, however, the resulting change in ocean chemistry could adversely affect marine life, particularly organisms with calcium carbonate shells such as corals, mussels, mollusks, small creatures in the lower levels of the food chain (Guinotte and Fabry 2008), affecting as well the higher organisms such as sea turtles that rely on these species as prey. Sea grasses may benefit from extra atmospheric $CO_{2,}$ affording some benefit to green turtles (Guinotte and Fabry 2008).

The Intergovernmental Panel on Climate Change (IPCC 2007) has indicated greenhouse gas emissions are one of the most important drivers of recent changes in climate. Wilson et al. (2014) inventoried the sources of greenhouse gases in the Gulf of Mexico from sources associated with oil platforms and other activities such as fishing. Their study concluded commercial fishing and recreational vessels make up a small percentage of the total estimated greenhouse gas emissions in the Gulf of Mexico (1.43% and 0.59%, respectively).

Fully monitoring ocean acidification in the Atlantic and understanding the effects of climate change on listed species of sea turtles will require expansion of existing monitoring programs and development of conceptual and predictive models. Continued acquisition and maintenance of long-term data sets on sea turtle life history and responses to environmental changes will be needed to apply and maintain these models. At this time, the type and extent of effects to sea turtles of ocean acidification and other results of global climate change on sea turtles cannot, for the most part, be accurately predicted. Therefore, the information necessary to determine the significance of these effects is incomplete and unavailable.

Directed harvest likely caused the original decline of sea turtle populations in the Northwest Atlantic. Currently, 33 of 46 countries/territories in the North Atlantic now legislate complete protection of sea turtles in their territorial waters (see Appendix 3 of NMFS and USFWS 2008e, followed by the Bahamas ban of sea turtle harvest effective September 1, 2009). Twelve Caribbean countries still allow some harvest of sea turtles. Despite some continued directed harvest and all of these additional sources of sea turtle mortality, a National Research Council (NRC 1990) report concluded that for juveniles, subadults, and adult female loggerheads in coastal waters, the most important source of human caused mortality in U.S. Atlantic waters was fishery interactions. Fishery interactions continue to be identified as an important anthropogenic mortality source in every U.S. sea turtle recovery plan.

Incidental capture in fishery operations remains one of the primary marine anthropogenic mortality sources to Atlantic sea turtle populations. Sea turtle takes incidental to U.S. fishery operations have been documented in bottom trawls targeting shrimp, summer flounder, Atlantic sea scallop, and other demersal species in inshore, nearshore, and offshore U.S. Atlantic waters. Dredge fisheries for Atlantic sea scallops have also incidentally injured and killed sea turtles. Sea turtle captures have been documented in the U.S. Mid-Atlantic and Southeast bottom longline shark fishery, as well as the Gulf of Mexico and South Atlantic bottom longline fisheries for reef fish and snapper-grouper. Pelagic longline fisheries, particularly for swordfish and tuna, are known to take sea turtles in the Gulf of Mexico and Atlantic Ocean. Commercial and recreational vertical hook and line gear have also been known to take sea turtles. Although sea turtles taken in vertical hook and line fisheries are often alive when released, ingested hooks and entanglement in gear have been documented as the cause of death in some turtles. Takes of sea turtles have also been documented in large- and small-mesh gillnet fisheries operating off the Atlantic and Gulf of Mexico coasts. Sea turtles have also been entangled, sometimes lethally, in Chesapeake Bay pound net leaders. Takes in fish weirs and sea turtles entangled in the vertical buoy lines of whelk, sea bass, lobster, and crab pots have also been documented.

3.3.3.8 Existing Measures to Reduce Sea Turtle Mortalities

Measures to Reduce Non-Fishery Threats

Nest and beach habitat protection efforts in the United States are focused on the most valuable nesting areas. Important sea turtle nesting beaches, encompassing 25% of all U.S. loggerhead sea turtle nesting, has been acquired and designated as the Archie Carr National Wildlife Refuge in Florida. Beach stabilization and nourishment projects are conducted with seasonal restrictions and other protective conditions developed through consultations with federal and state biologists. South Carolina, Georgia, and Florida have developed lighting ordinances and voluntary measures to reduce the disorienting effects of artificial lights on hatchlings. Most major nesting beaches within the continental United States employ predator control measures to protect sea turtle nests. Beach cleaning activities, which require state permits, are conditioned to minimize their effects on nesting sea turtles, nests, and hatchlings. Beach vehicular driving is prohibited on most U.S. nesting beaches. In Volusia County, Florida, where beach driving is still allowed, driving is restricted to daylight hours, in areas where nest densities are lowest and on the lower beach below sea turtle nests which must be well marked. Additionally, throughout the southern United States, efforts to eradicate exotic plants that contribute to beach erosion or that diminish nesting beach suitability are ongoing.

Federal actions that may affect sea turtles are assessed through ESA Section 7 consultations, as discussed above, and the actions are modified to monitor and reduce effects to sea turtles. Mitigation efforts include limits on incidental take, monitoring of power plant intake structures, observer requirements and seasonal restrictions on dredging and beach nourishment projects, observer requirements and seasonal restrictions on military operations, and restrictions on boat races. Additionally, the Marine Pollution Act enacted under the International Convention for the

Prevention of Pollution from Ships, and subsequent U.S. Coast Guard (USCG) regulations, restricts the disposal by all vessels and offshore platforms of all plastics, paper, rags, glass, metal, bottles, crockery, and similar refuse. To mitigate accidental oil releases, various federal, state, and local entities have oil release contingency plans and emergency response teams that could reduce potential effects from these oil releases.

Natural mortality events in the nearshore marine environment, such as red tide outbreaks and cold weather effects, are frequently first detected by the STSSN. When husbandry or healthcare is possible, these volunteers often help in the care and subsequent release of beached sea turtles. For example, during the winter of 2010, an unprecedented cold-stunning event occurred in the Southeast as a result of a sudden drop in temperature. Over 4,500 sea turtles stranded, including over 4,300 green turtles. Volunteer responders were able to save all but about 940, mostly green, sea turtles.

Internationally in the broader Northwest Atlantic, the USFWS and ourselves work with other countries in the Americas and the Caribbean thorough direct bilateral activities, capacity building related to gear research, participation in the Northwest Atlantic loggerhead and Kemp's ridley Binational Working Groups, and through compliance with and participation in multinational organizations working to promote the recovery of sea turtles, including the United Nation's Convention on International Trade in Endangered Species and the Inter-American Convention for the Protection and Conservation of Sea Turtles.

Measures to Reduce Fishery Threats

Incidental catch in commercial fisheries is identified as a threat in all sea turtle recovery plans. As early as 1975, upon proposing the listing of loggerheads as a threatened species, incidental capture in trawl fisheries was identified as a factor affecting the continued existence of sea turtles (40 FR 21975, May 20 1975). The listing determination identified fisheries bycatch as "most serious in the trawl fisheries of the South Atlantic and Gulf of Mexico regions" and discussed ongoing development of an excluder panel and plans for testing under commercial fishing conditions (43 FR 32800 July 28, 1978). These earliest efforts to mitigate the effects of fishing on sea turtles focused on the Southeastern U.S. shrimp fisheries and the development of TEDs. These efforts, as well as a summary of TED regulations, are discussed in detail in Appendix II.

TEDs incorporate an escape opening, usually covered by a webbing flap, which allow sea turtles to escape from trawl nets. To be approved by us, a TED design must be shown to be 97% effective in excluding sea turtles during testing based upon our approved scientific testing protocols (50 CFR 223.207(e)(1)). Our approved testing protocols established to date include the "small turtle test" (55 FR 41092, October 9, 1990) and the "wild turtle test" (52 FR 24244, June 29, 1987). Additionally, we have established a leatherback model testing protocol to evaluate a candidate TED's ability to exclude adult leatherback sea turtles (66 FR 24287, May 14, 2001). Because testing with live leatherbacks is impossible, we obtained the carapace measurements of 15 nesting female leatherback turtles and used these data to construct an aluminum pipe-frame model of a leatherback turtle measuring 40 in (101.6 cm) in width, 60 in (152.4 cm) in length, and 21 in (53.3 cm) in height. If the leatherback model and a diver with full scuba gear are able to pass through the escape opening of a candidate TED, that escape opening is judged to be capable of excluding adult leatherback sea turtles, as well as other large adult sea turtles.

A summary of regulatory measures that have been implemented to reduce incidental sea turtle bycatch and mortality in Atlantic fisheries (including the Gulf of Mexico) is provided in Table 5 below.

Table 5. Summary of regulatory measures to reduce sea turtle bycatch/mortality in Atlantic fisheries.

GEAR	AREA AND SEASON	REQUIREMENTS	DATE	CITATION
Shrimp Trawls	Inshore and offshore waters south of the Virginia border; Year-round.	TEDs	1987-1990	§223.206(d)(2), §223.207
Summer Flounder Trawls	Summer Flounder-Sea Turtle Protection Area (offshore waters from Cape Charles, Virginia, south to a line extending from the North Carolina/South Carolina border); Year-round south of Oregon Inlet, North Carolina; March 16 through January 14 from Cape Charles, Virginia south to Oregon Inlet, North Carolina.	TEDs	11/15/1992	§223.206(d)(2)(iii), §223.207
Inshore Gillnets (> 4.25 in (10.8cm) stretched)	Pamlico Sound, North Carolina and contiguous tidal waters; September 1 through December 15.	Closure	12/10/1999	§223.206(d)(7)
Large-Mesh Gillnets (> 7 in (17.8 cm) stretched)	Chincoteague, Virginia south to a line extending from the North Carolina/South Carolina border.	Expanding closure	05/18/2000	§223.206(d)(8)
Atlantic Pelagic Longline	Entire Atlantic; Year-round.	Gear modification, handling, and release protocols	10/10/2000	§223.206(d)(1)(ii), §635.21(c)-(d)
Gulf of Mexico Bottom Longline	Shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida; June through August.	Closure, gear and effort reduction	05/26/2010	§622.34(q)(1)-(3)
Pound Nets	Designated areas in Virginia mainstem of the Chesapeake Bay; May 6 through July 15.	Gear modification (modified leader)	06/19/2001	§223.206(d)(10)
Atlantic Sea Scallop Dredges	South of 41° 9' N; May 1 through November 30.	Gear modification (chain mats)	09/26/2006	§223.206(d)(11)

3.3.4 Other Protected Species

3.3.4.1 Marine Mammals

This section provides information on marine mammals that occur in U.S. Atlantic waters and that may be affected by the alternatives considered within this DEIS. The Marine Mammal Protection Act (MMPA) of 1972 protects all marine mammals, regardless of whether or not they are listed under the ESA. The Secretary of Commerce is responsible for the protection of all cetaceans (whales, porpoises, and dolphins) and pinnipeds (seals and sea lions), except walruses, and has delegated authority for implementing the MMPA to us. The Secretary of the Interior is responsible for the protection of walruses, polar bears, sea otters, manatees, and dugongs, and has delegated this responsibility to the USFWS. These responsibilities include providing oversight and advice to regulatory agencies on all federal actions that might affect these species.

The MMPA prohibits the “take” of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. Under the MMPA, take is defined as “harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect.”

Take causing serious injury and mortality of marine mammals incidental to commercial fishing operations is a primary threat to many marine mammal species. The MMPA of 1972 states that marine mammal species and stocks should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part. In 1994, Congress amended the MMPA to address the incidental mortality and serious injury of marine mammals in U.S. commercial fisheries. Section 118 of the MMPA established a system for classifying commercial fisheries according to their levels of marine mammal bycatch and created the take reduction plan process to reduce that bycatch (45086 60 FR 45086, August 30, 1995).

Measures are in place to reduce the effects of fisheries on marine mammals, where necessary. None of the alternatives considered within this DEIS would overtly increase the likelihood of incidental capture of marine mammals in the shrimp fisheries. However, TED requirements in some of the fisheries may result in an increase in trawling time due to reduced target catch rates, and resultant increase in opportunity for incidental capture. The increase in tows to compensate target catch loss caused by TEDs, however, is not likely to significantly increase overall effort.

3.3.4.1.1 List of Fisheries

We classify commercial fisheries annually under 1 of 3 categories based on marine mammal take information contained in annual stock assessment reports (SARs) as well as other sources of new information (see 81 FR 20550, April 8, 2016). Category I fisheries are those with frequent incidental mortality and serious injury of marine mammals. Category II fisheries are those fisheries with occasional incidental mortality and serious injury of marine mammals. Category III fisheries are those with a remote likelihood of or no known incidental mortality and serious injury of marine mammals. Participants in Category I and II fisheries must register with the Marine Mammal Authorization Program; carry a Marine Mammal Authorization Program certificate aboard their vessel while fishing; report, within 48 hours of returning to port, all marine mammal accidental or incidental injuries or mortalities that occurred while fishing; accommodate an observer upon request; and comply with any applicable take reduction plans that may be developed for fisheries with high capture levels of certain “strategic” stocks (defined below). The Southeastern U.S. shrimp fisheries were elevated from a Category III fishery in 2010, and are currently categorized as a Category II fishery.

The proposed 2011 List of Fisheries (75 FR 36318, June 25, 2010) based the elevated classification on interactions reported through observer reports, stranding data, and fisheries research data (2009 SAR), with multiple strategic marine mammal stocks (bottlenose dolphin, South Carolina coastal; bottlenose dolphin, Georgia coastal; bottlenose dolphin, Northern Gulf of Mexico coastal (Eastern, Northern, and Western); and bottlenose dolphin, Gulf of Mexico bay, sound and estuarine) and non-strategic marine mammal stocks (bottlenose dolphin, Northern Gulf of Mexico continental shelf; and spotted dolphin, Northern Gulf of Mexico). The potential biological removal (PBR) levels were known only for 2 of these stocks, the South Carolina and

Georgia coastal stocks of bottlenose dolphins. The PBR levels were unknown or undetermined for the remaining stocks because of outdated population estimates (e.g., estimates are over 8 years old) and lack of abundance and mortality data necessary to calculate a PBR level. For this reason, the annual serious injury and mortality rate as it compares to each stock's PBR cannot be calculated for most of these stocks. The 2016 List of Fisheries (81 FR 20550, April 8, 2016) listed the marine mammal species and stocks incidentally killed or injured in the Southeastern U.S. shrimp fisheries: Atlantic spotted dolphin, Gulf of Mexico continental and oceanic; bottlenose dolphin, Charleston estuarine system; bottlenose dolphin, Eastern, Northern, and Western Gulf of Mexico coastal;[11] bottlenose dolphin, Gulf of Mexico continental shelf; bottlenose dolphin, Gulf of Mexico bay, sound, and estuarine; bottlenose dolphin, South Carolina/Georgia coastal; bottlenose dolphin, southern migratory coastal; West Indian manatee, Florida.

We determine whether a Category II classification is warranted for a given fishery (i.e., the fishery has occasional incidental mortality and serious injury of marine mammals) by other factors, such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, qualitative data from logbooks or fisher reports, stranding data, and the species or distribution of marine mammals in the area, or at the discretion of the Assistant Administrator (see 50 CFR 229.2). Due to the lack of PBR data and low observer coverage, we conducted a qualitative analysis to determine the appropriate classification for the "Southeastern U.S. Atlantic, Gulf of Mexico shrimp trawl" fisheries. We reviewed the best scientific data available, including known and observed serious injuries and mortalities of bottlenose and other dolphin species obtained during extremely low observer coverage (less than 1%). We considered the low level of observer coverage; number and type of documented interactions with trawl gear; levels of fishing effort; type of fishing gear used; lack of deterrence gear or methods; fishing process including soak time; and spatial and temporal co-occurrence of the shrimp trawl fisheries and strategic marine mammal stocks. Based on this information, which is summarized below, we proposed classifying this fishery in Category II.

These fisheries were observed between 1992 and 2006 under a voluntary program, which became mandatory in 2007. Observer coverage has been less than 1% for all observed years. Even with low coverage, we observed 12 dolphin takes (of which 11 animals were seriously injured or killed) in these fisheries since 1993. Eleven of these takes occurred since 2002. Because observer data sheets often listed "dolphin" and did not specify the species, we can only confirm that 4 of the 12 takes were bottlenose dolphins. Based on the location of the 8 observed takes that were not identified to species, the takes may be either bottlenose dolphins or Atlantic spotted dolphins. However, bottlenose dolphins are ubiquitous, and are the most commonly found cetacean throughout southeastern U.S. coastal waters, bays, sounds and estuaries.

In addition to observer reports of marine mammals seriously injured or killed in these fisheries, the final 2009 SARs note that "occasional interactions with bottlenose dolphins have been observed (in the shrimp trawl fishery), and there is infrequent evidence of interactions from stranded animals." The lack of stranding evidence is not unusual. Some fisheries (e.g., gillnet and trap/pot) leave distinctive wounds on stranded animals, which are often found still entangled

[11] Fishery classified based on serious injuries and mortalities of this stock, which are greater than 50% (Category I) or greater than 1% and less than 50% (Category II) of the stock's PBR.

with tell-tale gear. However, it is thought that serious injuries or mortalities to marine mammals from trawl fisheries are less obvious on gross inspection: cause of death is more likely to be by blunt trauma from trawl doors, or drowning by enclosure in, rather than by entanglement with the net.

Marine Mammal Authorization Program records indicate 1 voluntarily-reported dolphin take in shrimp trawl gear in South Carolina in 2002. We have documented 13 additional dolphin takes, 10 since 2002, in Southeast U.S. research trawl operations, and/or relocation trawls conducted in conjunction with dredging and other marine construction activities. Twelve of the 13 takes resulted in serious injury or mortality, and 1 out of the 13 was an Atlantic spotted dolphin; the remaining animals were bottlenose dolphins. There are no substantive differences between commercial fishing and relocation trawls, although relocation trawls are not equipped with TEDs, and soak time is considerably less (usually about 30 minutes) than commercial shrimp trawls.

3.3.4.1.2 Marine Mammals Listed under the ESA

Species of large whales protected by the ESA that occur throughout the Gulf of Mexico and Atlantic Ocean include the blue whale (*Balaenoptera musculus*), humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), North Atlantic right whale (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), and the sperm whale (*Physeter macrocephalus*). Additionally, the West Indian manatee (*Trichechus manatus*) also occurs both in the Gulf of Mexico and the Atlantic Ocean; the West Indian manatee is under the jurisdiction of the USFWS. These species are also considered depleted under the MMPA. Depleted and endangered designations afford special protections from captures, and further measures to restore populations to recovery or the optimum sustainable population are identified through required recovery (ESA species) or Conservation Plans (MMPA depleted species).

Blue, fin, sei, and sperm whales are predominantly found seaward of the continental shelf where shrimping does not take place. North Atlantic right whales and humpback whales are coastal animals and have been sighted in the nearshore environment in the Atlantic along the southeastern United States from November through March. North Atlantic right and humpback whales have been spotted in the Gulf of Mexico on rare occasions; however, these are thought to be inexperienced juveniles. There are no known endemic populations of these whales in the Gulf of Mexico. Sperm whales can be found along the continental shelf in the Gulf of Mexico, however, there is little or no shrimp fishing in this area in the Gulf of Mexico. There have been no reported interactions between large whales and shrimp vessels in the Atlantic or Gulf of Mexico. Also shrimp trawlers move slowly (e.g., 2 knots while trawling) which would give a whale or the fishing vessel time to avoid a collision.

According to the final rule for the 2011 List of Fisheries (75 FR 68468, November 8, 2010), there has been at least 1 confirmed take of a West Indian manatee in the Southeastern U.S. shrimp fisheries since 1987; a manatee that was killed by a commercial shrimp trawler, with an observer aboard, in Georgia in 1997. Also, according to the USFWS' 2009 SAR, the bait shrimp fishery was suggested to cause 3 unconfirmed manatee mortalities in 1990. Furthermore, observer coverage for the shrimp trawl fishery has been less than 1% since 1992. Due to extremely low observer coverage, confirmed and unconfirmed takes by shrimp trawl gear, and the spatial and temporal co-occurrence of the shrimp trawl fishery and the Florida subspecies of the West Indian manatee, we believe there is at least a remote likelihood of incidental mortality and serious injury for the Florida subspecies of the West Indian manatee.

Further information on the aforementioned ESA-listed whale species can be found in a number of published documents, including recovery plans (NMFS 1991, 1998a, 2005, 2010a), the Marine Mammal SARs (e.g., NMFS 2010b), status reviews, and other publications (e.g., Clapham et al. 1999; Perry et al. 1999; Best 2001), and are incorporated herein by reference. Detailed information on the West Indian manatee can be found in the Recovery Plan (USFWS 2001) and the 5-year status review (USFWS 2007), which are also incorporated herein by reference.

3.3.4.1.3 Other Marine Mammal Species

Numerous species of marine mammals listed under the MMPA occur throughout the Atlantic Ocean and/or Gulf of Mexico, including the bottlenose dolphin (*Tursiops truncatus*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), short-beaked common dolphin (*Delphinus delphis*), harbor porpoise (*Phocoena phocoena*), Risso's dolphin (*Grampus griseus*), Atlantic spotted dolphin (*Stenella frontalis*), pantropical spotted dolphin (*Stenella attenuata*), striped dolphin (*Stenella coeruleoalba*), spinner dolphin (*Stenella longirostris*), rough-toothed dolphin (*Steno bredanensis*), Clymene dolphin (*Stenella clymene*), Fraser's dolphin (*Lagenodelphis hosei*), as well as the killer whale (*Orcinus orca*), Brydes's whale (*Balaenoptera edeni*), Cuvier's beaked whale (*Ziphius cavirostris*), Blainville's beaked whale (*Mesoplodon densirostris*), Gervais' beaked whale (*Mesoplodon europaeus*), false killer whale (*Pseudorca crassidens*), pygmy killer whale (*Feresa attenuata*), dwarf sperm whale (*Kogia sima*), pygmy sperm whale (*Kogia breviceps*), melon-headed whale (*Peponocephala electra*), and the short-finned pilot whale (*Globicephala macrorhynchus*).

Information on these species can be found in their respective SARs (NMFS 2010b) and are incorporated herein by reference. Aside from the interactions discussed for bottlenose and spotted dolphins in Section 3.3.4.1.1 and West Indian manatees in Section 3.3.4.1.2, there have been no reported interactions with other marine mammal species in the Southeastern U.S. shrimp fisheries.

3.3.4.1.4 Marine Mammal Bycatch Mortality in the Gulf of Mexico Shrimp Otter Trawl Fishery

Soldevilla et al. (2015) analyzed observer data in the for the otter trawl component of the Southeastern U.S. shrimp fisheries to estimate bycatch mortality estimates for Gulf of Mexico dolphin stocks. They analyzed a total of 14 marine mammal interactions observed by the Observer Program between 1993 and the first season of 2012, with 12 of those occurring within this study's bycatch rate estimation period from 1997 to 2011. Of these 12 animals, 5 were identified as bottlenose dolphins, with the remaining 7 identified as either unidentified dolphin or marine mammal. Six entanglement events occurred in the lazy line (i.e., a line attached to the codend and aids in bringing the net on board for emptying), followed by 5 entanglements in TED nets. A single entanglement occurred in the tickler chain. The 2 other entanglements were identified as decomposed and were entangled in the TED nets, with tow durations for these events ranging between 5-13 hours.

All dolphin bycatch interactions resulted in mortalities except for 1 unidentified dolphin that was released alive in 2009. Soldevilla et al. (2015) provide mortality estimates calculated from analysis of shrimp fishery effort data and our Observer Program bycatch data. Observer program coverage does not extend into bays/sounds/estuaries (BSE) waters; time-area stratified bycatch rates were extrapolated into inshore waters to estimate bycatch mortalities from inshore fishing effort. Annual mortality estimates were calculated for the years 1997-2011 from stratified annual fishery effort and bycatch rates, and a 5-year unweighted mean mortality estimate for 2007-2011 was calculated for Gulf of Mexico dolphin stocks (Table 6). The 4-area (Texas, Louisiana, Mississippi/Alabama, and Florida) stratification method was chosen because it best approximates how fisheries operate (Soldevilla et al. 2015). The BSE stock mortality estimates were aggregated at the state level as this was the spatial resolution at which fishery effort is modeled (e.g., Nance et al. 2006). The mean annual mortality estimates for the BSE stocks are as follows: Texas BSE (from Galveston Bay, East Bay, Trinity Bay south to Laguna Madre): 0; Louisiana BSE (from Sabine Lake east to Barataria Bay): 88 (CV=1.01); Mississippi/Alabama BSE (from Mississippi River Delta east to Mobile Bay, Bonsecour Bay): 41 (CV=0.67); and Florida BSE (from Perdido Bay east and south to the Florida Keys): 3.4 (CV=0.99). These estimates do not include skimmer trawl effort, which may represent up to 50% of shrimp fishery effort in Louisiana, Alabama, and Mississippi inshore waters, because Observer Program coverage of skimmer trawls is limited. Limitations and biases of annual bycatch mortality estimates are described in detail in Soldevilla et al. (2015).

Table 6. Five-year mean of 2007-2011 annual stock bycatch estimates for the Gulf of Mexico otter trawl shrimp fisheries.

SPECIES	STOCK	NUMBER OF MORTALITIES
BOTTLENOSE DOLPHIN	CONTINENTAL SHELF	56
	WESTERN COASTAL	68
	NORTHERN COASTAL	21
	EASTERN COASTAL	2.3
	TEXAS BSE	0
	LOUISIANA BSE	88
	MISSISSIPPI/ALABAMA BSE	41
	FLORIDA BSE	3.4
ATLANTIC SPOTTED DOLPHIN	NORTHERN GULF OF MEXICO	42

3.3.4.1.5 2010-2014 Unusual Mortality Event

An unusual mortality event (UME) is defined under the MMPA as, "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response." The Marine Mammal UME Program was established in 1991. From 1991 to the present, there have been 52 formally recognized UMEs in the U.S., involving a variety of species and dozens to hundreds of individual marine mammals per event. The most common species involved in UMEs are bottlenose dolphins, California sea lions, and West Indian manatees. Causes have been determined for 25 of the 52 UMEs documented since 1991. Causes of UMEs include infections, biotoxins (e.g., domoic acid and brevetoxin), human interactions, and malnutrition.

A UME was declared for cetaceans in the Northern Gulf of Mexico (Texas/Louisiana border through Franklin County, Florida) from February 2010 through July 2014. The UME involved 1,141 Cetacean strandings in the Northern Gulf of Mexico (5% stranded alive and 95% stranded dead). Of these strandings, 89 cetaceans stranded prior to the DWH oil spill event response phase (February 1, 2010 - April 29, 2010); 119 cetaceans stranded or were reported dead offshore during the initial DWH oil spill event response phase (April 30, 2010 - November 2, 2010); and 933[12] cetaceans stranded after the initial DWH oil spill event response phase ended (November 3, 2010 - July 31, 2014[13]). There have been 614 strandings in Louisiana, 318 strandings in Mississippi, and 169 strandings reported in Alabama waters from February 2010 through July 2014.

The UME investigation and the DWH Natural Damage Resource Assessment have determined that the DWH oil spill resulted in the death of marine mammals and is the most likely explanation of the persistent, elevated stranding numbers in the northern Gulf of Mexico after the spill. The evidence to date supports that exposure to DWH petroleum products was the most likely explanation of the adrenal and lung disease in dolphins, which has contributed to increased deaths of dolphins living within the oil spill footprint and increased fetal loss. While the number of dolphin mortalities in the area decreased after the peak from February 2010 through July 2014, it does not indicate that the effects of the oil spill on these populations have ended. Researchers still saw evidence of chronic lung disease and adrenal impairment even 4 years after spill (in July 2014) and saw evidence of failed pregnancies in 2015.

3.3.4.2 Fish Species Listed Under the Endangered Species Act (Including Critical Habitat)

Gulf sturgeon (*Acipenser oxyrinchus desotoi*), shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), smalltooth sawfish (*Pristis pectinate*), and Nassau grouper (*Epinephelus striatus*) occur within the area encompassed by the alternatives analyzed within this DEIS. The 5-year review for Gulf sturgeon (USFWS and NMFS 2009) notes that bycatch in shrimp trawls has been documented but has likely been mitigated by TEDs and bycatch reduction devices (BRDs). However, informal conversations with shrimpers suggest that Gulf sturgeon are commonly encountered in Choctawhatchee Bay, Florida, during nocturnal commercial fishing (D. Fox., Delaware State University, pers. comm., in USFWS and NMFS 2009). The recovery plan for shortnose sturgeon (NMFS 1998b) states incidental take of shortnose sturgeon has been documented in shrimp trawls. As noted in the Status Review of Atlantic Sturgeon (NMFS 2007), Atlantic sturgeon have been reportedly captured in shrimp trawls, though TED and BRD requirements may reduce incidental take of Atlantic sturgeon in this fishery. The listing of the Carolina and South Atlantic DPS of Atlantic sturgeon on February 6, 2012 (77 FR 5914), however, noted data supplied by NCDMF documenting over 958 observed tows conducted by commercial shrimp trawlers working in North Carolina with no

[12] This number includes 13 dolphins that were killed incidental to fish related scientific data collection and 1 dolphin killed incidental to trawl relocation for a dredging project.
[13] The initial response phase ended for all 4 states on November 2, 2010. Response re-opened for eastern and central Louisiana on December 3, 2010 and closed again on May 25, 2011.

Atlantic sturgeon reported. Reports from the mandatory observer program in the South Atlantic shrimp fisheries documented the capture of 9 Atlantic sturgeon off South Carolina and Georgia between 2008 and 2011. TED testing was conducted by our SEFSC Harvesting Systems Branch in North Carolina from 2008 through 2009. Sturgeon were only captured during 4 test tows, but TED usage resulted in an 87% reduction in Atlantic sturgeon bycatch by number of individuals, and a 95% reduction by weight (B. Ponwith, NMFS, March 2, 2012, memorandum to D. Bernhart, NMFS).

The shrimp fisheries may directly affect smalltooth sawfish that are foraging within or moving through an active trawling location via direct contact with the gear. The long, toothed rostrum of the smalltooth sawfish causes this species to be particularly vulnerable to entanglement in any type of netting gear, including the netting used in shrimp trawls. The saw penetrates easily through nets, causing the animal to become entangled when it attempts to escape. Mortality of entangled smalltooth sawfish is believed to occur as a result of the net being out of the water for a period of time with the smalltooth sawfish hanging from it before being disentangled (Simpfendorfer pers. comm. 2005). Despite increased effort placed on collecting smalltooth sawfish data since we were petitioned to list the smalltooth sawfish in 1999 (e.g., Simpfendorfer and Wiley 2004; Poulakis and Seitz 2004), records of incidental capture in shrimp trawls are rare. The recovery plan for smalltooth sawfish (NMFS 2009b) documents that the species was documented as bycatch in the shrimp fisheries, with the greatest amount of data available from Louisiana (this does not mean the greatest catches were made in Louisiana, only that this is where the best records were kept). One data set from shrimp trawlers off Louisiana from the late 1940s through the 1970s (Simpfendorfer 2002) suggests a rapid decline in the species from the period 1950-1964. Anecdotal information collected by our port agents indicates that smalltooth sawfish are now taken very rarely in the Louisiana shrimp trawl fishery.

We have no information on potential interactions between the shrimp fisheries and Nassau grouper. Due to the species' habitat preferences and the areas where shrimp trawlers typically operate, we do not anticipate take of Nassau grouper by the shrimp fisheries.

While noting that there have been documented interactions between the above mentioned species (with the exception of Nassau grouper) and shrimp trawls, none of the actions considered in the proposed alternatives are likely to increase the likelihood of incidental take of these listed species. Detailed status information on the fish species listed under the ESA that may be affected by the proposed alternatives is included in Appendix III.

Gulf sturgeon critical habitat would potentially be affected by the alternatives considered herein. Critical habitat for Atlantic sturgeon was proposed on June 3, 2016 (81 FR 36078), however, the areas proposed are restricted to South Atlantic rivers where the shrimp fisheries do not operate. Therefore, the following discussion is limited to Gulf sturgeon critical habitat.

Gulf sturgeon critical habitat was jointly designated by NMFS and USFWS on April 18, 2003 (50 CFR 226.214). Critical habitat is defined in Section 3(5)(A) of the ESA as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features: (a) essential to the conservation of the species, and (b) that may require special management considerations or protection; and (2) specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. The term "conservation" is defined in Section 3(3) of the ESA as the use of all methods and procedures that are necessary to bring any endangered or threatened species to the point at which listing under the ESA is no longer necessary.

Gulf sturgeon critical habitat includes areas within the major river systems that support the 7 currently reproducing subpopulations (USFWS et al. 1995), and associated estuarine and marine habitats. Gulf sturgeon use the rivers for spawning, larval and juvenile feeding, adult resting and staging, and to move between the areas that support these components. Gulf sturgeon use the lower riverine, estuarine, and marine environment during winter months primarily for feeding and, more rarely, for inter-river migrations. Estuaries and bays adjacent to the riverine units provide unobstructed passage of sturgeon from feeding areas to spawning grounds.

Fourteen areas (units) are designated as Gulf sturgeon critical habitat. Critical habitat units encompass a total of 2,783 river kilometers (km) and 6,042 km^2 of estuarine and marine habitats, and include portions of the following Gulf of Mexico rivers, tributaries, estuarine, and marine areas:

Unit 1	Pearl and Bogue Chitto Rivers in Louisiana and Mississippi;
Unit 2	Pascagoula, Leaf, Bowie, Big Black Creek, and Chickasawhay Rivers in Mississippi;
Unit 3	Escambia, Conecuh, and Sepulga Rivers in Alabama and Florida;
Unit 4	Yellow, Blackwater, and Shoal Rivers in Alabama and Florida;
Unit 5	Choctawhatchee and Pea Rivers in Florida and Alabama;
Unit 6	Apalachicola and Brothers Rivers in Florida;
Unit 7	Suwannee and Withlacoochee Rivers in Florida;
Unit 8	Lake Pontchartrain (east of causeway), Lake Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay, and Mississippi Sound systems in Louisiana and Mississippi, and sections of the state waters within the Gulf of Mexico;
Unit 9	Pensacola Bay system in Florida;
Unit 10	Santa Rosa Sound in Florida;
Unit 11	Nearshore Gulf of Mexico in Florida;
Unit 12	Choctawhatchee Bay system in Florida;
Unit 13	Apalachicola Bay system in Gulf and Franklin Counties, Florida; and
Unit 14	Suwannee Sound in Florida.

Critical habitat determinations focus on those physical and biological features that are essential to the conservation of the species (50 CFR 424.12). Federal agencies must ensure that their activities are not likely to result in the destruction or adverse modification of critical habitat through adverse effects to the essential features on which designations are based. Therefore, proposed actions that may impact designated critical habitat require an analysis of potential impacts to each essential feature.

Features identified as essential for the conservation of the Gulf sturgeon consist of: (1) abundant food items, such as detritus, aquatic insects, worms, and/or mollusks, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusks and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages; (2) riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay; (3) riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions; (4) a flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, staging, and for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging; (5) water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; (6) sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and (7) safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage).

As stated in the final rule designating Gulf sturgeon critical habitat, the following activities, among others, when authorized, funded, or carried out by a federal agency, may destroy or adversely modify critical habitat: (1) actions that would appreciably reduce the abundance of riverine prey for larval and juvenile sturgeon, or of estuarine and marine prey for juvenile and adult Gulf sturgeon, within a designated critical habitat unit, such as dredging, dredged material disposal, channelization, in-stream mining, and land uses that cause excessive turbidity or sedimentation; (2) actions that would appreciably reduce the suitability of Gulf sturgeon spawning sites for egg deposition and development within a designated critical habitat unit, such as impoundment, hard-bottom removal for navigation channel deepening, dredged material disposal, in-stream mining, and land uses that cause excessive sedimentation; (3) actions that would appreciably reduce the suitability of Gulf sturgeon riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, believed necessary for minimizing energy expenditures and possibly for osmoregulatory functions, such as dredged material disposal upstream or directly within such areas, and other land uses that cause excessive sedimentation; (4) actions that would alter the flow regime (the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) of a riverine critical habitat unit such that it is appreciably impaired for the purposes of Gulf sturgeon migration, resting, staging, breeding site selection, courtship, egg fertilization, egg deposition, and egg development, such as impoundment; water diversion; and dam operations; (5) actions that would alter water quality within a designated critical habitat unit, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability, such as dredging, dredged material disposal, channelization, impoundment, in-stream mining, water diversion, dam operations, land uses that cause excessive turbidity, and release of chemicals, biological pollutants, or heated effluents into surface water or connected groundwater via point sources or dispersed non-point sources; (6) actions that would alter sediment quality within a designated critical habitat unit such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability, such as dredged material disposal, channelization, impoundment, in-stream mining, land uses that cause excessive sedimentation, and release of chemical or biological pollutants that accumulate in sediments; and (7) actions that would obstruct migratory pathways within and between adjacent riverine, estuarine, and marine critical habitat units, such as dams, dredging, point-source-pollutant discharges, and other physical or chemical alterations of channels and passes that restrict Gulf sturgeon movement (68 FR 13399).

3.4 DESCRIPTION OF THE ECONOMIC ENVIRONMENT

Gulf of Mexico Shrimp Fisheries

Descriptions of the Gulf of Mexico shrimp fisheries are contained in previous amendments and our regulatory actions, and are incorporated herein by reference (see Shrimp Amendment 13 (GMFMC 2005); Shrimp Amendment 14/Reef Fish Amendment 27 (GMFMC 2007); Regulatory Impact Review and Regulatory Flexibility Act Analysis for Making Technical Changes to TEDs to Enhance Turtle Protection in the Southeastern United States Under Sea Turtle Conservation Regulations (NMFS 2002b); Regulatory Impact Review and Regulatory Flexibility Act Analysis, and Social Impact Assessment for the Proposed Rule to Revise the Gulf/South Atlantic Bycatch Reduction Device Testing Manual and Modify the Bycatch Reduction Criterion for Bycatch Reduction Devices Used in the Penaeid Shrimp Fishery West of Cape San Blas, Florida (NMFS 2006); Framework Action to Establish Funding Responsibilities for the Electronic Logbook Program in the Shrimp Fishery of the Gulf of Mexico (GMFMC 2013); Shrimp Amendment 16 (GMFMC 2014); and Shrimp Amendment 17A (GMFMC 2016b). The following discusses certain key characteristics of the Gulf of Mexico shrimp fisheries.

The Gulf of Mexico shrimp fisheries consist of 3 major sectors: harvesting sector, dealer/wholesaler sector, and processing sector. The following discussion provides summary statistics and selected characteristics for these sectors. Imports are also presented.

The harvesting sector is composed of 2 types of fleets: 1) a small vessel fleet that is predominantly active in inshore and state offshore waters and very diverse with respect to gear and other operating characteristics; and 2) a large vessel fleet predominantly active in offshore waters, particularly the EEZ, and almost always using otter trawl gear. In 2003, a federal shrimp permit was instituted requiring vessels to possess the permit when fishing for penaeid shrimp in the Gulf of Mexico EEZ. A moratorium on the issuance of new federal shrimp permits became effective in March 2007. Currently, vessels must possess a SPGM when fishing for penaeid shrimp in the Gulf of Mexico EEZ. In addition, a royal red shrimp endorsement (GRRS), which is an open-access permit for those holding a SPGM, is required for harvesting royal red shrimp in the Gulf of Mexico EEZ.

Selected Characteristics of Participating Vessels in the Gulf of Mexico Shrimp Fisheries

Selected characteristics of participation in the Gulf of Mexico shrimp fisheries from 2007 through 2014 are summarized in Table 7. Estimates of the total number of active shrimp vessels are based on the number of unique vessels landing shrimp as recorded in the Gulf Shrimp System (GSS) database. The number of active vessels is likely an overestimate because of vessel identification errors in the GSS database, specifically with respect to state registered boats that mostly operate in inshore waters. The number of active permitted vessels was generated by cross referencing GSS landings data with the SERO's permit database. The number of active permitted vessels is likely an underestimate of the "actual" number of active permitted vessels based on other research (Travis 2010). However, this method for estimating active participation in the Gulf of Mexico shrimp fisheries allow standardized estimates to be generated over a longer time frame compared to other methods.

Table 7. Selected characteristics of participation in the Gulf of Mexico food shrimp fisheries, 2007-2014.

	2007	2008	2009	2010	2011	2012	2013	2014
NUMBER OF ACTIVE VESSELS[1]	4,717	4,152	4,640	4,510	5,285	5,191	4,669	4,916
PERCENT OF ACTIVE VESSELS WITH A FEDERAL PERMIT	33	30	27	25	22	22	24	23
NUMBER OF ACTIVE VESSELS WITH A FEDERAL PERMITS	1,553	1,237	1,232	1,132	1,187	1,148	1,110	1,116
PERCENT OF ACTIVE VESSELS WITHOUT A FEDERAL PERMIT	67	70	73	75	78	78	76	77
NUMBER OF ACTIVE VESSELS WITHOUT A FEDERAL PERMITS	3,164	2,915	3,408	3,378	4,098	4,043	3,559	3,800
NUMBER OF FEDERALLY-PERMITTED VESSELS	2,514	1,930	1,764	1,685	1,641	1,587	1,544	1,515
PERCENT ACTIVE	62	64	70	67	72	72	72	74
PERCENT INACTIVE	38	36	30	33	28	28	28	26
FOOD SHRIMP LANDINGS (MILLION LBS, HEADS-OFF)	140	120	155	111	137	134	128	131
GROSS REVENUES (2014 DOLLARS, MILLIONS)	398	389	321	354	441	389	504	557
PERCENT OF FOOD SHRIMP LANDINGS BY FEDERALLY-PERMITTED VESSELS	68	66	69	63	67	63	60	56
PERCENT OF FOOD SHRIMP GROSS REVENUES BY FEDERALLY-PERMITTED VESSELS	78	77	76	74	78	72	72	68

[1] Active means a vessel had at least 1 lb of Gulf of Mexico shrimp landings in a year based on GSS data (R. Hart, NMFS, pers. comm., April 25, 2016). These are likely overestimates of the actual number of active vessels because of vessel identification errors in the GSS data.

The number of permitted and non-permitted active vessels (i.e., vessels reporting landings in the Gulf of Mexico shrimp fisheries) has been above 4,000 and generally around 5,000 in the last 4 years (Table 7). There were an estimated 8,401 vessels active in the Gulf of Mexico food shrimp fisheries in one or more years between 2011 and 2014. Although approximately one-third of the active vessels were federally permitted (vessels with SPGM) at the beginning of the moratorium, less than 25% of active vessels had federal permits in each of the last 4 years (i.e., vessels without a permit are representing an increasing percentage of active vessels in the fisheries over time). Despite being fewer in number, federally-permitted vessels generally accounted for about 67% of shrimp landings and 76% of shrimp revenues in the fisheries between 2007 and 2011. However, the permitted vessels' shares of the fisheries' landings and revenues have declined noticeably in the last 3 years, to only 56% and 68%, respectively. Thus, vessels without permits have been accounting for a greater percentage of the fisheries' production and revenues in recent years.

The royal red shrimp sector is a relatively small segment of the Gulf of Mexico shrimp fisheries. As of October 18, 2016, there were 1,364 valid SPGM permits and 285 GRRS endorsements. On average (2006-2014), royal red shrimp accounted for less than 1% of total Gulf of Mexico shrimp landings and ex-vessel revenues. The deep-water nature of the fishery, the limited geographic location of known fishing grounds, and the equipment needed to fish for royal red shrimp may have contributed to the relatively low share of the royal red shrimp landings and revenues to the overall shrimp landings and revenues in the Gulf of Mexico. A more detailed discussion of vessels participating in the royal red shrimp fishery is provided in Shrimp Amendment 16 (GMFMC 2015) and Shrimp Amendment 17A (GMFMC 2016).

Key Economic and Financial Characteristics of Federally-Permitted Gulf of Mexico Shrimp Vessels

The following descriptions are based on a series of annual reports on the economics of the federal Gulf of Mexico shrimp fishery for the years 2006 through 2014 (Liese 2011, 2013a, 2013b, 2014, 2016; Liese and Travis 2010; Liese et al. 2009a, 2009b). These reports present the results of the Annual Economic Survey of Federal Gulf Shrimp Permit Holders. The first survey, which was administered in 2007, collected data for the 2006 fishing year.

The type of economic data the survey collects is based on an accounting framework of money flows and values associated with the productive activity of commercial shrimping. With these data, 3 financial statements (the balance sheet, the cash flow statement, and the income statement) are prepared to give a comprehensive overview of the financial and economic situation of the offshore shrimp fishery.[14] Table 8 shows a summary of these financial statements. In this table, financial statements for 2010 and onward include costs and revenues related to the DWH oil spill. Dollar values are averages in 2014 dollars. The year 2010 was unique for the operations of many shrimp vessels in the Gulf of Mexico because of the DWH oil spill. This oil spill and British Petroleum's (BP) responses had a confounding effect on the economics of the Gulf of Mexico shrimp fisheries in 2010 and onward.

In 2010, the majority of vessels (66%) reported receiving oil spill-related revenues. The 2 primary sources of this revenue were damage claims (passive income) and revenue generated by participation in BP's vessel of opportunity program (VOOP) where vessels were hired to clean up oil. Of the surveyed vessels in 2010, 28% participated in the VOOP. Both sources provided substantial revenue for participating vessels, thereby obscuring the economics of the Gulf of Mexico shrimp fishery. Further, vessels participating in the VOOP incurred non-negligible costs unrelated to commercial fishing. For more details on DWH-related revenues, see Liese (2011, 2013a, 2013b, and 2014). It is noted that some shrimp vessels continued to receive DWH-related revenues after 2010, but the amounts in these later years were small relative to that received in 2010.

[14] For more detailed descriptions of these three financial statements, see Liese et al. 2009a.

Table 8. Economic and financial characteristics of an average vessel with a federal Gulf of Mexico commercial shrimp permit, 2007-2014. Dollar values are averages in 2014 dollars (Liese 2009, 2013a, 2013b, 2014, 2016; Liese and Travis 2010; Liese et al. 2009a, 2009b).

	2007	2008	2009	2010	2011	2012	2013[2]	2014[2]
NUMBER OF OBSERVATIONS	505	497	427	429	456	442	380	396
BALANCE SHEET								
ASSETS	223,750	223,393	226,617	246,276	306,511	298,608	288,598	356,141
LIABILITIES	94,932	77,605	66,283	53,339	43,198	51,083	42,813	27,205
EQUITY	128,818	145,789	160,334	192,936	263,313	247,525	245,785	328,936
CASH FLOW								
INFLOW	217,839	234,211	229,689	359,688	331,621	385,803	368,187	354,236
OUTFLOW	224,269	229,481	220,736	257,550	294,647	314,442	312,533	303,035
NET CASH FLOW	-6,431	4,729	8,952	102,138	36,974	71,361	55,654	51,201
INCOME STATEMENT								
REVENUE (COMMERCIAL FISHING OPERATIONS)	210,295	231,352	224,973	N/A[1]	315,914	320,066	321,400	351,585
EXPENSES	229,705	236,625	224,190	258,502	301,446	316,022	315,497	310,155
VARIABLE COSTS: NON-LABOR	49.5%	53.7%	50.1%	42.4%	47.8%	52.0%	48.0%	47.4%
VARIABLE COSTS: LABOR	25.2%	25.3%	27.1%	32.6%	32.0%	28.2%	30.5%	33.7%
FIXED COSTS	25.4%	21.0%	22.8%	25.0%	20.2%	19.8%	21.5%	18.9%
NET REVENUE FROM OPERATIONS	-19,410	-5,273	783	N/A[1]	14,468	4,044	5,903	41,430
NET RECEIPTS FROM NON-OPERATING ACTIVITIES	882	-2,218	495	N/A[1]	13,013	62,642	43,402	449
NET REVENUE BEFORE TAX (PROFIT OR LOSS)	-18,528	-7,490	1,278	97,761	27,482	66,686	49,306	41,879
RETURNS								
ECONOMIC RETURN	-8.7%	-2.4%	0.3%	N/A[1]	4.7%	1.4%	2.0%	11.6%
RETURN ON EQUITY	-14.4%	-5.1%	0.8%	50.7%	10.4%	26.9%	20.1%	12.7%

[1] In 2010, many sampled vessels (28%) participated in BP's VOOP cleaning up oil. As a result, business operations and resulting cost (as reported on the survey and here) reflect both fishing and VOOP activities. In other years, operations were strictly commercial fishing. The survey did not ask respondents to separate revenue from participation in VOOP and damage claims (passive income), hence we cannot determine "Revenue from Operations" and calculate "Net Revenue from Operations" or "Economic Return."

[2] 2013 and 2014 numbers are preliminary.

Except for a dip in asset value in 2008, the average vessel shows a fair amount of equity that rose through the years (Table 9). This resulted from a combination of an increasing market value of the assets (vessel and permits being the main assets) and declining liabilities (mainly loans). Because of vastly improved economic conditions in the Gulf of Mexico shrimp and other fisheries these vessels participate in, asset value increased by 23% and, in turn, equity increased even more (34%) in 2014 relative to 2013.

Except for 2007, the average vessel shows positive net cash flows. The absolute amounts of net cash flow were relatively low in 2008 and 2009, but it does indicate a certain level of solvency for continued operation in the federal shrimp fishery, at least in the short term. Since the moratorium was put in place, and cognizant of the importance of the DWH-related revenues in 2010, the years after the DWH oil spill recorded much higher net cash flows. Revenues from shrimp were the major source of cash inflows while fuel and labor (crew and hired captain) costs were the top sources of cash outflows.

The income statement generally reflects the relatively fragile financial condition of an average permitted shrimp vessel between 2007 and 2013. Before the occurrence of DWH-related activities, net revenues from fishing operations were generally negative, except for 2009. As is true of most averages, many shrimp vessels deviated from the average and were profitable. A very different financial scenario characterized the average shrimp vessel between 2010 and 2013 when including DWH-related activities. These activities materially affected the cash flow and income statement of the average vessel. Net cash flows were significantly positive for these years relative to those of the previous years. In addition, the bottom line profits (net revenue before tax) were also relatively high for these years. In 2014, even in the absence of cash flows from DWH-related activities, economic conditions in the Gulf of Mexico shrimp fisheries improved significantly as reflected by the significant increase in net revenues from fishing operations.

Table 9 provides a summary of the financial statements for active vessels. Active vessels are defined as vessels with at least one pound of Gulf of Mexico shrimp landings in a year based on GSS data (R. Hart, NMFS, pers. comm., April 25, 2016). Similar to averages for all federally-permitted vessels, average equity for active vessels has been increasing, particularly in 2014 when it increased by 19%. However, averages focusing on active vessels highlight the fragile economic state of shrimp harvesters between 2007 and 2013, as illustrated by average net revenue from operations and economic returns for active vessels (Table 9).

Table 9. Economic and financial characteristics of an average active vessel with a federal Gulf of Mexico commercial shrimp permit, 2007-2014. Dollar values are averages in 2014 dollars (Liese 2009, 2013a, 2013b, 2014, 2016; Liese and Travis 2010; Liese et al. 2009a, 2009b).

	2007	2008	2009	2010[1]	2011	2012	2013[2]	2014[2]
NUMBER OF OBSERVATIONS	388	383	348	332	368	370	293	333
BALANCE SHEET								
ASSETS	206,917	200,324	210,593	224,083	235,021	244,911	249,398	272,193
LIABILITIES	104,537	75,047	71,249	54,259	42,939	51,250	37,095	19,825
EQUITY	102,380	125,277	139,344	169,823	192,082	193,661	212,303	252,368
CASH FLOW								
INFLOW	247,776	261,788	249,764	250,988	330,645	399,822	417,630	376,594
OUTFLOW	254,414	257,930	243,316	251,799	303,563	332,571	353,654	321,793
NET CASH FLOW	-6,638	3,859	6,448	-811	27,082	67,251	63,976	54,801
INCOME STATEMENT								
REVENUE (COMMERCIAL FISHING OPERATIONS)	238,826	258,305	244,072	248,753	312,141	324,557	361,229	373,490
EXPENSES	260,664	267,759	247,722	253,481	310,702	334,713	359,662	333,314
VARIABLE COSTS: NON-LABOR	53.0%	56.6%	52.4%	50.8%	52.4%	55.6%	49.8%	49.7%
VARIABLE COSTS: LABOR	23.9%	24.2%	25.4%	27.2%	27.7%	25.1%	29.2%	32.2%
FIXED COSTS	23.0%	19.2%	22.2%	21.9%	19.9%	19.2%	20.9%	18.1%
NET REVENUE FROM OPERATIONS	-21,838	-9,454	-3,650	-4,728	1,439	-10,155	1,567	40,176
NET RECEIPTS FROM NON-OPERATING ACTIVITIES	1,285	-1,492	1,111	-730	15,833	71,991	52,961	1,221
NET REVENUE BEFORE TAX (PROFIT OR LOSS)	-20,553	-10,945	-2,539	-5,458	17,273	61,836	54,528	41,397
RETURNS								
ECONOMIC RETURN	-10.6%	-4.7%	-1.7%	-2.1%	0.6%	-4.1%	0.6%	14.8%
RETURN ON EQUITY	-20.1%	-8.7%	-1.8%	-3.2%	9.0%	31.9%	25.7%	16.4%

[1] 2010 numbers are adjusted to remove payments and costs (cleanup activities) related to DWH.
[2] 2013 and 2014 numbers are preliminary.

However, economic conditions for vessels active in the fishery improved dramatically in 2014. Ex-vessel shrimp prices increased significantly, most likely due to a decrease in shrimp imports caused by diseases (early mortality syndrome (EMS)) that affected cultured shrimp in some major exporting countries (e.g., Thailand). In addition, fuel prices, a major cost item for shrimp vessel operation, decreased in 2014. In fact, the difference between ex-vessel shrimp price and fuel price was greater in 2014 by far than in any other year during the moratorium, and likely since the early 2000s. Preliminary data for 2015 suggests fuel prices have continued to decline, but shrimp prices reverted to their lower levels before 2013. Thus, economic conditions in 2014 likely reflect a "best case" scenario for the harvesting sector, with future economic conditions not being as favorable in the short term.

Because of the difference in economic conditions and performance in the years before and after the DWH oil spill, as well as the year to year differences in the years after the oil spill, Table 10 provides an average of financial and economic conditions for active permitted vessels between 2011 and 2014. These estimates may best approximate expected financial and economic conditions for these vessels in the foreseeable future. Most importantly, average gross revenue from fishing operations was approximately $343,000 but net revenue from operations was only about $8,300.

Table 10. Average economic and financial characteristics for active vessels with a federal Gulf of Mexico commercial shrimp permit, 2011-2014. Dollar values are averages in 2014 dollars.

NUMBER OF OBSERVATIONS	1,364
BALANCE SHEET	
ASSETS	250,381
LIABILITIES	37,777
EQUITY	212,604
CASH FLOW	
INFLOW	381,172
FROM SHRIMP (ANY)	91.1%
OUTFLOW	327,895
NET CASH FLOW	53,277
INCOME STATEMENT	
REVENUE (COMMERCIAL FISHING OPERATIONS)	342,854
EXPENSES	334,597
VARIABLE COSTS: NON-LABOR	51.9%
VARIABLE COSTS: LABOR	28.6%
FIXED COSTS	19.5%
NET REVENUE FROM OPERATIONS	8,257
NET RECEIPTS FROM NON-OPERATING ACTIVITIES	35,501
NET REVENUE BEFORE TAX (PROFIT OR LOSS)	43,758
RETURNS	
ECONOMIC RETURN	3.0%
RETURN ON EQUITY	20.8%

Key Economic and Financial Characteristics of Non-Federally-Permitted Shrimp Vessels

Some aggregate information regarding the non-federally-permitted vessel component of the fisheries is in Table 7. Detailed information regarding the financial and economic performance of non-federally-permitted vessels is not available on an annual basis. However, economic surveys that collected such information from this fleet were conducted in 2008 (Miller and Isaacs 2011) and 2012 (Miller and Isaacs 2014). Given the aforementioned changes in the economic conditions for the harvesting sector as a whole and the federally-permitted fleet, particularly after the DWH oil spill, the 2008 estimates are outdated and thus the estimates from the 2012 survey are the most current and thus best available information regarding these vessels' financial and economic performance. The following is a summary of the report's more important findings regarding these vessels' financial and economic performance in 2012.

About 92% of these vessels are owner-operated. The average vessel was about 37 ft long, 24 years old, and had a current market value of about $60,000. Because only 7.7% of respondents had loan balances in 2012, average debt was relatively low ($2,354), and average equity was relatively high at approximately $58,000. The average non-federally-permitted vessel took about 53 trips and spent an average of 97 days at sea in 2012. Most non-federally-permitted shrimpers (approximately 72%) harvested only shrimp and no other types of seafood. Most of their shrimp was sold to dealers or processors. About 85% sold no shrimp to retailers and 60% claimed to have sold no shrimp directly to the public.

Average cash inflows were about $85,000, considerably less than federally-permitted vessels, while average cash outflows were approximately $59,000, about two-thirds of which was related to fuel, repairs and maintenance, and overhead. Average net cash flows were about $26,000, but median cash inflows were only $6,000. Net cash flows were zero or negative for about 40 percent of these vessels. When non-cash expenses like depreciation and owner's vessel time (opportunity cost) are included, and revenues unrelated to commercial fishing operations are excluded, average net income from operations falls to about -$5,000. Net income before taxes, which considers all sources of revenue, averaged $16,000. Net income before taxes was negative for the majority of these vessels.

There is a considerable amount of variability in the economic performance among non-federally-permitted shrimp vessels in the Gulf of Mexico. Although average net cash flow and net income before taxes were positive, estimates for both were negative for many vessels. Economic performance with respect to net cash flow, net revenue from operations, and other measures of profitability varied significantly across vessels based on gross revenue category (cash inflow). More specifically, measures of net revenue and profitability were directly related to vessels' gross revenue (i.e., vessels who earned greater gross revenue also had higher net revenue/profits). This is illustrated in Table 11. The gross revenue/cash inflow categories are as follows: Q1 = Cash Inflow of $13,000 or less, Q2 = Cash Inflow of $13,001 to $40,000, Q3 = Cash Inflow of $40,001 to $65,000, Q4 = Cash Inflow of $65,001 to $110,000, and Q5 = Cash Inflow of more than $110,000. Average gross revenue (nominal) for vessels in each of the 5 gross revenue categories were as follows, from highest to lowest: $230,389 (Q5), $86,469 (Q4), $52,847 (Q3), $27,322 (Q2), and $5,449 (Q1). The report's estimates of net revenue from operations are not identical to those produced for the federally-permitted fleet. Further, many of these vessels only operate in the fisheries on a part-time basis, and even then only in certain years, particularly the vessels in the Q1, Q2, and Q3 categories. As such, they tend to behave more like households than businesses and, based on the following estimates, often do not attempt to maximize "profits." The following represent adjusted estimates from that report that better represent net revenues for these vessels, and more accurately are their "net cash flow from operations" (i.e., net cash flows minus revenues from sources other than seafood): $44,032 (Q5), $2,953 (Q4), -$7,754 (Q3), -$13,173 (Q2), and -$9,012 (Q1).

Table 11. Economic and financial characteristics of an average active vessel without a federal Gulf of Mexico commercial shrimp permit in 2012 (dollar values are nominal).

	GULF	Q1	Q2	Q3	Q4	Q5
NUMBER OF OBSERVATIONS	246	47	51	46	47	55
BALANCE SHEET						
ASSETS: MARKET VALUE OF VESSEL	59,950	24,789	43,483	56,737	80,663	90,255
PURCHASE PRICE	47,576	23,045	38,761	39,661	60,468	72,772
LIABILITIES: LOAN ON VESSEL	2,354	598	2,176	435	7,534	1,200
EQUITY: OWNER'S EQUITY IN VESSEL	57,596	24,191	41,306	56,302	73,129	89,055
PERCENTAGE WITH INSURANCE	6.1%	12.8%	3.9%	10.9%	4.3%	0.0%
INSURANCE COVERAGE AS A PERCENTAGE OF VALUE	3.1%	11.6%	4.1%	4.6%	2.9%	0.0%
CASH INFLOW						
INFLOW: TOTAL	84,618	5,449	27,322	52,847	86,469	230,389
REVENUE FROM SHRIMP	57,058	4,949	19,459	33,139	62,736	151,604
REVENUE FROM OTHER SEAFOOD	6,377	475	4,573	1,708	6,447	16,938
REVENUE FROM SOURCES OTHER THAN SEAFOOD	21,183	25	3,291	18,000	17,285	61,848
OUTFLOW: TOTAL	58,928	14,436	37,203	42,602	66,231	124,509
FUEL	18,418	3,552	9,623	13,133	22,925	39,847
OIL	1,792	223	1,373	462	1,436	4,939
ICE	3,278	374	1,329	1,740	2,646	9,394
SALT	787	111	475	328	877	1,961
GROCERIES	2,406	393	1,753	1,509	3,357	4,668
OTHER TRIP SUPPLIES	1,686	243	1,241	900	1,727	3,953
LABOR	7,412	1,004	3,351	5,496	9,317	16,630
REPAIRS AND MAINTENANCE (REGULAR VESSEL AND GEAR)	6,107	2,118	4,681	5,550	6,550	10,925
REPAIRS AND MAINTENANCE (NEW PURCHASES AND UPGRADES)	4,243	1,073	1,614	5,737	3,057	9,156
INSURANCE PREMIUMS	83	100	25	184	128	0
OVERHEAD	12,160	4,820	11,335	7,172	13,067	22,595
INTEREST PAYMENTS	126	33	176	16	328	76
PRINCIPAL PAYMENTS	429	392	226	375	816	366
NET CASH FLOWS	25,689	-8,987	-9,882	10,246	20,238	105,880
NON-CASH EXPENSE ESTIMATES						
OWNER'S VESSEL TIME	11,826	3,537	8,654	12,755	16,311	17,242
DEPRECIATION	2,270	802	1,353	2,492	2,523	3,970
INCOME STATEMENT (2012)						
REVENUE FROM OPERATIONS	63,435	5,424	24,031	34,847	69,183	168,542
OPERATING EXPENSES	68,226	17,277	45,195	51,721	80,864	136,123
TRIP-RELATED EXPENDITURES	41.6%	28.3%	34.9%	34.9%	40.8%	47.6%
LABOR EXPENDITURES	10.9%	5.8%	7.4%	10.6%	11.5%	12.2%
FIXED COSTS	47.6%	65.8%	57.6%	54.4%	47.7%	40.2%
NET INCOME FROM OPERATION	-4,791	-11,853	-21,163	-16,874	-11,681	32,418
NET INCOME BEFORE TAXES	16,266	-11,861	-18,049	1,110	5,276	94,190
ECONOMIC RETURNS (2012)						
ECONOMIC RETURN	-8.0%	-47.8%	-48.7%	-29.7%	-14.5%	35.9%
RETURN ON EQUITY	28.2%	-49.0%	-43.7%	2.0%	7.2%	105.8%

Based on these estimates, economic conditions remained challenging for many non-federally-permitted vessels in the Gulf of Mexico shrimp fisheries in 2012. However, it should be noted that economic conditions for the average federally-permitted vessel in 2012 was the worst and the only year the average vessels had negative net revenue from operations within the 2011 to 2014 time period. Thus, the 2012 "net revenue" estimates for the non-federally-permitted likely understate the net revenues these vessels earned on average during these years, particularly as economic conditions for the shrimp fisheries as a whole improved in 2013 and particularly 2014. Nonetheless, these are the best available estimates of "net revenue" for non-federally-permitted vessels.

Dealers and Processors

Between 2007 and 2014, the number of food shrimp dealers ranged from 558 (2008) to 896 (2011) in a given year. In 2014, there were 627 dealers. Between 2011 and 2014, there were 1,427 dealers that purchased food shrimp at some point in time in the Gulf of Mexico.[15] Table 12 provides selected characteristics for Gulf of Mexico shrimp dealers in each year. As illustrated by the percentage of the value of shrimp purchases relative to total seafood purchases, most shrimp dealers in the Gulf of Mexico are very specialized. Between 2007 and 2014, annual food shrimp purchases account for around 83% of their total annual seafood purchases. Between 2007 and 2014, annual Gulf of Mexico food shrimp purchases by dealers averaged about $423 million per year (in 2014 dollars), while total seafood purchases by these dealers averaged almost $489 million. However, as in the harvesting sector, the value of these dealers' food shrimp and total seafood purchases increased significantly in 2013 and 2014 as a result of the increases in shrimp prices, with the value of shrimp purchases increasing by more than 50% between 2012 and 2014. The value of food shrimp purchases per dealer also increased by more than 50% during this time. Although the average value of food shrimp and total seafood purchases per dealer appears relatively small, $24,000 and $50,000 in 2014 respectively based on the median, Gulf of Mexico food shrimp dealers are a very heterogeneous group. Many, if not most, "dealers" are actually vessel owners and fishers who have chosen to act as their own dealers and bypass so-called "middlemen" so they can reduce costs and retain more of their net revenue (profit). So, as vessels move in and out of the fisheries, so do dealers to a large degree. A much smaller number of these dealers are also shrimp processors, and their operations generate much larger revenues on average (see below).

Selected characteristics for Gulf of Mexico shrimp processors are provided in Table 13. Between 2007 and 2014, the number of Gulf of Mexico shrimp processors was relatively stable (except for 2012), averaging 53 during this time. Thus, the consolidation seen in this sector in previous years appears to have largely abated. During the same time period, the annual value of processed shrimp averaged more than $639 million (in 2014 dollars). Like dealers, shrimp processors are also very specialized. Shrimp products accounted for more than 90% of the total value processed between 2007 and 2014. However, processors are much larger businesses on average than dealers, with the value of processed shrimp and all processed products averaging $4.46 million and $5.3 million per processor between 2007 and 2014.

[15] This figure could be a slight overestimate of the actual number of dealers. It is based on a compilation of unique dealer codes across the GSS and Accumulated Landings System (ALS) databases. Although most codes could be matched, there are some inconsistencies in the codes within and across these databases over time.

Table 12. Selected characteristics of Gulf of Mexico food shrimp dealers, 2007-2014. Pounds are whole weight, dollar values are in 2014 dollars (NMFS SERO, ALS 2007-2014).

	2007	2008	2009	2010	2011	2012	2013	2014
NUMBER OF DEALERS[1]	663	558	593	726	896	808	600	627
POUNDS OF FOOD SHRIMP PURCHASED (MILLIONS)[1]	222.59	186.19	228.64	175.06	184.86	201.65	202.36	206.61
AVERAGE PRICE PER POUND (MEAN)	$1.79	$2.09	$1.40	$2.02	$2.39	$1.93	$2.49	$2.84
VALUE OF PURCHASED FOOD SHRIMP (MILLIONS)	$397.51	$388.93	$321.12	$353.96	$441.33	$389.45	$503.75	$585.91
TOTAL VALUE OF ALL PURCHASES BY SHRIMP DEALERS (MILLIONS)	$448.51	$443.60	$376.23	$410.14	$517.36	$463.59	$580.20	$668.83
AVERAGE POUNDS OF FOOD SHRIMP PURCHASED, PER DEALER (MEDIAN)	3,929	5,141	4,938	4,018	3,738	4,500	4,059	6,862
AVERAGE VALUE OF FOOD SHRIMP PURCHASED, PER DEALER (MEDIAN)	$8,475	$13,332	$9,846	$9,603	$10,123	$12,621	$10,777	$24,025
AVERAGE TOTAL VALUE OF ALL PURCHASES BY SHRIMP DEALERS, PER DEALER (MEDIAN)	$13,443	$19,702	$14,820	$12,782	$18,613	$20,942	$23,523	$50,207
AVERAGE PERCENT OF PURCHASES IS FOOD SHRIMP, PER DEALER (MEAN)	85	83	83	86	84	83	81	78

[1] Number of dealers may be overestimated due to the lack of a unique dealer identifier across states in the GSS data. Only shrimp species included in the GSS database are included in these estimates, though landings of all such species are included regardless of where they were harvested. A Gulf of Mexico shrimp dealer is a dealer located in Gulf of Mexico that purchased shrimp regardless of where shrimp were harvested. Most averages are reported in terms of medians rather than means because the data distributions are highly skewed.

Economic trends in the processing sector do not exactly mirror trends in the harvesting and dealer sectors. For example, for the sector as a whole, there were increases in the value of processed shrimp and all processed products by these processors in 2013 and 2014. But they were relatively minor in the aggregate, and those values were still below values seen in 2010. The reason for this difference is because processors process imported product as well as domestic product, whereas the dealer data only represents domestic production. A comparison of the dealer and processor data indicates that processors in the Gulf of Mexico relied heavily on imported shrimp in 2010, and were able to increase the value of their processed products as a result. Conversely, in 2014, processors appear to have been much more dependent on domestic product. And although the value of the processed shrimp was somewhat less in 2014 relative to 2010, the average value of processed shrimp per processor was considerably greater in 2014 than in 2010, increasing by 189% from $2.8 million in 2010 to more than $8 million per processor in 2014. What this finding suggests is that, while imported product can and has been important for this sector as a whole, imports are important to a relatively small number of shrimp processors. Conversely, all Gulf of Mexico shrimp processors are somewhat if not highly reliant on domestic production. Thus, when the value of domestic production increases, as it did in 2013 and 2014, such increases benefit all processors rather than only a relatively few.

Table 13. Selected characteristics of the Gulf of Mexico shrimp processing industry, 2007-2014. Pounds are whole weight, dollar values are in 2014 dollars.

	2007	2008	2009	2010	2011	2012	2013	2014
NUMBER OF PROCESSORS	47	50	51	54	50	67	53	51
POUNDS OF SHRIMP PROCESSED (MILLIONS)[1]	273.01	260.82	335.02	271.12	294.43	355.60	282.57	322.86
AVERAGE PROCESSED PRICE PER POUND (MEAN)	$1.75	$2.01	$1.73	$2.82	$1.96	$1.97	$2.61	$2.32
VALUE OF PROCESSED SHRIMP (MILLIONS)	$477.36	$524.84	$580.41	$764.56	$577.97	$702.23	$736.12	$749.98
TOTAL VALUE OF ALL PRODUCTS PROCESSED BY SHRIMP PROCESSORS (MILLIONS)	$484.01	$557.05	$625.59	$818.11	$622.74	$750.96	$779.40	$798.89
AVERAGE POUNDS OF SHRIMP PROCESSED, PER PROCESSOR (MEDIAN, MILLIONS)	3.98	2.56	2.87	1.87	3.06	2.35	2.02	3.18
AVERAGE VALUE OF PROCESSED SHRIMP, PER PROCESSOR (MEDIAN, MILLIONS)	$4.70	$3.67	$3.94	$2.78	$3.92	$4.04	$4.57	$8.05
AVERAGE TOTAL VALUE OF ALL PRODUCTS PROCESSED BY SHRIMP PROCESSORS, PER PROCESSOR (MEDIAN, MILLIONS)	$5.44	$4.31	$5.20	$3.31	$5.05	$4.44	$6.52	$8.10
AVERAGE PERCENT OF TOTAL PROCESSED VALUE IS SHRIMP, PER PROCESSOR (MEAN)	96	94	94	88	90	93	89	92
AVERAGE NUMBER OF EMPLOYEES, PER PROCESSOR (MEDIAN)	38	28	35	28	34	31	31	36

[1] Includes all shrimp regardless of where harvested, but only includes shrimp processed for human consumption (i.e., shrimp processed for bait or shrimp meal are excluded). Most averages are reported in terms of medians rather than means because the data distributions are highly skewed (Source: Office of Science and Technology).

Imports

On average, between 2007 and 2014, the United States has imported more than 1.2 billion lbs (product weight) of shrimp products annually. Imports were relatively stable between 2007 and 2011, but decreased by about 7.2% in 2012 and an additional 5% in 2013. These decreases are likely part of the reason why domestic ex-vessel shrimp prices increased in 2013 and 2014. Imports subsequently increased by almost 12% in 2014, returning to previous levels, which in turn likely caused the apparent decrease in domestic ex-vessel shrimp prices in 2015. The value of imported shrimp products averaged $4.95 billion (2014 dollars) annually between 2007 and 2014. Table 14 provides annual pounds and value of shrimp imports and the share of imports by country of origin.

The distribution of shrimp imports into the United States across exporting countries has changed significantly. Thailand was the primary country of origin for shrimp products imported into the United States between 2007 and 2012, and in fact typically accounted for about one-third of all imports during that time. Vietnam and Indonesia were the next largest exporting countries to the United States, but still only accounted for about 20% of shrimp imports during that time. The decrease in imports from Thailand, which was primarily driven by EMS, led to the overall decrease in imports in 2012 and 2013. As imports of shrimp from Thailand decreased (down to just over

12% in 2014), other countries took advantage of the situation by increasing their exports of shrimp to the United States and, as a result, have increased their market share in recent years. For example, India's share of the imports quadrupled from 2007 to 2014, increasing from 5% to 20.5%. Other countries that have significantly increased their market share include Indonesia, whose share increased from 11.4% to 19.7%, and Ecuador, whose share increased from 7.9% to 13.5%. Unlike earlier years when Thailand dominated the market of shrimp imports into the United States, market share was more evenly distributed by 2014, with India, Indonesia, Vietnam, Ecuador, and Thailand having between 12% and 20% of the market.

Table 14. Annual pounds and value of shrimp imports and share of imports by country, 2007-2014. Pounds of shrimp imports (M. Travis, pers. comm., Gulf of Mexico Data Management, September 15, 2016, http://www.st.nmfs.noaa.gov/commercial-fisheries/market-news/related-links/market-news-archives/index). Values and market share by country (M. Travis, pers. comm., Office of Science and Technology, September 15, 2016).

	2007	2008	2009	2010	2011	2012	2013	2014
MILLION POUNDS OF SHRIMP IMPORTS	1,227.8	1,243.9	1,209.3	1,231.5	1,267.9	1,176.6	1,118.6	1,251.2
VALUE OF SHRIMP IMPORTS (MILLIONS, NOMINAL DOLLARS)	$3,914	$4,105	$3,778	$4,296	$5,166	$4,463	$5,277	$6,696
VALUE OF SHRIMP IMPORTS (MILLIONS, 2014 DOLLARS)	$4,354	$4,478	$4,090	$4,595	$5,414	$4,595	$5,353	$6,696
PERCENTAGE SHARE OF IMPORTS								
THAILAND	31.7	31.4	35.8	35.3	33.3	26.9	17.1	12.2
VIETNAM	11.8	11.7	10.1	11.9	10.1	10.0	13.8	15.0
CHINA[1]	6.0	6.1	6.2	6.4	5.6	5.1	4.5	4.1
INDIA	5.0	3.5	4.4	7.2	10.2	12.9	19.1	20.6
MEXICO	9.2	8.3	8.8	5.3	5.6	5.7	5.0	4.5
ECUADOR	7.9	8.3	8.7	9.5	10.3	12.5	12.4	13.5
INDONESIA	11.4	15.4	13.0	11.5	13.5	14.8	17.2	19.7
BANGLADESH	3.9	3.1	2.4	2.1	1.2	0.9	1.0	0.4
MALAYSIA	3.9	4.5	3.0	3.5	4.1	3.8	1.5	2.7
ALL OTHERS	9.2	7.7	7.5	7.4	6.2	7.3	8.2	7.3

[1] Does not include imports from Hong Kong, Taipei, or Macao.

South Atlantic Shrimp Fisheries

Unlike the GMFMC Shrimp FMP, the SAFMC Shrimp FMP has not been amended since 2012, and in fact has only been amended twice in the last decade. Thus, there is not as much detailed economic data currently available as there is for the Gulf of Mexico shrimp fisheries. Additional information is forthcoming, much of which has been used in the analysis of economic effects in Section 4. Nonetheless, limited information regarding the fisheries' operations and economic characteristics can be found in Amendment 9 (SAFMC 2012) and Amendment 7 (SAFMC 2008), and that information is incorporated herein by reference.

Harvesting Sector

From 2011 through 2014, approximately 1,658 vessels participated in the South Atlantic shrimp fisheries at some point in time. There was some variance in participation over time, with 1,243, 1,334, 1,185, and 1,136 vessels participating in each year, respectively. Some vessels participate by targeting shrimp, particularly white, brown, pink, white, and rock shrimp. There were 1,310 vessels that harvested food shrimp at some point between 2011 and 2014. These shrimp are generally harvested for food or consumption purposes. Some of these shrimp and other species are harvested for bait purposes.

As can be seen in Table 15, the vast majority of shrimp is harvested for food purposes. Although bait shrimp represent a relatively minor proportion of the shrimp landings in the South Atlantic, shrimp harvested for such purposes receive a significantly higher price per pound on average relative to shrimp harvested for food purposes. This table also illustrates that these vessels are highly dependent on revenue from species and fisheries other than shrimp. In fact, revenue from non-shrimp species has typically accounted for around one-third of these vessels revenues each year between 2011 and 2014. These revenues are also important to these vessels because landings of food shrimp decreased significantly in 2013 and 2014 relative to previous years. The cause of the decrease is unknown at this time. However, from an economic standpoint, the increases in shrimp prices in 2013 and 2014, as also seen in the Gulf of Mexico, have largely offset the decline in landings, at least for now.

Table 15. Summary statistics for vessels in the South Atlantic shrimp fisheries, 2011-2014. Pounds are whole weight, dollar values are in 2014 dollars (pers. comm., ACCSP, September 15, 2016).

	2011	2012	2013	2014
NUMBER OF VESSELS	1,243	1,334	1,185	1,136
FOOD SHRIMP POUNDS	26,362,903	24,284,777	15,204,516	17,600,482
FOOD SHRIMP REVENUE	$64,764,420	$62,156,717	$43,608,496	$57,623,710
AVERAGE PRICE PER POUND FOOD SHRIMP	$2.46	$2.56	$2.87	$3.27
BAIT SHRIMP POUNDS	278,397	168,511	125,967	164,782
BAIT SHRIMP REVENUE	$1,488,626	$815,478	$613,277	$837,029
AVERAGE PRICE PER POUND BAIT SHRIMP	$5.35	$4.84	$4.87	$5.08
NON-SHRIMP REVENUE	$36,034,784	$29,190,324	$29,755,821	$31,073,025
TOTAL REVENUE	$102,287,830	$92,162,519	$73,977,595	$89,533,764

Similar to the Gulf of Mexico shrimp fisheries, the South Atlantic shrimp fisheries are composed of vessels with federal permits and those without federal permits. As in the Gulf of Mexico, relatively larger vessels tend to have federal permits, particularly those that target rock shrimp. Vessels are required to have federal permits to harvest penaeid shrimp (SPA) in federal waters. Federal shrimp permits are open access permits, with the exception of the limited access permit (RSLA) allowing vessels to harvest rock shrimp off of east Florida and Georgia.

As in the Gulf of Mexico, an annual economic survey of federally-permitted vessels is conducted each year. However, the last annual assessment of these vessels' economic performance was for calendar year 2011 (Liese 2013b). According to that report, in 2011, SPA-permitted vessels were, on average, generating a positive cash flow, net revenue from operations, and profit. The economic return (20%) and return on the equity (28%) are respectable. Much of this profit was being made by vessels not active or not primarily active in the South Atlantic penaeid or rock shrimp fisheries. When only vessels that land penaeid shrimp are considered, the results are somewhat moderated, but qualitatively similar, with positive cash flows and returns. The economic return, a reflection of the return to commercial fishing, was 17%. Vessels that generate a majority of their revenue from penaeid shrimp, in contrast to previous years, also generated similar, economically healthy results, including an economic return of 18% and a return on equity of 29%.

Looking at vessels defined by ownership of an RSLA permit leads to similar results. All vessels that owned a RSLA permit had a positive and relatively high cash flow, net revenue, and returns. When only vessels actually landing rock shrimp are considered, the economic return drops to 11% from 19%. The economic return tentatively indicates that rock shrimp was the least profitable commercial fishery (among those engaged in by the studied vessels), yet 11% still seems healthy (i.e., they operate well above break-even). The active rock shrimp fleet is mostly located in the Gulf of Mexico and benefited, on average, from about $17,000 of DWH-related payments in 2011. Due to a sample size of 9, these results were highly uncertain.

Response rates to the economic survey in the South Atlantic decreased noticeably between 2012 and 2014. Thus, annual economic reports have not been produced. However, a report looking at changes in and average economic conditions during this time is forthcoming (C. Liese, pers. comm., September 30, 2016). Some of the preliminary results from that forthcoming report are in Table 16. Similar to the results in previous years, the South Atlantic shrimp fisheries are composed of diverse groups of vessels. Vessels that target rock shrimp, and vessels that are primarily engaged in other fisheries but also harvest South Atlantic penaeid shrimp, have high annual gross revenues from fishing relative to vessels that primarily harvest penaeid shrimp. In fact, these vessels' gross revenues are significantly higher than the average federally-permitted Gulf of Mexico shrimp vessel. As was seen in the Gulf of Mexico non-federally-permitted fleet, vessels with higher gross revenues also had greater net cash flow and greater net revenue from operations. Some vessels' economic characteristics most closely resemble the revenue and economic profiles of one of the three groups of vessels, while others are hybrids and most closely resemble the "average" vessel in the federally-permitted fleet.

Economic surveys of non-federally-permitted vessels in the South Atlantic shrimp fisheries have not been conducted. Economic surveys that may have covered such vessels are many years old and were specific to a particular state, and thus are not considered useful for describing recent participation in the fisheries or performance. However, a preliminary assessment of these non-federally-permitted vessels suggests that their level of activity and operational characteristics are likely similar to non-federally-permitted vessels in the Gulf of Mexico, particularly with respect to annual gross revenue. As such, it is assumed that their costs of operation, net cash flows, and net revenues are similar to those of non-federally-permitted vessels in the Gulf of Mexico and, more specifically, that such measures of profitability have the same relationship to annual gross revenue (i.e., non-permitted vessels in the South Atlantic shrimp fisheries with gross revenues similar to their counterparts in the Gulf of Mexico are assumed to also have similar net cash flows, net revenues, etc.). This is a reasonable assumption based on available evidence.

Table 16. Economic and financial characteristics of an average South Atlantic active shrimp vessel with a federal shrimp permit (SPA, RSLA), averaged across 2011-2014. All dollar values are in 2014 dollars. Source: The Annual Economic Survey of Federal South Atlantic Shrimp Permit Holders, NMFS-SEFSC. All numbers are preliminary until the 2012 to 2014 report is released.

	ALL	RSLA	SPA PRIMARY	SPA SECONDARY
NUMBER OF OBSERVATIONS	205	29	160	36
BALANCE SHEET				
ASSETS	167,657	554,389	119,108	339,035
LIABILITIES	16,755	74,043	11,480	24,355
EQUITY	150,902	480,346	107,629	314,680
CASH FLOW				
INFLOW	270,077	683,727	178,222	584,493
ATLANTIC PENAEID SHRIMP	56%	58%	85%	21%
ATLANTIC ROCK SHRIMP	3%	11%	4%	0%
GULF SHRIMP (ANY)	14%	24%	2%	25%
NON-SHRIMP SEAFOOD	24%	1%	5%	53%
NON-FISHING REVENUE	3%	5%	4%	1%
OUTFLOW	228,875	561,463	152,099	491,672
NET CASH FLOW	41,202	122,264	26,123	92,821
INCOME STATEMENT				
REVENUE (COMMERCIAL FISHING OPERATIONS)	262,563	650,743	170,794	580,281
EXPENSES	239,190	566,872	163,432	500,060
VARIABLE COSTS: NON-LABOR	42.8%	44.1%	44.0%	41.3%
VARIABLE COSTS: LABOR	34.6%	31.6%	34.1%	36.4%
FIXED COSTS	22.6%	24.3%	21.9%	22.3%
NET REVENUE FROM OPERATIONS	23,374	83,872	7,362	80,221
NET RECEIPTS FROM NON-OPERATING ACTIVITIES	6,522	28,735	6,982	2,289
NET REVENUE BEFORE TAX (PROFIT OR LOSS)	29,896	112,607	14,345	82,510
RETURNS				
ECONOMIC RETURN	14.3%	14.3%	7.5%	22.9%
RETURN ON EQUITY	20.2%	24.7%	14.9%	25.9%

Dealers and Processors

Between 2011 and 2014, the number of South Atlantic food shrimp dealers each year ranged from 363 (2014) to 440 (2012). There were 592 dealers that purchased food shrimp at some point during these years. Thus, as with vessels, there are many fewer food shrimp dealers in the South Atlantic relative to the Gulf of Mexico. Table 17 provides selected characteristics for South Atlantic food shrimp dealers. As illustrated by the percentage of the value of shrimp purchases relative to total seafood purchases, most food shrimp dealers in the South Atlantic are very specialized. Between 2011 and 2014, annual food shrimp purchases account for around 99% (median per dealer) of their total annual seafood purchases. Purchases of food shrimp landings averaged around 18.2 million lbs per year for these dealers though, as seen in the harvesting sector, purchases were considerably lower with respect to volume in 2013 and 2104. Between 2011 and 2014, the annual ex-vessel value of food shrimp purchases by South Atlantic dealers averaged about $49.4 million per year (in 2014 dollars) though, as with the South Atlantic harvesting sector, there was a significant decrease in 2013 relative to the other years. The significant increase in ex-vessel price in 2014 largely offset the lower landings in that year, allowing total value to increase back to levels in 2011 and 2012. Total seafood purchases by these dealers averaged almost $65 million per year between 2011 and 2014. So although most South Atlantic food shrimp dealers are highly dependent on purchases of food shrimp, a minority of these dealers are highly engaged in purchasing other species. Although the average value of food shrimp and total seafood purchases per dealer appear relatively small, about $5,800 and $13,700 in 2014 respectively based on the median, South Atlantic food shrimp dealers are very heterogeneous, just like Gulf of Mexico food shrimp dealers. Many, if not most, "dealers" are actually vessel owners and fishers who have chosen to act as their own dealers and bypass so-called "middlemen" so they can reduce costs and retain more of their net revenue (profit). A much smaller number of these dealers are also shrimp processors, and their operations generate much larger revenues on average (see below).

Table 17. Selected characteristics of South Atlantic food shrimp dealers, 2011-2014. A South Atlantic shrimp dealer is a dealer located in the South Atlantic that purchased shrimp regardless of where shrimp were harvested. Averages are reported in terms of medians rather than means because the data distributions are highly skewed. Pounds are whole weight, dollar values are in 2014 dollars (pers. comm., ACCSP, September 15, 2016).

	2011	2012	2013	2014
NUMBER OF DEALERS	426	440	381	363
POUNDS OF FOOD SHRIMP PURCHASED (MILLIONS)	22,372,812	21,135,300	13,609,370	15,829,128
AVERAGE PRICE PER POUND (MEAN)	$2.43	$2.53	$2.84	$3.23
VALUE OF PURCHASED FOOD SHRIMP (MILLIONS)	$54,321,724	$53,536,892	$38,677,106	$51,104,766
TOTAL VALUE OF ALL PURCHASES BY SHRIMP DEALERS (MILLIONS)	$71,848,766	$66,487,167	$52,866,949	$68,962,439
AVERAGE POUNDS OF FOOD SHRIMP PURCHASED, PER DEALER (MEDIAN)	2,075	2,195	2,665	2,166
AVERAGE VALUE OF FOOD SHRIMP PURCHASED, PER DEALER (MEDIAN)	$6,155	$5,925	$7,833	$5,822
AVERAGE TOTAL VALUE OF ALL PURCHASES BY SHRIMP DEALERS, PER DEALER (MEDIAN)	$11,576	$9,943	$13,967	$13,741
AVERAGE PERCENT OF PURCHASES IS FOOD SHRIMP, PER DEALER (MEDIAN)	99	100	98	98

Information regarding South Atlantic shrimp processors is provided in Table 18. As was the case with South Atlantic shrimp dealers, South Atlantic shrimp processors are fewer in number and smaller in size with respect to their operations relative to their Gulf of Mexico counterparts.

Table 18. Selected characteristics of the South Atlantic shrimp processing industry, 2007-2014. Pounds are whole weight, dollar values are in 2014 dollars.

	2007	2008	2009	2010	2011	2012	2013	2014
NUMBER OF PROCESSORS	5	5	7	7	8	10	8	8
POUNDS OF SHRIMP PROCESSED (MILLIONS)[1]	35.1	5.0	47.4	34.5	9.1	12.0	42.6	43.3
AVERAGE PROCESSED PRICE PER POUND (MEAN)	$3.08	$1.80	$2.22	$3.27	$2.37	$1.79	$3.14	$3.19
VALUE OF PROCESSED SHRIMP (MILLIONS)	$108.2	$9.1	$105	$112.8	$21.6	$21.5	$133.7	$138.1
TOTAL VALUE OF ALL PRODUCTS PROCESSED BY SHRIMP PROCESSORS (MILLIONS)	$163.9	$33.2	$214.1	$210.6	$55.2	$30.9	$142	$146.4
AVERAGE POUNDS OF SHRIMP PROCESSED, PER PROCESSOR (MEDIAN, MILLIONS)	1,041	310	754	743	415	513	665	563
AVERAGE VALUE OF PROCESSED SHRIMP, PER PROCESSOR (MEDIAN, MILLIONS)	$2,960	$492	$2,360	$2,422	$1,732	$2,048	$2,260	$2,273
AVERAGE TOTAL VALUE OF ALL PRODUCTS PROCESSED BY SHRIMP PROCESSORS, PER PROCESSOR (MEDIAN, MILLIONS)	$6.4	$4.9	$5.7	$7.2	$3.6	$2.9	$3.0	$3.9
AVERAGE PERCENT OF TOTAL PROCESSED VALUE IS SHRIMP, PER PROCESSOR (MEAN)	38	30	49	49	44	79	86	94
AVERAGE NUMBER OF EMPLOYEES, PER PROCESSOR (MEDIAN)	85	85	70	70	53	34	30	27

[1] Includes all shrimp regardless of where harvested, but only includes shrimp processed for human consumption (i.e., shrimp processed for bait or shrimp meal are excluded). Most averages are reported in terms of medians rather than means because the data distributions are highly skewed. (Source: Office of Science and Technology).

Some additional characteristics and changes in the South Atlantic shrimp processing sector are worth highlighting. First, more so than in the Gulf of Mexico, economic activity by South Atlantic processors seems to vary much more directly with respect to changes in imports, though domestic production is still likely a significant component of their processed volume and value. This is to be expected given that processors rely on volume and the South Atlantic shrimp fisheries are much smaller with respect to volume compared to the Gulf of Mexico. Also, on average, processors have become smaller with respect to processed volume and value. The smaller size has led to a significant reduction (more than 70%) in the average number of employees per processor. This change also coincides with a much greater dependence on processing shrimp in 2012 through 2014 relative to previous years. In other words, these processors have become much less diversified with respect to the seafood they process. Before 2012, shrimp accounted for less than half of their processed value on average. But in 2014, shrimp accounted for more than 90% of their processed value on average. Thus, significant reductions in domestic shrimp production or shrimp imports would be likely to have significant adverse effects on the processing sector.

3.5 DESCRIPTION OF THE SOCIAL ENVIRONMENT

The action in this impact statement affects the sea turtle bycatch and mortality reduction requirements for commercial shrimp trawl vessels in the Southeastern U.S. This section provides the background for the proposed actions which will be evaluated in Section 4. This section includes a description of shrimp dealers, processors, and harvesters in the Southeastern U.S. at the community level, when possible. Community level information is included in order to provide a geographical distribution of shrimp involvement. Descriptions of fishing communities including the top communities involved in shrimp fishing in the Gulf of Mexico and South Atlantic by landings in pounds and value are included here. Shrimp processors by community are displayed. Federal and state shrimp permits and licenses or active fishers by state and community or parish are included. An analysis of the Southeast Asian surnames of shrimp vessels owners are presented as a proxy for the number of vessels that may have minorities associated. And lastly, social vulnerability data are presented to assess the potential for environmental justice concerns.

Recent descriptions of the social environment for those engaged in shrimp fishing and associated communities in the Gulf of Mexico are contained in Shrimp Amendment 17A (GMFMC 2016b) and Shrimp Amendment 16 (GMFMC 2014) and are incorporated herein by reference or are incorporated where appropriate in the following text. The most recent descriptions of the social environment of the South Atlantic shrimp fisheries are contained in Coral Amendment 8 (SAFMC 2013) and Shrimp Amendment 9 (SAFMC 2012) and are incorporated by reference. The Shrimp Amendment 17A description focuses on the top communities involved in brown, pink, white, and total shrimp fishing in the Gulf of Mexico; federal Gulf of Mexico shrimp permits by community; processors by community; and overall fishing engagement and reliance of communities involved in shrimp fishing. The Shrimp Amendment 16 description focuses on the top communities involved in royal red shrimp fishing and the number of vessels landing royal red shrimp. The Coral Amendment 8 and Shrimp Amendment 9 descriptions focus on the top communities involved in the royal red and rock shrimp components of the South Atlantic shrimp fisheries and the brown, pink, and white shrimp components of the South Atlantic shrimp fisheries, respectively.

The shrimp fisheries are one of the more economically important fisheries within the Gulf of Mexico. The fisheries have seen a decline in active vessels harvesting several species of shrimp, which has likely affected many coastal communities along the Gulf of Mexico coast. The reasons for this decline are numerous and are related to shrimp imports, fuel prices, and shrimp prices and have obviously affected shrimp fishing households (GMFMC 2014, 2015). The major sectors that have been affected by this decline include: the harvesting sector, dealer/wholesaler sector, and processing sector. These sectors are described below.

Past hurricanes fundamentally affected the Gulf of Mexico shrimp fisheries, their supporting infrastructure, and communities. Hurricane Katrina (2005) impacted Louisiana, Mississippi, and Alabama, and accelerated recent challenges to the shrimp fisheries including rising costs and shrinking revenues, labor shortages, and loss of marine-based infrastructure and services (IAI 2007). Hurricane Rita (2005) magnified and aggravated the impacts in an already compromised region. Impacts from Hurricanes Katrina and Rita include damage or destruction of physical and service infrastructure in fishing communities, loss or damage of a large number of commercial vessels, loss of landings revenue, loss of seafood due to the loss of electricity, displacement of thousands of people in the seafood and harvest distribution sectors, labor shortages, and a shortage of marine-based supplies. Damage to the region was widespread. Thousands of commercial vessels were lost and damaged in coastal Louisiana and vessels due to Hurricane Katrina. Vessels were also beached, damaged, or destroyed in Alabama; 60% of the commercial shrimp boats in Bayou La Batre alone were destroyed. Seafood processing plants and dealers were also damaged or destroyed. Six of the 18 largest seafood processing plants, and many piers, docks, and boat launches were destroyed in Biloxi, Mississippi. The waterfront of Biloxi has been gentrified including the construction of casinos and diminished availability of waterfront space for vessel moorage and seafood processors (IAI 2012). Hurricanes Ike (2008) and Gustav (2008) also impacted the Gulf of Mexico region.

The DWH oil spill in 2010 occurred when many seafood industry business owners along the Gulf of Mexico coast were still recovering from or addressing the effects from recent hurricanes (IAI 2012). After the DWH spill there was a regional drop in shrimp production from 76 million lbs in 2009 to 46.9 million lbs in 2010; a significant shift in commercial fisheries productivity and profitability at the community level during the spill year with levels of production in most port areas well below the 10-year average, but with some communities having a higher volume of landings than average; a reluctance in American consumers to purchase Gulf of Mexico-caught shrimp after the spill and an increase in demand of non-domestic shrimp; and varying reports of the quality of the shrimp harvest during the 2011 season.

Effects from an increasing global market for shrimp and the stresses placed upon fishers and their communities, fuel costs, and low prices for seafood are issues facing shrimp fishers in the South Atlantic (SAFMC 2012). Additional information on the Gulf of Mexico and South Atlantic shrimp fisheries are provided in the Description of the Fisheries in Section 3.1 and the Economic Environment in Section 3.4.

3.5.1 Regional Quotients by Community

The regional quotient (RQ) is a way to measure the relative importance of a given species across all shrimp fishing communities in the region and represents the proportional distribution of commercial landings of a particular species by community. This graphical representation of this proportional measure presented here does not provide the number of pounds or the value of the catch, data which might be confidential at the community level for some locations. The RQ is calculated by dividing the total pounds (or value) of a species landed in a given community by the total pounds (or value) for that species for all communities within the region with shrimp landings. A strong relationship with shrimp is defined as having significant landings and revenue for the species. This measure includes all landings of a particular species, but it does not distinguish where they may have been caught. It is important to note that location of the dealer in the Accumulated Landings System (ALS) dataset may not always correspond to where seafood was initially landed. The landings associated with a dealer location within a community are derived from the reported address of that dealer. In some cases a dealer may have several locations, but landings are reported to one primary address.

3.5.1.1 Gulf of Mexico Communities

Depending upon which shrimp species is being targeted, the volume and value for regional quotient varies considerably by community. In Figure 8, which is Gulf of Mexico brown shrimp landings only, the top 5 communities are from 3 different Gulf of Mexico states. In fact, Texas and Louisiana communities dominate brown shrimp landings although Bayou La Batre, Alabama, has the highest RQ for 2014. Louisiana communities tend to have higher landings but lower value compared to dealers in other states, which may be indicative of size differentiation in harvest, with smaller sizes being landed from inshore fisheries in Louisiana that bring lower prices than larger shrimp from offshore waters.

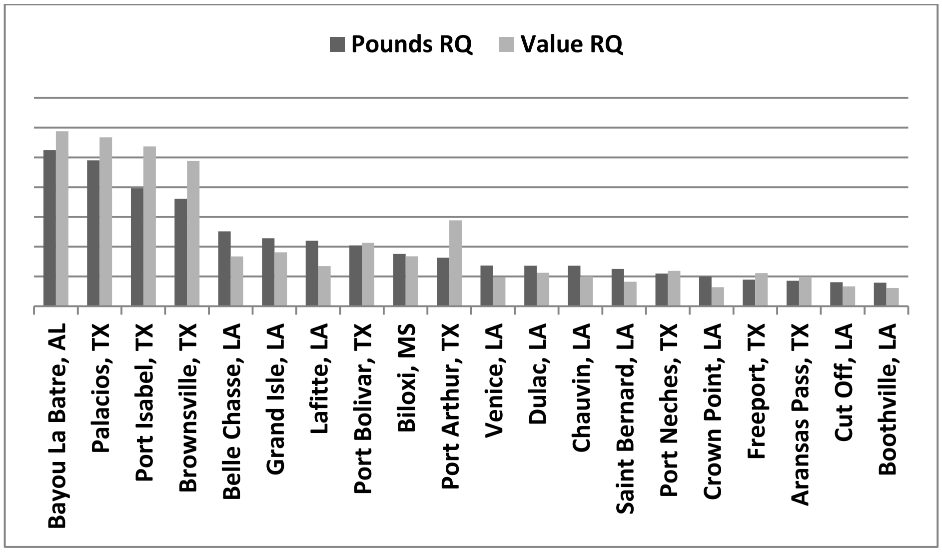

Figure 8. Top 20 communities ranked on pounds and value RQ for brown shrimp in the Gulf of Mexico (SERO ALS 2014).

Gulf of Mexico pink shrimp landings primarily occur in Florida with a large portion of the landings in Fort Myers Beach (Figure 9), followed by Tampa and Tarpon Springs. Bayou La Batre and Irvington, Alabama, are both in the top 10, with Key West, Florida, between them in fifth place. There are several Texas communities within the top 20, although pink shrimp landed in Texas may have been harvested elsewhere as the majority of pink shrimp are harvested off the west coast of Florida. There may also be mislabeling of brown shrimp in Texas that accounts for some pink shrimp landings in that state.

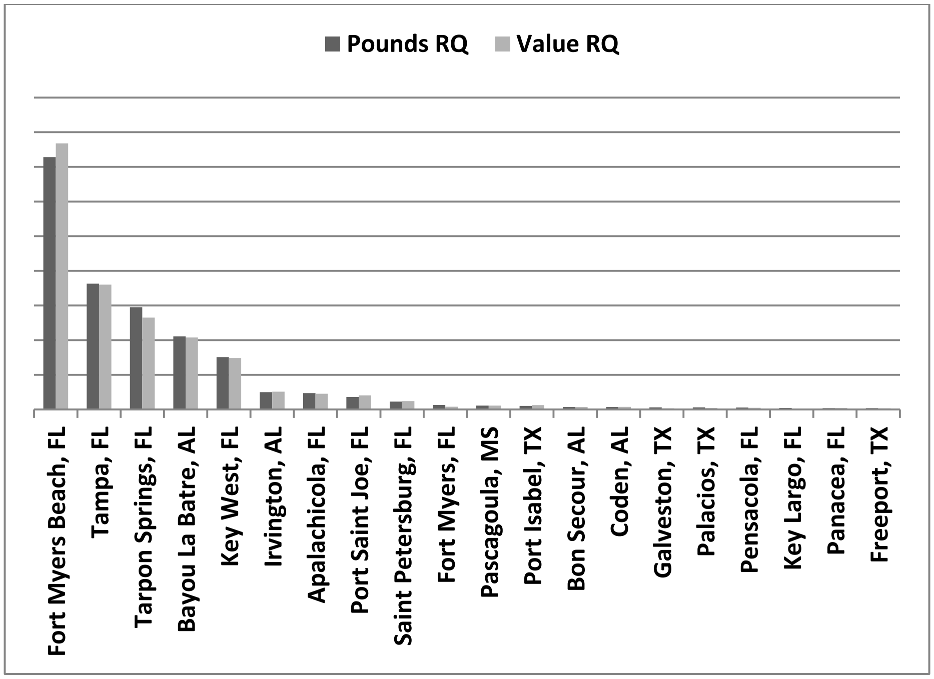

Figure 9. Top 20 communities ranked on pounds and value RQ for pink shrimp in the Gulf of Mexico (SERO ALS 2014).

White shrimp landings (Figure 10) primarily occur in the northern and western Gulf of Mexico with Port Arthur, Texas, having the highest RQ in terms of pounds and value. Other communities have comparable RQ in regard to pounds landed but are not near the value RQ found in Port Arthur.

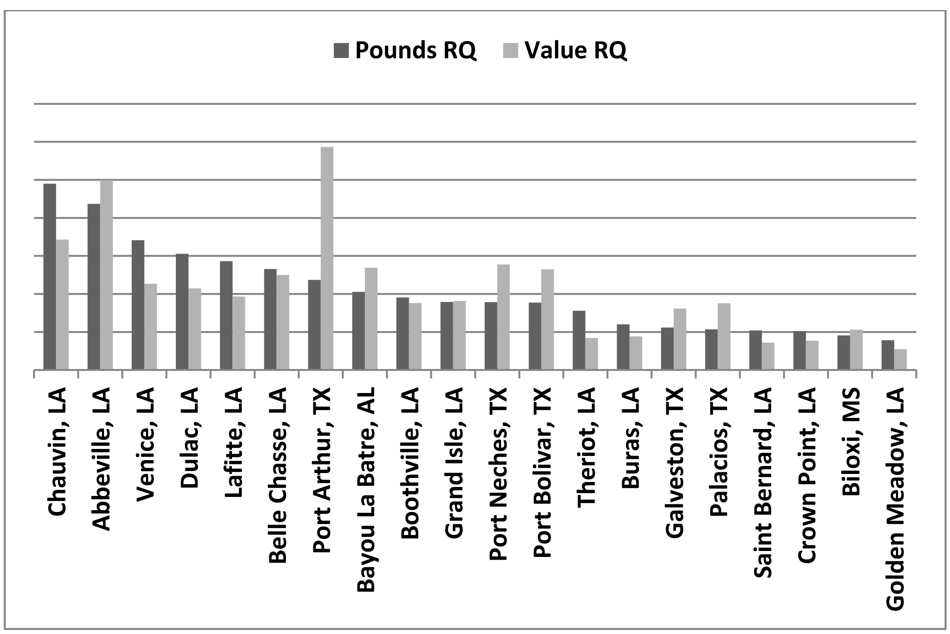

Figure 10. Top 20 communities ranked on pounds and value RQ for white shrimp in the Gulf of Mexico (SERO ALS 2014).

Gulf of Mexico rock shrimp landings are primarily attributed to Florida communities as shown in Figure 11, with Port St. Joe first in both pounds and value of RQ. Rock shrimp for most vessels is a bycatch, but can be a targeted fishery for some.

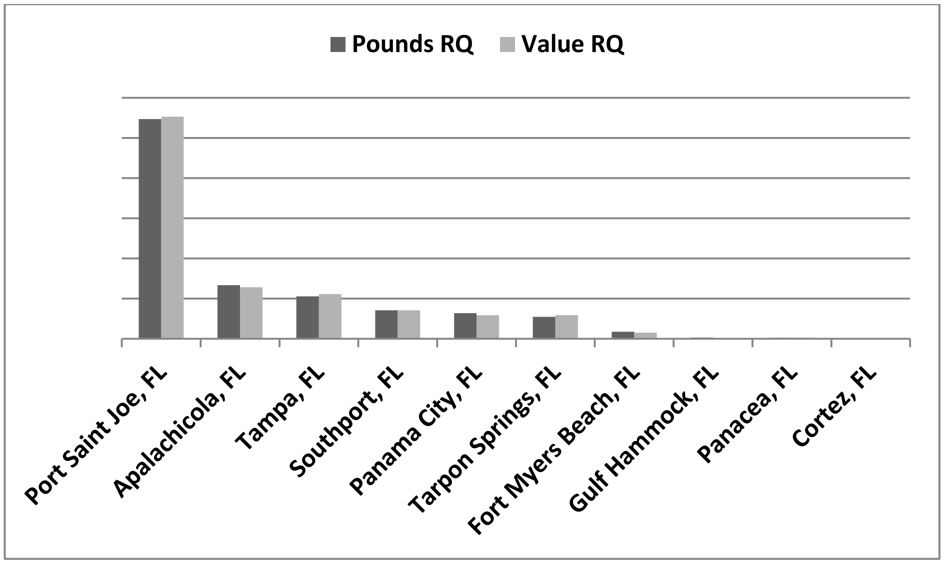

Figure 11. Top 10 communities ranked on pounds and value RQ for rock shrimp in the Gulf of Mexico (SERO ALS 2014).

Gulf of Mexico royal red shrimp landings largely occur in Alabama and Florida (Figure 12). The communities of Bon Secour, Alabama, Port St. Joe, Florida, and Bayou La Batre, Alabama, were the top landing ports.

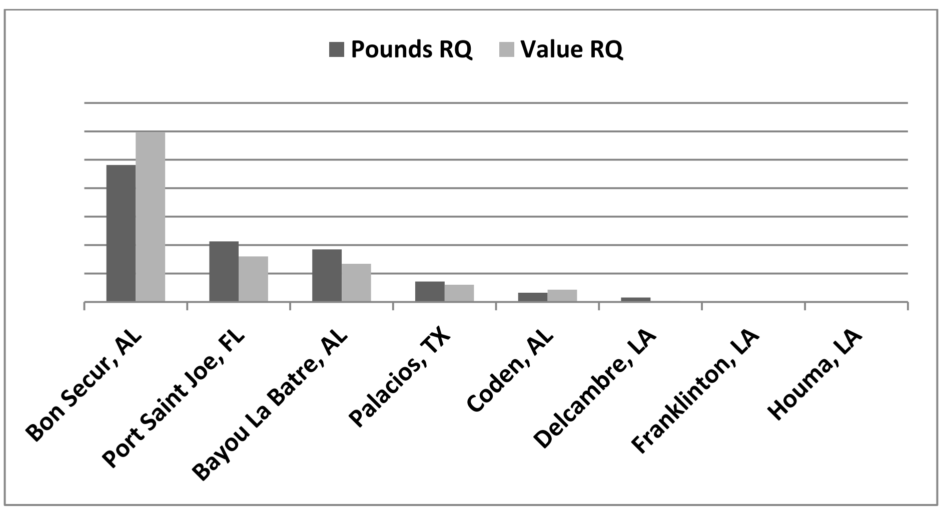

Figure 12. All communities ranked on pounds and value RQ for royal red shrimp in the Gulf of Mexico (SERO ALS 2014).

When the combined landings of Gulf of Mexico shrimp are compared in Figure 13, which is ranked by pounds, the landings are dominated by Texas and Louisiana communities, though Bayou La Batre, Alabama, ranks first in terms of pounds of overall shrimp landings (brown, white, pink, royal red, rock, seabob). Port Arthur, Texas, ranks second in terms of value RQ for total shrimp and Port Isabel is fourth. Many Louisiana communities have a lower RQ for value as displayed for some single species, which indicates lower prices for smaller shrimp in most cases.

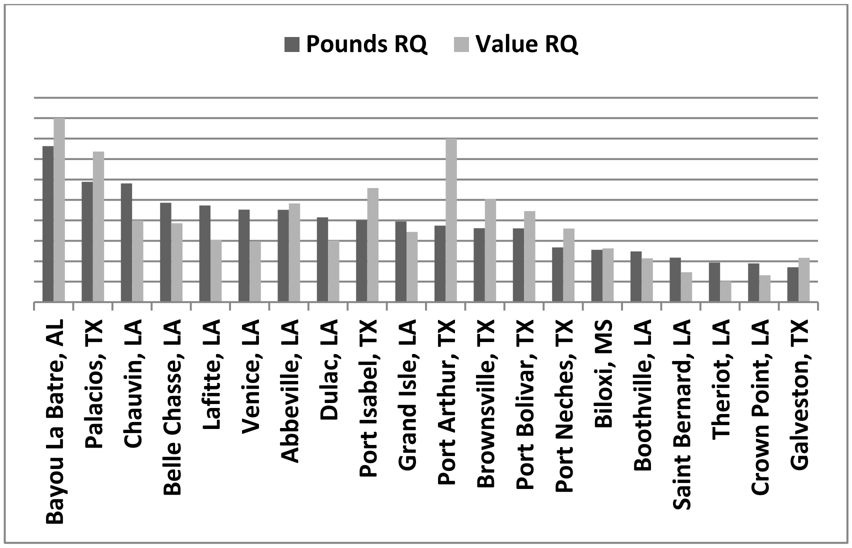

Figure 13. Top 20 communities ranked on pounds and value RQ for total shrimp in the Gulf of Mexico (SERO ALS 2014).

3.5.1.2 South Atlantic Communities

In the South Atlantic, brown shrimp landings (Figure 14) largely occur in North Carolina, with Engelhard having the highest RQ in terms of pounds and value. The communities of Oriental, Wanchese, and Beaufort also include a sizable portion of the landings and value of brown shrimp in the North Carolina. Communities in other South Atlantic states are also represented in the top communities reporting brown shrimp landings.

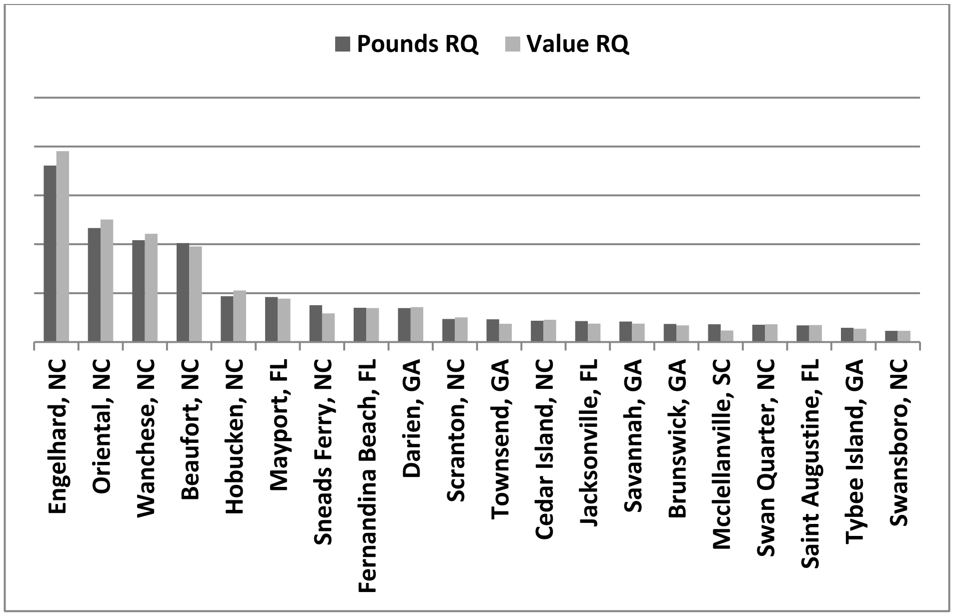

Figure 14. Top 20 communities ranked on pounds and value RQ for brown shrimp in the South Atlantic (SERO ALS 2014).

The majority of South Atlantic pink shrimp landings stem from Florida, with a large portion of the landings occurring in Key West (Figure 15). The Florida communities of Fernandina Beach, Opa-Locka, Mayport, and Titusville follow in rank; however, these communities include a smaller proportion of the total pink shrimp landings. Several North Carolina communities are included in the top 20, however, these communities also include a much smaller proportion of the total pink shrimp landings.

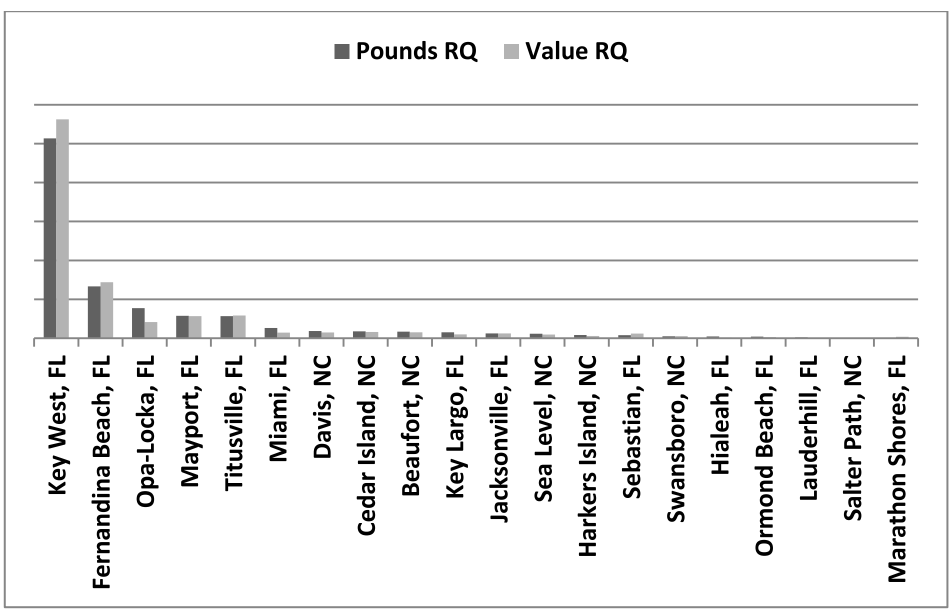

Figure 15. Top 20 communities ranked on pounds and value RQ for pink shrimp in the South Atlantic (SERO ALS 2014).

The greatest percentage of South Atlantic white shrimp is landed in Florida, with a large portion of the landings in Mayport (Figure 16), followed by Jacksonville and Fernandina Beach. The Georgia communities of Brunswick, Darien, Townsend, and Savannah also include sizable portions of the total white shrimp landings. Additional Florida and Georgia communities, as well as North Carolina and South Carolina communities, are included in the top 20; however, many of these communities include a much smaller proportion of the total white shrimp landings.

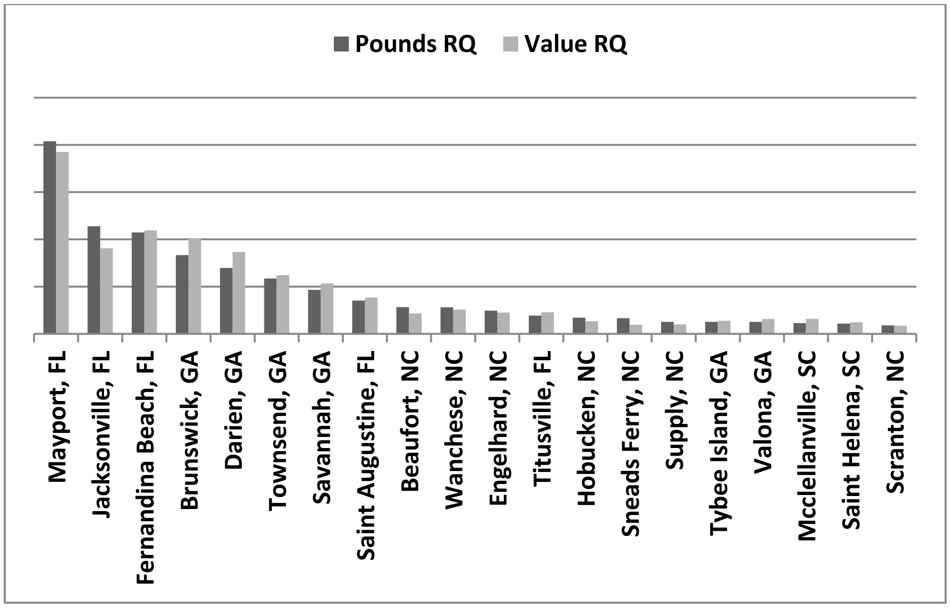

Figure 16. Top 20 communities ranked on pounds and value RQ for white shrimp in the South Atlantic (SERO ALS 2014).

Nearly all South Atlantic rock shrimp landings are in Florida, with a large portion of the landings in Mayport (Figure 17), followed by Jacksonville and Titusville. A small portion of rock shrimp landings occur in Georgia (Townsend) and North Carolina (Cedar Point). Rock shrimp and royal red shrimp use the same vessels and gear, and royal red shrimp are primarily caught by fishers targeting rock shrimp. South Atlantic royal red shrimp landings are documented in Mayport, Titusville, and Jacksonville, Florida (Figure 18).

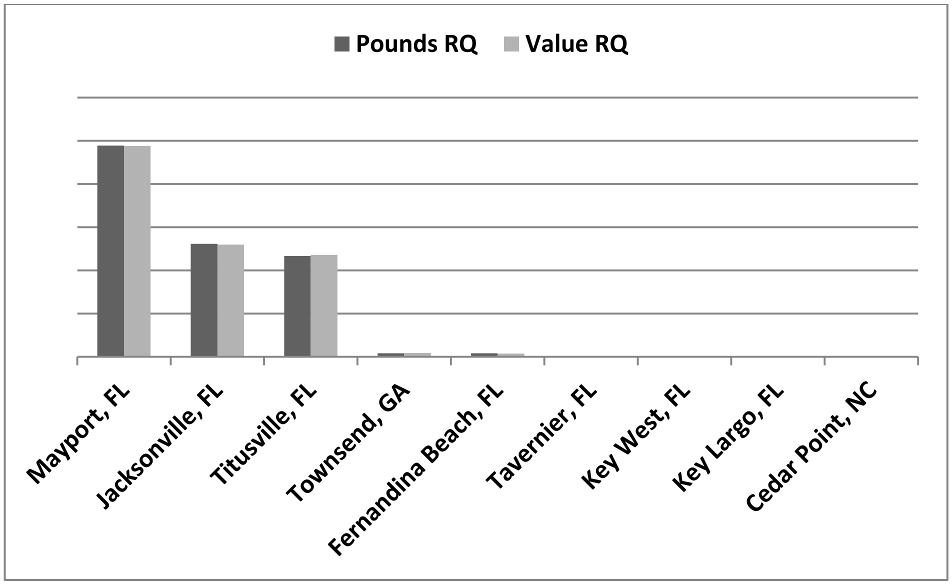

Figure 17. All communities ranked on pounds and value RQ for rock shrimp in the South Atlantic (SERO ALS 2014).

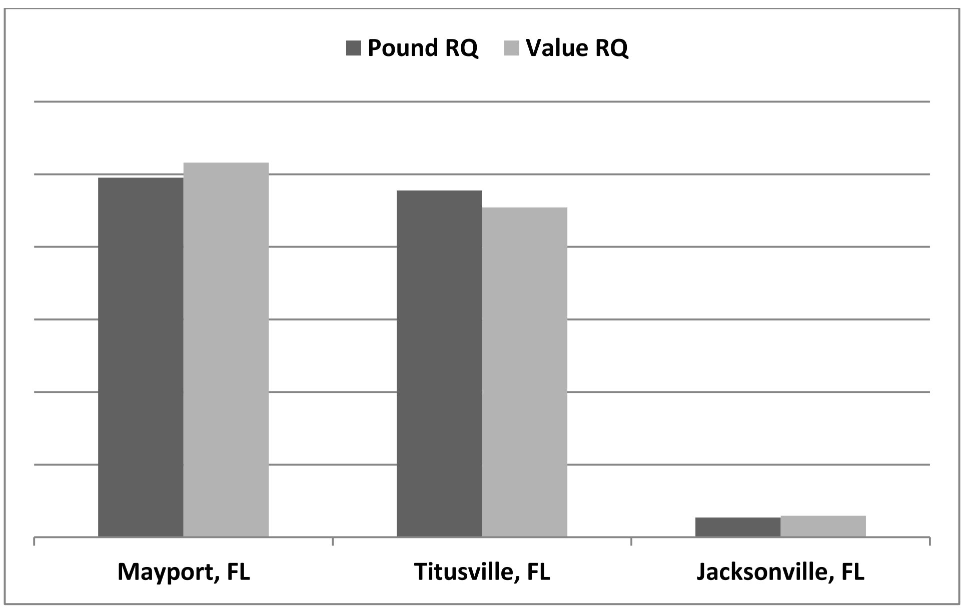

Figure 18. All communities ranked on pounds and value RQ for royal red shrimp in the South Atlantic (SERO ALS 2014).

When the combined landings of South Atlantic shrimp are compared in Figure 19, which is ranked by pounds, the landings include a mix of Florida, North Carolina, and Georgia communities. Mayport, Florida is ranked first in terms of pounds of overall shrimp landings (brown, white, pink, royal red, rock, seabob), followed by Fernandina Beach and Jacksonville. Engelhard, North Carolina, ranks fourth in terms of value RQ for total shrimp and Beaufort, North Carolina, is fifth. One South Carolina community (McClellanville) is included in the top 20; however, it includes a small proportion of the total shrimp landings.

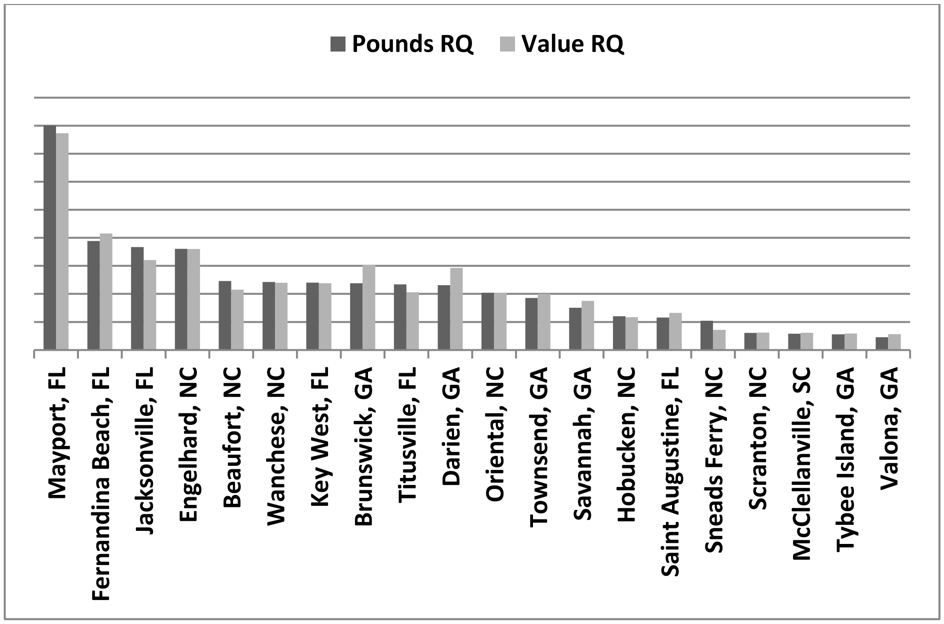

Figure 19. Top 20 communities ranked on pounds and value RQ for total shrimp in the South Atlantic (SERO ALS 2014).

3.5.2 Processors by Community

Figure 20 provides the geographical distribution of shrimp processors in the Southeastern U.S. More shrimp processors are located in the Gulf of Mexico (13 in Texas, 16 in Louisiana, 15 in Alabama-Mississippi, and 6 in West Florida) than in the South Atlantic (4 in East Florida and 5 in Georgia-North Carolina). No shrimp processors are located in South Carolina. While some processors may also be a wholesale dealer, some processors deal with product from outside the state and may also process imported shrimp.

Figure 20. Number of Gulf of Mexico and South Atlantic shrimp processors by community (NMFS Processor Database 2014).

3.5.3 Permits, Licenses, and Fishers by Location and Fleet Demographics

3.5.3.1 Federal Permits

From 2011 to 2014, there were a range of 1,501 to 1,632 federally-permitted Gulf of Mexico shrimp vessels (SPGM permits, NMFS SERO Permit Office). During the same time period, there were a range of 579 to 638 federally-permitted South Atlantic penaeid shrimp vessels (SPA permits), 105 to 111 federally-permitted South Atlantic EEZ rock shrimp vessels (RSLA permits), and 128 to 162 federally-permitted rock shrimp Carolina Zone vessels (RSCZ permits). Because a valid Gulf of Mexico shrimp permit is required for a Gulf of Mexico royal red shrimp endorsement, they are not described here in detail because they are included in the information provided for SPA permits.

Federal permits are issued to individuals in all Gulf of Mexico and South Atlantic states and to individuals in other states (Alaska, California, Hawaii, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Virginia, and Washington) as documented in Table 19 below.

Table 19. Federal shrimp permits by state (NMFS SERO Permit Office 2014).

STATE	SPGM	SPA	RSLA	RSCZ
TEXAS	503	46	3	13
LOUISIANA	459	9	N/A[1]	5
MISSISSIPPI	125	20	6	3
ALABAMA	124	45	34	5
FLORIDA	200	166	28	22
GEORGIA	10	90	4	7
SOUTH CAROLINA	2	49	N/A[1]	11
NORTH CAROLINA	48	139	22	47
OTHER	30	15	5	15
TOTAL	**1,501**	**579**	**105**	**128**

[1] Data confidentiality prevents providing a specific number.

Communities with the most federal permits by permit type are presented in Tables 20 and 21 below. Communities with the most SPGM permits are located along the Gulf of Mexico, whereas communities with the most SPA permits are located along the South Atlantic. Communities with the most RSLA and RSCZ permits are located in Texas, Louisiana, Mississippi, Alabama, Florida, and North Carolina.

Table 20. Top communities by number of federal SPGM and SPA permits (NMFS SERO Permit Office 2014).

SPGM			SPA		
STATE	COMMUNITY	NUMBER	STATE	COMMUNITY	NUMBER
LOUISIANA	NEW ORLEANS	118	ALABAMA	BAYOU LA BATRE	29
TEXAS	BROWNSVILLE	104	GEORGIA	SAVANNAH	20
ALABAMA	BAYOU LA BATRE	70	GEORGIA	DARIEN	19
MISSISSIPPI	BILOXI	68	NORTH CAROLINA	SNEADS FERRY	19
TEXAS	PORT ISABEL	53	FLORIDA	JACKSONVILLE	17
TEXAS	PORT LAVACA	49	NORTH CAROLINA	BEAUFORT	17
TEXAS	PALACIOS	47	FLORIDA	MAYPORT	16
LOUISIANA	CHAUVIN	40	NORTH CAROLINA	SWAN QUARTER	16
TEXAS	PORT ARTHUR	40	GEORGIA	BRUNSWICK	15
TEXAS	HOUSTON	34	FLORIDA	FORT MYERS BEACH	14
FLORIDA	HERNANDO BEACH	30	FLORIDA	MIAMI	14
TEXAS	GALVESTON	30	FLORIDA	PORT CANAVERAL	13

Table 21. Top communities by number of federal RSLA and RSCZ permits (NMFS SERO Permit Office 2014).

RSLA			RSCZ		
STATE	COMMUNITY	NUMBER	STATE	COMMUNITY	NUMBER
ALABAMA	BAYOU LA BATRE	20	NORTH CAROLINA	NEW BERN	12
FLORIDA	JACKSONVILLE	7	NORTH CAROLINA	SNEADS FERRY	12
NORTH CAROLINA	BEAUFORT	7	NORTH CAROLINA	WANCHESE	7
MISSISSIPPI	PASCAGOULA	6	NORTH CAROLINA	BEAUFORT	5
FLORIDA	FERNANDINA BEACH	5	LOUISIANA	NEW ORLEANS	4
ALABAMA	IRVINGTON	4	TEXAS	PORT ISABEL	4
FLORIDA	MAYPORT	4			
NORTH CAROLINA	SWAN QUARTER	4			

3.5.3.2 State Licenses and Active Fishers

Because available data varies by state, the information and years of data presented below differ for each state. The most recent estimate on number of shrimp vessels and number of vessels by gear are described. A range or total number of licenses sold, issued, or active by state over a time series are provided to provide a sense of the fluctuation in number of participants by year. In other situations, the total number of fishers for the years 2011 through 2014 is provided. For Texas, Louisiana, Mississippi, and Alabama, state-issued commercial shrimp licenses are included by community or parish (in the case of Louisiana). For Florida, Georgia, South Carolina, and North Carolina, we include numbers of active shrimp fishers by community. Community or parish level information is provided to show the top communities or parishes which could be impacted by the proposed alternatives. Community or parish level information is presented for the year 2014 and is provided as a snapshot for the purposes of comparison with other information provided throughout the social environment section, and some community level information is presented using time series data for the years 2011 through 2014.

Texas

In 2015, the number of residential Texas state-licensed commercial shrimp vessels was estimated at 995 vessels of which all were otter trawl vessels (Table 2). From 2013 to 2015, a range of 1,561 to 1,681 residential commercial shrimp boat licenses were issued (TPWD License Data); however multiple licenses can be issued to the same vessel in a given year. As described in Section 3.1, there are 3 commercially-licensed shrimp fisheries in Texas: bay shrimp, Gulf of Mexico shrimp, and bait shrimp. Because bait shrimp vessels are allowed by TPWD to participate in the commercial bay and Gulf of Mexico shrimp fisheries, bait shrimp trawlers are required to use TEDs. Because of this requirement, bait shrimp licenses are included in the following analysis. License data for 2014 was analyzed and records with duplicate vessel identification numbers were removed, which resulted in a total of 1,080 unique resident commercial shrimp vessels (TPWD License Data). The majority of Texas resident state-licensed commercial shrimp vessels reported addresses in Texas (approximately 99.5%, TPWD License Data 2014); however, a few licenses were issued to individuals with reported addresses in Alabama, Louisiana, Mississippi, Illinois, and Massachusetts. Texas resident state-licensed commercial shrimp vessels are issued to residents of 112 communities, of which the majority are Texas communities. The majority of Texas resident state-licensed commercial vessels occur in Palacios (11% of resident state-licensed commercial shrimp vessels, Table 22), followed by Houston (7.8%) and Brownsville (7.7%).

Table 22. Top communities by number of unique Texas resident state-licensed commercial shrimp vessels (TPWD License Data 2014).

COMMUNITY	NUMBER OF VESSELS
PALACIOS	121
HOUSTON	84
BROWNSVILLE	83
PORT LAVACA	43
DICKINSON	39
PORT ARTHUR	37
ROCKPORT	34
GALVESTON	33
PORT ISABEL	29
ARANSAS PASS	28
CORPUS CHRISTI	27
BACLIFF	25
LAGUNA VISTA	25
SEADRIFT	25
TEXAS CITY	24
LEAGUE CITY	23
SAN LEON	20
LOS FRESNOS	18
NEDERLAND	18
PORT O'CONNOR	15

Louisiana

We estimated 7,187 resident commercial shrimp vessels were licensed by Louisiana in 2015 (3,651 skimmer and 2,576 otter trawl vessels, and 960 wing nets[16]) (Table 2). The number of resident shrimp fishers participating in the fisheries can be estimated through shrimp gear fees (otter trawl,

[16] The majority of Louisiana wing nets are associated with a fixed structure rather than a vessel; 680 unique individuals purchased the 960 wing net gear licenses. As vessels would typically purchase 2 licenses, this preponderance of single licenses indicate that most of the wing nets are associated with fixed structures.

skimmer trawl, or wing net license fees). LDWF reported that according to gear fee sales, the number of resident and non-resident licensed shrimp fishers in the Louisiana shrimp fishery from 2000 to 2013 has steadily declined from highs of 9,900 and 10,006 in 2000 and 2001, to a low of 5,101 in 2008, and averaging fewer than 5,600 through 2013 (LDWF 2016).

In 2014, a total of 6,663 resident state licenses for commercial shrimp vessels were sold in Louisiana, including 2,527 otter trawl, 680 wing net (see previous note about wing nets associated with fixed structures), and 3,453 skimmer trawl vessels (LDWF License Data). The majority (99.9%) of all resident state licenses for commercial shrimp were sold to residents of Louisiana parishes, though a small number of resident state licenses were sold to residents of other states. As presented in Table 23 below, most of the resident commercial shrimp licenses are held by individuals in Terrebonne Parish (approximately 21% of resident state commercial shrimp licenses), followed by Jefferson (15%) and Plaquemines (12%) Parishes.

Table 23. Top parishes by total number of resident Louisiana state commercial shrimp licenses (LDWF License Data 2014).

PARISH	NUMBER OF LICENSES
TERREBONNE	1,375
JEFFERSON	1,023
PLAQUEMINES	794
LAFOURCHE	708
ST. BERNARD	387
ST. TAMMANY	275
CALCASIEU	260
VERMILLION	211
CAMERON	195
ORLEANS	182
ST. MARY	181
IBERIA	145
ST. CHARLES	117
LAFAYETTE	105
ST. JOHN THE BAPTIST	101
TANGIPAHOA	91
JEFFERSON DAVIS	69
ACADIA	63
ST. MARTIN	49
ASCENSION	48

Most of the resident otter trawl licenses are held by those in Jefferson Parish (15.7% of resident commercial shrimp trawl licenses, Table 24), with Terrebonne (12.7%) and Lafourche (12%) following. Most of the wing net licenses are held by those residing in Terrebonne Parish (27% of resident commercial shrimp wing net licenses), with Cameron (13.7%), and Calcasieu (10.6%) following. Terrebone Parish also hosts the most skimmer trawl licenses (25% of resident commercial shrimp skimmer nets licenses), followed by Jefferson (16.7%), and Plaquemines (16%) Parishes.

Table 24. Top Louisiana parishes by license gear type and number of resident Louisiana state commercial shrimp licenses (LDWF License Data 2014).

OTTER TRAWL		WING NET		SKIMMER TRAWL	
PARISH	NUMBER	PARISH	NUMBER	PARISH	NUMBER
JEFFERSON	397	TERREBONNE	185	TERREBONNE	868
TERREBONNE	322	CAMERON	93	JEFFERSON	576
LAFOURCHE	303	CALCASIEU	72	PLAQUEMINES	552
PLAQUEMINES	207	JEFFERSON	50	LAFOURCHE	375
ST. TAMMANY	137	ST. BERNARD	37	ST. BERNARD	215
ST. BERNARD	135	PLAQUEMINES	35	ST. TAMMANY	110
IBERIA	112	LAFOURCHE	30	CALCASIEU	92
VERMILLION	111	ST. TAMMANY	28	ST. MARY	79
CALCASIEU	96	VERMILLION	21	VERMILLION	79
ORLEANS	88	LAFAYETTE	20	ORLEANS	77
ST. MARY	87	ORLEANS	17	ST. CHARLES	53
CAMERON	65	ACADIA	16	TANGIPAHOA	40
ST. JOHN THE BAPTIST	63	ST. MARY	15	CAMERON	37
LAFAYETTE	61	BEAUREGARD	7	ST. JOHN THE BAPTIST	35
ST. CHARLES	57	JEFFERSON DAVIS	7	JEFFERSON DAVIS	29
TANGIPAHOA	45	ST. CHARLES	7	IBERIA	28
ST. MARTIN	35	EAST BATON ROUGE	6	ACADIA	25
JEFFERSON DAVIS	33	TANGIPAHOA	6	LAFAYETTE	24
ASCENSION	25	IBERIA	5	ST. JAMES	21
ACADIA	22	ST. LANDRY	5	ASCENSION	20

Mississippi

As described in Table 2, in 2015, the number of residential Mississippi state-licensed commercial shrimp vessels was estimated at 474 vessels (150 skimmer, 274 otter, and 50 skimmer-otter). From 2011 to 2014, a total of 1,942 residential Mississippi state commercial shrimp licenses were sold (MDMR License Data). Mississippi resident commercial shrimp licenses are issued according to vessel size (under 30 ft, 30-45 ft, and over 45 ft). Because Mississippi commercial shrimp licenses are not issued according to gear type, and in order to present the possible universe of participants, all Mississippi resident commercial shrimp license types for the years 2011 through 2014 were summed together to present community level totals. Live bait licenses were excluded from the following analysis because a TED exemption exists for these vessels and, therefore, would not be impacted by the proposed alternatives. Records with duplicate license entries were removed which resulted in a total of 896 unique resident commercial shrimp licenses issued from 2011 through 2014 (MDMR License Data).

The majority of Mississippi resident commercial shrimp licenses are issued to those with addresses in Mississippi (approximately 99%, MDMR License Data 2011-2014); however about 10 licenses were issued to individuals with reported addresses in Alabama, Louisiana, Michigan, and Texas. Mississippi residential commercial shrimp licenses are issued to residents of 57 communities. Residents of Biloxi (approximately 16.7% of licenses, Table 25) hold the most Mississippi resident commercial shrimp licenses, followed by Ocean Springs (12%) and Bay St. Louis (11%).

Table 25. Top communities by number of Mississippi resident commercial shrimp licenses (MDMR License Data 2011-2014).

COMMUNITY	NUMBER OF VESSELS
BILOXI	150
OCEAN SPRINGS	106
BAY ST LOUIS	99
PASS CHRISTIAN	53
GULFPORT	50
MOSS POINT	47
D'IBERVILLE	44
WAVELAND	39
LONG BEACH	38
PASCAGOULA	38
VANCLEAVE	37
GAUTIER	31
KILN	22
LUCEDALE	19
SAUCIER	14
PICAYUNE	13
CARRIERE	12
PERKINSTON	9
ESCATAWPA	6
PEARLINGTON	6
WIGGINS	6

When only licenses issued for shrimp boats under 30 ft in length are considered, a total of 360 unique Mississippi resident commercial shrimp licenses were issued from 2011 through 2014 (MDMR License Data). Nearly all (99.7%) of Mississippi resident commercial shrimp licenses for boats under 30 ft in length are issued to those with addresses in Mississippi. Mississippi resident commercial shrimp licenses for boats less than 30 ft in length are issued to residents of 43 communities. Residents of Bay St. Louis (11.4% of licenses, Table 26) hold the most Mississippi resident commercial shrimp licenses for boats under 30 ft in length, followed by Ocean Springs (9.2%) and Biloxi (7.5%).

Table 26. Top communities by number of Mississippi resident commercial shrimp licenses for boats under 30 ft in length (MDMR License Data 2011-2014).

COMMUNITY	NUMBER OF VESSELS
BAY ST LOUIS	41
OCEAN SPRINGS	33
BILOXI	27
MOSS POINT	26
GULFPORT	23
PASS CHRISTIAN	22
WAVELAND	22
VANCLEAVE	16
PASCAGOULA	14
LUCEDALE	13
CARRIERE	12
LONG BEACH	12
PICAYUNE	12
KILN	11
GAUTIER	10
D'IBERVILLE	9
PERKINSTON	7
PEARLINGTON	5
SAUCIER	5
ESCATAWPA	4
HATTIESBURG	4

Alabama

As described in Table 2, in 2014, the number of residential Alabama state-licensed commercial shrimp vessels was estimated at 552 vessels. Alabama resident commercial shrimp licenses are issued and categorized according to vessel size (under 30 ft, 30-45 ft, and over 45 ft). Live bait vessels were excluded from the following analysis because a TED exemption exists for these vessels and, therefore, would not be impacted by the proposed alternatives. From 2011 to 2014, a range of 547 to 719 residential Alabama state commercial shrimp licenses were sold (ADCNR License Data). In 2014, 552 residential Alabama state commercial shrimp licenses were sold including 343 licenses for boats less than 30 ft in length (ADCNR License Data). All Alabama resident commercial shrimp licenses are issued to those with addresses in Alabama.

Alabama residential commercial shrimp licenses are issued to residents of 64 Alabama communities. Alabama residential commercial shrimp licenses for boats less than 30 ft in length are issued to residents of 58 Alabama communities. Residents of Irvington and Coden hold the most Alabama resident commercial shrimp licenses and the most Alabama resident commercial shrimp licenses for boats less than 30 ft in length (approximately 14% and 13% in Irvington and 11% and 10% in Coden, respectively, Table 27).

Table 27. Top Alabama communities by number of Alabama resident commercial shrimp licenses for all license types and boats under 30 ft in length (ADCNR License Data 2014).

COMMUNITY	TOTAL LICENSES	COMMUNITY	LICENSES < 30 FT
IRVINGTON	77	IRVINGTON	45
CODEN	61	CODEN	35
MOBILE	59	FOLEY	32
BAYOU LA BATRE	47	MOBILE	27
FOLEY	40	ELBERTA	22
GRAND BAY	31	GRAND BAY	19
THEODORE	25	THEODORE	16
FAIRHOPE	24	BAYOU LA BATRE	15
ELBERTA	23	FAIRHOPE	12
BON SECOUR	22	BAY MINETTE	9
GULF SHORES	18	BON SECOUR	9
BAY MINETTE	9	GULF SHORES	9
SUMMERDALE	9	SUMMERDALE	8
DAUPHIN ISLAND	8	DAUPHIN ISLAND	7
SPANISH FORT	7	LOXLEY	6
LOXLEY	6	DAPHNE	5
ROBERTSDALE	6	LILLIAN	5
DAPHNE	5	SILVERHILL	5
EIGHT MILE	5	SPANISH FORT	5
LILLIAN	5	CHUNCHULA	4
ORANGE BEACH	5	EIGHT MILE	4
SILVERHILL	5	ROBERTSDALE	4

Florida

As described in Table 2, in 2015, the number of residential Florida state-licensed commercial shrimp vessels was estimated at 665 vessels (1 skimmer trawl, 407 otter trawl, 103 wing net, 103 roller frame trawl, and 51 unclassified). Landings data was analyzed and fishers associated with shrimp landings through their commercial license number were included. Fishers were partitioned by the state that issued the license which appeared in the landings records. Fishers with bait shrimp landings are included which likely results in an overestimation of participation. From 2011 to 2014, a total of 939 Florida state-licensed commercial fishers were active in the shrimp fisheries. The majority of active Florida state-licensed shrimp fishers are residents of Florida (92%, ACCSP Shrimp Fishers Data), but some fishers are residents of other Gulf of Mexico states (approximately 3%), other South Atlantic states (approximately 5%), and other states (less than 1%).

Active Florida state-licensed commercial shrimp fishers are residents of 233 communities. The top community by the number of active Florida state-licensed commercial shrimp fishers is Miami (10%, Table 28), followed by Jacksonville (5%) and Hialeah (4%).

Table 28. Top communities by number of active Florida state-licensed commercial shrimp fishers (ACCSP Shrimp Fishers Data, 2011-2014).

COMMUNITY	NUMBER OF FISHERS
MIAMI	93
JACKSONVILLE	49
HIALEAH	39
APALACHICOLA	26
OAK HILL	25
PANAMA CITY	25
FORT MYERS BEACH	22
EASTPOINT	21
HUDSON	20
PENSACOLA	18
SPRING HILL	15
SOUTHPORT	14
PORT SAINT JOE	13
ATLANTIC BEACH	12
BOKEELIA	12
INGLIS	12
YULEE	12
EDGEWATER	11
NEW SMYRNA BEACH	11
TAMPA	11

East Florida

Landings data was matched to the commercial fishing licenses in order to associate fishers with fishing gear and vessel size. Fishers were partitioned by recorded state of residence and sub-region, the South Atlantic sub-region corresponds to east Florida. Fishers with bait shrimp landings were excluded from the following analysis because a TED exemption exists for these vessels and, therefore, would not be impacted by the proposed alternatives. From 2011 to 2014, a confidential number of east Florida commercial fishers used skimmer trawl gear to land shrimp (ACCSP Shrimp Vessel Landings and Fishers Data). During the same time period, 122 east Florida commercial shrimp fishers fished with wing net trawl gear and 69 fished with wing net trawl gear on vessels less than 26 ft in length. Active east Florida commercial wing net trawl fishers are residents of 23 communities. The top community by number of active east Florida commercial shrimp wing net trawl fishers is Miami (48.4%, Table 29), followed by Hialeah (26.2%) and Homestead (3.3%). Active east Florida commercial shrimp wing net trawl fishers on vessels less than 26 ft in length are residents of 17 communities. The top community by number of active east Florida commercial shrimp wing net trawl fishers on vessels less than 26 ft in length is Miami (50.7%, Table 29), followed by Hialeah (21.7%).

Table 29. Top communities by number of East Florida commercial shrimp wing net trawl fishers on all vessels and on vessels under 26 ft in length (ACCSP Shrimp Vessel Landings and Fishers Data, 2011-2014).

TOTAL WING NET		WING NET < 26 FT	
COMMUNITY	NUMBER OF FISHERS	COMMUNITY	NUMBER OF FISHERS
MIAMI	59	MIAMI	35
HIALEAH	32	HIALEAH	15
HOMESTEAD	4		
NORTH MIAMI BEACH	3		
PALMETTO BAY	3		

From 2011 to 2014, 10 east Florida commercial shrimp fishers fished with wing net trawl gear outside of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County. The top community by number of active east Florida commercial shrimp wing net fishers excluding the Biscayne Bay wing net fishery is Miami (70%, ACCSP Shrimp Vessel Landings and Fishers Data, 2011-2014). From 2011 to 2014, 8 east Florida commercial shrimp fishers fished with wing net trawl gear on vessels less than 26 ft in length outside of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County. The top community by number of active east Florida commercial shrimp wing net fishers on vessels less than 26 ft in length and excluding the Biscayne Bay wing net fishery is Miami (75%, ACCSP Shrimp Vessel Landings and Fishers Data, 2011-2014).

West Florida

Landings data was matched to the commercial license numbers of fishers in order to associate fishers with fishing gear and vessel size. Fishers were partitioned by recorded state of residence and sub-region, the Gulf of Mexico sub-region corresponds to west Florida. Fishers with bait shrimp landings were excluded from the following analysis because a TED exemption exists for these vessels and, therefore, would not be impacted by the proposed alternatives. From 2011 to 2014, 6 west Florida commercial fishers used wing net gear to land shrimp (ACCSP Shrimp Vessel Landings and Fishers Data). The majority of active west Florida wing net fishers are residents of communities along the east coast of Florida; however, addresses were not reported for some fishers and their community of residence is unknown.

Georgia

As described in Table 2, in 2015, the number of residential Georgia state-licensed commercial shrimp vessels was estimated at 208 vessels of which all were otter trawl vessels. Landings data was analyzed and fishers associated with shrimp landings through their commercial license number were included. Fishers were partitioned by the state that issued the license which appeared in the landings records. Fishers with bait shrimp landings are included which likely results in an overestimation of participation. From 2011 to 2014, a total of 236 Georgia state-licensed commercial fishers were active in the shrimp fisheries. The majority of active Georgia state-licensed shrimp fishers are residents of Georgia (approximately 82%, ACCSP Shrimp Fishers Data), but some fishers are residents of other Gulf of Mexico states (approximately 16%, including Florida), other South Atlantic states (approximately 7%, including Florida), and other states (about 1.7%).

Active Georgia state-licensed commercial shrimp fishers are residents of 73 communities. The top community by the number of active Georgia state-licensed commercial shrimp fishers is Townsend (13.6%, Table 30), followed by Darien (11.4%) and Savannah (11.4%).

Table 30. Top communities by number of active Georgia state-licensed commercial shrimp fishers (ACCSP Shrimp Fishers Data, 2011-2014).

STATE	COMMUNITY	NUMBER OF FISHERS
GEORGIA	TOWNSEND	32
GEORGIA	DARIEN	27
GEORGIA	SAVANNAH	27
GEORGIA	BRUNSWICK	20
GEORGIA	CRESCENT	7
GEORGIA	MIDWAY	6
GEORGIA	ST. MARYS	6
FLORIDA	JACKSONVILLE	5
GEORGIA	MERIDIAN	5
GEORGIA	WOODBINE	5
GEORGIA	HORTENSE	4
GEORGIA	JESUP	4
GEORGIA	RICHMOND HILL	4
GEORGIA	TYBEE ISLAND	4
GEORGIA	VALONA	4
GEORGIA	WAYNESVILLE	4
FLORIDA	FERNANDINA BEACH	3
GEORGIA	HINESVILLE	3
GEORGIA	TWIN CITY	3

South Carolina

As described in Table 2, in 2015, the number of residential South Carolina state-licensed commercial shrimp vessels was estimated at 292 vessels of which all were otter trawl vessels. Landings data was analyzed and fishers associated with shrimp landings through their commercial license number were included. Fishers were partitioned by the state that issued the license which appeared in the landings records. Fishers with bait shrimp landings are included which likely results in an overestimation of participation. From 2011 to 2014, a total of 260 South Carolina state-licensed commercial fishers were active in the shrimp fisheries. The majority of active South Carolina state-licensed shrimp fishers are residents of South Carolina (approximately 63.5%, ACCSP Shrimp Fishers Data), but a sizable number of fishers are residents of North Carolina (approximately 32.7%) and some fishers are residents of other South Atlantic states (3.5%, including Georgia and Florida).

Active South Carolina state-licensed commercial shrimp fishers are residents of 95 communities. The top community by the number of active South Carolina state-licensed commercial shrimp fishers is Georgetown (11.2%, Table 31), followed by Beaufort (7.7%) and McClellanville (5.4%).

Table 31. Top communities by number of active South Carolina state-licensed commercial shrimp fishers (ACCSP Shrimp Fishers Data, 2011-2014).

STATE	COMMUNITY	NUMBER OF FISHERS
SOUTH CAROLINA	GEORGETOWN	29
SOUTH CAROLINA	BEAUFORT	20
SOUTH CAROLINA	MCCLELLANVILLE	14
NORTH CAROLINA	SNEADS FERRY	11
NORTH CAROLINA	BEAUFORT	10
SOUTH CAROLINA	ST HELENA	10
NORTH CAROLINA	SALTER PATH	8
SOUTH CAROLINA	RIDGELAND	8
SOUTH CAROLINA	CHARLESTON	7
SOUTH CAROLINA	MT PLEASANT	6
SOUTH CAROLINA	MURRELLS INLET	6
SOUTH CAROLINA	ST HELENA ISLAND	6
NORTH CAROLINA	SUPPLY	5
SOUTH CAROLINA	BLUFFTON	5
NORTH CAROLINA	HARKERS ISLAND	4
NORTH CAROLINA	NEWPORT	4
NORTH CAROLINA	GLOUCESTER	3
SOUTH CAROLINA	AWENDAW	3
SOUTH CAROLINA	GREEN POND	3
SOUTH CAROLINA	HILTON HEAD ISLAND	3
SOUTH CAROLINA	JOHNS ISLAND	3
SOUTH CAROLINA	PAWLEYS ISLAND	3
SOUTH CAROLINA	PORT ROYAL	3
SOUTH CAROLINA	WADMALAW ISLAND	3

North Carolina

As described in Table 2, in 2014, the number of residential North Carolina state-licensed commercial shrimp vessels was estimated at 451 vessels (75 skimmer trawl and 376 otter trawl). Landings data was analyzed and fishers associated with shrimp landings through their commercial license number were included. Fishers were partitioned by the state that issued the license which appeared in the landings records. Fishers with bait shrimp landings are included which likely results in an overestimation of participation. From 2011 to 2014, a total of 743 North Carolina state-licensed commercial fishers were active in the shrimp fishery. Nearly all active North Carolina state-licensed shrimp fishers are residents of South Carolina (99.5%, ACCSP Shrimp Fishers Data), but a few fishers were residents of other states (Georgia, South Carolina, and Virginia).

Active North Carolina state-licensed commercial shrimp fishers are residents of 122 communities. The top community by the number of active North Carolina state-licensed commercial shrimp fishers is Sneads Ferry, NC (11.2%, Table 32), with Beaufort (8.1%) and Supply (5.4%) following.

Table 32. Top communities by number of active North Carolina state-licensed commercial shrimp fishers (ACCSP Shrimp Fishers Data, 2011-2014).

COMMUNITY	NUMBER OF FISHERS
SNEADS FERRY	67
BEAUFORT	60
SUPPLY	40
HARKERS ISLAND	31
WANCHESE	27
HAMPSTEAD	22
BELHAVEN	21
NEWPORT	20
MOREHEAD CITY	18
NEW BERN	16
SWANSBORO	16
ATLANTIC	15
WILMINGTON	15
CEDAR ISLAND	13
SWAN QUARTER	13
ENGELHARD	12
GLOUCESTER	12
HOLLY RIDGE	12
SEALEVEL	12
SCRANTON	11
STUMPY POINT	11

Landings data was matched to the commercial fishing licenses in order to associate fishers with fishing gear and vessel size. Fishers were partitioned by recorded state of residence. From 2011 to 2014, a total of 140 North Carolina commercial shrimp fishers fished with skimmer trawl gear. Active North Carolina commercial shrimp skimmer trawl fishers are residents of 35 recorded communities. The top community by number of active North Carolina commercial shrimp trawl fishers is Sneads Ferry (17.1%, Table 33), with Beaufort (12.9%) and Newport (8.6%) following.

Table 33. Top communities by number of North Carolina commercial shrimp skimmer trawl fishers (ACCSP Shrimp Vessel Landings and Fishers Data, 2011-2014).

COMMUNITY	NUMBER OF FISHERS
SNEADS FERRY	24
BEAUFORT	18
NEWPORT	12
SWANSBORO	11
HAMPSTEAD	9
HARKERS ISLAND	7
MOREHEAD CITY	7
SALTER PATH	6
GLOUCESTER	4
HAVELOCK	4
HOLLY RIDGE	3
JACKSONVILLE	3
WANCHESE	3

From 2011 to 2014, a total of 82 North Carolina commercial fishers fished with skimmer trawl gear on vessels less than 26 ft in length. Active North Carolina commercial shrimp skimmer trawl fishers on vessels less than 26 ft in length are residents of 23 recorded communities. The top community by number of active North Carolina commercial shrimp trawl fishers is Beaufort (17.1%, Table 34), with Sneads Ferry (15.9%) and Swansboro (11%) following.

Table 34. Top communities by number of North Carolina commercial shrimp skimmer trawl fishers on vessels under 26 ft in length (ACCSP Shrimp Vessel Landings and Fishers Data, 2011-2014).

COMMUNITY	NUMBER OF FISHERS
BEAUFORT	14
SNEADS FERRY	13
SWANSBORO	9
HAMPSTEAD	8
NEWPORT	7
HARKERS ISLAND	5
HAVELOCK	3
HOLLY RIDGE	3

3.5.3.3 Demographics

While we do not have demographics for shrimp captains and crew, we can identify a proxy for the number of vessels that may have minorities associated with the vessel by looking at surnames from the federal permit file and counting those that are Southeast Asian in their origin. This technique was first utilized in a memorandum from GMFMC Director Wayne Swingle to the Shrimp Management Committee dated March 28, 2003. In that memorandum, Dr. Swingle indicated that of the 1,836 federally-permitted shrimp vessels, 524 (or 28.7%) had owners with Southeast Asian surnames or corporate names. We conducted a similar count in 2009, which resulted in 484 out of 1,853[17] (or 26.1%) of permit owners with Southeast Asian surnames. Unfortunately, we do not know if these are active vessels and whether the crew is also of Southeast Asian ethnicity. However, this does give a rough indication of the participation rate of Southeast Asians within the Gulf of Mexico shrimp fisheries.

A similar count was completed for the South Atlantic federal shrimp permit files using 2014 data. Of the 507 federally-permitted SPA shrimp vessels, 6 (or approximately 1%) had owners with Southeast Asian surnames or corporate names. Of the 107 federally-permitted RSCZ shrimp vessels, 7 vessels (6.5%) had owners with Southeast Asian surnames. And of the 103 federally-permitted RSLA shrimp vessels, 3 vessels (approximately 3%) had owners with Southeast Asian surnames. The total number of permits provided here includes permits as of December 31, 2014, and may differ from numbers provided elsewhere in the document.

While these analyses apply to federally-permitted vessels, they suggest that a sizable percentage of Gulf of Mexico state-licensed vessels and a smaller percentage of South Atlantic state-licensed

[17] This is a snapshot of permits at one point in time and not exclusive to shrimp vessels, so numbers may vary at different points in time. This is a very rough estimate of the number of vessels with owners of Southeast Asian background. It is not a precise count of persons involved in the fisheries who may be of Southeast Asian descent or other minorities.

vessels are owned by Southeast Asian owners. Because the greatest percentage of Southeast Asian owners is located in the Gulf of Mexico, Gulf of Mexico state license files or active fisher files were analyzed using the Southeast Asian surname count technique. A count was completed for Texas resident state-licensed commercial shrimp vessels using 2014 data. Out of the 1,080 unique Texas resident commercial shrimp vessels, 337 (31.2%) had owners with Southeast Asian surnames or corporate names. A count was conducted for the Lousiana state commercial vessel license file as of August 29, 2016; however, licenses are not specific to the shrimp fisheries. Of the 48,902 Louisiana commercial vessel license records, 4,932 (approximately 10%) had owners with Southeast Asian surnames or corporate names. A count was conducted for the Mississippi state resident commercial shrimp licenses with the exclusion of bait licenses, using licenses issued from 2011 through 2014. Of the 896 unique Mississippi resident commercial shrimp licenses issued from 2011 through 2014, 258 (approximately 29%) individuals had Southeast Asian surnames. A count was completed for residential Alabama state commercial shrimp licenses with the exclusion of live bait vessels, using 2014 data. Of the 552 residential Alabama state commercial shrimp licenses sold, 19 (3.4%) had Southeast Asian surnames. A similar count was completed for active Florida-state licensed commercial shrimp fishers, using 2011 to 2014 data. Of the 939 Florida state-licensed commercial fishers that were active in the shrimp fisheries, 25 (approximately 2.7%) fishers had Southeast Asian surnames or corporate names. This methodology has not been attempted for other minority groups. It has been suggested that Hispanics make up a large portion of the crew on Gulf of Mexico shrimp vessels in Texas and possibly other states in the western Gulf of Mexico (G. Graham, GSAFF, pers. comm.). Unfortunately, we have little data on crew and are unable to calculate a credible number for that participation.

3.5.4 Environmental Justice

Executive Order 12898 requires federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. This executive order is generally referred to as Environmental Justice (EJ).

To evaluate EJ considerations, analyses were completed utilizing a suite of indices created to examine the social vulnerability of coastal communities. These indices were applied to top shrimp communities and are depicted in Figures 21 and 22. The 3 indices are poverty, population composition, and personal disruptions and were created using the 2005-2009 American Community Survey estimates at the U.S. Census Bureau (Jepson and Colburn 2013; Jacob et al. 2013). The variables included in each of these indices have been identified through the literature as being important components that contribute to a community's vulnerability. Indicators such as increased poverty rates for different groups; more single female-headed households; more households with children under the age of 5; and disruptions like higher separation rates, higher crime rates, and unemployment all are signs of populations having vulnerabilities. The thresholds of 1 and ½ standard deviation are the same for these standardized indices. Again, for those communities that exceed the threshold for all indices it would be expected that they would exhibit vulnerabilities to sudden changes or social disruption that might accrue from regulatory change. Conversely, for communities below the mean it would be expected that they would be the least vulnerable.

The vulnerability indices use normalized factor scores. Comparison of vulnerability scores is relative, but the score is related to the percent of communities with similar attributes. The social vulnerability indices provide a way to gauge change over time with these communities but also provides a comparison of one community with another.

With regard to social vulnerabilities, the following communities exceed the threshold of ½ standard deviation for at least one of the social vulnerability indices (Figures 21 and 22): Palacios, Port Isabel, Port Arthur, Brownsville, and Galveston, Texas; Chauvin, Lafitte, Abbeville, Dulac, Grand Isle, and Boothville-Venice, Louisiana; Biloxi, Mississippi; Bayou La Batre, Alabama; Brunswick, Darien, and Savannah, Georgia; and Beaufort, North Carolina. The communities of Port Isabel, Port Arthur, and Brownsville, Texas; Abbeville, Louisiana; Bayou La Batre, Alabama; and Brunswick, Georgia exceed the thresholds on all 3 social vulnerability indices. These communities have vulnerabilities and may be susceptible to effects from regulatory change depending upon the direction and extent of that change.

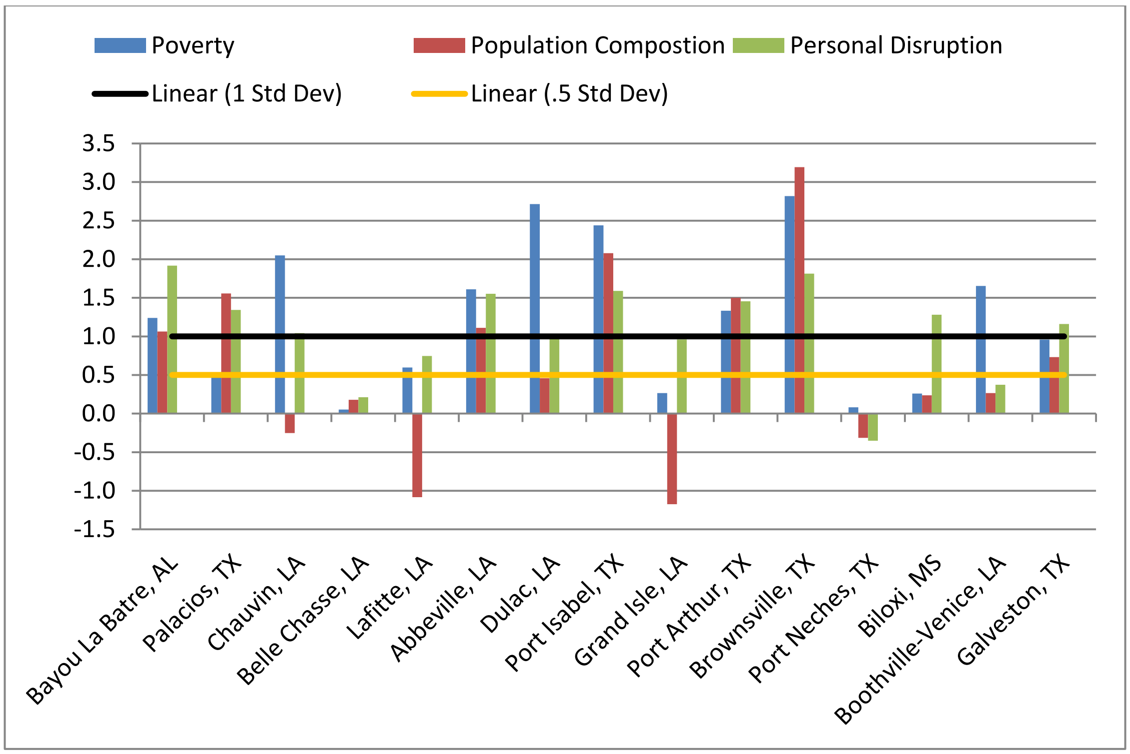

Figure 21. Social vulnerability indices for top communities ranked on pounds and value RQ for total shrimp in the Gulf of Mexico (SERO, Social Indicator Database, 2012).

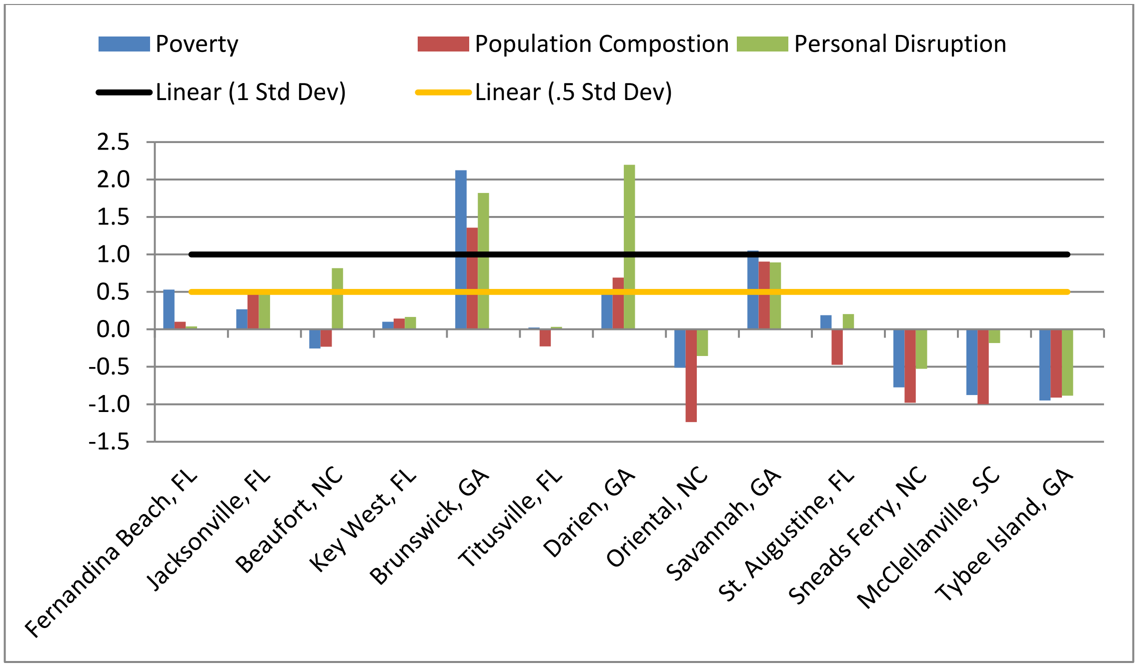

Figure 22. Social vulnerability indices for top communities ranked on pounds and value RQ for total shrimp in the South Atlantic (SERO, Social Indicator Database, 2012).

These indicators of vulnerability have been developed using secondary data at the community level. Because these types of data are not collected at the individual level by us or by other agencies, it is difficult to understand the social vulnerabilities that might exist on either a household or individual level. It is hard to recognize or attribute impacts that will directly affect individuals who are fishers or work in a related business because we do not know what those specific vulnerabilities may be. Therefore, our measure of vulnerability is a broader measure at the community level and not specific to fishers or the related businesses and their employees. Furthermore, there has been little research and relatively no data collected on subsistence fishing patterns of fishers in the Southeast U.S., and therefore impacts on subsistence fishing within the shrimp fisheries cannot be assessed.

3.6 DESCRIPTION OF THE ADMINISTRATIVE ENVIRONMENT

Under the ESA, we have the responsibility to implement programs to conserve marine life listed as endangered or threatened. Section 9 of the ESA prohibits the take (including harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting or attempting to engage in any such conduct), including incidental take, of endangered sea turtles. Pursuant to section 4(d) of the ESA, we have issued regulations extending the prohibition of take, with exceptions, to threatened sea turtles (50 CFR 223.205and 223.206). Section 11(f) of the ESA authorizes the issuance of regulations to enforce the take prohibitions. TED regulations applicable to the Southeastern U.S. shrimp fisheries are enforced through actions by our Office of Law Enforcement (OLE), the USCG, and various state authorities.

Federal fishery management is conducted under the authority of the MSA (16 U.S.C. 1801 et seq.), originally enacted in 1976 as the Fishery Conservation and Management Act. The MSA claims sovereign rights and exclusive fishery management authority over most fishery resources within the exclusive economic zone, an area extending 200 nmi from the seaward boundary of each of the coastal states, and authority over U.S. anadromous species and continental shelf resources that occur beyond the exclusive economic zone.

Responsibility for federal fishery management is shared by the Secretary of Commerce (Secretary) and 8 regional fishery management councils that represent the expertise and interests of constituent states. Regional councils are responsible for preparing, monitoring, and revising management plans for fisheries needing management within their jurisdiction. The Secretary is responsible for promulgating regulations to implement proposed plans and amendments after ensuring management measures are consistent with the MSA and with other applicable laws. In most cases, the Secretary has delegated this authority to us.

The GMFMC and SAFMC are responsible for fishery resources in federal waters of the Gulf of Mexico and South Atlantic, respectively. For the Gulf of Mexico, these waters extend to 200 nmi offshore from the 9-mile seaward boundary of the states of Florida and Texas, and the 3-mile seaward boundary of the states of Alabama, Mississippi, and Louisiana. The length of the Gulf of Mexico coastline is approximately 1,631 mi. Florida has the longest coastline of 770 mi along its Gulf of Mexico coast, followed by Louisiana (397 mi), Texas (367 mi), Alabama (53 mi), and Mississippi (44 mi). For the South Atlantic, these waters extend to 200 nmi offshore from the 3-mile seaward boundary of North Carolina, South Carolina, Georgia, and east Florida to Key West. Again, Florida has the longest coastline of 580 mi along its Atlantic coast, followed by North Carolina (301 mi), South Carolina (187 mi), and Georgia (100 mi).

The GMFMC consists of 17 voting members: 11 public members appointed by the Secretary; 1 each from the fishery agencies of Texas, Louisiana, Mississippi, Alabama, and Florida; and 1 representing us. Non-voting members include representatives of the USFWS, USCG, and Gulf States Marine Fisheries Commission. The public is also involved in the fishery management process through participation on advisory panels and through Council meetings that, with few exceptions for discussing personnel matters, are open to the public. The regulatory process is also in accordance with the Administrative Procedures Act, in the form of "notice and comment" rulemaking, which provides extensive opportunity for public scrutiny and comment, and requires consideration of and response to those comments. Similarly, the SAFMC has 13 voting members: 1 representing us; 1 each from the state fishery agencies of North Carolina, South Carolina, Georgia, and Florida; and 8 public members appointed by the Secretary. Non-voting members include representatives of the USFWS, USCG, and Atlantic States Marine Fisheries Commission.

Regulations contained within fishery management plans are enforced through actions of our OLE, the USCG, and the various state authorities. Our OLE has only 12 special agents and 3 enforcement officers in 7 duty stations (Corpus Christi, Texas; Galveston, Texas; Slidell, Louisiana; Niceville, Florida; Panama City, Florida; St. Petersburg, Florida; and Marathon, Florida) to address all agency enforcement concerns in the Gulf of Mexico region. As a result, we rely heavily on the USCG and state law enforcement agencies for patrol and monitoring enforcement services. Gulf of Mexico and South Atlantic coastal states (with the exception of North Carolina) are authorized to enforce our laws and regulations through the Cooperative Enforcement Program, and funding for patrol services related to federal laws is received through the Joint Enforcement Agreement program.

The purpose of state representation at the Council level is to ensure state participation in federal fishery management decision-making and to promote the development of compatible regulations in state and federal waters. The states are also involved through the Gulf States Marine Fisheries Commission and the Atlantic States Marine Fisheries Commission in management of marine fisheries. These commissions were created to coordinate state regulations and develop management plans for interstate fisheries. State governments have the authority to manage their respective state fisheries. Each of the states exercises legislative and regulatory authority over their respective state's natural resources through discrete administrative units. Although each agency is the primary administrative body with respect to the states' natural resources, all states cooperate with numerous state and federal regulatory agencies when managing marine resources.

More information about these agencies can be found from the following web pages:
Texas Parks and Wildlife Department - http://www.tpwd.state.tx.us
Louisiana Department of Wildlife and Fisheries - http://www.wlf.state.la.us/
Mississippi Department of Marine Resources - http://www.dmr.state.ms.us/
Alabama Department of Conservation and Natural Resources - http://www.dcnr.state.al.us/
Florida Fish and Wildlife Conservation Commission - http://www.myfwc.com
Georgia Department of Natural Resources, Coastal Resources Division - http://crd.dnr.state.ga.us/
South Carolina Department of Natural Resources - http://www.dnr.sc.gov/
North Carolina Department of Environmental and Natural Resources - http://portal.ncdenr.org/web/guest/

4 ENVIRONMENTAL CONSEQUENCES

This section provides an evaluation of the potential direct, indirect, and cumulative effects to the affected environment described in Section 3, caused by the management alternatives proposed to reduce incidental bycatch and mortality of sea turtles in the Southeastern U.S. shrimp fisheries. Expected effects on sea turtles, other protected and marine species (including critical habitat and EFH), and the shrimp fisheries are considered below.

4.1 DIRECT AND INDIRECT EFFECTS ON SEA TURTLES

As discussed throughout this DEIS, the capture of sea turtles incidental to fishing operations has been identified as a primary threat to the recovery of sea turtle populations in the Atlantic, including the Gulf of Mexico. The capture and mortality of sea turtles in bottom fishing trawl gear is well documented (e.g., Henwood and Stuntz 1987; NMFS and USFWS 1991b, 1992, 2008; NRC 1990). Although sea turtles can voluntarily remain submerged for relatively long periods of time, when forcibly submerged in fishing gear, they appear to rapidly consume oxygen stores, disturbing acid-base balance to potentially lethal levels (Lutcavage and Lutz 1997).

The ESA statutory and regulatory definitions of "take" encompass all types of interactions that may occur between fishing vessels and sea turtles. Sea turtles that encounter trawls that are equipped with functional TEDs are typically excluded without being observed, but are considered "taken" in the statutory sense. The term captured is used in the DEIS to refer to all observable sea turtle interactions, including those turtles brought on deck or observed falling from a net upon haulback. Mortalities or lethal takes are a further subset of captures. Observed captures include turtles reported as apparently uninjured, comatose, injured, or condition unknown.

Post-Interaction Mortality

Recent efforts have also examined the significance of post-interaction mortality (PIM) in sea turtles, which may occur following release due to the effects of capture or injuries sustained during the interaction. We convened a technical expert workshop consisting of sea turtle biologists, veterinarians, observer program experts, and resource managers to explore the issue and develop PIM criteria (Stacy et al. 2016). The workshop examined available information on sea turtle mortality due to various disorders and injuries that could provide insight into conditions and injuries as a result of fisheries interactions. For example, physiological effects and attendant clinical deficits associated with physical exertion and oxygen deprivation; blood loss, secondary infections, and other complications caused by traumatic injuries; and immediate and delayed consequences of drowning are not limited to fisheries interactions and are regularly encountered by veterinarians practicing in sea turtle care/treatment facilities. This combination of available studies and clinical experience provided a considerable basis for expert opinion on mortality associated with various degrees of impairment and injury observed in sea turtles that may be incidentally captured by trawl fisheries.

Observation categories of captured sea turtles include low risk of mortality (PIM 1), intermediate risk (PIM 2), high risk (PIM 3), and observed condition considered as death (PIM D). Sea turtles captured in trawl fisheries that are apparently uninjured and exhibit indications of normal behavior and activity; slight alterations in behavior or activity that may still be considered within the bounds of normal; and turtles with minor, non-life threatening traumatic injuries were determined to present a low risk of mortality (PIM 1). As skimmer trawl (as well as pusher-head trawl and wing net) fisheries occur in shallow, coastal waters and tows are relatively short (i.e., 1 hour versus 4 hours), we do not anticipate decompression sickness to be a serious PIM consideration. Therefore, we assigned a 10% PIM rate for all sea turtles determined to be at a low risk of mortality (PIM 1) captured and released in the skimmer trawl fisheries based on the PIM criteria (Stacy et al. 2016). Because otter trawling typically fishes gear longer and in deeper water on average, we assigned a 20% mortality rate for the low risk of mortality category (PIM 1) for that gear type when fished in coastal waters (i.e., state waters) analyzed in this DEIS. The remaining PIM criteria assigns a 50% mortality for intermediate risk of mortality (PIM 2), an 80% mortality for high risk of mortality (PIM 3), and 100% mortality for sea turtles determined to be dead or in a condition incompatible with survival (PIM D).

In some instances, observer notes on a captured sea turtle's condition does not provide sufficient detail to determine what PIM category should be assigned to that turtle. Notes, for example, may simply state a turtle was captured "alive, uninjured" and then "released alive." In some instances this is due to a captured turtle being released by crew before an observer has an opportunity to conduct an assessment. Due to the uncertainty on these turtles, we ran 2 analyses. In the first approach, we include all observed turtles and assign a low risk of mortality (PIM 1) for turtles that are documented to be captured alive and released alive. In the second, more conservative approach, we exclude all turtles that don't have observer notes that allow a more detailed conclusion on its condition to confidently assign PIM. As a result, this provides a range of estimated mortality for the Gulf of Mexico. Due to the small sample size (i.e., n=4) in North Carolina, we only ran a single approach utilizing all observed turtles for that skimmer trawl fishery.

Skimmer Trawls

To date, we have 4 years of observer effort on skimmer trawls in the Gulf of Mexico to provide insight related to the effects the fisheries may have on sea turtle populations. Other studies (e.g., Price and Gearhart 2011; Brown 2016) were used to determine the effects of skimmer trawls in North Carolina. We use this data to estimate CPUE and associated mortality rates because we determined it to be the best available information. Relying on otter trawl CPUE estimates, such as those used in Epperly et al. (2002), for skimmer trawl gear was deemed inappropriate due to potential gear selectivity issues between otter and skimmer trawls and a lack of observed effort in areas where skimmer trawl gear is primarily used; there was no observed otter trawl effort for inshore waters of the Western Gulf of Mexico and there was no observed otter trawl effort for any waters in the Eastern Gulf of Mexico (i.e., east of the Mississippi River) or North Carolina.

The process for calculating sea turtle bycatch estimates for skimmer trawls is described below; estimates are provided separately for the Gulf of Mexico and North Carolina skimmer trawl, pusher-head trawl, and wing net fisheries. As noted previously, skimmer trawls are used in Louisiana, Mississippi, Alabama, Florida, and North Carolina. Because Florida already requires TEDs to be used by skimmer trawls in state waters, they are excluded from this analysis; in this section we are calculating the effects of skimmer trawl fisheries operating without TEDs. Additionally, for the purposes of this analysis, pusher-head trawl and wing net vessels are included in the bycatch estimates for Gulf of Mexico skimmer trawl gear as they are included in the total non-otter trawl effort data we collect. We acknowledge that there may be differences in CPUE between these gears and skimmer trawls, but due to the lack of more detailed information we are using skimmer trawls as a proxy for pusher-head trawls and wing nets.

Observed CPUE varied greatly between observed years—likely a reflection of nesting success in prior years due to the prevalence of 1-2 year old sea turtles captured by Gulf of Mexico skimmer trawls—demonstrating that the effects of these fisheries are not static. While we provide an average CPUE and mortality estimates, this can vary significantly from year to year. For example, with anticipated increases in nesting of Kemp's ridley sea turtles, we expect to see a related increase in small sea turtles in shallow, coastal waters of the Gulf of Mexico in subsequent years. Therefore, should nesting (or skimmer trawl effort) significantly increase in future years, skimmer trawl take estimates may likewise increase.

We used observer data collected on skimmer trawls operating in the Gulf of Mexico from 2012-2015. A total of 2,699.23 hours were observed during that period. Likewise, a total of 41 sea turtles were observed captured; we excluded 2 sea turtles, however, as their condition conclusively indicated they were previously dead and did not expire due to exposure in the observed skimmer trawl. That provided a cumulative CPUE for the Gulf of Mexico skimmer trawl fisheries (39 sea turtles / 2,699.23 hours = 0.01445 turtles/hour). Using this CPUE, we extrapolated out total estimated captures in the Gulf of Mexico skimmer trawl fisheries utilizing the non-otter trawl effort for the region (0.01445 turtles/hour * 539,394 hours = 7,794 turtles). This information is presented in Table 35.

Table 35. Observed captures of sea turtles in the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries extrapolated out to estimate total sea turtle captures in the fisheries; observer effort was conducted specifically on skimmer trawls but effort was based on non-otter trawl effort, which includes the other gear types (SEFSC data).

	ESTIMATES BASED ON 2012-2015 OBSERVER EFFORT	ESTIMATES BASED ON 2011-2014 TOTAL AVERAGE EFFORT
EFFORT HOURS	2,699.23	539,394
TOTAL CAPTURES	39	7,794
CPUE (MEAN)	0.01445	0.01445

We then estimated mortalities, including PIM, based on the aforementioned PIM categories. Expert veterinarian review of the observer notes categorized the captured turtles in 1 of the 4 PIM categories based on documented condition. In the first approach, all 39 observed captures were included, while in the second approach only 25 sea turtles were categorized and 14 sea turtles were excluded due to a lack of specificity on the sea turtles' condition in the observer notes. This categorization leads to the calculation of an observed mortality rate, which was then extrapolated out using total estimated captures from Table 35 to obtain total estimated mortalities. For example, under the first approach, we determined 27 observed sea turtle captured in the Gulf of Mexico skimmer trawl fisheries were at low risk of mortality (10% PIM), 7 turtles were at moderate risk of mortality (50% PIM), 3 turtles were at high risk of mortality (80% PIM), and 2 turtles were dead (100% mortality). This results in an observed mortality rate of 0.2718 (i.e., [27 * 0.10] + [7 * 0.50] + [3 * 0.80] + [2 * 1.0] = 10.6 / 39 = 0.2718) and a total estimate of annual sea turtle mortality as a result of the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries of 2,118 turtles (0.2718 * 7,794 captures = 2,118). This information, as well as information for the second, more conservative approach ([13 * 0.10] + [7 * 0.50] + [3 * 0.80] + [2 * 1.0] = 9.2 / 25 = 0.368), is presented in Table 36. In summary, based on current average conditions (i.e., sea turtle abundance and fisheries effort), we estimate the operation of the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries are resulting in 2,118-2,868 total sea turtle mortalities per year.

Table 36. Observed mortalities of sea turtles in the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries extrapolated out to estimate total sea turtle mortalities in the fisheries. Post-interaction mortality categories include PIM 1=10% mortality, PIM 2=50% mortality, PIM 3=80% mortality, and PIM D=100% mortality.

	PIM 1	PIM 2	PIM 3	PIM D	OBSERVED MORTALITIES	TOTAL ANNUAL ESTIMATED MORTALITIES
APPROACH 1	27	7	3	2	10.6 (0.2718)	2,118
APPROACH 2	13	7	3	2	9.2 (0.368)	2,868

Likewise, we calculated captures and mortalities of sea turtles in the North Carolina skimmer trawl fishery, with estimates largely based on work conducted by NCDMF (Brown 2016). Observers documented 62 skimmer trawl trips encompassing 238 tows, which averaged 3.839 tows per trip. The study documented mean average tow time at 0.719 hours, which results in 2.76 effort hours per average trip (3.839 tows per trip * 0.719 hours per tow = 2.76 hours per trip). We excluded trips that used installed TEDs in skimmer nets, resulting in 47 observed naked net trips and 129.72 observed effort hours (2.76 hours per trip * 47 trips = 129.72 effort hours). CPUE (4 turtles / 129.72 hours = 0.03084 turtles/hour) and mortality rates (0.50) were based on 4 documented takes and 2 documented mortalities that occurred during the observed effort (4 documented takes / 2 mortalities = 0.50).

A second, earlier study (Price and Gearhart 2011) was also utilized due to concerns the NCDMF work was not reflective of actual working conditions in regards to average effort per trip. In 2010, Price and Gearheart (2011) observed 6 North Carolina skimmer boats to examine target shrimp catch retention, bycatch reduction, and TED feasibility in skimmer trawl gear. During testing, a TED was installed in 1 net, while the other was left naked (i.e., no TED installed), with the TED switched between nets daily to remove potential vessel side bias. Fishing locations and times were considered to be representative of the North Carolina skimmer trawl fishery (B. Price, NMFS, pers. comm.). Price and Gearheart (2011) observed 358 tows during 56 trips, for a total of 244.1 effort hours (J. Gearhart, NMFS, pers. comm.). No sea turtle interactions were observed in TED-equipped nets; however, 3 Kemp's ridley sea turtles were captured in naked nets. To evaluate the status quo (i.e., no TEDs in skimmer trawls) the 244.1 hours of total effort was adjusted by 50% to reflect that observed effort was only for 1 naked net, versus 2 naked nets usually fished per vessel, resulting in 122.0 adjusted vessel effort hours (244.1 total hours / 2 = 122.0). Therefore, CPUE for Kemp's ridley sea turtles based on observed take in Price and Gearheart (2011) was estimated to be 0.02459 turtles/hour (3 Kemp's ridley sea turtle captures / 122.0 effort hours = 0.02459). Based on mean observed effort per tow of 0.6818 hours and with an average of 6.3929 tows per trip, Price and Gearhart (2011) documented 4.36 hours of effort on an average observed trip. This average effort is higher than the NCDMF study, though it should be noted this study required a minimum of 6 tows per trip, which could have biased effort upwards. It was acknowledged, however, that some North Carolina skimmer trawl trips do document more effort than was reflected in the NCDMF study, as noted earlier (K. Brown, NCDMF, pers. comm.). Due to this potential difference in average trip effort, we will utilize both average effort estimates to generate a range of estimated captures and mortalities for the North Carolina skimmer trawl fishery.

Brown (2016) was a fishery characterization while Price and Gearhart (2011) was an evaluation of TED performance in the skimmer trawl fisheries. Additionally, Brown (2016) is a more recent study that observed 6.21% of total annual effort compared to 5.11% of total effort in Price and Gearhart (2011). Therefore, we believe it to be more representative of current conditions and utilize all other metrics from the former study (i.e., observed captures, CPUE, number of annual trips across the fishery, observed mortality rate incorporating PIM). Resulting estimates generated in the same manner as discussed for the Gulf of Mexico fisheries are presented in Tables 37 and 38 below (i.e., 4.36 average effort hours per trip * 1,096 total trips in study year = 4,778.56 total estimated effort hours * 0.02459 turtles/hour CPUE = 118 turtle captures for Price and Gearheart (2011) data; 4.36 average effort hours per trip * 999 total trips in study year = 4,355.64 total estimated effort hours * 0.03084 turtles/hour CPUE = 134 turtle captures using the data synthesis). In summary, based on current average conditions (i.e., sea turtle abundance and fishery effort), we estimate the operation of the North Carolina skimmer trawl fishery is resulting in 47-74 sea turtle mortalities per year (i.e., [2 * 0.10] + [2 * 1.0] = 2.2 / 4 = 0.55 mortality rate * 85 low-end captures = 47 low-end sea turtle mortalities; [2 * 0.10] + [2 * 1.0] = 2.2 / 4 = 0.55 mortality rate * 134 high-end captures = 74 high-end sea turtle mortalities).

Table 37. Observed captures of sea turtles in the North Carolina skimmer trawl fishery extrapolated out to estimate total sea turtle captures in the fishery (based on data in Price and Gearhart (2011) and Brown (2016)).

	PRICE AND GEARHART (2011)	BROWN (2016)	SYNTHESIS
OBSERVED TRIPS	56	62[18]	
OBSERVED TOWS	358	238	
OBSERVED CAPTURES	3	4	4
AVERAGE EFFORT HOURS PER TRIP	4.36	2.76	4.36
TOTAL SKIMMER TRAWL TRIPS IN STUDY YEAR	1,096	999	999
TOTAL ESTIMATED EFFORT HOURS IN NC SKIMMER FISHERY	4,778.56	2,757.24	4,355.64
OBSERVED CPUE	0.02459[19]	0.03084	0.03084
ANNUAL TOTAL CAPTURES	118	**85**	**134**

Table 38. Observed mortalities of sea turtles in the North Carolina skimmer trawl fishery extrapolated out to estimate total sea turtle mortalities in the fishery. Post-interaction mortality categories include PIM 1=10% mortality, PIM 2=50% mortality, PIM 3=80% mortality, and PIM D=100% mortality.

	PIM 1	PIM 2	PIM 3	PIM D	OBSERVED MORTALITIES	TOTAL ANNUAL ESTIMATED MORTALITIES
APPROACH 1	2	0	0	2	2.2 (0.55)	47-74

4.1.1 Effects of Alternative 1: No Action

The ongoing effects to sea turtles as a result of the shrimp fisheries, as discussed in the preceding sections, would continue to affect sea turtle populations. In summary, we estimate the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries result in 2,118-2,868 sea turtle mortalities annually given current parameters and the North Carolina skimmer trawl fishery results in 47-74 sea turtle mortalities. We have no new information to accurately quantify the effects of the otter trawl fisheries on small turtles. As noted in the 2014 biological opinion for the shrimp fisheries (NMFS 2014), “we could not reliably determine actual take numbers for sea turtle species adversely affected by the U.S. Southeast shrimp fisheries.” The way the otter trawl fisheries operate with TEDs introduces significant issues in evaluating effects to sea turtles under the status quo, as the vast majority of interactions can’t be directly observed (i.e., sea turtle being excluded from the trawl via a TED underwater). Regardless, as this alternative would not change how the fisheries operate, we anticipate any currently existing effects to continue into the future, and potentially increase as sea turtle populations continue to recover. Therefore, we predict the no action alternative would have the greatest potential for negative effects to sea turtles.

4.1.2 Effects of Alternative 2: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

[18] Only 47 observed tows did not use TEDs.
[19] Adjusted to reflect TED use on one side of the skimmer vessel.

This alternative would amend the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and only apply to vessels less than 26 ft in length, thereby requiring vessels 26 ft and greater in length employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs in their nets. The alternative tow time restrictions specify tow times are not to exceed 55 minutes from April 1 through October 31, and 75 minutes from November 1 through March 31 (50 CFR 223.206(d)(3)(i)(A) and (B)).

We anticipate the use of TEDs by vessels 26 ft and greater in length using skimmer trawls, pusher-head trawls, and wing nets will reduce the incidental bycatch and mortality of sea turtles by those vessels. This will aid in the recovery of threatened and endangered sea turtle populations. To determine the potential effects of this alternative, we first calculate the effects of TED use on sea turtle populations across the entire skimmer trawl, pusher-head trawl, and wing net fisheries. The following tables calculate sea turtle take based on TED use in the skimmer trawl, pusher-head trawl, and wing net fisheries. We utilize the Gulf of Mexico sea turtle capture estimates in Table 35, which become interactions in a trawl net equipped with a TED. That is, we anticipate the same number of turtles to encounter or enter a TED-equipped net compared to a trawl under the status quo (i.e., naked net), but due to the installed TEDs a significant proportion of those turtles escape and are not captured. Captures in a TED-equipped trawl net are primarily a result of poor TED compliance, which impacts the effectiveness of a TED to exclude sea turtles. Therefore, we need to take into account the effect of TED violations on sea turtle capture rates and total mortalities. We anticipate initial TED effectiveness in the skimmer trawl fisheries to be low. As fishers learn how to effectively and efficiently fish with TEDs, however, we expect compliance and TED effectiveness to increase over time. To take into consideration the anticipated differential TED effectiveness rates, we utilize a low TED effectiveness rate of 81% for the initial period of use. This rate corresponds to low compliance observed in the otter trawl fisheries in early 2014. Yet, the otter trawl fisheries have been exposed to required TED use for a significant period of time (i.e., decades), so this rate may overestimate actual TED effectiveness when initially used in the skimmer trawl fisheries. This initial estimate is not offered as a high-precision metric. Instead, it is presented to demonstrate the potential effects of this alternative on sea turtle populations will not be instantaneous, but will increase over time.

Based on initial TED effectiveness of 81%, we anticipate that the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries will result in 1,481 captures (7,794 interactions * 0.19 = 1,481) and 1,362-1,378 total mortalities using the Gulf of Mexico inshore/nearshore trawl retention mortality rate of 88.99% from Epperly et al. (2002) enhanced by the PIM approaches discussed in Section 4.1. While the mortality rates in Epperly et al. (2002) are for otter trawls, we believe, in the absence of other information, these rates represent the best available information and insight into how skimmer trawls would operate with TEDs and no tow times. This results in a range based on PIM approach of 1,362-1,378 sea turtle mortalities assuming low TED compliance (i.e., 1,481 captures * 0.8899 = 1,318 mortalities; 1,481 captures - 1,318 mortalities = 163 released turtles * 0.2718 Approach 1 PIM rate = 44 PIM turtles + 1,318 initial mortalities = 1,362 total turtle mortalities; and 1,481 captures * 0.8899 = 1,318 mortalities; 1,481 captures - 1,318 mortalities = 163 released turtles * 0.368 Approach 2 PIM rate = 60 PIM turtles + 1,318 initial mortalities = 1,378 total turtle mortalities) and a potential reduction of 756-1,490 sea turtle mortalities in the Gulf of Mexico over the status quo (2,118 status quo mortalities - 1,362 mortalities under Approach

1 PIM rate = 756 turtles; and 2,868 status quo mortalities - 1,378 mortalities under Approach 2 PIM rate = 1,490 turtles).

Assuming average TED compliance increases to the degree currently observed in the otter trawl fisheries (i.e., 94% TED effectiveness), the subsequent number of mortalities will decrease to 430-435 sea turtles, resulting in a corresponding reduction of 1,688-2,433 sea turtle mortalities in the Gulf of Mexico compared to the status quo (i.e., 2,118 low-end status quo sea turtle mortalities - 430 low-end sea turtle mortalities at 94% TED effectiveness = 1,688 difference in sea turtle mortalities; 2,868 high-end status quo sea turtle mortalities - 435 high-end sea turtle mortalities at 94% TED effectiveness = 2,433 difference in sea turtle mortalities). This information is presented in Table 39 below for the Gulf of Mexico fisheries and Table 40 for the North Carolina fishery (i.e., 47 low-end status quo sea turtle mortalities - 5 low-end sea turtle mortalities at 94% TED effectiveness = 42 difference in sea turtle mortalities; 74 high-end status quo sea turtle mortalities - 7 high-end sea turtle mortalities at 94% TED effectiveness = 67 difference in sea turtle mortalities); a 73.03% north inshore trawl retention mortality rate from Epperly et al. (2002) was used for the North Carolina fishery.

Table 39. Estimated mortalities and conservation benefit to sea turtles over the status quo in the Gulf of Mexico skimmer trawl, pusher-head trawl, and wing net fisheries. Captures in a naked net fishery become interactions in a TED-equipped fishery. Subsequent captures in a TED-equipped fishery are based on TED compliance; with 81% effectiveness, 19% of sea turtle interactions become captures (7,794 interactions * 0.19 = 1,481 captures). Mortality of captured turtles is based on GOM inshore/nearshore rate of 88.99% from Epperly et al. (2002). We anticipate additional dead sea turtles due to PIM (e.g., 1,481 captures - 1,318 mortalities = 163 released turtles * 0.2718 approach 1 PIM rate = 44 PIM turtles + 1,318 initial mortalities = 1,362 total turtle mortalities), which are reflected in the change from the status quo estimates in the last column.

TOTAL AVERAGE INTERACTIONS IN TED-EQUIPPED SKIMMER TRAWLS	7,794			
	CAPTURES	MORTALITIES	WITH PIM	Δ STATUS QUO
BASED ON ASSUMED INITIAL TED COMPLIANCE (81%)	1,481	1,318	1,362-1,378	**756-1,490**
BASED ON ASSUMED EVENTUAL TED COMPLIANCE (94%)	468	416	430-435	**1,688-2,433**

Table 40. Estimated mortalities and conservation benefit to sea turtles over the status quo in the North Carolina skimmer trawl fishery. Captures in a naked net fishery become interactions in a TED-equipped fishery. Subsequent captures in a TED-equipped fishery are based on TED compliance; with 81% effectiveness, 19% of sea turtle interactions become captures (e.g., 85 interactions * 0.19 = 16 captures). Mortality of captured turtles is based on Atlantic north inshore rate of 73.03% from Epperly et al. (2002). We anticipate additional dead sea turtles due to PIM (e.g., 16 captures - 12 mortalities = 4 released turtles * 0.55 PIM rate = 2 PIM turtles + 12 initial mortalities = 14 total turtle mortalities), which are reflected in the change from the status quo estimates in the last column.

TOTAL AVERAGE INTERACTIONS IN TED-EQUIPPED SKIMMER TRAWLS	85-134			
	CAPTURES	MORTALITIES	WITH PIM	Δ STATUS QUO
BASED ON ASSUMED INITIAL TED COMPLIANCE (81%)	16-25	12-18	14-22	**33-52**
BASED ON ASSUMED EVENTUAL TED COMPLIANCE (94%)	5-8	4-6	5-7	**42-67**

Adding the changes from the status qou colums from Tables 39 and 40, the above analyses conclude that a TED requirement for all vessels participating in the Gulf of Mexico and North

Carolina skimmer trawl, pusher-head trawl, and wing net fisheries could reduce sea turtle mortalities from those currently occurring under the status quo by 789-1,543 in the near term and 1,730-2,500 after TED compliance rises to final anticipated levels. We now need to consider the effect of exempting skimmer trawl, pusher-head trawl, and wing net vessels under 26 ft in length, which we estimate to be 2,734 vessels out of 5,837 total non-otter trawl vessels (Table 45; 5,837 total vessels - 3,103 non-otter trawl vessels 26 ft and greater in length = 2,734 exempted vessels).

Generally, shrimp vessels less than 26 ft in length are outboard powered and primarily fish in shallower waters within the upper estuary (LDWF 2016). Because of their limited size and capabilities, we anticipate these vessels take fewer (i.e., due to weather considerations) and shorter (i.e., due to limited space and accommodation for overnight or extended trips) trips than larger vessels. Furthermore, anecdotal information indicates some recreational fishers obtain commercial shrimp gear licenses enhance their catch for personal consumption or other recreational purposes. Therefore, we expect a potential for an effort differential, which would translate to a differential in sea turtle interactions and mortalities between vessels of varying sizes. These conclusions are supported when looking at the landings between the size classes (i.e., < 26 ft in length and >/= 26 ft in length) (Table 41). That is, while this alternative would allow 2,734 vessels less than 26 ft in length to continue to operate (and require 3,103 vessels to install and use TEDs designed to exclude small turtles in their nets), these small vessels only account for 12.61% of landings in the Gulf of Mexico and 20.49% of landings in the South Atlantic (Table 41). As we don't have more explicit effort data by size class, we believe that landings can be utilized as a proxy for effort. Therefore, we multiplied the total estimated change from the status quo (Tables 39 and 40) by the percentage of landings/effort to obtain the estimated range of turtle mortalities assocated with vessels at least 26 ft in length for both the Gulf of Mexico and South Atlantic. This resulted in 1,475 (1,688 * 0.8739) to 2,126 (2,433 * 0.8739) Gulf of Mexico sea turtle mortalities and 33 (42 * 0.7951) to 53 (67 * 0.7951) South Atlantic sea turtle mortalities attributable to vessels at least 26 ft in length. The resulting calculations (1,475 Gulf of Mexico sea turtles + 33 South Atlantic sea turtles = 1,508 total sea turtles; 2,126 Gulf of Mexico sea turtles + 53 South Atlantic sea turtles = 2,179 total sea turtles) indicate that exempting vessels under 26 ft in length in the skimmer trawl, pusher-head trawl, and wing net fisheries would still result in a potential conservation benefit of 1,508-2,179 sea turtles based on high (94%) TED effectiveness.

Table 41. Summary of landings by vessel and vessel size as a proxy for effort under Alternatives 2 and 3.

	GULF OF MEXICO				SOUTH ATLANTIC			
	VESSELS	LANDINGS	PERCENT	SEA TURTLES	VESSELS	LANDINGS	PERCENT	SEA TURTLES
ALTERNATIVE 3	5,660	61,406,340	100	1,688-2,433	177	1,617,282	100	42-67
ALTERNATIVE 2	3,032	53,663,653	87.39	1,475-2,126	71	1,285,964	79.51	33-53
< 26'	2,628	7,742,687	12.61	213-307	106	331,318	20.49	9-14

We know there may be other vessels 26 ft in length and greater not outfitted with power or mechanical-advantage trawl retrieval system (i.e., nets recovered by hand) that could still employ tow times in lieu of TEDs under the exemption at 50 CFR 223.206(d)(2)(ii)(A)(*1*). Sea turtles may still be captured by these vessels. At this time, we don't have sufficient information necessary to determine the significance of these other vessels. But we believe the above estimates provide accurate insight into the effects of this alternative on sea turtle populations.

This alternative would potentially result in direct beneficial effects for listed sea turtles. The rationale for this alternative is that past assumptions on skimmer trawl fisheries, specifically that skimmer boats retrieved their nets at intervals that would not be fatal to any sea turtles that were captured in the net, are no longer valid. This could be due to either: (1) current tow time requirements may be too long, and sea turtles, particularly small sea turtles, may be more sensitive to submergence than previously thought (Sasso and Epperly 2006); (2) increased sea turtle abundance (see Section 3.2.3) has resulted in repeated incidental bycatch exposure that is proving fatal for a significant number of turtles; (3) sea turtles may be getting trapped in pockets of netting in skimmer trawls that are not easily observed during fishing operations; or (4) skimmer trawlers may be working in areas that don't require regular dumping of their nets (e.g., clean bottom absent of debris) and, therefore, they exceed tow time requirements.

This alternative focuses on the portions of the skimmer trawl fisheries operating larger vessels that have the ability to more easily operate in deeper water (compared to smaller vessels). Information obtained during the scoping period for the 2012 DEIS indicate many small skimmer trawl vessels in Louisiana operate in shallow waters (e.g., 4-5 ft) of bays and lakes where sea turtles may not be expected to be as abundant as openwater estuaries and in deeper channels. The average length of the 3 Louisiana skimmer vessels that participated in Scott-Denton et al. (2006) was 39.7 ft, and the average tow depth averaged 7.8 ft (+/- 1.2 ft s.d.). Subsequent observer effort in 2012-2014 was also focused on moderate-length skimmer trawl vessels (2012: 26-55 ft; 2013: 38-61 ft; and 2014: 37-58 ft) fishing in deeper water on average (2012: 9.6 ft; 2013: 12.6 ft; and 2014: 11.4 ft).

In summary, Alternative 2 would potentially reduce fisheries bycatch and mortality of 1,509-2,179 sea turtles annually in the Southeastern U.S. shrimp fisheries in the long term. We don't anticipate these benefits to accrue to this level until the affected fishers learn to effectively utilize TEDs in their nets and TED compliance rises to the levels we currently observe in the otter trawl fisheries. Additionally, this anticipated conservation benefit may change should the abundance of sea turtles—particularly small sea turtles—significantly vary; for instance, we expect the conservation benefit to increase should nesting of Kemp's ridley sea turtles continue to improve in the future, resulting in a greater abundance of small sea turtles in shallow, coastal waters of the Northern Gulf of Mexico. The anticipated conservation benefits resulting from this alternative are obviously greater than the status quo (Alternative 1), but less than that expected from Alternatives 3 and 5-7. The conservation benefit of this alternative is also greater than that offered by Alternative 4, but is not significantly greater.

4.1.3 Effects of Alternative 3 (Preferred Alternative): Amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

This alternative would withdraw the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*), thereby requiring vessels employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs in their nets. We anticipate the use of TEDs by all skimmer trawls, pusher-head trawls, and wing nets will reduce the incidental bycatch and mortality of sea turtles by those vessels. This will aid in the recovery of threatened and endangered sea turtle populations. Yet, we know that some percentage of vessels, particularly small vessels, included in this alternative may not be outfitted with power or mechanical-advantage trawl retrieval system (i.e., nets recovered by hand) and, therefore, could still employ tow times in lieu of TEDs under the exemption at 50 CFR 223.206(d)(2)(ii)(A)(*1*). Due to a lack of specific vessel information, however, we are unable to quantify the number of vessels that could still operate without TEDs under this exemption. Therefore, conclusions on potential sea turtle conservation benefit by requiring all vessels to use TEDs may by overestimated to some degree.

We previously calculated the effect of requiring TEDs in all 5,837 skimmer trawls, pusher-head trawls, and wing nets in Section 4.1.2. That analysis concluded that a TED requirement in the Gulf of Mexico and North Carolina skimmer trawl, pusher-head trawl, and wing net fisheries could reduce annual sea turtle mortalities from those currently occurring under the status quo by 789-1,543 in the near term and 1,730-2,500 after TED compliance rises to final anticipated levels. This alternative provides a greater conservation benefit to sea turtles than Alternatives 1-2 and 4-5, but less conservation benefit than Alternatives 6-7.

4.1.4 Effects of Alternative 4: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls to use TEDs designed to exclude small turtles

This alternative would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require all skimmer trawl vessels 26 ft and greater in length to use TEDs designed to exclude small turtles in their nets. While similar to Alternative 2, this alternative is specific only to skimmer trawls. Alternative 4 would also not impact the existing exemption for vessels operating without any power or mechanical-advantage trawl retrieval system at 50 CFR 223.206(d)(2)(ii)(A)(*1*). The vast majority of non-otter trawl shrimp vessels (i.e., currently operating without required TEDs) are comprised of skimmer trawlers. In the Gulf of Mexico 93.80% of the non-otter trawl landings are attributed to skimmer trawls, while that percentage is 98.18% for the South Atlantic (Table 42). Similar to the approach utilized for Alternative 2, we use landings as a proxy for effort. We estimate there are 5,432 total active skimmer trawl vessels in the Southeastern U.S. shrimp fisheries, and 2,519 of those vessels are anticipated to be under 26 ft in length. These small skimmer trawl vessels accounted for 12.11% of total non-otter trawl landings in the Gulf of Mexico and 19.26% of the non-otter trawl landings in the South Atlantic (Table 42). Therefore, we multiplied the total estimated change from the status quo (Tables 39 and 40) by the percentage of landings/effort to obtain the estimated range of turtle mortalities assocated with skimmer vessels at least 26 ft in length for both the Gulf of Mexico and South Atlantic. This resulted in 1,379 (1,688 * 0.8168) to 1,987 (2,433 * 0.8168) Gulf of Mexico sea turtle mortalities and 33 (42 * 0.7891) to 53 (67 * 0.7891) South Atlantic sea turtle mortalities attributable to skimmer vessels at least 26 ft in length. The resulting calculations (1,379 Gulf of Mexico sea turtles + 33 South Atlantic sea turtles = 1,412 total sea turtles; 1,987 Gulf of Mexico sea turtles + 53 South Atlantic sea turtles = 2,040 total sea turtles) indicate that exempting skimmer trawl vessels under 26 ft in length would result in a potential conservation benefit of 1,412-2,040 sea turtles based on high (94%) TED effectiveness.

Table 42. Summary of landings by vessel and vessel size as a proxy for effort under Alternatives 3-5.

	GULF OF MEXICO				SOUTH ATLANTIC			
	VESSELS	LANDINGS	PERCENT	SEA TURTLES	VESSELS	LANDINGS	PERCENT	SEA TURTLES
ALTERNATIVE 3	5,660	61,406,340	100	1,688-2,433	177	1,617,282	100	42-67
ALTERNATIVE 5	5,269	57,598,263	93.80	1,583-2,282	163	1,587,790	98.18	41-66
ALTERNATIVE 4	2,847	50,159,146	81.68	1,379-1,987	66	1,276,257	78.91	33-53
< 26'	2,422	7,439,117	12.11	204-295	97	311,533	19.26	8-13

This alternative would require the 2,913 skimmer trawl vessels 26 ft in length and greater to use TEDs designed to exclude small turtles from their nets. Similar to the discussion for Alternative 2, however, we know there may be other vessels 26 ft in length and greater not outfitted with power or mechanical-advantage trawl retrieval system (i.e., nets recovered by hand) that could still employ tow times in lieu of TEDs under the exemption at 50 CFR 223.206(d)(2)(ii)(A)(*1*). Sea turtles may still be captured by these vessels.

In summary, Alternative 4 would potentially reduce fisheries bycatch and mortality of 1,412-2,040 sea turtles annually in the Southeastern U.S. shrimp fisheries in the long term. We don't anticipate these benefits to accrue to this level until the affected fishers learn to effectively utilize TEDs in their nets and TED compliance rises to the levels we currently observe in the otter trawl fisheries. Additionally, this anticipated conservation benefit may change should the abundance of sea turtles—particularly small sea turtles—significantly vary; for instance, we expect the conservation benefit to increase should nesting of Kemp's ridley sea turtles continue to improve in the future, resulting in a greater abundance of small sea turtles in shallow, coastal waters of the Northern Gulf of Mexico. The anticipated conservation benefits resulting from this alternative are obviously greater than the status quo (Alternative 1), but less than that expected from Alternatives 2-3 and 5-7. The conservation benefit, however, is relatively close (94%) to that offered by Alternative 2.

4.1.5 Effects of Alternative 5: Amend the existing TED regulations to require all vessels using skimmer trawls to use TEDs designed to exclude small turtles

Alternative 5 would amend the existing TED exemption at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require the use of TEDs designed to exclude small turtles in all skimmer trawl nets. Small skimmer trawls that operate without any power or mechanical-advantage trawl retrieval system (i.e., any device used to haul any part of the net aboard) would still be allowed to employ alternative tow times per the exemption at 50 CFR 223.206(d)(2)(ii)(A)(*1*). Due to a lack of specific vessel information, however, we are unable to quantify the number of vessels that could still operate without TEDs under this exemption. Therefore, conclusions on potential sea turtle conservation benefit by requiring all skimmer trawl vessels to use TEDs may by overestimated to some degree.

Similar to the analyses for the previous alternatives, we employ landings as a proxy for effort. We previously estimated there are 5,432 total active skimmer trawl vessels in the Southeastern U.S. shrimp fisheries, which account for 93.80% of the non-otter trawl landings in the Gulf of Mexico and 98.18% of the landings in the South Atlantic (Table 42). Similar to the approach utilized for Alternative 2, we use landings as a proxy for effort. Therefore, we multiplied the total estimated change from the status quo (Tables 39 and 40) by the percentage of landings/effort to obtain the estimated range of turtle mortalities assocated with all skimmer vessels for both the Gulf of Mexico and South Atlantic. This resulted in 1,583 (1,688 * 0.9380) to 2,282 (2,433 * 0.9380) Gulf of Mexico sea turtle mortalities and 41 (42 * 0.9818) to 66 (67 * 0.9818) South Atlantic sea turtle mortalities attributable to skimmer vessels at least 26 ft in length. We estimate this alternative would potentially reduce fisheries bycatch and mortality of 1,624-2,348 sea turtles (1,583 Gulf of Mexico sea turtles + 41 South Atlantic sea turtles = 1,624 total sea turtles; 2,282 Gulf of Mexico sea turtles + 66 South Atlantic sea turtles = 2,348 total sea turtles) once TED compliance rises to levels we currently observe in the otter trawl fisheries (94% effectiveness). The anticipated conservation benefits resulting from this alternative are greater than the status quo (Alternative 1) and those alternatives that exempt small vessels (i.e., Alternatives 2 and 4), but less than that expected from Alternatives 3 and 6-7. As the majority of non-otter trawl landings/effort is attributed to skimmer trawls, however, the conservation benefit is relatively close (94%) to that offered by Alternative 3 (Preferred Alternative).

4.1.6 Effects of Alternative 6: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers fishing within state waters

This alternative would remove the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*), thereby requiring all vessels employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs designed to exclude small turtles in their nets. Additionally, all otter trawlers operating in state waters would also have to utilize TEDs designed to exclude small turtles in their nets. Trawlers operating under other existing exemptions from the TED requirements (e.g., trawlers that operate without any power or mechanical-advantage trawl retrieval system under 50 CFR 223.206(d)(2)(ii)(A)(*1*) or trawlers using a single try net under 50 CFR 223.206(d)(2)(ii)(A)(*5*)), however, would not be affected by this alternative.

As noted in Section 4.1.1, we are unable to reliably quantify sea turtle take for otter trawlers equipped with currently authorized TEDs. Therefore, it is not possible to quantify the potential reduction in sea turtle bycatch mortality as a result of this alternative beyond what has already been conducted for the skimmer trawl, pusher-head trawl, and wing net fisheries. In part, this is due to the fact that otter trawlers are currently required to utilize TEDs in their nets, albeit with 4-in bar spacing. As a result, they are excluding a significant proportion of sea turtles that enter the trawl net. While we know it is possible otter trawlers working in state waters will encounter small/juvenile turtles that could pass through the currently required 4-in bar spacing in their nets, we don’t have adequate spatially-explicit data on otter trawl effort in state waters, reliable CPUE estimates for this segment of the fisheries, or abundance/density information of small turtles in state waters that would allow us to calculate overlap and quantifiably estimate effects of this alternative. For example, there are only 8 fishery observer records of small sea turtles passing through the bars of currently-required TEDs on otter trawlers operating in Gulf of Mexico state waters from 2008-2015 (Stokes and Gearhart 2016). There are no fishery observer records of small turtles passing through the bars of otter trawlers in state or federal waters in the South Atlantic. As otter trawlers operating in state waters fish in different areas and in deeper water on average as compared to skimmer trawlers, it would be inappropriate and misleading to use skimmer trawl CPUE estimates or size information from sea turtles captured in the skimmer trawl fisheries as a proxy for otter trawlers fishing in state waters.

Below, however, we explore available information to provide insight on the potential effects of this alternative beyond that considered in Alternative 3 (Preferred Alternative) as discussed in Section 4.1.3. First, we try to estimate shrimp fisheries effort in state waters. This has not been attempted before; water depth in fathoms has been one of the key data elements recorded in reports. Effort in the Gulf of Mexico has been further binned in statistical areas (Figure 23) that do not correspond to state boundaries, further complicating matters.

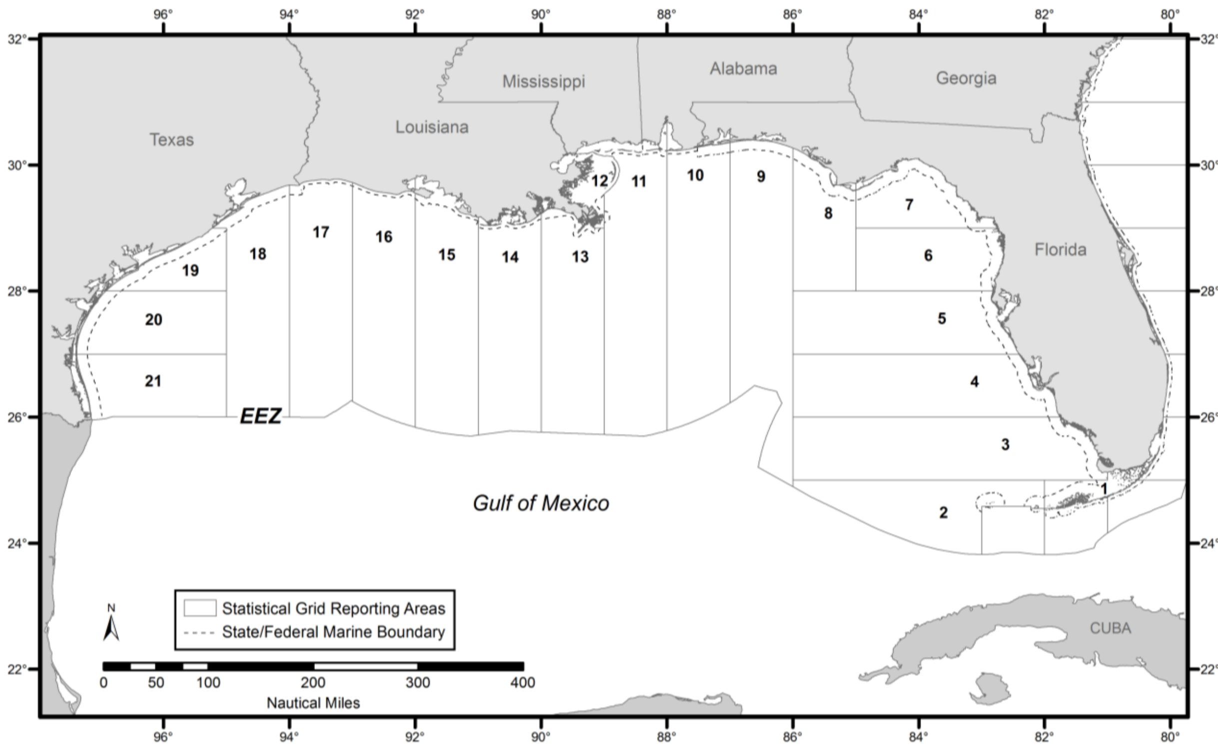

Figure 23. Gulf of Mexico fishery statistical reporting areas.

In order to provide insight into effort occurring in state waters of the Gulf of Mexico, estimated effort were proportioned into proxy effort values (B. Ponwith memorandum to M. Barnette, NMFS, September 28, 2016). The 4 currently utilized depth strata (i.e., inshore, 0-10 fm, 10-30 fm, and >30 fm) were evaluated in ArcGIS to partition effort in areas that shared both state and federal waters. One of the critical assumptions made in calculating these estimates was that effort was uniformly distributed across area. This assumption was made due to the absence of better, spatially-discrete effort information; however, we don't have great confidence in the accuracy of this approach. The resulting estimates were summed for the corresponding areas (i.e., state and federal waters) and are presented in Table 43, which demonstrates that approximately 48% of all shrimp fishing effort occurs in state waters based on the aforementioned assumption used to partition the one effort area (i.e., 0-10 fm) that encompasses both state and federal waters. A significant portion of the total estimated state effort, however, is attributed to skimmer trawl effort. Average Gulf of Mexico skimmer trawl effort during 2011-2014 was 539,394 hours or 22,475 days

(539,394 hours / 24 hours/day = 22,474.75 days). This corresponds to approximately 41.37% of total effort in Gulf of Mexico state waters (22,475 skimmer trawl days / 54,321 all gear combined days = 0.41374). Therefore, this alternative may have some additional beneficial effects on sea turtle populations (i.e., compared to Alternatives 3 and 5) by reducing the incidental bycatch and mortality in state waters by otter trawlers. Any benefit would likely be greater in states with larger proportion of otter trawl effort compared to skimmer trawls (e.g., Texas and Florida). Due to the lack of information on small/juvenile sea turtle densities in state waters and CPUE differences of small turtles in otter trawls with currently-authorized TEDs with 4-in bar spacing compared to proposed TEDs with 3-in bar spacing we are unable to quantify those benefits.

Table 43. Gulf of Mexico shrimp fisheries effort in state waters and total including EEZ (24-hour days).

YEAR	STATISTICAL AREAS 1-9		STATISTICAL AREAS 10-12		STATISTICAL AREAS 13-17		STATISTICAL AREAS 18-21		TOTAL	
	STATE	TOTAL	STATE	TOTAL	STATE	TOTAL	STATE	TOTAL	STATE	TOTAL
2011	3,907	9,339	12,570	17,204	42,295	72,535	3,903	22,727	62,675	121,805
2012	404	4,959	11,399	17,235	39,606	74,434	5,770	20,456	57,178	117,085
2013	3,494	8,481	8,689	14,860	34,241	62,960	4,735	21,429	51,160	107,730
2014	867	4,173	3,611	9,092	30,309	63,833	11,484	32,220	46,270	109,317
AVERAGE	**2,168**	**6,738**	**9,067**	**14,598**	**36,613**	**68,441**	**6,473**	**24,208**	**54,321**	**113,984**
% STATE WATERS	**32.18**		**62.11**		**53.50**		**26.74**		**47.66**	

In contrast, the proportion of state shrimp fisheries effort is higher in the South Atlantic than the Gulf of Mexico (Table 44). Further, otter trawls are the primary gear in the South Atlantic, with the exception of North Carolina, which permits skimmer trawls. Stokes and Gearhart (2016), however, indicate average body depth for Kemp's ridley and green sea turtles is greater for the South Atlantic than the Gulf of Mexico. And as previously mentioned, there are no observer reports of small turtles passing through the bars of currently-required TEDs (i.e., maximum 4-in bar spacing) in the South Atlantic. This lack of observer reports does not necessarily indicate an absence of small/juvenile sea turtles in the South Atlantic region (state or federal waters), just that we have no available observer data with which we can base any conclusions or assumptions.

Table 44. South Atlantic shrimp fisheries effort in state waters and total including EEZ (number of trips).

YEAR	FLORIDA		GEORGIA		SOUTH CAROLINA		NORTH CAROLINA		TOTAL	
	STATE	TOTAL	STATE	TOTAL	STATE	TOTAL	STATE	TOTAL	STATE	TOTAL
2011	810	2,745	1,307	1,935	3,125	3,172	3,038	4,354	8,280	12,206
2012	835	2,586	914	1,909	3,833	4,203	4,471	6,176	10,053	14,874
2013	549	1,717	548	1,295	2,667	3,176	3,954	5,486	7,718	11,674
2014	795	2,069	683	1,584	2,900	3,145	3,314	4,400	7,692	11,198
AVERAGE	**747**	**2,280**	**863**	**1,681**	**3,694**	**5,104**	**3,131**	**3,424**	**8,436**	**12,488**
% STATE WATERS	**32.76**		**51.33**		**72.37**		**91.44**		**67.55**	

Because we do not believe small sea turtle densities are consistent across all waters (state waters and EEZ) and we do not have information that allows us to make any assumptions on anticipated differences in densities, we are unable to quantify sea turtle take. Therefore, we are also unable to quantify additional potential benefits to small sea turtles from this alternative over Alternative 3 (Preferred Alternative). Specifically, we lack sufficient information to come to any conclusions on differential sea turtle CPUE by otter trawlers using TEDs with either 4-in or 3-in bar spacing across a range of water depths and fishing areas. While we believe some additional sea turtle conservation may result from this alternative compared to Alternatives 3 and 5, we are uncertain on the degree or significance of those benefits.

4.1.7 Effects of Alternative 7: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers

This alternative would remove the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*) and require all vessels employing skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use newly-defined TEDs designed to exclude small turtles in their nets. Additionally, all otter trawlers would also have to utilize the aforementioned TEDs designed to exclude small turtles in their nets. Trawlers operating under other existing exemptions from the TED requirements (e.g., trawlers that operate without any power or mechanical-advantage trawl retrieval system under 50 CFR 223.206(d)(2)(ii)(A)(*1*) or trawlers fishing for royal red shrimp under 50 CFR 223.206(d)(2)(ii)(B)(*2*)), however, would not be affected by this alternative.

Observers have documented small Kemp's ridley and green sea turtles passing through standard TED grid bars and becoming captured in the federally-permitted otter trawl fishery operating in the EEZ. Stokes and Gearhart (2016) documented 22 turtles with body depths estimated to be less than 4 in (i.e., current TED bar spacing) captured in the EEZ from 2008-2015. They noted, however, that the data could not be interpreted as representative of the size distribution of the total population. Because fishery observers are largely conducting bycatch assessment related to Magnuson Stevens Fishery Conservation and Management Act provisions, effort is typically associated with federally-permitted otter trawlers. That is, effort is not uniform and the fishery observer data does not lend itself to making any definitive conclusions about sea turtle populations aside from very limited insight into presence/absence. Looking at all available sea turtle size data compiled in Stokes and Gearhart (2016), the majority of small (i.e., body depths less than 4 in) Kemp's ridley and green sea turtles have been documented in state waters. Of 71 total Kemp's ridleys documented in the Gulf of Mexico with body depths less than 4 in, 55 were from state waters. Likewise, of 155 green sea turtles documented in the Gulf of Mexico with body depths less than 4 in, 143 occurred in state waters. Similar trends occur in the South Atlantic region for both species. But, as with the observer data, the state/federal disparity may be more related to the origin of the data (i.e., location of the study) rather than indicative of actual sea turtle size distributions. Therefore, we believe the available literature on sea turtle biology, including satellite tracking data, provides better insight into habitat preferences and utilization. And this literature concludes the Kemp's ridley sea turtle is predominantly a coastal species. Specifically, Seney and Landry (2011) reported that almost 70% of filtered locations of immature Kemp's ridley sea turtles tracked in the western Gulf of Mexico were in depths less than 5 m. Likewise, Coleman et al. (2016) found that almost 60% of the filtered locations of tracked turtles in the northern Gulf of Mexico were in water depths less than 10 m. So while small sea turtles may occasionally occur in the deeper waters of the EEZ in the Gulf of Mexico, we don't expect significant numbers of them to overlap with federally-permitted otter trawl vessels operating in these areas, even when considering that over half of all shrimp effort in the Gulf of Mexico occurs in the EEZ. In the South Atlantic, less than one-third of all shrimp effort occurs in federal waters (Table 44), so there would be even less benefit to small/juvenile sea turtles from this alternative in that region. As a result, we believe any reduction in the incidental bycatch and mortality of small/juvenile sea turtles from this alternative to be insignificant and indistinguishable from Alternative 6.

4.2 DIRECT AND INDIRECT EFFECTS ON OTHER PROTECTED AND MARINE SPECIES (INCLUDING CRITICAL HABITAT AND EFH)

As discussed in Section 3.3.4.1, the MMPA protects all marine mammals, regardless of whether or not they are listed under the ESA. The MMPA prohibits the “take” of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. The capture of marine mammals causing serious injury and mortality, incidental to commercial fishing operations, is a primary threat to many marine mammal species. The effects of the Southeastern U.S. shrimp fisheries on marine mammals are estimated and considered annually in SARs, and voluntary strategies have been developed to reduce serious injury or mortality of marine mammals in bottom trawl gear where necessary. The Southeastern U.S. shrimp fisheries are designated a Category II fishery under the MMPA List of Fisheries.

U.S. Atlantic and Gulf of Mexico Marine Mammal SARs have been published annually since 1995 to meet the requirements of the 1994 amendments to the MMPA. The SARs review marine mammal fishery interactions from data sources including the Marine Mammal Stranding Network database. Although all historical data are reviewed in the SARs, mortality estimates are derived from the most recent 5-years for which data are available. Therefore the SARs are most comprehensive in reviewing data collected since 1989, the earliest year included within the first SARs.

Historically, there have been very low numbers of incidental mortality or injury in the bottlenose dolphin stocks associated with shrimp trawls (NMFS 2010b). A voluntary observer program for the Gulf of Mexico shrimp trawl fishery began in 1992 and became mandatory in 2007. Three bottlenose dolphin mortalities were observed in the Gulf of Mexico shrimp trawl fishery: 1 mortality occurred in 2008 off the coast of Texas in the vicinity of Laguna Madre; 1 mortality occurred in 2007 off the coast of Louisiana in the vicinity of Atchafalaya Bay; and 1 mortality occurred in 2003 off the coast of Alabama near Mobile Bay (NMFS 2010b). During 1992-2008 the observer program recorded an additional 6 unidentified dolphins caught in a lazy line or TED, and one or more of these animals may have belonged to the Eastern or Northern Coastal stocks, and it is likely that 3 or 4 of the animals belonged to the continental shelf stock or the Atlantic spotted dolphin (*Stenella frontalis*) stock. In 2 of the 6 cases, an observer report indicated the animal may have already been decomposed, but this could not be confirmed in the absence of a necropsy. In 2008, an additional dolphin carcass was caught on the tickler of a shrimp trawl; however, the animal’s carcass was severely decomposed and may have been captured in this state. Only 1 bottlenose dolphin take has been reported for the South Atlantic portion of the Southeastern U.S. shrimp fisheries: in August 2002, a Beaufort County, South Carolina fisher self-reported a dolphin entanglement in a commercial shrimp trawl.

It is worth noting that dolphin interactions with shrimp trawls primarily occur due to the feeding behavior of dolphins. Video documentation demonstrates that dolphins will actively swim alongside the trawl and voluntarily enter the TED escape opening to feed on bycatch. In some instances, these animals may become trapped or entangled, potentially resulting in mortality.

No interactions between ESA-listed whales and shrimp trawlers have been documented within the data sources summarized in the SARs. The Southeastern U.S. shrimp fisheries are not identified in Recovery Plans and Status Reviews as threats to endangered marine mammals. None of the endangered marine mammals that occur in U.S. Atlantic waters are likely to interact with shrimp trawls as currently fished or as potentially operated under the alternatives considered within this DEIS.

Manatees are managed under the jurisdiction of the USFWS. USFWS has only prepared 2 SARs, 1 in 1995 and 1 in 2009 (74 FR 69136, December 30, 2009). From 2003 to 2007, no manatee deaths or injuries attributable to the shrimp fisheries have been reported from the South Atlantic and Gulf of Mexico coasts in the Southeastern United States. Furthermore, this commercial fishery is not known to have taken any manatees since 1987, when the last confirmed report of a manatee captured and drowned in fishery shrimp trawl was recorded. However, 3 unconfirmed deaths were documented in 1990. Necropsy findings and/or circumstances associated with these cases suggested that an inshore bait shrimp trawl may have been responsible for the deaths but definitive information was lacking. A manatee that died in a shrimp trawl in 1997 was captured by a research trawler investigating excluder devices; the researchers used a shrimp trawl without installed TEDs (S. Branstetter, NMFS, pers. comm.), but they were not engaged in commercial fishing operations.

In addition to incidental capture by fishing vessels, vessels can harm marine mammals through harassment or more directly by collision. Low frequency vessel noise may interfere with baleen whales' ability to communicate, navigate, detect prey, or conduct other vital functions (Croll et al. 2001; Wright et al. 2007). Aside from the possibility that fishing vessels may contribute to noise in the ocean environment that can affect baleen whales' sound production and reception capabilities and disrupt the associated functions, other more acute effects of vessels have been posited. Terhune and Verboom (1999) suggested that confusion caused by sounds produced over an area by multiple vessels may make it difficult for whales to detect and avoid approaching vessels. Additionally, baleen whales may not be able to hear high frequency propeller noises (Terhune and Verboom 1999), possibly contributing to their vulnerability to vessel strikes. Manatees, to the contrary, may be unable to hear low frequencies well (Gerstein et al. 1999), which some researchers suggest make them ineffective at detecting and avoiding vessels (USFWS 2001). Laist et al. (2001) summarize data from 58 large whale ship strike incidences and determined that although vessels of any size can injure whales, most severe injuries are caused by vessels 80 m or greater in length and traveling at speeds of 14 knots or faster. Manatee mortalities are primarily considered to be caused by small recreational vessels, and studies indicate vessel strikes at speeds of 13-15 mph (15-17.3 knots) can cause fractures to manatee bones (Clifton 2005). Most shrimp trawlers operate below these speed thresholds, although smaller and slower vessels can still cause injuries. Measures are in place to protect manatees and right whales from ship strikes in their most vulnerable locations; specifically, speed zones and protective areas have been established and shown to be protective for manatees in

Florida (USFWS 2001); and since 2008, vessels 65 ft (19.8 m) and larger must travel at 10 knots (11.5 mph) or slower in certain locations along the U.S. Atlantic coast in certain times of year to reduce the threat of collisions with right whales (50 CFR 224.105). Although fishing vessels may affect marine mammals through noise production or vessels strikes, currently they are considered a very low threat, particularly when compared to larger and faster vessels that share the same waters (NMFS 2008; Hatch et al. 2007).

Effects on Listed Fish Species

Gulf sturgeon (*Acipenser oxyrinchus desotoi*), shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and smalltooth sawfish (*Pristis pectinata*), which are listed under the ESA, occur within the area encompassed by the alternatives analyzed within this DEIS. As discussed in Section 3.3.4.2, captures of these species are rare or undocumented in shrimp trawl fisheries. None of the actions considered in the alternatives analyzed within this DEIS are likely to increase the likelihood of incidental capture of these listed species or otherwise increase the likelihood of adverse effects. As discussed below, beneficial effects may occur to listed fish species as a result of the various management alternatives.

Effects on Other Marine Species

In general, the discarded bycatch of fish and invertebrates in shrimp fisheries is highly variable according to season and area. Marine species frequently encountered as bycatch in shrimp fisheries include Atlantic menhaden (*Brevoortia tyrannus*), Gulf menhaden (*Brevoortia patronus*), bay anchovy (*Anchoa mitchilli*), striped mullet (*Mugil cephalus*), Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus*), red snapper (*Lutjanus campechanus*), sheepshead (*Archosargus probatocephalus*), whiting (*Menticirrhus littoralis*), flounder (*Paralicthys* sp.), red goatfish (*Mullus auratus*), inshore lizardfish (*Synodus foetens*), gafftopsail catfish (*Bagre marinus*), Spanish mackerel (*Scomberomorus maculatus*), king mackerel (*Scomberomorus cavalla*), weakfish (*Cynoscion regalis*), sand seatrout (*Cynoscion arenarius*), cannonball jellyfish (*Stomolophus meleagris*), blue crab (*Callinectes sapidus*), lesser blue crab (*C. similis*), and other various invertebrate species.

Research during the 1990s in the Gulf of Mexico and South Atlantic shrimp trawl fisheries examined the proportions of catch and bycatch by weight between 1990 and 1996. The data indicated that catches (by weight) in the Gulf of Mexico consisted of about 67% finfish, 16% commercial shrimp, 13% non-commercial shrimp, and 4% other invertebrates, while in the South Atlantic the catch averaged 51% finfish, 18% commercial shrimp, 13% non-commercial shrimp and crustaceans, and 18% non-crustacean invertebrates. During 1997 and 1998, shrimp trawlers in federal waters of the Gulf of Mexico and South Atlantic regions were required to use a BRD in their nets. Use of BRDs resulted in significant reductions for weakfish, croaker and spot in the South Atlantic region, and for Atlantic croaker and red snapper in the Gulf of Mexico.

Effects on Critical Habitat and EFH

Federal action agencies are required to consult with us on activities that may adversely affect EFH. Information within this DEIS represents the assessment of the effects of the analyzed alternatives on EFH. As discussed in Sections 3.3.1 and 3.3.2, EFH for species and life stages that rely on the seafloor for shelter (e.g., from predators), reproduction, or food is vulnerable to disturbance by trawls. Additionally, the MSA requires FMPs to include measures to reduce the effects of fishing on EFH. Adverse EFH effects of all fishing activities managed under FMPs have been minimized to the extent practicable within the management actions implemented in recent years. Generally, this is done through a variety of measures concurrent with rebuilding overfished stocks or preventing overfishing. In some cases, gear restricted areas or closures to bottom trawls are implemented to protect EFH or HAPC. One example of this is the Oculina Bank HAPC.

Two general conclusions, originally derived from studies that focused on the effects of trawling in the North Sea (Lindeboom and de Groot 1998), were that low-energy environments populated by organisms unused to disturbance are more affected by bottom trawling, and that bottom trawling affects the potential for habitat recovery (i.e., after trawling ceases, benthic communities and habitats may not always return to their original pre-impacted state). Therefore, factors such as the type of habitat, its vulnerability to disturbance, the degree of natural disturbance, and the degree to which the habitat is already being impacted by bottom-tending mobile gear used in other fisheries, are also relevant to an evaluation of the seriousness of the effects that proposed changes to bottom trawling effort and distribution may have on EFH and HAPC. As none of the alternatives are expected to redistribute effort and trawling will continue to occur in areas where bottom trawling has occurred for decades, we anticipate effects of all the alternatives on EFH to be largely the same as those occurring under the status quo. Likewise, we also conclude the effects of all the alternatives on designated critical habitat to be largely the same as those occurring under the status quo.

4.2.1 Effects of Alternative 1: No Action

Effects to marine mammals, listed fish species, and other marine species, as well as designated critical habitat and EFH, as a result of the shrimp fisheries would continue to occur as discussed in preceding sections.

4.2.2 Effects of Alternative 2: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

In general, requiring vessels to use TEDs is not expected to result in operational changes such as time, location, or fishing practices that may affect marine mammal interaction rates. It may result in an increase in trawling time due to reduced catch rates of shrimp, potentially increasing the opportunity for incidental capture of marine mammals to occur. Furthermore, as discussed in Section 3.3.4.1.4, there have been documented instances of dolphins becoming entangled in TEDs as they try to enter the net to feed on captured prey. As a result, any alternative that increases the use of TEDs may potentially increase negative effects to marine mammals due to entanglement.

This alternative may result in a reduction of finfish bycatch on those vessels required to use TEDs, particularly of larger species such as sharks and rays. As previously mentioned, bycatch in the shrimp fisheries is highly variable, not only in season and area, but also depending on gear used by individual vessels; bycatch reduction is likely affected not only by when and where a vessel fishes, but what kind of a TED is employed and how it is rigged. Holland (1989) documented a 15% total finfish catch reduction in North Carolina waters with the use of a Georgia TED with 4-in bar spacing. In contrast, Renaud et al. (1990) noted the use of an accelerator funnel in front of a TED significantly decreased finfish bycatch, from 12 lb/hr finfish bycatch without a funnel to 3.9 lb/hr with a funnel. Price and Gearhart (2011) documented significant reductions in teleost fish and rays in Mississippi, Alabama, and North Carolina waters.

It is expected TEDs could reduce the incidental bycatch of Gulf sturgeon in the Northern Gulf of Mexico, as well as shortnose and Atlantic sturgeon in North Carolina. It is unclear how significant this benefit may actually be, as skimmer trawls currently have to comply with alternative tow time restrictions, and, therefore, it is anticipated captured Gulf sturgeon could be released alive in most instances. Regardless, the use of a TED could potentially reduce a sturgeon's exposure in a net and avoid the need for fishers to handle a large fish on the deck of their boat, potentially subjecting the fish to injury. As a result, the use of TEDs would likely be beneficial to sturgeons. In contrast, TED use would likely have an insignificant effect on smalltooth sawfish, as most interactions and injuries in shrimp trawls occur when the sawfish entangles its toothed rostrum in netting. Further, smalltooth sawfish are rarely documented outside of Florida, where TED use is already required in state waters.

The use of a TED does not typically result in a significant interaction with the seabed, in and of itself. The main components of a trawl that interact with the benthos include the doors and footrope (and tickler chain), and also the codend of the net when burdened with a large catch. Depending on the net rigging and habitat type, a TED frame could interact with the bottom. For example, it is possible for a TED frame to rub the seafloor, and in muddy habitat, it could grab and gouge the sediment. However, this could be mitigated by the use of mud roller gear. Furthermore, a heavy bag following the TED frame could potentially overshadow any impact made by the TED itself. While this alternative is not expected to have any significant positive or negative impacts to EFH, it should be pointed out that the skimmer trawl fisheries currently operate in areas that have been subjected to trawling—and numerous other anthropogenic impacts such as dredging and other fishing activities—for several decades, as well as been frequently impacted by numerous high-intensity storms, including hurricanes. Therefore, the required use of a TED would likely have indistinguishable impacts on EFH (e.g., sediment resuspension) or designated critical habitat compared to the no action alternative.

4.2.3 Effects of Alternative 3 (Preferred Alternative): Amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

We anticipate this alternative would potentially offer additional bycatch reduction benefits due to the expansion of the TED requirement to all skimmer trawl, pusher-head trawl, and wing net vessels. Yet, it is unclear how significant this bycatch reduction would be as some small vessels may still use tow times in lieu of TEDs if they have no power assisted or mechanical-advantage trawl retrieval device on board. As previously mentioned, we don't expect any additional effects from this alternative on EFH or critical habitat compared to the no action alternative.

4.2.4 Effects of Alternative 4: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls to use TEDs designed to exclude small turtles

As skimmer trawls are the dominant non-otter trawl gear type in the Gulf of Mexico and South Atlantic (e.g., Table 2 in Section 3.1), we anticipate the effects of this alternative to be identical to those effects discussed for Alternative 2, except for slight changes in the extent of the impacts, due to this alternative applying to fewer vessels.

4.2.5 Effects of Alternative 5: Amend the existing TED regulations to require all vessels using skimmer trawls to use TEDs designed to exclude small turtles

As skimmer trawls are the dominant non-otter trawl gear type in the Gulf of Mexico and South Atlantic, we anticipate the effects of this alternative to be identical to those effects discussed for Alternative 3 (Preferred Alternative), except for slight changes in the extent of the impacts, due to this alternative applying to fewer vessels.

4.2.6 Effects of Alternative 6: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers fishing within state waters

We do not anticipate any additional effects to marine mammals, listed fish species, designated critical habitat, or EFH beyond what was discussed in Sections 4.2.3 and 4.2.5 as a result of this alternative. Reducing the maximum required TED bar spacing from 4 in to 3 in in otter trawls is not expected to increase, decrease, or appreciably change the effects on marine mammals, listed species, designated critical habitat, or EFH.

At this time, we do not have information available to quantify the bycatch reduction of other marine species that could occur from the use of TEDs with 3-in bar spacing compared to TEDs with 4-in bar spacing the otter trawl fisheries currently are required to use. Furthermore, while the current TED requirements specify a maximum bar spacing of 4 in, TED inspections indicate many vessels use TED grids with bar spacing less than 4 in (e.g., 3.5 in) to provide some regulatory latitude should bars become bent during fishing. Therefore, we are only able to make a general qualitative assumption on the effects of this alternative beyond what was discussed in Sections 4.2.3 and 4.2.5 for the non-otter trawl fisheries. We anticipate that the reduction of bar spacing under this alternative may potentially reduce bycatch in some situations, though it is unclear if those potential reductions would be considered statistically significant.

4.2.7 Effects of Alternative 7: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers

We believe the effects of this alternative on marine mammals, listed fish species, designated critical habitat, and EFH to be identical to those discussed in Section 4.2.6 for Alternative 6, except for a difference in the geographic scope of any such impacts, because the impacts will occur over a larger area. As this alternative affects a larger area, we assume the potential beneficial effects from reducing bycatch of other marine species under this alternative will be greater than the effects resulting from Alternative 6.

4.3 DIRECT AND INDIRECT EFFECTS ON THE ECONOMIC ENVIRONMENT

The following analyses focus on the expected direct effects of the alternatives being considered on vessels participating in the harvesting sectors of the Gulf of Mexico and South Atlantic shrimp fisheries. Indirect economic effects are discussed in Sections 4.3.8, 4.3.9, and 4.3.10. Except when noted otherwise, baseline economic conditions and performance in the following analyses are based on average annual values over the 2011-2014 time period. Further, the estimates in the following analyses only account for commercial shrimping activity as they are based on commercial landings data submitted to the states via commercial trip tickets or to us and, thus, do not account for "recreational" shrimping activity.

4.3.1 Effects of Alternative 1: No Action

Because this alternative would not change TED requirements for shrimp vessels in the Gulf of Mexico or South Atlantic, no changes are expected to vessels' operating behavior and, thus, baseline economic conditions and performance would be expected to continue, all other things being equal (e.g., shrimp prices and fuel prices). Given the lack of direct effects on vessels in the harvesting sector, associated businesses in the onshore sector would also not be indirectly affected under this alternative.

More specifically, current economic conditions in the harvesting sector are characterized in Table 81 in relation to the analysis of Alternatives 6 and 7 because those alternatives are expected to affect all food shrimp harvesting vessels that could be required to use new TEDs under any of the alternatives being considered, other than Alternative 1 (No Action). For the Gulf of Mexico, there are 8,401 vessels that could be required to use new TEDs under one or more of the other alternatives. Those vessels are responsible for generating approximately 145.6 million lbs of food shrimp landings with an ex-vessel value of about $518 million. Their total gross revenue is $553.1 million while net revenue is -$26 million. The averages per vessel are 17,238 lbs, $61,647 in food shrimp gross revenue, $65,384 in total gross revenue, and -$3,091 in net revenue. For the South Atlantic, there are 1,310 vessels that could be required to use new TEDs under one or more of the other alternatives. Those vessels are responsible for generating approximately 23.5 million lbs of food shrimp landings with an ex-vessel value of about $64.5 million. Their total gross revenue is $96.3 million while net revenue is about -$202,000. The averages per vessel are 17,949 lbs, $49,241 in food shrimp gross revenue, $73,496 in total gross revenue, and -$154 in net revenue.

4.3.2 Effects of Alternative 2: Amend the existing TED regulations to require vessels 26 ft and greater in length[20] using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

The important baseline economic conditions for vessels directly affected under Alternative 2 are presented in Table 45, the expected economic effects of Alternative 2 on these vessels in the first year and the long term are presented in Table 46, and the resulting change in net revenue and percentage losses in gross revenue and net revenue for these vessels in the first year and in the long term are presented in Table 47. In these and subsequent tables for Alternatives 2-5, revenue loss is due to expected food shrimp loss for vessels using certain gears that would be required to use TEDs that do not currently use TEDs, which is estimated to be 6.21% on average (ranging from 3.07%-10.61%). For Alternatives 6 and7, revenue loss is also due to expected food shrimp loss for vessels that would be required to use TEDs that do not currently use TEDs, as well as additional shrimp loss for otter trawl vessels that would be required to switch to new TEDs, which is estimated to be 4.43%. These losses would be incurred in the first year and all future years. TED costs are the costs of purchasing TEDs and are only incurred in the first year.

TED costs are based on the number of nets known or thought to be used by each vessel, inclusive of one set of spare nets and thus TEDs for each vessel. Anecdotal information suggests that vessel owners and captains would prefer to keep a fully-equipped set of spare nets on board. Due to financial constraints, they may sometimes choose to only keep one fully-equipped spare net on board. But economic conditions have improved in recent years, particularly for the more active and federally-permitted vessels. However, keeping only one spare can be risky if all the nets become hung up and damaged while on a trip, particularly if that trip is the first trip after a season opens (e.g., the brown and white season openings in Louisiana and the opening off of Texas). If a vessel operator has to abort a trip to obtain additional gear, not only would this result in lost fuel, it could also result in lost landings and revenues because the highest CPUEs generally occur at the beginning of a season. Further, captains and crew of vessels that use skimmer, pusher-head, and wing nets are not familiar with TEDs and how to install and use them properly. Compared to operators of otter trawl vessels, they are also relatively unskilled with respect to effecting repairs to

[20] Length information was missing for 1,179 state registered boats that were active in the Gulf of Mexico sometime between 2011 and 2014, of which about 800 were vessels that used skimmer trawls, pusher-head trawls, or wing nets. Several linear regression models were tested to predict the missing length values. Several binary logistic regression models were tested to predict the probability that a vessel with missing length data was less than 26 ft or greater than/equal to 26 ft in length (i.e., the dependent variable is effectively “yes” or “no”). In general, it is easier to predict whether a missing value is at/above or below a particular value as opposed to predicting the missing quantitative value. This was borne out in the model results as the binary logistic regression models consistently outperformed the linear regression models with respect to correctly predicting the known values, the power of the model, and the significance of the explanatory variables. The best binary logistic regression model had the following explanatory variables: from 2011 through 2014, number of years the vessel was actively shrimping, average skimmer landings, average food shrimp landings, average annual gross revenue, average annual food shrimp revenue, average annual revenue from skimmer net landings, average annual revenue from butterfly net landings, average annual revenue from bait shrimp landings (west Florida only), average annual revenue from gears other than otter trawls, skimmers, pusher-head trawls, or wing nets, and average annual revenue from species other than shrimp. The model has a p-value of .000, all variables are statistically significant, and the model correctly predicted 78% of the known length values. Thus, we have a high level of confidence in the model’s results.

their gear and gear modifications and therefore would likely not choose to take the risk of going on a trip without a fully-equipped set of spare nets; nearly every vessel that participated in fishery-dependent TED testing had at least 1 complete set of spare nets onboard (J. Gearhart, pers. comm., November 3, 2016). Thus, this analysis assumes vessel owners will choose to purchase enough TEDs for the nets they use plus one spare set of nets. To the extent some vessel owners choose not to have a fully-equipped set of spare nets inclusive of TEDs due to financial constraints, the following estimates of the number of TEDs needed and the costs of those TEDs will be overestimated. The cost of a new TED is estimated to be $325 for smaller vessels using smaller TEDs and $550 for larger vessels using larger TEDs.[21] Thus, if a small vessel uses two nets, the expected cost of buying new TEDs would be $1,440. The expected cost for a large vessel that uses 4 nets would be $4,400. The total adverse effect is the combination of revenue losses and TED costs in the first year only.

Table 45. Average annual aggregate (total) and per vessel baseline economic conditions for vessels affected under Alternative 2 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE	NET REVENUE[1]
AVERAGE TOTAL GULF	3,032	53,663,653	$139,596,364	$152,291,852	-$7,333,944
AVERAGE PER VESSEL GULF		17,699	$46,041	$50,228	-$2,419
AVERAGE TOTAL SA	71	1,285,964	$3,285,356	$4,943,063	-$202,126
AVERAGE PER VESSEL SA		18,112	$46,273	$69,621	-$2,494

[1] Aggregate net revenues are estimated by applying available average annual net revenue per vessel estimates to all vessels within a particular vessel category.

Table 46. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels under Alternative 2. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT (YEAR 1)
AVERAGE TOTAL GULF	3,032	2,178,773	$5,348,960	$3,935,100	$9,284,060
AVERAGE PER VESSEL GULF		719	$1,764	$1,298	$3,062
AVERAGE TOTAL SA	71	11,170	$19,092	$92,300	$111,392
AVERAGE PER VESSEL SA		157	$269	$1,300	$1,569

[21] In this context, a "small" vessel as a vessel less than 60 ft while a "large" vessel is a vessel greater than or equal to 60 ft, consistent with previous studies. Also, these estimates represent the current prices of TEDs. If a sudden and significant increase in demand for TEDs occurs, it is highly likely the price of TEDs will increase. The magnitude of that increase cannot be determined at this time due to insufficient data on TED producers and retailers. Thus, the price and cost estimates may be underestimated, particularly for alternatives that require the greatest number of TEDs to be produced (e.g., Alternatives 3, 5, and 6-7).

Table 47. Net revenue post-effects and average percentage loss in gross and net revenue per vessel for Gulf of Mexico and South Atlantic shrimp vessels under Alternative 2, first year and long term. Dollars are in 2014 dollars.

	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
GULF	-$5,481	-$4,183	43.3	4.6	54.4	34.4
SA	-$4,063	-$2,763	40.0	1.8	21.9	4.5

For the 3,032 vessels in the Gulf of Mexico that are expected to be affected by Alternative 2, the aggregate loss in gross revenue from shrimp loss is about $5.35 million, which represents about 3.5% of their gross revenue. Including the costs of purchasing TEDs, which is about $3.94 million, the total adverse effect in the first year is about $9.28 million, which represents about 6% of their gross revenue in the aggregate. These vessels are already earning losses of about $7.3 million in the aggregate, and these adverse effects would increase those losses to about $16.6 million. The same percentages apply to an "average" vessel in the aggregate (i.e., assuming all vessels are the same). Similarly, in the aggregate, net revenue for an average vessel is currently negative (-$2,419). Additional costs and revenue reductions would increase the losses these vessels are already incurring, specifically to -$5,481 in the first year and -$4,183 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

However, the adverse effects on the average vessel are considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 4.6% on average, the loss of gross revenue in the first year is more than 43% on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels. The percentage reductions in net revenue are even larger, about 55% in the first year and about 34% in the long term, because many vessels are already earning negative net revenues or slightly positive net revenues.

The adverse effects on South Atlantic vessels under Alternative 2 are much smaller in absolute terms. First, only 71 vessels are expected to be adversely affected under this alternative. The aggregate loss in gross revenue from shrimp loss is around $19,000, which represents only .4% of their gross revenue. Including the costs of purchasing TEDs, which is $92,300, the total adverse effect in the first year is just over $111,000, which represents about 2.2% of their gross revenue in the aggregate. These vessels are already earning losses of about $202,000 in the aggregate, and these adverse effects would increase those losses to about $323,000. The same percentages apply on an average per vessel basis in the aggregate. Thus, for the South Atlantic vessels, the costs associated with buying TEDs are the primary source of the adverse effects under this alternative. Also, as in the Gulf of Mexico, even in the aggregate, net revenue for an average vessel is currently negative (-$2,494). Additional costs or revenue reductions would increase the losses these vessels are already incurring, specifically to -$4,063 in the first year and -$2,763 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

As in the Gulf of Mexico, the adverse effects are considerably larger in relative terms for the average South Atlantic vessel. Although the average loss in gross revenue in the long term is still only around 1.8% on average, and even the loss in net revenue in the long term is only about 4.5%, the loss of gross revenue in the first year is 40% on average and the loss in net revenue is almost 22% in the first year on average. Again, this is because a relatively large number of vessels earn relatively small annual average gross revenues and are already earning negative net revenues or slightly positive net revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels.

The vessels affected under Alternative 2 are heterogeneous with respect to their average annual gross revenue and net revenue. Some vessels are also different with respect to their dependence on revenue from food shrimp, particularly in the South Atlantic. Even though the estimates above accurately represent the expected adverse economic effects on Gulf of Mexico and South Atlantic vessels in the aggregate, for an "average" vessel, as well as in absolute and relative terms, the expected economic effects will also vary across different types of vessels, or rather, by vessel "category."

In other words, the effects will differ depending on a vessel's economic characteristics. Category in this case refers to particular types of vessels, consistent with the categories or types of vessels described in Section 3.4. Although estimates of gross revenue for each vessel are available in all years from 2011-2014, estimates of net revenue are not. Net revenue estimates are only available for a sample of federally-permitted vessels in the Gulf of Mexico and South Atlantic in each of these years, and for a sample of non-federally-permitted vessels in the Gulf of Mexico for a single year (2012). Thus, the available average net revenue estimates are used and applied in the manner described below.

For example, in the Gulf of Mexico, vessels have been placed into 1 of 6 categories: average federally-permitted vessel in the Gulf of Mexico (federal), Q5, Q4, Q3, Q2, and Q1. In the South Atlantic, vessels were placed into 9 categories: rock shrimp (RSLA), primary penaeid (SPA Primary), secondary penaeid (SPA Secondary), average federally-permitted South Atlantic penaeid vessel (AS), Q5, Q4, Q3, Q2, and Q1. Vessels were placed in a category based on their average annual gross (total) revenue from 2011-2014 and which category that average most closely approximated. In the South Atlantic, the distribution of revenue between shrimp and non-shrimp species was also taken into account. Specifically, in the Gulf of Mexico, the average annual gross revenue ranges for the federal, Q5, Q4, Q3, Q2, and Q1 categories are as follows: >/= $255K, < $255K and >/= $119K, < $119K and >/= $52K, < $52K and >/=$ 29K, < $29K and >/= $17K, and < $17K. In the South Atlantic, the ranges are the same for the Q5, Q4, Q3, Q2, and Q1 categories. [22] A vessel was placed in the RSLA category if 50% or more of its gross revenue came from shrimp and its average annual gross revenue was >/= $456K. A vessel was placed in the AS category if 50% or more of its gross revenue came from shrimp and its average annual gross

[22] No South Atlantic vessels ended up in the Q5 category because of the additional categories in that region that capture such vessels. The ranges for the Q5, Q4, Q3, Q2, and Q1 categories do not exactly match those in Miller and Isaacs (2014) because this analysis covers all food shrimp vessels in the South Atlantic as well as the Gulf of Mexico, rather than just non-permitted vessels in the Gulf of Mexico, and is therefore based on a different distribution of gross revenue data.

revenue was < $456K and >/= $216K. A vessel was placed in the SPA Primary category if 50% or more of its gross revenue came from shrimp and its average annual gross revenue was < $216K and >/= $119K. Finally, a vessel was placed in the SPA Secondary category if < 50% of its gross revenue came from shrimp and its average annual gross revenue was >/= $119K. These categories should not be presumed to imply that every vessel in a particular category has a particular permit associated with the category name, as that is not always the case. Further, every alternative may not affect one or more vessels in every category.

The expected economic effects by vessel category for the Gulf of Mexico under Alternative 2 are presented in Tables 48-50, and the expected economic effects by vessel category for the South Atlantic under Alternative 2 are presented in Tables 51-53.

Table 48. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 2 in the Gulf of Mexico. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	70	219	671	501	359	1,212
TOTAL GROSS REVENUE	$28,587,438	$35,188,323	$52,699,841	$19,763,152	$8,266,174	$7,786,925
AVERAGE GROSS REVENUE	$408,392	$160,677	$78,539	$39,447	$23,026	$6,425
AVERAGE NET REVENUE	$8,257	$44,032	$2,953	-$7,754	-$13,173	-$9,012

Table 49. Aggregate (total) and average vessel level effects on Gulf of Mexico shrimp vessels by vessel category under Alternative 2. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	70	219	671	501	359	1,212
TOTAL GROSS REVENUE LOSS	$143,291	$1,167,962	$2,411,966	$868,420	$370,877	$386,444
TOTAL TED COSTS	$91,000	$284,700	$871,000	$648,700	$466,050	$1,573,650
TOTAL ADVERSE EFFECT	$234,291	$1,452,662	$3,282,966	$1,517,120	$836,927	$1,960,094
AVERAGE GROSS REVENUE LOSS	$2,047	$5,333	$3,595	$1,733	$1,033	$319
AVERAGE TED COSTS	$1,300	$1,300	$1,298	$1,295	$1,298	$1,298
AVERAGE ADVERSE EFFECT	$3,347	$6,633	$4,893	$3,028	$2,331	$1,617

Table 50. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for Gulf of Mexico vessels under Alternative 2, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
FEDERAL	$4,910	$6,210	1.0	0.6	40.5	24.8
Q1	-$10,629	-$9,331	97.6	5.2	17.9	3.5
Q2	-$15,504	-$14,206	10.2	4.5	17.7	7.8
Q3	-$10,782	-$9,487	7.8	4.4	39.1	22.4
Q4	-$1,940	-$642	6.3	4.6	165.7	121.7
Q5	$37,399	$38,699	4.3	3.5	15.1	12.1

In general, these results indicate that relatively few of the vessels affected under Alternative 2 in the Gulf of Mexico are federal (2%), Q5 (7%), or Q4 (12%) vessels. Many more vessels are affected in the other categories: Q1 (40%), Q2 (22%), and Q3 (17%). Thus, almost 80% of the Gulf of Mexico vessels affected under Alternative 2 fall into the 3 categories of vessels that have the lowest average annual gross revenue and lowest average annual net revenue. These vessels are the least able to absorb revenue reductions and cost increases.

In absolute terms, the average adverse effects per vessels on Q5 and Q4 vessels are greater than the effects on vessels in the other categories, while the effects on vessels in the Q1 and Q2 categories are much smaller in absolute terms. However, in general, the relative magnitude of the adverse effects is much less for federal and Q5 vessels compared to the vessels in the Q4, Q3, Q2, and particularly the Q1 category. In the long term, the average loss in gross revenue per vessel is lowest for the federal and Q5 vessels, though not considerably lower. Further, even though the total adverse effect for Q1 vessels is about 25% of their total gross revenues, the average loss in gross revenue per vessel in year 1 for the Q1 vessels is nearly 100% of their gross revenue.[23] This outcome is not economically sustainable for the average Q1 vessel and it is highly likely that many owners of these vessels would choose to stop shrimping. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. Although the percentage loss in gross revenue for Q4 vessels is not relatively high, those vessels were operating on relatively small but positive net revenues. Thus, the percentage loss in net revenue terms is relatively high and sufficient to cause their net revenues to become negative as well, though likely not sufficiently negative to stop operating.

Table 51. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 2 in the South Atlantic. Dollars are in 2014 dollars.

	SPA SECONDARY	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	3	9	13	7	38
TOTAL GROSS REVENUE	N/A[1]	$2,505,811	$637,742	$495,970	$152,511	$213,171
AVERAGE TOTAL REVENUE	N/A[1]	$835,270	$70,860	$38,152	$21,787	$5,610
AVERAGE NET REVENUE	$80,221	$83,872	$2,953	-$7,754	-$13,173	-$9,012

[1] Redacted due to data confidentiality.

Table 52. Aggregate (total) and average vessel level effects on South Atlantic shrimp vessels by vessel category under Alternative 2. Dollars are in 2014 dollars.

	SPA SECONDARY	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	3	9	13	7	38
TOTAL REVENUE LOSS	N/A[1]	$818	$4,798	$6,986	$1,783	$4,699
TOTAL TED COSTS	$1,300	$3,900	$11,700	$16,900	$9,100	$49,400
TOTAL ADVERSE EFFECT	N/A[1]	$4,718	$16,498	$23,886	$10,883	$54,099
AVERAGE GROSS REVENUE LOSS	N/A[1]	$273	$533	$537	$255	$124
AVERAGE TED COSTS	$1,300	$1,300	$1,300	$1,300	$1,300	$1,300
AVERAGE ADVERSE EFFECT	N/A[1]	$1,573	$1,833	$1,837	$1,555	$1,424

[1] Redacted due to data confidentiality.

[23] These and similar results under other alternatives suggest there is some heterogeneity even within vessel categories.

Table 53. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for South Atlantic vessels under Alternative 2, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
Q1	-$10,436	-$9,136	70.9	2.4	15.8	1.4
Q2	-$14,728	-$13,428	7.3	1.2	11.8	1.9
Q3	-$9,591	-$8,291	4.9	1.4	23.7	6.9
Q4	$1,120	$2,420	2.8	0.9	62.1	18.1
RSLA	$82,299	$83,599	0.2	0.0	1.9	0.3
SPA SECONDARY	$78,913	$80,213	0.1	0.0	1.6	0.0

Though at a much smaller scale, similar results to the Gulf of Mexico are seen in the South Atlantic. In the South Atlantic, there are very few RSLA (3) and SPA Secondary (1) vessels affected. The average adverse effect per vessel for these vessels differs little from the effects on vessels in the other categories because the costs of purchasing TEDs represent the majority of the adverse effects in all categories. Because their reliance on shrimp harvested using skimmer and wing nets is minimal at best, the RSLA and SPA Secondary vessels may choose to forego the expense and not harvest shrimp using those gears in the future.

Almost 54% of the South Atlantic vessels affected under Alternative 2 fall in the Q1 category. The percent loss in gross revenue in the long term is relatively low in general, and compared to the Gulf of Mexico, for the Q4, Q3, Q2, and Q1 vessels. However, even though the adverse effect for Q1 vessels is about 25% of their total gross revenue in the first year, the percent loss in gross revenue per vessels in the first year is nearly 71% for these vessels on average, and thus it is likely some and possibly many of these vessels would stop shrimping. The relative effects for Q3 and Q2 vessels are also relatively high compared to the other categories in the first year with respect to losses in gross revenue, but they are even higher in terms of net revenue because those vessels are already earning negative net revenues on average. Thus it is possible some of these vessels will also stop shrimping. The percentage loss in net revenue for Q4 vessels is even higher because they were earning slightly positive net revenues, though their net revenues remain positive and thus they would likely continue shrimping with skimmer trawls and wing nets.

4.3.3 Effects of Alternative 3 (Preferred Alternative): Amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

The important baseline economic conditions for vessels directly affected under Alternative 3 (Preferred Alternative) are presented in Table 54, the expected economic effects of Alternative 3 (Preferred Alternative) on these vessels in the first year and the long term are presented in Table 55, and the resulting change in net revenue and percentage losses in gross revenue and net revenue for these vessels in the first year and in the long term are presented in Table 56.

Table 54. Average annual aggregate (total) and per vessel baseline economic conditions for vessels affected under Alternative 3 (Preferred Alternative) in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE	NET REVENUE[1]
AVERAGE TOTAL GULF	5,660	61,406,340	$158,180,716	$180,333,757	-$29,511,663
AVERAGE PER VESSEL GULF		10,847	$27,942	$31,861	-$5,214
AVERAGE TOTAL SA	177	1,617,282	$3,990,566	$6,593,228	-$1,096,981
AVERAGE PER VESSEL SA		9,137	$22,546	$37,250	-$6,198

[1] Aggregate net revenues are estimated by applying available average annual net revenue per vessel estimates to all vessels within a particular vessel category.

Table 55. Average annual aggregate (total) and per vessel effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 3 (Preferred Alternative). Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT (YEAR 1)
AVERAGE TOTAL GULF	5,660	2,538,252	$6,142,573	$7,345,650	$13,488,223
AVERAGE PER VESSEL GULF		448	$1,085	$1,298	$2,383
AVERAGE TOTAL SA	177	15,441	$25,880	$215,800	$241,680
AVERAGE PER VESSEL SA		87	$146	$1,219	$1,365

Table 56. Net revenue post-effects and average percentage loss in gross and net revenue per vessel for Gulf of Mexico and South Atlantic shrimp vessels under Alternative 3 (Preferred Alternative), first year and long term. Dollars are in 2014 dollars.

	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
GULF	-$7,588	-$6,290	122.1	4.6	38.3	20.4
SA	-$7,563	-$6,344	68.3	1.5	17.3	2.2

For the 5,660 vessels in the Gulf of Mexico that are expected to be affected by Alternative 3 (Preferred Alternative), the aggregate loss in gross revenue from shrimp loss is about $6.14 million, which represents about 3.4% of their gross revenue. Including the costs of purchasing TEDs, which is about $7.35 million, the total adverse effect in the first year is about $13.49 million, which represents about 7.5% of their gross revenue in the aggregate. These vessels are already earning losses of about $29.5 million in the aggregate, and these adverse effects would increase those losses to about $43 million. The same percentages apply to an "average" vessel in the aggregate (i.e., assuming all vessels are the same). However, even in the aggregate, net revenue for an average vessel is currently negative (-$5,214). Additional costs and revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,588 in the first year and -$6,290 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

However, the adverse effects are considerably larger in relative terms for the average Gulf of Mexico vessel. Although the average loss in gross revenue in the long term is still only around 4.6% on average, the loss of gross revenue in the first year is more than 122% on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels. This outcome is not economically sustainable and would likely cause "average" vessels to stop operating. The percentage reductions in net revenue are also relatively large, about 38% in the first year and about 20% in the long term, because many vessels are already earning negative net revenues or slightly positive net revenues.

The adverse effects on South Atlantic vessels under Alternative 3 (Preferred Alternative) are much smaller in absolute terms. Only 177 vessels are expected to be adversely affected under this alternative. The aggregate loss in gross revenue from shrimp loss is around $26,000, which represents only 0.4% of their gross revenue. Including the costs of purchasing TEDs, which is about $216,000, the total adverse effect in the first year is about $242,000, which represents about 3.7% of their gross revenue in the aggregate. These vessels are already earning losses of about $1.1 million in the aggregate, and these adverse effects would increase those losses to about $1.34 million. The same percentages apply on an average per vessel basis in the aggregate. Thus, for the South Atlantic vessels, the costs associated with buying TEDs are the primary source of the adverse effects under this alternative. Also, as in the Gulf of Mexico, even in the aggregate, net revenue for an average vessel is currently negative (-$6,198). Additional costs or revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,563 in the first year and -$6,344 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

As in the Gulf of Mexico, the adverse effect on the average South Atlantic vessel is considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 1.5% on average, and even the loss in net revenue in the long term is only about 2.2%, the loss of gross revenue in the first year is 68% on average and the loss in net revenue is more than 38% in the first year on average. As under Alternative 2, this is because a relatively large number of vessels earn relatively small average annual gross revenues and are already earning negative net revenues or slightly positive net revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels.

The vessels affected under Alternative 3 (Preferred Alternative) are heterogeneous with respect to their average annual gross revenue and net revenue. Some vessels are also different with respect to their dependence on revenue from food shrimp, particularly in the South Atlantic. Even though the estimates above accurately represent the expected adverse economic effects on Gulf of Mexico and South Atlantic vessels in the aggregate, for an "average" vessel, as well as in absolute and relative terms, the expected economic effects will also vary across different types of vessels, or rather, by vessel "category."

In other words, the effects will differ depending on a vessel's economic characteristics. The categorization of vessels under Alternative 3 (Preferred Alternative) follows the same approach used in Alternative 2. The expected economic effects by vessel category for the Gulf of Mexico under Alternative 3 (Preferred Alternative) are presented in Tables 57-59, and the expected economic effects by vessel category for the South Atlantic under Alternative 3 (Preferred Alternative) are presented in Tables 60-62.

Table 57. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 3 (Preferred Alternative) in the Gulf of Mexico. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	72	232	781	655	534	3,386
TOTAL GROSS REVENUE	$29,207,782	$37,336,213	$60,682,376	$25,629,880	$12,160,637	$15,316,870
AVERAGE GROSS REVENUE	$405,664	$160,932	$77,698	$39,130	$22,773	$4,524
AVERAGE NET REVENUE	$8,257	$44,032	$2,953	-$7,754	-$13,173	-$9,012

Table 58. Aggregate (total) and average vessel level effects on Gulf of Mexico shrimp vessels by vessel category under Alternative 3 (Preferred Alternative). Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	72	232	781	655	534	3,386
TOTAL GROSS REVENUE LOSS	$144,200	$1,198,782	$2,557,040	$994,285	$481,233	$715,532
TOTAL TED COSTS	$93,600	$301,600	$1,010,750	$848,250	$693,550	$4,396,600
TOTAL ADVERSE EFFECT	$237,800	$1,500,382	$3,567,790	$1,842,535	$1,174,783	$5,112,132
AVERAGE GROSS REVENUE LOSS	$2,003	$5,167	$3,274	$1,518	$901	$211
AVERAGE TED COSTS	$1,300	$1,300	$1,294	$1,295	$1,299	$1,298
AVERAGE ADVERSE EFFECT	$3,303	$6,467	$4,568	$2,813	$2,200	$1,510

Table 59. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for Gulf of Mexico vessels under Alternative 3 (Preferred Alternative), first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
FEDERAL	$4,954	$6,254	1.0	0.6	40.0	24.3
Q1	-$10,522	-$9,223	199.4	5.1	16.8	2.3
Q2	-$15,373	-$14,074	9.8	4.0	16.7	6.8
Q3	-$10,567	-$9,272	7.3	3.9	36.3	19.6
Q4	-$1,615	-$321	6.0	4.2	154.7	110.9
Q5	$37,565	$38,865	4.2	3.4	14.7	11.7

In general, these results indicate that relatively few of the vessels affected under Alternative 3 (Preferred Alternative) in the Gulf of Mexico are federal (1.2%) or Q5 (4.1%) vessels. Many more vessels are affected in the other categories. Specifically, almost 60% of the vessels affected are Q1 vessels. The other affected vessels are distributed as follows: Q4 (13.8%), Q3 (11.6%), and Q2 (9.4%). These results demonstrate that, relative to Alternative 2, almost 83% of the additional 2,628 vessels that would be affected under Alternative 3 (Preferred Alternative) are Q1 vessels, while 12.5% are Q2 and Q3 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. Thus, not only does Alternative 3 (Preferred Alternative) adversely affect many more vessels in the Gulf of Mexico relative to Alternative 2, the vast majority are vessels that are the least able to absorb revenue reductions and cost increases.

In absolute terms, the average adverse effects per vessels on Q5 and Q4 vessels are greater than the effects on vessels in the other categories, while the effects on vessels in the Q1 and Q2 categories are much smaller in absolute terms. However, in general, the relative magnitude of the adverse effects is much less for federal and Q5 vessels compared to the vessels in the Q4, Q3, Q2, and particularly the Q1 category. In the long term, the average loss in gross revenue per vessel is lowest for the federal and Q5 vessels, though not considerably lower. Further, although the total adverse effect for Q1 vessels is about one-third of their total gross revenue in the aggregate, which is considerable, the average loss in gross revenue per vessel in year 1 for the Q1 vessels is nearly 200% of their gross revenue, or double the average loss under Alternative 2. This outcome is not economically sustainable and it is highly likely that many and possibly most owners of these vessels would choose to stop shrimping. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. Although the percentage loss in gross revenue for Q4 vessels is not relatively high, those vessels were operating on relatively small but positive net revenues. Thus, the percentage loss in net revenue terms is relatively high and sufficient to cause their net revenues to become negative as well, though likely not sufficiently negative to stop operating.

Table 60. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 3 (Preferred Alternative) in the South Atlantic. Dollars are in 2014 dollars.

	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	1	3	13	17	19	123
TOTAL GROSS REVENUE	N/A[1]	N/A[1]	$2,505,811	$933,956	$668,595	$433,142	$658,000
AVERAGE TOTAL REVENUE	N/A[1]	N/A[1]	$835,270	$71,843	$39,329	$22,797	$5,350
AVERAGE NET REVENUE	$80,221	$23,374	$83,872	$2,953	-$7,754	-$13,173	-$9,012

[1] Redacted due to data confidentiality.

Table 61. Aggregate (total) and average vessel level effects on South Atlantic shrimp vessels by vessel category under Alternative 3 (Preferred Alternative). Dollars are in 2014 dollars.

	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	1	3	13	17	19	123
TOTAL REVENUE LOSS	N/A[1]	N/A[1]	$818	$4,907	$7,535	$3,439	$9,169
TOTAL TED COSTS	$1,300	$1,300	$3,900	$16,250	$20,800	$22,750	$149,500
TOTAL ADVERSE EFFECT	N/A[1]	N/A[1]	$4,718	$21,157	$28,335	$26,189	$158,669
AVERAGE GROSS REVENUE LOSS	N/A[1]	N/A[1]	$273	$377	$443	$181	$75
AVERAGE TED COSTS	$1,300	$1,300	$1,300	$1,250	$1,224	$1,197	$1,215
AVERAGE ADVERSE EFFECT	N/A[1]	N/A[1]	$1,573	$1,627	$1,667	$1,378	$1,290

[1] Redacted due to data confidentiality.

Table 62. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for South Atlantic vessels under Alternative 3 (Preferred Alternative), first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
Q1	-$10,302	-$9,087	96.5	1.9	14.3	0.8
Q2	-$14,551	-$13,354	6.2	0.8	10.5	1.4
Q3	-$9,421	-$8,197	4.4	1.1	21.5	5.7
Q4	$1,326	$2,576	2.4	0.6	55.1	12.8
RSLA	$82,299	$83,599	0.2	0.0	1.9	0.3
AS	$22,070	$23,370	0.3	0.0	5.6	0.0
SPA SECONDARY	$78,913	$80,213	0.1	0.0	1.6	0.0

Though at a much smaller scale, similar results to the Gulf of Mexico are seen in the South Atlantic. In the South Atlantic, there are very few RSLA (3), SPA Secondary (1), and average federally-permitted South Atlantic penaeid (1) vessels affected. The average adverse effect per vessel for these vessels differs little from the effects on vessels in the other categories because the costs of purchasing TEDs represent the majority of the adverse effects in all categories. Because their reliance on shrimp harvested using skimmer trawls and wing nets is minimal at best, the RSLA, SPA Secondary, average federally-permitted South Atlantic penaeid vessels may choose to forego the expense and not harvest shrimp using those gears in the future.

Almost 70% of the South Atlantic vessels affected under Alternative 3 (Preferred Alternative) fall in the Q1 category, while 20% are Q2 and Q3 vessels. Further, of the additional 106 vessels affected under Alternative 3 (Preferred Alternative) relative to Alternative 2, more than 80% are Q1 vessels and 25% are Q2 and Q3 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. Thus, not only does Alternative 3 (Preferred Alternative) adversely affect more South Atlantic vessels relative to Alternative 2, but the vast majority are vessels that are the least able to absorb revenue reductions and cost increases.

The percent loss in gross revenue in the long term is relatively low in general, and compared to the Gulf of Mexico, for the Q4, Q3, Q2, and Q1 vessels. However, the total adverse effect on Q1 vessels represents about 24% of their average annual gross revenues and the percent loss in gross revenue per vessel in the first year is nearly 97% for these vessels on average. This outcome is not economically sustainable and it is highly likely many and possibly most owners of these vessels would choose to stop shrimping. The relative effects for Q3 and Q2 vessels are also relatively high in the first year compared to other categories with respect to losses in gross revenue, but they are even higher in terms of net revenue because those vessels are already earning negative net revenues on average. Thus it is possible some of these vessels will also stop shrimping. The percentage loss in net revenue for Q4 vessels is even higher because they were already earning slightly positive net revenues, though their net revenues remain positive and thus they would likely continue shrimping with skimmer trawls and wing nets.

4.3.4 Effects of Alternative 4: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls to use TEDs designed to exclude small turtles

The important baseline economic conditions for vessels directly affected under Alternative 4 are presented in Table 63, the expected economic effects of Alternative 4 on these vessels in the first year and the long term are presented in Table 64, and the resulting change in net revenue and percentage losses in gross revenue and net revenue for these vessels in the first year and in the long term are presented in Table 65.

As expected, because vessels 26 ft and greater in length that exclusively harvest shrimp using pusher-head trawls or wing nets would not be affected under Alternative 4, the number of vessels affected and the magnitude of adverse effects in absolute terms are slightly less under Alternative 4 relative to Alternative 2 and significantly less than under Alternative 3 (Preferred Alternative). Specifically, for the 2,847 vessels in the Gulf of Mexico that are expected to be affected by Alternative 4, the aggregate loss in gross revenue from shrimp loss is about $5.06 million, which represents about 3.6% of their gross revenue. Including the costs of purchasing TEDs, which is about $3.7 million, the total adverse effect in the first year is about $8.76 million, which represents about 6.3% of their gross revenue in the aggregate. These vessels are already earning losses of about $6.9 million in the aggregate, and these adverse effects would increase those losses to about $15.7 million. The same percentages apply to an "average" vessel in the aggregate (i.e., assuming all vessels are the same). However, even in the aggregate, net revenue for an average vessel is currently negative (-$2,425). Additional costs and revenue reductions would increase the losses these vessels are already incurring, specifically to -$5,501 in the first year and -$4,203 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

However, the adverse effects on the average vessel are considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 4.6% on average, the loss of gross revenue in the first year is more than 40% on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels. The percentage reductions in net revenue are even larger, about 55% in the first year and about 35% in the long term, because many vessels are already earning negative net revenues or slightly positive net revenues.

The adverse effects on South Atlantic vessels under Alternative 4 are much smaller in absolute terms. Only 66 vessels are expected to be adversely affected under this alternative. The aggregate loss in gross revenue from shrimp loss is nearly $19,000, which represents only 0.4% of their gross revenue. Including the costs of purchasing TEDs, which is about $86,000, the total adverse effect in the first year is about $105,000, which represents about 2.1% of their gross revenue in the aggregate. These vessels are already earning losses of about $122,000 in the aggregate, and these adverse effects would increase those losses to about $228,000. The same percentages apply on an average per vessel basis in the aggregate. Thus, as under Alternatives 2 and 3, for the South Atlantic vessels, the costs associated with buying TEDs is the primary source of the adverse effects under this alternative. Also, as in the Gulf of Mexico, even in the aggregate, net revenue for an average vessel is currently negative (-$1,874). Additional costs or revenue reductions would increase the losses these vessels are already incurring, specifically to-$3,460 in the first year and -$2,160 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

As in the Gulf of Mexico, the adverse effects on the average vessel are considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 1.8% on average, and even the loss in net revenue in the long term is only about 4.8%, the loss of gross revenue in the first year is 39% on average and the loss in net revenue is more than 23% in the first year on average. As under Alternatives 2 and 3, this is because a relatively large number of vessels earn relatively small average annual gross revenues and are already earning negative net revenues or slightly positive net revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels.

Table 63. Average annual aggregate (total) and per vessel baseline economic conditions for vessels affected under Alternative 4 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE	NET REVENUE[1]
AVERAGE TOTAL GULF	2,847	50,159,146	$127,635,139	$139,164,310	-$6,904,249
AVERAGE PER VESSEL GULF		17,618	$44,831	$48,881	-$2,425
AVERAGE TOTAL SA	66	1,276,257	$3,272,528	$4,891,113	-$123,673
AVERAGE PER VESSEL SA		19,337	$49,584	$74,108	-$1,874

[1] Aggregate net revenues are estimated by applying available average annual net revenue per vessel estimates to all vessels within a particular vessel category.

Table 64. Average annual aggregate (total) and per vessel effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 4. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT (YEAR 1)
AVERAGE TOTAL GULF	2,847	2,061,823	$5,062,521	$3,695,900	$8,758,421
AVERAGE PER VESSEL GULF		724	$1,778	$1,298	$3,076
AVERAGE TOTAL SA	66	11,015	$18,880	$85,800	$104,680
AVERAGE PER VESSEL SA		167	$286	$1,300	$1,586

Table 65. Net revenue post-effects and average percentage loss in gross and net revenue per vessel for Gulf of Mexico and South Atlantic shrimp vessels under Alternative 4, first year and long term. Dollars are in 2014 dollars.

	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
GULF	-$5,501	-$4,203	40.0	4.6	55.0	34.9
SA	-$3,460	-$2,160	38.6	1.8	22.6	4.8

As under Alternatives 2 and 3, the vessels affected under Alternative 4 are heterogeneous with respect to their average annual gross revenue and net revenue. Some vessels are also different with respect to their dependence on revenue from food shrimp, particularly in the South Atlantic. Even though the estimates above accurately represent the expected adverse economic effects on Gulf of Mexico and South Atlantic vessels in the aggregate, for an "average" vessel, as well as in absolute and relative terms, the expected economic effects will also vary across different types of vessels, or rather, by vessel "category."

In other words, the effects will differ depending on a vessel's economic characteristics. The categorization of vessels under Alternative 4 follows the same approach used in Alternative 2. The expected economic effects by vessel category for the Gulf of Mexico under Alternative 4 are presented in Tables 66-68, and the expected economic effects by vessel category for the South Atlantic under Alternative 4 are presented in Tables 69-71.

Table 66. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 4 in the Gulf of Mexico. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	55	205	647	469	337	1,134
TOTAL GROSS REVENUE	$21,870,183	$32,796,098	$50,932,726	$18,481,594	$7,748,492	$7,335,216
AVERAGE GROSS REVENUE	$397,640	$159,981	$78,721	$39,406	$22,993	$6,468
AVERAGE NET REVENUE	$8,257	$44,032	$2,953	-$7,754	-$13,173	-$9,012

Table 67. Aggregate (total) and average vessel level effects on Gulf of Mexico shrimp vessels by vessel category under Alternative 4. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	55	205	647	469	337	1,134
TOTAL GROSS REVENUE LOSS	$124,169	$1,121,978	$2,311,711	$794,438	$345,654	$364,572
TOTAL TED COSTS	$71,500	$266,500	$839,800	$607,750	$437,450	$1,472,900
TOTAL ADVERSE EFFECT	$195,669	$1,388,478	$3,151,511	$1,402,188	$783,104	$1,837,472
AVERAGE GROSS REVENUE LOSS	$2,258	$5,473	$3,573	$1,694	$1,026	$321
AVERAGE TED COSTS	$1,300	$1,300	$1,298	$1,296	$1,298	$1,299
AVERAGE ADVERSE EFFECT	$3,558	$6,773	$4,871	$2,990	$2,324	$1,620

Table 68. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for Gulf of Mexico vessels under Alternative 4, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
FEDERAL	$4,699	$5,999	1.1	0.7	43.1	27.3
Q1	-$10,632	-$9,333	89.8	5.2	18.0	3.6
Q2	-$15,497	-$14,199	10.2	4.4	17.6	7.8
Q3	-$10,744	-$9,448	7.7	4.3	38.6	21.8
Q4	-$1,918	-$620	6.3	4.6	164.9	121.0
Q5	$37,259	$38,559	4.4	3.6	15.4	12.4

In general, these results indicate that relatively few of the vessels affected under Alternative 4 in the Gulf of Mexico are federal (1.9%) or Q5 (7.2%) vessels. Many more vessels are affected in the other categories. Specifically, almost 40% of the vessels affected are Q1 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. The other affected vessels are distributed as follows: Q4 (22.7%), Q3 (16.5%), and Q2 (11.8%). These results are very similar to the results for Alternative 2 because the number of vessels 26 ft and greater in length that exclusively use pusher-head trawls or wing nets (185 vessels) is small relative to the number that exclusively or occasionally use skimmer nets (2,847 vessels).

In absolute terms, the average adverse effects per vessel on Q5 and Q4 vessels are greater than the effects on vessels in the other categories, while the effects on vessels in the Q1 and Q2 categories are much smaller in absolute terms. However, in general, the relative magnitude of the adverse effects is much less for federal and Q5 vessels compared to the vessels in the Q4, Q3, Q2, and particularly the Q1 category. In the long term, the average loss in gross revenue per vessel is lowest for the federal and Q5 vessels, though not considerably lower. Further, although the total adverse effect for Q1 vessels is about 25% of their total gross revenue in the aggregate, which is considerable, the average loss in gross revenue in year 1 for the Q1 vessels is nearly 90% of their gross revenue. This outcome is not economically sustainable for the average Q1 vessel and it is highly likely that many owners of these vessels would choose to stop shrimping. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are considerably greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. Although the percentage loss in gross revenue for Q4 vessels is not relatively high, those vessels were operating on relatively small but positive net revenues. Thus, the percentage loss in net revenue terms is relatively high and sufficient to cause their net revenues to become negative as well, though likely not sufficiently negative to stop operating. Again, the effects at the vessel category level under Alternative 4 are very similar to the effects under Alternative 2.

Table 69. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 4 in the South Atlantic. Dollars are in 2014 dollars.

	SPA SECONDARY	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	3	9	13	5	35
TOTAL GROSS REVENUE	N/A[1]	$2,505,811	$637,742	$495,970	$109,627	$204,105
AVERAGE TOTAL REVENUE	N/A[1]	$835,270	$70,860	$38,152	$21,925	$5,832
AVERAGE NET REVENUE	$80,221	$83,872	$2,953	-$7,754	-$13,173	-$9,012

[1] Redacted due to data confidentiality.

Table 70. Aggregate (total) and average vessel level effects on South Atlantic shrimp vessels by vessel category under Alternative 4. Dollars are in 2014 dollars.

	SPA SECONDARY	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	3	9	13	7	38
TOTAL REVENUE LOSS	N/A[1]	$818	$4,798	$6,986	$1,688	$4,582
TOTAL TED COSTS	$1,300	$3,900	$11,700	$16,900	$6,500	$45,500
TOTAL ADVERSE EFFECT	N/A[1]	$4,718	$16,498	$23,886	$8,188	$50,082
AVERAGE GROSS REVENUE LOSS	N/A[1]	$273	$533	$537	$338	$131
AVERAGE TED COSTS	$1,300	$1,300	$1,300	$1,300	$1,300	$1,300
AVERAGE ADVERSE EFFECT	N/A[1]	$1,573	$1,833	$1,837	$1,638	$1,431

[1] Redacted due to data confidentiality.

Table 71. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for South Atlantic vessels under Alternative 4, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
Q1	-$10,443	-$9,143	69.1	2.4	15.9	1.5
Q2	-$14,811	-$13,511	7.6	1.6	12.4	2.6
Q3	-$9,591	-$8,291	4.9	1.4	23.7	6.9
Q4	$1,120	$2,420	2.8	0.9	62.1	18.1
RSLA	$82,299	$83,599	0.2	0.0	1.9	0.3
SPA SECONDARY	$78,913	$80,213	0.1	0.0	1.6	0.0

Though at a much smaller scale, similar results to the Gulf of Mexico are seen in the South Atlantic. All of the following results are very similar to the effects under Alternative 2 because there are very few vessels 26 ft and greater in length in the South Atlantic that exclusively use wing nets (5) outside of Biscayne Bay relative to the number that exclusively or occasionally use skimmer nets (66).

In the South Atlantic, there are very few RSLA (3) and SPA Secondary (1) vessels affected under Alternative 4. The average adverse effect per vessel for these vessels differs little from the effects on vessels in the other categories because the costs of purchasing TEDs represent the majority of the adverse effects in all categories. Because their reliance on shrimp harvested using skimmer trawls and wing nets is minimal at best, the RSLA and SPA Secondary vessels may choose to forego the expense and not harvest shrimp using those gears in the future.

Almost 53% of the 66 South Atlantic vessels affected under Alternative 4 fall in the Q1 category. The percent loss in gross revenue in the long term is relatively low in general, and compared to the Gulf of Mexico, for the Q4, Q3, Q2, and Q1 vessels. However, similar to the Gulf of Mexico, the percent loss in gross revenue in the first year is about 69% for the Q1 vessels, and thus it is likely some and possibly many of these vessels would stop shrimping. The relative effects for Q3 and Q2 vessels are also relatively high compared to the other categories in the first year with respect to losses in gross revenue, but they are even higher in terms of net revenue because those vessels are already earning negative net revenues. Thus it is possible some of these vessels will also stop shrimping. The percentage loss in net revenue for Q4 vessels is even higher because they were earning slightly positive net revenues, though their net revenues remain positive and thus they would likely continue shrimping with skimmer trawls and wing nets.

4.3.5 Effects of Alternative 5: Amend the existing TED regulations to require all vessels using skimmer trawls to use TEDs designed to exclude small turtles

The important baseline economic conditions for vessels directly affected under Alternative 5 are presented in Table 72, the expected economic effects of Alternative 5 on these vessels in the first year and the long term are presented in Table 73, and the resulting change in net revenue and percentage losses in gross revenue and net revenue for these vessels in the first year and in the long term are presented in Table 74.

Table 72. Average annual aggregate (total) and per vessel baseline economic conditions for vessels affected under Alternative 5 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE	NET REVENUE[1]
AVERAGE TOTAL GULF	5,269	57,598,263	$145,588,053	$165,096,221	-$27,284,604
AVERAGE PER VESSEL GULF		10,929	$27,626	$31,334	-$5,178
AVERAGE TOTAL SA	163	1,587,790	$3,951,638	$6,505,952	-$962,491
AVERAGE PER VESSEL SA		9,741	$24,243	$39,914	-$5,905

[1] Aggregate net revenues are estimated by applying available average annual net revenue per vessel estimates to all vessels within a particular vessel category.

Table 73. Average annual aggregate (total) and per vessel effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 5. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT (YEAR 1)
AVERAGE TOTAL GULF	5,269	2,377,885	$5,766,195	$6,838,650	$12,604,845
AVERAGE PER VESSEL GULF		451	$1,094	$1,298	$2,392
AVERAGE TOTAL SA	163	15,010	$25,303	$197,600	$222,903
AVERAGE PER VESSEL SA		92	$155	$1,212	$1,368

Table 74. Net revenue post-effects and average percentage loss in gross and net revenue per vessel for Gulf of Mexico and South Atlantic shrimp vessels under Alternative 5, first year and long term. Dollars are in 2014 dollars.

	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
GULF	-$7,565	-$6,268	120.3	4.5	38.8	20.8
SA	-$7,272	-$6,060	69.6	1.5	17.5	2.4

As expected, because some vessels exclusively harvest shrimp using pusher-head trawls or wing nets (391), the number of Gulf of Mexico vessels affected under Alternative 5 (5,269) is somewhat less than the number of Gulf of Mexico vessels affected under Alternative 3 (Preferred Alternative) (5,660). Also, because there are 2,422 vessels less than 26 ft in length, the number of Gulf of Mexico vessels affected under Alternative 5 is much higher than under Alternative 4.

For the 5,269 vessels in the Gulf of Mexico that are expected to be affected by Alternative 5, the aggregate loss in gross revenue from shrimp loss is about $5.77 million, which represents about 3.5% of their gross revenue. Including the costs of purchasing TEDs, which is about $6.84 million, the total adverse effect in the first year is about $12.6 million, which represents about 7.3% of their gross revenue in the aggregate. These vessels are already earning losses of about $27.3 million in the aggregate, and these adverse effects would increase those losses to about $33.9 million. The same percentages apply to an "average" vessel in the aggregate (i.e., assuming all vessels are the same). However, even in the aggregate, net revenue for an average vessel is currently negative (-$5,178). Additional costs and revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,565 in the first year and -$6,268 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues. These effects are very similar to those for Alternative 3 (Preferred Alternative) because the number of vessels that exclusively harvest shrimp using pusher-head trawls or wing nets (391) is considerably less than the number of vessels that exclusively or occasionally use skimmer nets (5,269) and thus the majority of the effects under Alternative 3 (Preferred Alternative) are due to the effects on vessels that use skimmer nets (i.e., the vessels affected under Alternative 5).

However, the adverse effects are considerably larger in relative terms for the average Gulf of Mexico vessel. Although the average loss in gross revenue in the long term is still only around 4.5% on average, the loss of gross revenue in the first year is more than 120% on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels. This outcome is not economically sustainable and would likely cause "average" vessels to stop operating. The percentage reductions in net revenue are also relatively large, about 39% in the first year and about 21% in the long term, because many vessels are already earning negative net revenues or slightly positive net revenues. Again, these effects are almost identical to the effects under Alternative 3 (Preferred Alternative) for reasons noted above.

The adverse effects on South Atlantic vessels under Alternative 5 are much smaller in absolute terms. Only 163 vessels are expected to be adversely affected under this alternative, slightly less than the 177 vessels affected under Alternative 3 (Preferred Alternative) because there are 14 vessels outside of Biscayne Bay that exclusively use wing nets to harvest shrimp in the South Atlantic. The aggregate loss in gross revenue from shrimp loss is around $25,300, which represents only 0.4% of their gross revenue. Including the costs of purchasing TEDs, which is about $197,600, the total adverse effect in the first year is about $222,900, which represents about 3.4% of their gross revenue in the aggregate. These vessels are already earning losses of about $.96 million in the aggregate, and these adverse effects would increase those losses to about $1.19 million. The same percentages apply on an average per vessel basis in the aggregate. Thus, for the South Atlantic vessels, the costs associated with buying TEDs are the primary source of the adverse effects under this alternative. Also, as in the Gulf of Mexico, even in the aggregate, net revenue for an average vessel is currently negative (-$5,905). Additional costs or revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,272 in the first year and -$6,060 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

As in the Gulf of Mexico, the adverse effect on the average South Atlantic vessel is considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 1.5% on average, and even the loss in net revenue in the long term is only about 2.4%, the loss of gross revenue in the first year is almost 70% on average and the loss in net revenue is almost 18% in the first year on average. As under Alternatives 2, 3, and 4, this is because a relatively large number of vessels earn relatively small average annual gross revenues and are already earning negative net revenues or slightly positive net revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels.

The vessels affected under Alternative 5 are heterogeneous with respect to their average annual gross revenue and net revenue. Some vessels are also different with respect to their dependence on revenue from food shrimp, particularly in the South Atlantic. Even though the estimates above accurately represent the expected adverse economic effects on Gulf of Mexico and South Atlantic vessels in the aggregate, for an "average" vessel, as well as in absolute and relative terms, the expected economic effects will also vary across different types of vessels, or rather, by vessel "category."

In other words, the effects will differ depending on a vessel's economic characteristics. The categorization of vessels under Alternative 5 follows the same approach used in Alternative 2. The expected economic effects by vessel category for the Gulf of Mexico under Alternative 5 are presented in Tables 75-77, and the expected economic effects by vessel category for the South Atlantic under Alternative 5 are presented in Tables 78-80.

Table 75. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 5 in the Gulf of Mexico. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	57	218	748	612	497	3,137
TOTAL GROSS REVENUE	$22,490,526	$34,943,988	$58,198,745	$23,902,638	$11,309,095	$14,251,229
AVERAGE GROSS REVENUE	$394,571	$160,294	$77,806	$39,057	$22,755	$4,543
AVERAGE NET REVENUE	$8,257	$44,032	$2,953	-$7,754	-$13,173	-$9,012

Table 76. Aggregate (total) and average vessel level effects on Gulf of Mexico shrimp vessels by vessel category under Alternative 5. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	57	218	748	612	497	3,137
TOTAL GROSS REVENUE LOSS	$125,074	$1,152,665	$2,452,691	$912,119	$437,269	$659,178
TOTAL TED COSTS	$74,100	$283,400	$967,850	$793,000	$645,450	$4,073,550
TOTAL ADVERSE EFFECT	$199,174	$1,436,065	$3,420,541	$1,705,119	$1,082,719	$4,732,728
AVERAGE GROSS REVENUE LOSS	$2,194	$5,287	$3,279	$1,490	$880	$210
AVERAGE TED COSTS	$1,300	$1,300	$1,294	$1,296	$1,299	$1,299
AVERAGE ADVERSE EFFECT	$3,494	$6,587	$4,573	$2,786	$2,179	$1,509

Table 77. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for Gulf of Mexico vessels under Alternative 5, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
FEDERAL	$4,763	$6,063	1.1	0.7	42.3	26.6
Q1	-$10,521	-$9,222	197.4	5.0	16.7	2.3
Q2	-$15,352	-$14,053	9.7	3.9	16.5	6.7
Q3	-$10,540	-$9,244	7.2	3.8	35.9	19.2
Q4	-$1,620	-$326	6.0	4.2	154.9	111.0
Q5	$37,445	$38,745	4.3	3.4	15.0	12.0

In general, these results indicate that relatively few of the vessels affected under Alternative 5 in the Gulf of Mexico are federal (1.1%) or Q5 (4.1%) vessels. Many more vessels are affected in the other categories. Specifically, almost 60% of the vessels affected are Q1 vessels. The other affected vessels are distributed as follows: Q4 (14.2%), Q3 (11.6%), and Q2 (9.4%). These results demonstrate that, relative to Alternative 4, almost 83% of the additional 2,422 vessels that would be affected under Alternative 5 are Q1 vessels, while 12.5% are Q2 and Q3 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. Thus, not only does Alternative 5 adversely affect many more Gulf of Mexico vessels relative to Alternative 4, but the vast majority are vessels that are the least able to absorb revenue reductions and cost increases. These results are very similar to the results under Alternative 3 (Preferred Alternative) for reasons previously noted.

In absolute terms, the average adverse effects per vessel on Q5 and Q4 vessels are greater than the effects on vessels in the other categories, while the effects on vessels in the Q1 and Q2 categories are much smaller in absolute terms. However, in general, the relative magnitude of the adverse effects is much less for federal and Q5 vessels compared to the vessels in the Q4, Q3, Q2, and particularly the Q1 category. In the long term, the average loss in gross revenue per vessel is lowest for the federal and Q5 vessels, though not considerably lower. Further, although the adverse effect on Q1 vessels represents about one-third of their total gross revenue in the aggregate, which is considerable, the average loss in gross revenue per vessel in year 1 for the Q1 vessels is nearly 198% of their gross revenue, or about double the average loss under Alternatives 2 and 4. This outcome is not economically sustainable and it is highly likely that many and possibly most owners of these vessels would choose to stop shrimping. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. Although the percentage loss in gross revenue for Q4 vessels is not relatively high, those vessels were operating on relatively small but positive net revenues. Thus, the percentage loss in net revenue terms is relatively high and sufficient to cause their net revenues to become slightly negative as well, though likely not sufficiently negative to stop operating.

Table 78. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 5 in the South Atlantic. Dollars are in 2014 dollars.

	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	1	3	13	17	17	111
TOTAL GROSS REVENUE	N/A[1]	N/A[1]	$2,505,811	$933,956	$668,595	$390,258	$613,609
AVERAGE TOTAL REVENUE	N/A[1]	N/A[1]	$835,270	$71,843	$39,329	$22,956	$5,528
AVERAGE NET REVENUE	$80,221	$23,374	$83,872	$2,953	-$7,754	-$13,173	-$9,012

[1] Redacted due to data confidentiality.

Table 79. Aggregate (total) and average vessel level effects on South Atlantic shrimp vessels by vessel category under Alternative 5. Dollars are in 2014 dollars.

	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	1	3	13	17	17	111
TOTAL REVENUE LOSS	N/A[1]	N/A[1]	$818	$4,907	$7,535	$3,343	$8,687
TOTAL TED COSTS	$1,300	$1,300	$3,900	$16,250	$20,800	$20,150	$133,900
TOTAL ADVERSE EFFECT	N/A[1]	N/A[1]	$4,718	$21,157	$28,335	$23,493	$142,587
AVERAGE GROSS REVENUE LOSS	N/A[1]	N/A[1]	$273	$377	$443	$197	$78
AVERAGE TED COSTS	$1,300	$1,300	$1,300	$1,250	$1,224	$1,185	$1,206
AVERAGE ADVERSE EFFECT	N/A[1]	N/A[1]	$1,573	$1,627	$1,667	$1,382	$1,285

[1] Redacted due to data confidentiality.

Table 80. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for South Atlantic vessels under Alternative 5, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
Q1	-$10,297	-$9,090	100.3	1.9	14.3	0.9
Q2	-$14,555	-$13,370	6.2	0.9	10.5	1.5
Q3	-$9,421	-$8,197	4.4	1.1	21.5	5.7
Q4	$1,326	$2,576	2.4	0.6	55.1	12.8
RSLA	$82,299	$83,599	0.2	0.0	1.9	0.3
AS	$22,070	$23,370	0.3	0.0	5.6	0.0
SPA SECONDARY	$78,913	$80,213	0.1	0.0	1.6	0.0

All of the following results are very similar to the effects under Alternative 2 because there are relatively few vessels (14) in the South Atlantic that exclusively use wing nets outside of Biscayne Bay compared to the number that exclusively or occasionally use skimmer nets (163). Though at a much smaller scale, similar results to the Gulf of Mexico are seen in the South Atlantic. In the South Atlantic, there are very few RSLA (3), SPA Secondary (1), and average federally-permitted South Atlantic penaeid (1) vessels affected. The average adverse effect per vessel for these vessels differs little from the effects on vessels in the other categories because the costs of purchasing TEDs represent the majority of the adverse effects in all categories. Because their reliance on shrimp harvested using skimmer trawls and wing nets is minimal at best, the RSLA, SPA Secondary, average federally-permitted South Atlantic penaeid vessels may choose to forego the expense and not harvest shrimp using those gears in the future.

About 68% of the South Atlantic vessels affected under Alternative 5 fall in the Q1 category, while 21% are Q2 and Q3 vessels. Further, of the additional 97 vessels affected under Alternative 5 relative to Alternative 4, more than 78% are Q1 vessels and 16.5% are Q2 and Q3 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. Thus, not only does Alternative 5 adversely affect more South Atlantic vessels relative to Alternative 4, but the vast majority are vessels that are the least able to absorb revenue reductions and cost increases.

The percent loss in gross revenue in the long term is relatively low in general, and compared to the Gulf of Mexico, for the Q4, Q3, Q2, and Q1 vessels. And although the total adverse effect on Q1 vessels represents about 25% of their average annual gross revenues, the percent loss in gross revenue per vessel in the first year is more than 100% for these vessels on average. This outcome is not economically sustainable and it is highly likely that many and possibly most owners of these vessels would choose to stop shrimping. The relative effects with respect to losses in gross revenue for Q3 and Q2 vessels are also relatively high in the first year compared to other categories, but they are even higher in terms of net revenue because those vessels are already earning negative net revenues on average. Thus it is possible some of these vessels will also stop shrimping. The percentage loss in net revenue for Q4 vessels is even higher because they were already earning slightly positive net revenues, though their net revenues remain positive and thus they would likely continue shrimping with skimmer trawls and wing nets.

4.3.6 Effects of Alternative 6: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers fishing within state waters

The important baseline economic conditions for vessels directly affected under Alternative 6 are presented in Table 81, the expected economic effects of Alternative 6 on these vessels in the first year and the long term are presented in Table 82, and the resulting change in net revenue and percentage losses in gross revenue and net revenue for these vessels in the first year and in the long term are presented in Table 83.

Table 81. Aggregate (total) and average per vessel baseline economic conditions for vessels affected under Alternative 6 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE	NET REVENUE[1]
AVERAGE TOTAL GULF	8,401	145,593,690	$517,959,158	$553,070,043	-$25,966,245
AVERAGE PER VESSEL GULF		17,328	$61,647	$65,834	-$3,091
AVERAGE TOTAL SA	1,310	23,512,575	$64,505,532	$96,279,925	-$202,126
AVERAGE PER VESSEL SA		17,949	$49,241	$73,496	-$154

[1] Aggregate net revenues are estimated by applying available average annual net revenue per vessel estimates to all vessels within a particular vessel category.

Table 82. Aggregate (total) and average per vessel effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 6. Estimates do not include effects that would accrue as a result of otter trawl landings and revenue reductions in the Gulf of Mexico (about $256,400) that cannot be attributed to a specific vessel because the landings records were consolidated. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT (YEAR 1)
AVERAGE TOTAL GULF	8,401	7,096,999	$24,706,264	$14,122,050	$38,828,314
AVERAGE PER VESSEL GULF		845	$2,941	$1,680	$4,621
AVERAGE TOTAL SA	1,310	1,032,858	$2,837,056	$2,362,450	$5,199,506
AVERAGE PER VESSEL SA		788	$2,166	$1,803	$3,969

Table 83. Net revenue post-effects and average percentage loss in gross and net revenue per vessel for Gulf of Mexico and South Atlantic shrimp vessels under Alternative 6, first year and long term. Dollars are in 2014 dollars.

	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
GULF	-$7,682	-$6,001	131.1	4.7	62.0	40.0
SA	-$4,123	-$2,320	80.4	2.9	45.7	22.2

All vessels harvest shrimp from state waters at some point in time, even larger vessels with federal permits. Based on previous experience with how vessel owners responded to more restrictive bycatch reduction device requirements and anecdotal information from industry, owners of vessels using otter trawls are not expected to use different types of TEDs depending on whether they operate in state as opposed to federal waters for the following reasons. First, they are not expected to switch out TEDs within a trip because it is logistically difficult, particularly on smaller vessels. Further, the costs associated with buying and maintaining multiple sets of different TEDs for use in state versus federal waters are relatively high compared to using the same TEDs. Also, the risk associated with a captain potentially using the wrong TEDs would increase significantly and in turn increase the risk of costly enforcement violations. Thus, it is assumed owners of vessels using otter trawls will opt to use the more restrictive TEDs at all times, i.e., TEDs that will release small turtles.

Given the above, all 8,401 vessels that harvested food shrimp in the Gulf of Mexico are expected to be directly affected under Alternative 6. Thus, relative to Alternative 3 (Preferred Alternative), Alternative 6 would directly affect an additional 2,741 vessels that exclusively harvest shrimp in the Gulf of Mexico using otter trawls. For the 8,401 vessels in the Gulf of Mexico that are expected to be affected by Alternative 6, the aggregate loss in gross revenue from shrimp loss is about $24.7 million, which represents about 4.5% of their gross revenue. Including the costs of purchasing TEDs, which is about $14.1 million, the total adverse effect in the first year is about $38.8 million, which represents about 7% of their gross revenue in the aggregate. These vessels are already earning losses of about $26 million in the aggregate, and these adverse effects would increase those losses to about $61.7 million. The same percentages apply to an "average" vessel in the aggregate (i.e., assuming all vessels are the same).

Unlike Alternatives 2, 3, 4, and 5, the reduction in gross revenue due to shrimp loss is responsible for the majority of the adverse effects in the first year under Alternative 6 rather than the costs of buying TEDs. Further, relative to Alternative 3 (Preferred Alternative), Alternative 6 generates an additional $18.9 million in lost gross revenues each year and, more generally, an additional adverse effect of $21.1 million in the first year. Also, in the aggregate, net revenue for an average vessel is currently negative (-$3,091). Additional costs and revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,682 in the first year and -$6,001 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

The adverse effects are considerably larger in relative terms for the average Gulf of Mexico vessel. Although the average loss in gross revenue in the long term is still only around 4.7% on average, the loss of gross revenue in the first year is about 131% on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels. This outcome is not economically sustainable and would likely cause "average" vessels to stop operating. The percentage reductions in net revenue are also relatively large, about 62% in the first year and about 40% in the long term, because many vessels are already earning negative net revenues or slightly positive net revenues.

The adverse effects on South Atlantic vessels under Alternative 6 are much smaller in absolute terms. Approximately 1,310 vessels are expected to be adversely affected under this alternative. Thus, this alternative would directly affect an additional 1,133 South Atlantic vessels that exclusively harvest using otter trawls. Even though this increase in the number of affected vessels is not as large as in the Gulf of Mexico in absolute terms, the number of South Atlantic vessels affected under Alternative 6 is nearly 7 times greater than under Alternative 3 (Preferred Alternative). Further, the aggregate loss in gross revenue from shrimp loss is around $2.8 million, which represents about 3% of their gross revenue. Including the costs of purchasing TEDs, which is about $2.4 million, the total adverse effect in the first year is about $5.2 million, which represents about 5.4% of their gross revenue in the aggregate. These vessels are already earning losses of about $202,000 in the aggregate, and these adverse effects would increase those losses to about $5.32 million. The same percentages apply on an average per vessel basis in the aggregate. Thus, as is the case in the Gulf of Mexico, the loss in gross revenues due to shrimp loss constitutes the majority of the adverse effects under Alternative 6, unlike Alternatives 2, 3, 4, and 5.

Also, in the aggregate, net revenue for an average vessel is currently just about at the break-even level (-$154). Additional costs or revenue reductions would cause the average vessel to incur losses, specifically -$4,123 in the first year and -$2,020 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

As in the Gulf of Mexico, the adverse effect on the average South Atlantic vessel is considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 2.9% on average, the loss in net revenue in the long term is more than 22%, which is much higher than under Alternatives 2, 3, 4, and 5. Further, the loss of gross revenue in the first year is almost 80% on average and the loss in net revenue is about 46% in the first year on average. The latter is again much higher than under Alternatives 2, 3, 4, and 5. As under Alternatives 2, 3, 4, and 5, this is because many vessels earn relatively small average annual gross revenues and are already earning negative net revenues or slightly positive net revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels.

The vessels affected under Alternative 6 are heterogeneous with respect to their average annual gross revenue and net revenue. Some vessels are also different with respect to their dependence on revenue from food shrimp, particularly in the South Atlantic. Even though the estimates above accurately represent the expected adverse economic effects on Gulf of Mexico and South Atlantic vessels in the aggregate, for an “average” vessel, as well as in absolute and relative terms, the expected economic effects will also vary across different types of vessels, or rather, by vessel “category.”

In other words, the effects will differ depending on a vessel’s economic characteristics. The categorization of vessels under Alternative 6 follows the same approach used in Alternative 2. The expected economic effects by vessel category for the Gulf of Mexico under Alternative 6 are presented in Tables 84-86, and the expected economic effects by vessel category for the South Atlantic under Alternative 6 are presented in Tables 87-89.

Table 84. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 6 in the Gulf of Mexico. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	670	519	1,050	872	725	4,565
TOTAL GROSS REVENUE	$309,748,736	$89,838,803	$82,375,016	$34,325,468	$16,585,269	$20,196,752
AVERAGE GROSS REVENUE	$462,312	$173,100	$78,452	$39,364	$22,876	$4,424
AVERAGE NET REVENUE	$8,257	$44,032	$2,953	-$7,754	-$13,173	-$9,012

Table 85. Aggregate (total) and average vessel level effects on Gulf of Mexico shrimp vessels by vessel category under Alternative 6. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	670	519	1,050	872	725	4,565
TOTAL GROSS REVENUE LOSS	$13,577,235	$3,975,502	$3,789,422	$1,464,084	$700,903	$942,729
TOTAL TED COSTS	$2,665,250	$1,386,750	$1,703,950	$1,254,250	$1,038,50	$6,071,700
TOTAL ADVERSE EFFECT	$16,242,485	$5,362,252	$5,493,372	$2,718,336	$1,739,754	$7,014,429
AVERAGE GROSS REVENUE LOSS	$20,265	$7,660	$3,609	$1,679	$967	$207
AVERAGE TED COSTS	$3,978	$2,672	$1,622	$1,439	$1,433	$1,330
AVERAGE ADVERSE EFFECT	$24,242	$10,332	$5,232	$3,117	$2,400	$1,536

Table 86. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for Gulf of Mexico vessels under Alternative 6, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
FEDERAL	-$15,985	-$12,008	5.3	4.4	293.6	245.4
Q1	-$10,549	-$9,219	235.3	5.0	17.1	2.3
Q2	-$15,573	-$14,140	10.7	4.2	18.2	7.3
Q3	-$10,871	-$9,433	8.0	4.3	40.2	21.7
Q4	-$2,278	-$656	6.7	4.6	177.2	122.2
Q5	$33,700	$36,372	6.0	4.4	23.5	17.4

These results indicate that more and, in some cases, many more vessels in each category are affected under Alternative 6 relative to Alternatives 2, 3, 4, and 5. Relative to those other alternatives, the increases in the number of affected vessels are the most noticeable in the federal and Q1 vessel categories (e.g., from 72 federal vessels under Alternative 3 (Preferred Alternative) to 670 federal vessels under Alternative 6, and from 3,386 Q1 vessels under Alternative 3 (Preferred Alternative) to 4,565 Q1 vessels under Alternative 6). In short, this alternative affects relatively large numbers of "high revenue" and "low revenue" otter trawl vessels. The distribution of affected vessels across vessel categories under Alternative 6 in the Gulf of Mexico is somewhat different compared to Alternatives 2, 3, 4, and 5. Specifically, the distribution is as follows: 8%, 6.2%, 12.5%, 10.4%, 8.6%, and 54.3% for federal, Q5, Q4, Q3, Q2, and Q1 vessels, respectively. Thus, compared to Alternatives 2-5, relatively more federal, Q5, and Q4 vessels are affected under Alternative 6 (about 27% of the total affected). Still, about 73% of the affected vessels are Q1, Q2, or Q3 vessels, and these are the vessels with the lowest average annual gross revenues and net revenues.

In absolute terms, the total adverse effect on federal vessels is almost as large as the effects on the other vessel categories combined, accounting for more than 45% of the total adverse effects. Similarly, the average adverse effects per vessel on Q5 and particularly federal vessels are much greater than the effects on vessels in the other categories, while the effect per vessel on vessels in the Q1 category is much smaller in absolute terms.

However, the relative magnitude of the adverse effects differs across the various measures of relative effect. For example, in the long term, the average loss in gross revenue per vessel is almost identical across all categories, ranging from 4.2% to 5%. On the other hand, the average percentage loss in gross revenue per vessel in year 1 is directly correlated with average annual gross revenue. Specifically, losses by category are 5.3%, 6%, 6.8%, 8.0%, 10.7%, and 235% for federal, Q5, Q4, Q3, Q2, and Q1 vessels, respectively. All of these losses could reasonably be considered significant, but the losses to the Q1 vessels are clearly not economically sustainable and it is likely that many of these vessels' owners would choose to stop shrimping. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. Although the percentage loss in gross revenue for Q4 vessels is not relatively high, those vessels were operating on relatively small but positive net revenues. Thus, the percentage loss in net revenue terms is relatively high and sufficient to cause their net revenues to become slightly negative as well, though likely not sufficiently negative to stop operating. For federal vessels, which are currently operating with somewhat positive net revenues, their net revenues would become sharply negative under Alternative 6, in effect negating all of the economic gains that occurred in 2013 and 2014. Therefore, it is quite possible that some of these vessels' owners would choose to stop shrimping. Net revenues for Q5 vessels would still be positive and thus all of those vessels would likely continue to operate.

Table 87. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Alternative 6 in the South Atlantic. Dollars are in 2014 dollars.

	SPA PRIMARY	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	75	53	58	25	153	124	130	692
TOTAL GROSS REVENUE	$11,749,952	$26,383,719	$17,269,040	$17,062,980	$12,239,316	$4,829,335	$3,011,828	$3,733,755
AVERAGE TOTAL REVENUE	$156,666	$497,806	$297,742	$682,519	$79,996	$38,946	$23,168	$5,396
AVERAGE NET REVENUE	$7,362	$80,221	$23,374	$83,872	$2,953	-$7,754	-$13,173	-$9,012

Table 88. Aggregate (total) and average vessel level effects on South Atlantic shrimp vessels by vessel category under Alternative 6. Dollars are in 2014 dollars.

	SPA PRIMARY	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	75	53	58	25	153	124	130	692
TOTAL REVENUE LOSS	$492,886	$190,616	$713,759	$700,743	$440,730	$134,883	$72,873	$90,567
TOTAL TED COSTS	$271,100	$178,550	$230,400	$91,400	$369,250	$205,450	$180,000	$836,300
TOTAL ADVERSE EFFECT	$763,986	$369,166	$944,159	$792,143	$809,980	$340,333	$252,873	$926,866
AVERAGE GROSS REVENUE LOSS	$6,572	$3,597	$12,306	$28,030	$2,881	$1,088	$561	$131
AVERAGE TED COSTS	$3,615	$3,369	$3,972	$3,656	$2,413	$1,657	$1,385	$1,208
AVERAGE ADVERSE EFFECT	$10,186	$6,965	$16,279	$31,686	$5,294	$2,745	$1,945	$1,339

Table 89. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for South Atlantic vessels under Alternative 5, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
Q1	-$10,351	-$9,143	146.3	2.7	14.9	1.5
Q2	-$15,118	-$13,734	8.5	2.4	14.6	4.3
Q3	-$10,499	-$8,842	7.1	2.8	35.4	14.0
Q4	-$2,341	$72	6.6	3.5	179.2	97.5
RSLA	$52,186	$55,842	4.6	4.1	37.8	33.4
AS	$7,095	$11,068	5.5	4.1	69.6	52.6
SPA SECONDARY	$73,256	$76,624	1.8	0.8	8.7	4.5
SPA PRIMARY	-$2,824	$790	6.6	4.2	138.4	89.3

Though at a much smaller scale, similar results to the Gulf of Mexico are seen in the South Atlantic. These results indicate that more and, in most cases, many more South Atlantic vessels in each category are affected under Alternative 6 relative to Alternatives 2, 3, 4, and 5.

For example, no SPA Primary vessels are affected under those other alternatives, but 75 such vessels are affected under Alternative 6. Similarly, only 5 RSLA, SPA Secondary, and AS vessels are affected under Alternative 3 (Preferred Alternative), but 136 such vessels are affected under Alternative 6. Also, only 123 Q1 vessels are affected under Alternative 3 (Preferred Alternative), but 692 such vessels are affected under Alternative 6. In short, this alternative affects relatively large numbers of “high revenue” and “low revenue” otter trawl vessels. As a result, the distribution of affected vessels across vessel categories under Alternative 6 in the South Atlantic is somewhat different compared to the other alternatives. For example, under Alternative 3 (Preferred Alternative), about 70% of the affected vessels are Q1 vessels, 20% are Q2 or Q3 vessels, while the other 10% are in the other vessel categories (Q4, SPA Secondary, RSLA, AS). The percentage of Q2/Q3 vessels is about the same under Alternative 6, but the percentage of Q1 vessels is only 53% and the percentage of vessels in the other categories (Q4, SPA Secondary, SPA Primary, RSLA, and AS). Still, almost 73% of the vessels affected under Alternative 6 are Q1, Q2, or Q3 vessels. These vessels earn the lowest average annual gross revenues and net revenues and thus are the least able to absorb reductions in gross revenue or increases in costs.

In absolute terms, the total adverse effects on AS, Q1, Q4, RSLA, and SPA Primary vessels are similar to each other, but also much larger than those for SPA Secondary, Q3, and Q2 vessels. Further, the average adverse effects per vessel are much greater for RSLA vessels relative to vessels in other categories. Average adverse effects per vessel are also relatively greater for AS and SPA Primary vessels, as well as SPA Secondary and Q4 vessels to a lesser extent. Average adverse effects per vessel are much less for Q1 and Q2 vessels.

However, the relative magnitude of the adverse effects differs across the various measures of relative effect. For example, in year 1, the average loss in gross revenue per vessel is 146% for Q1 vessels, only 1.8% or SPA Secondary vessels, but ranges from 4.6-8.5% for the other vessel categories. While the latter could reasonably be considered significant, the losses to the Q1 vessels are clearly not economically sustainable and it is likely that many of these vessels' owners would choose to stop shrimping. On the other hand, the average percentage loss in gross revenue per vessel in the long term is much less across all categories, with SPA Secondary vessels only losing 0.8% on average and other categories losing between 2.4% to 4.2% on average. With respect to losses in net revenue in the first year and in the long term, the average loss per vessel is much higher for Q4 and SPA Primary vessels because those vessels were operating on relatively small but positive net revenues. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. However, net revenues for vessels in the other categories remain positive in the first year and in the long term, and thus vessels in those categories are likely to continue operating.

4.3.7 Effects of Alternative 7: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers

For reasons discussed in section 4.3.6, the expected economic effects on directly affected vessels under Alternative 7 are identical to those under Alternative 6. As such, those effects are incorporated here by reference and not repeated.

4.3.8 Indirect Effects on Gulf of Mexico and South Atlantic Dealers

Costs associated with purchasing TEDs would not be passed on to these businesses, but would result in additional economic activity for TED manufacturers and retailers. Conversely, any expected annual revenue losses incurred by vessels because of shrimp loss resulting from new TED requirements are expected to be passed on to associated dealers and would be expected to continue into the future. The rationale for this expectation is as follow.

In the aggregate, it is reasonable to assume that all or practically all available shrimp will be harvested if effort is at or near the level needed to harvest maximum sustainable yield (MSY). In the Gulf of Mexico offshore fishery, effort was at such levels in 2004 and in previous years. But offshore effort has declined to the point where it would have to increase by more than 105% in order to achieve aggregate MSY in the offshore fishery (GMFMC 2016a), and similar increases would be needed in the inshore fishery to achieve MSY for the Gulf shrimp fishery as a whole (R. Hart, pers. comm., June 7, 2016). Although a formal analysis for South Atlantic shrimp fisheries has not been conducted, anecdotal information suggests effort is currently also well below levels needed to achieve MSY. Therefore, it is highly unlikely that shrimp lost as a result of TEDs will be recaptured by other tows or vessels. Further, although it may be theoretically possible to compensate for this reduction in harvest with additional effort (more tows or trips), increasing effort will also increase operating costs. As previously noted, with the exception of 2014, the differential between shrimp and fuel prices has been very small in the past several years and thus vessels are already operating on small economic margins. Increasing effort is therefore likely to be economically risky, particularly for vessels that only or primarily harvest after the openings because CPUEs steadily decline over time and thus the additional revenue from each tow or trip steadily declines as well. Further, if additional effort was cost-effective or profitable, this effort would already be occurring and part of baseline fishing behavior. Therefore, it is not expected that individual vessels and thus the fisheries in the aggregate would or could compensate for lost shrimp and the associated gross revenues by increasing effort.

However, not all dealers are expected to be affected under every alternative. Dealers are only indirectly affected if they purchase shrimp from a vessel that is directly affected under a particular alternative. Thus, as was the case with vessels, the number of indirectly affected dealers varies by alternative, and the economic characteristics of those dealers also differ by alternative. The economic characteristics of the dealers indirectly affected under Alternatives 2, 3, 4, 5, and 6-7 are presented in Tables 90, 92, 94, 96, and 98, respectively. The expected indirect economic effects of each of these alternatives are presented in Tables 91, 93, 95, 97, and 99, respectively.

Table 90. Average annual aggregate (total) and per dealer baseline economic conditions for dealers indirectly affected under Alternative 2 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE
AVERAGE TOTAL GULF	502	117,703,005	$214,104,822	$243,973,386
AVERAGE PER DEALER GULF		234,936	$427,355	$486,003
AVERAGE TOTAL SA	52	6,614,418	$16,744,466	$23,890,572
AVERAGE PER DEALER SA		127,200	$322,009	$459,434

Table 91. Average annual aggregate (total) and per dealer effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 2. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS LOSS	PERCENT LOSS FOOD SHRIMP LANDINGS	GROSS REVENUE LOSS	PERCENT LOSS GROSS REVENUE
AVERAGE TOTAL GULF	502	2,178,773	1.9	$5,348,960	2.2
AVERAGE PER DEALER GULF		4,340	1.9	$10,655	2.2
AVERAGE TOTAL SA	52	11,170	0.2	$19,092	0.1
AVERAGE PER DEALER SA		215	0.2	$367	0.1

Table 92. Average annual aggregate (total) and per dealer baseline economic conditions for dealers indirectly affected under Alternative 3 (Preferred Alternative) in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE
AVERAGE TOTAL GULF	612	117,845,052	$214,425,779	$247,876,873
AVERAGE PER DEALER GULF		192,872	$350,942	$405,028
AVERAGE TOTAL SA	91	6,880,775	$17,390,942	$25,355,298
AVERAGE PER DEALER SA		75,613	$191,109	$278,630

Table 93. Average annual aggregate (total) and per dealer effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 3 (Preferred Alternative). Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS LOSS	PERCENT LOSS FOOD SHRIMP LANDINGS	GROSS REVENUE LOSS	PERCENT LOSS GROSS REVENUE
AVERAGE TOTAL GULF	612	2,538,252	2.2	$6,142,573	2.5
AVERAGE PER DEALER GULF		4.147	2.2	$10,037	2.5
AVERAGE TOTAL SA	91	15,441	0.2	$25,880	0.1
AVERAGE PER DEALER SA		170	0.2	$284	0.1

Table 94. Average annual aggregate (total) and per dealer baseline economic conditions for dealers indirectly affected under Alternative 4 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE
AVERAGE TOTAL GULF	473	112,699,586	$198,593,579	$228,359,115
AVERAGE PER DEALER GULF		238,770	$420,749	$482,789
AVERAGE TOTAL SA	47	6,362,196	$16,424,033	$22,642,100
AVERAGE PER DEALER SA		135,366	$349,448	$481,747

Table 95. Average annual aggregate (total) and per dealer effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 4. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS LOSS	PERCENT LOSS FOOD SHRIMP LANDINGS	GROSS REVENUE LOSS	PERCENT LOSS GROSS REVENUE
AVERAGE TOTAL GULF	473	2,061,823	1.8	$5,062,521	2.2
AVERAGE PER DEALER GULF		4,359	1.8	$10,703	2.2
AVERAGE TOTAL SA	47	11,015	0.2	$18,880	0.1
AVERAGE PER DEALER SA		234	0.2	$401	0.1

Table 96. Average annual aggregate (total) and per dealer baseline economic conditions for dealers indirectly affected under Alternative 5 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE
AVERAGE TOTAL GULF	572	112,828,498	$198,887,884	$232,233,343
AVERAGE PER DEALER GULF		197,598	$348,315	$406,002
AVERAGE TOTAL SA	84	6,624,215	$17,064,514	$24,097,252
AVERAGE PER DEALER SA		78,860	$203,149	$286,872

Table 97. Average annual aggregate (total) and per dealer effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 5. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS LOSS	PERCENT LOSS FOOD SHRIMP LANDINGS	GROSS REVENUE LOSS	PERCENT LOSS GROSS REVENUE
AVERAGE TOTAL GULF	572	2,377,885	2.1	$5,766,195	2.5
AVERAGE PER DEALER GULF		4,157	2.1	$10,081	2.5
AVERAGE TOTAL SA	84	15,010	0.2	$25,303	0.1
AVERAGE PER DEALER SA		179	0.2	$141	0.1

Table 98. Average annual aggregate (total) and per dealer baseline economic conditions for dealers indirectly affected under Alternative 6 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE
AVERAGE TOTAL GULF	1,068	220,808,118	$536,788,297	$622,705,303
AVERAGE PER DEALER GULF		206,943	$503,082	$583,057
AVERAGE TOTAL SA	467	14,900,928	$40,531,388	$56,546,242
AVERAGE PER DEALER SA		31,908	$86,791	$121,084

Table 99. Average annual aggregate (total) and per dealer effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 6. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS LOSS	PERCENT LOSS FOOD SHRIMP LANDINGS	GROSS REVENUE LOSS	PERCENT LOSS GROSS REVENUE
AVERAGE TOTAL GULF	1,068	7,096,999	3.2	$24,706,264	4.0
AVERAGE PER DEALER GULF		6,645	3.2	$23,133	4.0
AVERAGE TOTAL SA	467	1,032,858	6.9	$2,837,056	5.0
AVERAGE PER DEALER SA		2,211	6.9	$6,075	5.0

For reasons discussed in section 4.3.6, the expected economic effects on indirectly affected dealers under Alternative 7 are identical to those under Alternative 6. As such, those effects are incorporated here by reference and not repeated.

When comparing the indirect effects of the alternatives on dealers, the results are directly related and thus similar to the direct effects on the harvesting sector. Specifically, the estimated annual losses in food shrimp landings and gross revenues under each alternative are directly derived from the losses to the harvesting sector (i.e., they are equivalent). Thus, for example, the number of Gulf of Mexico dealers expected to be adversely affected under each alternative is considerably greater than the number of South Atlantic dealers. Similarly, the magnitude of these adverse effects is considerably larger for Gulf of Mexico dealers than for South Atlantic dealers, in the aggregate and on average.

Also like the harvesting sector, the total number of dealers expected to be adversely affected is the least under Alternative 4 (520), followed by Alternative 2 (554), Alternative 5 (656), Alternative 3 (Preferred Alternative) (703), and the greatest under Alternatives 6 and 7 (1,535). Similarly, the total adverse effects in terms of lost shrimp landings and associated revenues follows this same ranking, which again are equivalent to the losses to the harvesting sector and thus not repeated here.

In absolute terms, the expected average losses in annual average food shrimp landings and gross revenues to South Atlantic shrimp dealers differ little between Alternatives 2, 3, 4, and 5, though the losses are slightly greater under Alternatives 3 and 5 relative to Alternatives 2 and 4. The percentage losses in annual average food shrimp landings and gross revenues to South Atlantic shrimp dealers are roughly the same and relatively small (0.1-0.2%) under Alternatives 2-5. Although we do not possess estimates of profitability specifically for South Atlantic shrimp dealers, these losses are not expected to be significant for these dealers, and thus are also unlikely to cause any of these dealers to stop operating. Many of these dealers purchase other seafood and may be able to replace these minor reductions with other seafood purchases.

However, the expected average losses in annual food shrimp landings and gross revenues to South Atlantic shrimp dealers are higher under Alternatives 6 and 7, both in absolute and relative terms. With respect to loss of landings (purchases), the aggregate loss and average per dealer loss is about 6.9%, while the aggregate loss and average loss per dealer in gross revenue is slightly less at 5%. A 5% loss in gross revenue and nearly 7% loss in volume to the dealer sector would be considered significant. Further, given what is known about profit margins in the harvesting and processing sectors, such losses in gross revenue would likely be sufficient to force some dealers to stop operating if they cannot readily replace the lost purchases of shrimp with other seafood. It would be much more difficult for dealers to replace 5-7% of their seafood purchases than only the 0.1% they would have to replace under Alternatives 2-5.

In absolute terms, the expected average losses in annual average food shrimp landings and gross revenues to Gulf of Mexico shrimp dealers differ little between Alternatives 2, 3, 4, and 5, ranging from 4,200-4,400 lbs and $10-$11,000 per dealer. The percentage losses in annual average food shrimp landings and gross revenues to Gulf of Mexico shrimp dealers are roughly the same, ranging from 2.2% under Alternative 2 and 4 to 2.5% under Alternatives 3 and 5.

In absolute terms, the expected average losses in annual average food shrimp landings to Gulf of Mexico shrimp dealers are approximately 6,600 lbs under Alternatives 6 and 7, and the average loss in annual gross revenue is much higher ($23,100) than under Alternatives 2-5. With respect to loss of landings (purchases), the aggregate loss and average per dealer loss is about 3.2%, while the aggregate loss and average loss per dealer in gross revenue is somewhat higher at 4%.

A 4% loss in gross revenue to the dealer sector would likely be considered significant. Further, it would be somewhat more difficult for dealers to replace 4% of their seafood purchases than the 2% they would have to replace under Alternatives 2-5. However, it is difficult to predict with a high degree of certainty whether any and which specific dealers under these alternatives might choose to stop operating because of the adverse effects under Alternatives 2-5. Particularly in the Gulf of Mexico, dealers are a very heterogeneous group, more so than processors and even vessels, because they are partly composed of entities that are primarily harvesters, who are generally “small” dealers in terms of volume and value, while others are primarily processors, who are “large” dealers in terms of volume and value. Others are truly “dealers” in the sense that they only buy, sort, package, and transport shrimp, and generally lie somewhere between the other types of dealers with respect to volume and value.

Given what is known about profit margins in the harvesting and processing sectors, such losses in gross revenue would likely be sufficient to force some dealers to stop operating if they cannot readily replace the lost purchases of shrimp with other seafood. In addition, although the average loss to the “average” (based on the mean) dealer is only 4%, the percentage loss to smaller dealers would be expected to be much higher. For businesses that are both harvesters and dealers, if the losses to the harvesting component of the business are sufficient to cause the vessel(s) to stop operating, then it is highly likely the dealer component of the business would also be forced to shut down. Larger dealers that are also processors may be somewhat better able to absorb such losses, though profit margins in the processing sector have been very low in recent years (see discussion in Section 4.3.9). It may be that “traditional” dealers are in the best position to absorb these losses depending on how big their business is and how readily they can replace lost shrimp purchases with other seafood.

4.3.9 Indirect Effects on Gulf of Mexico and South Atlantic Processors

Although we possess data on shrimp landings that are purchased by specific dealers and also have data on the volume and value of processed shrimp by processors, no data collection program exists that tracks domestically harvested shrimp from dealers to processors, except in the few instances where the dealer and the processor are the same business. As a result, it is not possible to track landings expected to be lost due to new TED requirements from specific vessels in the harvesting sector to specific processors in the processing sector. In turn, we cannot determine how the adverse effects caused by these new requirements will be distributed across processors. Thus, estimates of adverse effects on the processing sector can only be analyzed in the aggregate and with respect to the “average” shrimp processor in the Gulf of Mexico and in the South Atlantic. Further, all processors in each region are assumed to be affected under each of the alternatives.

Gulf of Mexico Shrimp Processors

For example, between 2011 and 2014, there was an average of 55 food shrimp processors in the Gulf of Mexico. Gulf of Mexico shrimp processors processed an average of about 313.9 million lbs of shrimp, with an average processed value of $691.6 million. The total average value of all their processed products was about $738 million. Thus, the average volume of shrimp processed, average processed value of shrimp, and average value of all processed products per processor were about 5.7 million lbs, $12.6 million, and $13.4 million, respectively.[24]

With respect to Alternatives 2, 3, 4, and 5, the total expected annual loss in food shrimp landings are as follows: 2.2 million lbs, 2.5 million lbs, 2.1 million lbs, and 2.4 million lbs, respectively, or about 0.7% under Alternatives 2 and 4 and 0.8% under Alternatives 3 and of the food shrimp processed in the Gulf of Mexico, respectively. On a per-processor basis, the average annual loss in pounds is about 39,600 under Alternative 2; 46,150 under Alternative 3 (Preferred Alternative); 37,500 under Alternative 4; and 43,200 under Alternative 5, or between 1.4% (Alternative 4) and 1.8% (Alternative 3; Preferred Alternative) of their processed shrimp. Similarly, the expected average annual loss in revenues/sales of processed food shrimp is about $5.4 million, $6.1 million, $5.1 million, and $5.8 million under Alternatives 2, 3, 4, and 5, respectively, or about 0.7% of their processed products' value under Alternatives 2 and 4 and 0.8% of their processed products' value under Alternatives 3 and 5. On a per-processor basis, the expected average annual loss in processed value is about $97,000 under Alternative 2, $111,000 under Alternative 3 (Preferred Alternative), $93,000 under Alternative 4, and $105,000 under Alternative 5, or about 0.7% of their processed value under Alternatives 2 and 4, and about 0.8% of their processed value under Alternatives 3 and 5.

The estimated losses in processed pounds of shrimp are relatively the same across Alternatives 2-5, and are less than 1% in each case. Further, the losses with respect to the value of processed shrimp are about the same and also less than 1%. The ready availability of imports should allow many and possibly most Gulf of Mexico processors to substitute imports for domestic product under these alternatives. If available imports are not of a comparable value, it could be difficult for some processors to replace this lost value.

Further, over the past several years, marketing margins for shrimp processors have been 0.3% or less, or about $0.30/lb (Keithly et al. 2009; W. Keithly, pers. comm., September 14, 2016). Marketing margins (the difference between ex-vessel/raw import prices and processed prices) are a proxy for profit margins in the processing sector. Given reductions are less than 1%, it is assumed that most and possibly all Gulf of Mexico processors would choose and be able to switch to imports rather than shut down under Alternatives 2-5. On the other hand, given their high reliance on processing shrimp in recent years, such losses may be sufficient to force some of the smaller Gulf of Mexico shrimp processors to shut down if they are highly dependent on domestic product and cannot replace the lost value with imports of comparable value. Even if all Gulf of Mexico processors do switch to imported product, imports' share of the supply of shrimp in the U.S. would increase above its already currently high level of 93% (NMFS 2015).

With respect to Alternatives 6 and 7, the expected annual average losses in the volume of shrimp processed and the value of processed shrimp are greater. Specifically, the total expected annual loss in processed food shrimp landings is about 7.1 million lbs, or about 2.3% of the food shrimp

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[24] Because average effects on processors could only be estimated at the mean, the averages for Gulf of Mexico and South Atlantic processors used here are based on means, and thus differ from the median values in Section 3.4.

processed in the Gulf of Mexico. On a per-processor basis, the average annual loss in pounds is about 129,000 lbs, also about 2.3% of their processed shrimp volume. The expected annual loss in revenues/sales of processed food shrimp is about $24.7 million, or about 3.3% of the value of shrimp processed in the Gulf of Mexico. On a per-processor basis, the expected average annual loss in processed value is about $449,000, or 3.3% of their processed value.

The losses in volume to the Gulf of Mexico processing sector as a whole and the average processor are not minor. Further, for large processors, the losses in volume maybe relatively minor, but the losses to small processors could be much more significant depending on how the losses are distributed across processors. With respect to losses in processed value, the adverse effects are somewhat greater for the processing sector as a whole, and the average processor. The loss in sales/processed value for the sector as a whole is relatively large, and the loss to the average processor would be very large. Given recent marketing margins of 0.3% or less, these losses could cause some of the small processors to shut down, and even some of the larger processors may find it difficult to substitute imports of comparable value in place of the lost domestic product and continue to operate. Even if all Gulf of Mexico processors do switch to imported product, imports' share of the supply of shrimp in the U.S. would increase above its already currently high level of 93% (NMFS 2015). The amount of substitution that could occur under Alternatives 6 and 7could cause the seafood trade deficit to increase and act as a drag on local and regional economies as a result of the decrease in domestic production.

South Atlantic Shrimp Processors

Between 2011 and 2014, there was an average of 9 food shrimp processors in the South Atlantic. South Atlantic shrimp processors processed an average of about 26.8 million lbs of shrimp, with an average processed value of $78.7 million. The total average value of all their processed products was about $93.6 million. Thus, the average volume of shrimp processed, average processed value of shrimp, and average value of all processed products per processor were about 2.98 million lbs, $8.74 million, and $10.4 million, respectively.

With respect to Alternatives 2-5, the total expected annual loss in food shrimp landings is about 11,000 lbs for Alternatives 2 and 4 and around 15,000 lbs for Alternatives 3 and 5, or about 0.04% and 0.06% of the food shrimp processed in the South Atlantic, respectively. On a per-processor basis, the average annual loss in pounds is about 1,200 lbs under Alternatives 2 and 4, about 0.04% of their processed shrimp, and around 1,700 lbs under Alternatives 3 and 5, about 0.06% of their processed shrimp. Similarly, the expected average annual loss in revenues/sales of processed food shrimp is about $19,000 for Alternatives 2 and 4 and approximately $26,000 for Alternatives 3 and 5, or about 0.02% of their processed products' value for each of these alternatives. On a per-processor basis, the expected average annual loss in processed value is about $2,100 under Alternatives 2 and 4, and around $2,900 under Alternatives 3 and 5, about 0.03% of their processed value.

Such losses will be imperceptible to the South Atlantic processing sector as a whole, and to the operations of individual processors. Thus, Alternatives 2-5 are not expected to generate significant adverse effects on South Atlantic processors.

With respect to Alternatives 6 and 7, the expected annual average losses in the volume of shrimp processed and the value of processed shrimp are greater. Specifically, the total expected annual loss in food shrimp landings is about 1.03 million lbs, or about 3.8% of the food shrimp processed in the South Atlantic, respectively. On a per-processor basis, the average annual loss in pounds is about 114,444 lbs, about 3.8% of their processed shrimp. Similarly, the expected annual loss in revenues/sales of processed food shrimp is about $2.84 million, or about 3.6% of their processed products' value under each of these alternatives. On a per-processor basis, the expected average annual loss in processed value is about $315,600, about 3.6% of their processed value.

The losses in volume and value to the South Atlantic processing sector as a whole and to the average processor are relatively large. For large processors, these losses will likely still be relatively minor, but the losses to small processors could be very significant depending on how those losses are distributed across processors. Marketing margins (the difference between ex-vessel/raw import prices and processed prices) are a proxy for profit margins in the processing sector. Over the past several years, marketing margins for shrimp processors have been 0.3% or less (Keithly et al. 2009; W. Keithly, pers. comm., September 14, 2016). Given their high reliance on processing shrimp in recent years, such losses would be sufficient to force some South Atlantic shrimp processors to shut down if they are highly dependent on domestic product, or force them to rely more on imports. Given the availability of imports, it is assumed that most and possibly all processors would choose to switch to imports rather than shut down. If they do switch to imported product, imports' share of the supply of shrimp in the U.S. would increase above its already currently high level of 93% (NMFS 2015).

4.3.10 Indirect Effects on TED Manufacturers and Retailers

Although the costs associated with purchasing TEDs represent an adverse economic effect to vessels and the harvesting sector in general, these costs represent expenditures that would result in additional economic activity for TED manufacturers and retailers and, therefore, be expected to significantly increase their gross revenues and likely net revenues/profits. There are currently 5 TED manufacturers and 10 TED retailers in the Gulf of Mexico, but only 1 manufacturer and retailer in the South Atlantic (J. Gearhart, pers. comm., October 6, 2016). These manufacturers and retailers would benefit the most under Alternatives 6 and 7 and the least under Alternatives 4 and 2. However, the 5 manufacturers in the Gulf of Mexico are estimated to only be able to produce about 100 TEDs per week and the manufacturer in the South Atlantic can only produce 20 TEDs per week (J. Gearhart, pers. comm., October 6, 2016). Given their relatively small numbers, the manufacturers in particular could become overwhelmed by the suddern and significantly higher level of demand under certain alternatives resulting in production bottlenecks and disruptions to their operations. Particularly under certain alternatives, it would be a considerable period of time before these manufacturers could produce the required number of TEDs to allow all affected vessels to comply with the new requirements.

Although it is theoretically possible that these manufacturers could increase their productive capacity or new businesses could open in order to meet the higher demand, we do not possess economic data on the current manufacturers, individually or in the aggregate, that would allow us to predict how much they could expand production in the short term or the long term. Further, significant increases in productive capacity typically take time and will likely not occur in the short term unless current or new producers have a high degree of certainty regarding how much additional demand there will be in the short term and the long term. Such certainty would likely only exist after the proposed regulations are final and effective, and a contractual arrangement to purchase the TEDs in bulk exists between them and some other entity(ies) (e.g., NMFS, industry organizations, NGOs, etc.). Otherwise, changes are likely to occur incrementally and over time as individual vessel owners place their orders.

In addition, given the current productive capacity and the fact that there are only 6 producers in the Southeast region, a significant spike in demand would be expected to lead to price increases without one or more fixed-price contracts, all other things being equal. Producers would have an incentive and likely the ability to increase prices knowing that vessel owners will need the TEDs in order to comply with the new regulations. Further, if manufacturers expand their productive capacity, labor markets have been tightening as unemployment has decreased and the workers still available in those markets are the least skilled workers. Some degree of skill is needed to produce TEDs and the new workers would likely not be as productive as current workers. Thus, the average cost of producing TEDs would likely increase because wages would likely increase and the average productivity of labor would likely decrease. Again, producers would have an incentive and likely the ability to pass those costs along to vessel owners in the form of higher prices. The lack of economic data on TED producers prevents us from forecasting how much prices could increase under particular circumstances.

Given the information above, and because it is uncertain whether any fixed-price contracts may be agreed upon, current TED prices and productive capacities have been used throughout the analysis. The differences in the expected number of TEDs that need to be produced and the associated expenditures on those TEDs vary considerably by alternative, mostly because the number of vessels that would be required to purchase new TEDs varies considerably by alternative, but also because the number of TEDs that particular vessels need will vary as well, particularly between Alternatives 2-5 and Alternatives 6-7. These differences are illustrated in Table 100.

Table 100. Number of TEDs and TED expenditures (in millions) by region and alternative.

	ALTERNATIVE					
	1	2	3	4	5	6-7
NUMBER OF TEDS - GULF	0	12,108	22,602	11,572	21,042	37,410
NUMBER OF TEDS - SA	0	284	664	264	608	5,818
NUMBER OF TEDS - TOTAL	0	12,392	23,266	11,836	21,650	43,228
TED EXPENDITURES - GULF	0	$3.93	$7.35	$3.70	$6.84	$14.11
TED EXPENDITURES - SA	0	$.09	$.21	$.08	$.20	$2.36
TED EXPENDITURES - TOTAL	0	$4.02	$7.56	$3.78	$7.04	$16.47

The smallest number of TEDs would be needed under Alternatives 4 and 2, at around 11,600 and 12,100 in the Gulf of Mexico, 264 and 284 in the South Atlantic, and totals of around 11,800 and 12,400 respectively. These alternatives would in turn generate the least expenditures on TEDs, at around $3.7 and $3.93 million in the Gulf of Mexico, $0.08 and $0.09 million in the South Atlantic, and totals of around $3.78 million and $4.02 million, respectively. The number of TEDs needed and the associated expenditures would be considerably higher under Alternatives 5 and 3. Specifically, the number of TEDs needed would be around 21,000 and 22,600 in the Gulf of Mexico, 608 and 664 in the South Atlantic, and totals of around 21,700 and 23,300 respectively. Expenditures on TEDs under Alternatives 5 and 3 would be around $6.84 and $7.35 million in the Gulf of Mexico, $0.2 and $0.21 million in the South Atlantic, and totals of around $7.04 million and $7.56 million, respectively. Finally, the number of TEDs needed and the associated expenditures would be the greatest under Alternatives 6 and 7. Specifically, for both alternatives, the number of TEDs needed would be around 37,410 in the Gulf of Mexico, 5,800 in the South Atlantic, for a total of about 43,200. Expenditures on TEDs under Alternatives 6 and 7 would be around $14.1 million in the Gulf of Mexico, $2.4 million in the South Atlantic, for a total of about $16.5 million. In general, expenditures on TEDs would be expected to partially offset the adverse economic impacts to affected communities and regions resulting from reductions in gross revenues/sales in the onshore sector, though these countervailing positive effects would only be temporary.

Under Alternatives 4 and 2, it would be expected to take the Gulf of Mexico manufacturers approximately 27 months—more than 2 years—to produce the number of TEDs necessary for all affected Gulf of Mexico vessels to comply with the new TED requirement. Conversely, it would be expected to take less than 5 months for the single TED manufacturer in the South Atlantic to produce the necessary number of TEDs by South Atlantic vessels. If these estimates are accurate, the single manufacturer in the South Atlantic would be expected to see an increase in gross revenue of about $85,000 under these alternatives, while the 5 manufacturers in the Gulf of Mexico would be expected to see an increase of about $390,000 in each year.

Under Alternatives 5 and 3, it would be expected to take the Gulf of Mexico manufacturers approximately 52 months—more than 4 years—to produce the number of TEDs necessary for all affected Gulf of Mexico vessels to comply with the new TED requirement. Conversely, it would be expected to take about 8 months for the single TED manufacturer in the South Atlantic to produce the necessary number of TEDs by South Atlantic vessels. If these estimates are accurate, the single manufacturer in the South Atlantic would be expected to see an increase in gross revenue of about $220,000 under these alternatives, while the 5 manufacturers in the Gulf of Mexico would be expected to see an increase of about $355,000 in each year.

Finally, under Alternatives 6 and 7, it would be expected to take the Gulf of Mexico manufacturers approximately 86 months—more than 7 years—to produce the number of TEDs necessary for all affected Gulf of Mexico vessels to comply with the new TED requirement. Conversely, it would be expected to take about 67 months—more than 5 years—for the single TED manufacturer in the South Atlantic to produce the necessary number of TEDs by South Atlantic vessels. If these estimates are accurate, the single manufacturer in the South Atlantic would be expected to see an increase in gross revenue of about $470,000 under these alternatives, while the 5 manufacturers in the Gulf of Mexico would be expected to see an increase of about $403,000 in each year.

These results suggest that, given the current capacity to produce new TEDs, a delay in the effectiveness of the new requirements of at least 1-2 years will likely be needed, particularly in the Gulf of Mexico, under Alternatives 4 and 2. A much longer delay will likely be necessary under

Alternatives 5 and 3. If Alternative 6 or 7 is chosen, additional action will likely be needed to get the requisite number of TEDs produced within a reasonable period of time, as 7 years will likely not be considered “reasonable” by various stakeholder groups.

4.3.11 Potential Changes in Effects if Certain Vessels Shut Down

The analyses of Alternatives 2-7 noted the strong possibility that certain vessels could be forced to shut down due to the relatively large adverse effects in the first year (i.e., the combination of TED costs and losses in gross revenue due to shrimp loss). It was also noted that, in general, the vessels most likely to shut down as a result of these adverse effects are the part-time vessels (i.e., the vessels in the Q1, Q2, and Q3 categories). These vessels have the lowest average annual gross revenues per vessel ($4,424, $22,876, and $39,364, respectively), earn relatively high negative net revenues on average, and are therefore the least able to absorb revenue reductions and cost increases.

In theory, vessels and businesses in general are expected to shut down when they cannot cover their variable costs. However, data on variable costs is not available for all vessels potentially affected by the considered alternatives. Estimates of average variable costs for certain vessels are available, as are estimates of net revenues, but those estimates are not helpful with respect to estimating how many and which vessel owners will likely choose to stop operating. Thus, the most appropriate measure to use for projecting how many and which vessels may stop operating is the percentage loss in average annual gross revenue, estimates of which are available for all of the potentially affected vessels.

There is no single “hard and fast” decision rule for determining what percentage loss in gross revenue will definitively cause a vessel to stop operating. However, given the characteristics of these part-time vessels as noted above, it seems reasonable to assume that an adverse effect in the first year that represents more than 20% of their average annual gross revenue would be sufficient to cause them to shut down. If vessels choose to shut down rather than continue operating, the losses to the harvesting sector would change, as would the indirect effects to the onshore sector (dealers, processors, and TED manufacturers and retailers). As there is some uncertainty with respect to this outcome, only certain changes in the effects are explored below.

Table 101 illustrates the results of applying the shut down decision rule described above. Because Alternatives 6 and 7 affect many more vessels than the other alternatives, they also cause the most part-time vessels to shut down. However, the differences between the other alternatives require additional explanation, particularly with respect to the percentage of affected vessels that are expected to shut down. The numbers of part-time vessels expected to shut down are greater under Alternatives 3 and 5 compared to Alternatives 2 and 4, and this is to be expected as Alternatives 3 and 5 will affect more vessels. However, the percentage of affected vessels that are expected to shut down are considerably higher under Alternatives 3 and 5 (48%) relative to Alternatives 2 and 4 (28%). This result occurs because vessels less than 26 ft are affected under Alternatives 3 and 5, but not under Alternatives 2 and 4, and proportionally more of the Q1, Q2, and Q3 vessels that use skimmer trawls, pusher-head trawls, and wing nets are less than 26 ft.

Table 101. Number of Part-time Vessels Projected to Shut Down by Alternative.

	ALTERNATIVE					
	1[1]	2	3	4	5	6-7
GULF	0	832	2,728	778	2,526	3,718
SA	0	28	82	25	71	434
TOTAL	0	860	2,810	803	2,597	4,152
% OF AFFECTED VESSELS	N/A	27.7	48.1	27.6	47.8	42.8

[1] Because some of these vessels were already earning negative net revenues, it may not be completely accurate to say that none of them would shut down under Alternative 1 (No Action). However, the point of the table is to convey the relative effects of the management measures under each alternative, and so the comparison is valid.

If vessels shut down, the estimates of adverse effects change significantly, but differently as well depending on the measure. In general, if vessels shut down, they will no longer be landing shrimp or other species, nor will they be generating gross revenues or net revenues associated with those landings (i.e., their loss in landings and gross revenue is 100%). Thus, those landings and gross revenues will be lost to the fisheries, all other things being equal. Further, the average percentage loss in gross revenue per vessel will in turn increase, particularly in the long-term because shutting down causes a long-term reduction in landings and gross revenue for the vessels that shut down. In theory, the loss of net revenues may improve or worsen economic conditions within the affected group of vessels depending on whether the economic performance (as measured by net revenues) of the vessels that shut down is better or worse than the average vessel. Because the vessels shutting down are thought to earn relatively high losses in net revenue terms, economic performance for the group would be expected to improve in the aggregate and on average.

On the other hand, because vessels that shut down will no longer require TEDs, the number of TEDs needed and the total costs of purchasing those TEDs will decrease. The decrease in TED costs will help to mitigate the total adverse effects in the aggregate, but the losses in gross revenue would generally be expected to far outweigh the reductions in aggregate TED costs and thus the total adverse effects would be expected to increase. Further, the reductions in TED costs do not mitigate such costs for the vessels that continue operating.

The results in Table 102 bear out these expected results with respect to Alternative 2. For example, if certain vessels shut down, the losses in food shrimp landings increase by about 1.32 million lbs and 33,000 lbs for Gulf of Mexico and South Atlantic vessels, respectively. The losses in gross revenue increase by almost $2.9 million and $83,000 for Gulf of Mexico and South Atlantic vessels, respectively. The number of TEDs needed decreases by about 3,300 and 110 for Gulf of Mexico and South Atlantic vessels, respectively. In turn, TED costs decrease by about $1.1 million and $36,000 for Gulf of Mexico and South Atlantic vessels, respectively. Thus, the total adverse effects in the first year increase by about $1.8 million and $70,000 for Gulf of Mexico and South Atlantic vessels, respectively. The adverse effect per vessel as a percentage of gross revenue in the first year differs little from the initial estimates when certain vessels were not assumed to shut down, though the average is somewhat less in the Gulf because some vessels are not incurring TED costs, but the total adverse effect as a percentage of gross revenue in the long-term is significantly higher at 31% and 40% compared to 5% and 2% for Gulf of Mexico and South Atlantic vessels, respectively. However, the economic performance of the vessels that remain is markedly better compared to the situation where vessels experienced the adverse effects but none stopped operating.

Specifically, when vessels did not shut down, the aggregate net revenues for this group of vessels were losses of about $16.6 million and $323,000 for Gulf of Mexico and South Atlantic vessels in the first year, respectively. The average net revenues per vessel in the first year were losses of about $5,500 and $4,100 for Gulf of Mexico and South Atlantic vessels, respectively. Conversely, these losses are reduced to $7.9 million for Gulf of Mexico vessels while South Atlantic vessels have positive net revenues of about $2,000 in the aggregate. On a per-vessel basis, the average loss is reduced to about $3,600 for Gulf of Mexico vessels while South Atlantic vessels earn a positive net revenue of about $50 (i.e., break-even).

Table 102. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels, net revenue post-effects year 1, and number of TEDs needed under Alternative 2 if vessels shut down. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT YEAR 1	PERCENT GROSS REVENUE LOSS YEAR 1	PERCENT GROSS REVENUE LOSS LONG-TERM	NET REVENUE YEAR 1	NUMBER OF TEDS
NUMBER OF VESSELS	3,032	3,032	2,200	3,032	3,032	3,032	2,200	2,200
AVERAGE TOTAL GULF	3,496,265	$8,211,966	$2,854,150	$11,066,116	N/A	N/A	-$7,874,288	8,782
AVERAGE PER VESSEL GULF	1,153	$2,708	$1,297	$3,650	33.6	30.6	-$3,579	4.0
NUMBER OF VESSELS	71	71	43	71	71	71	43	43
AVERAGE TOTAL SA	44,248	$106,383	$55,900	$162,283	N/A	N/A	$2,151	172
AVERAGE PER VESSEL SA	623	$1,498	$1,300	$2,286	43.3	40.2	$50	4

Similar results occur under Alternative 3 as illustrated in in Table 103, though at a much higher scale. If certain vessels shut down, the losses in food shrimp landings increase by about 3.1 million lbs and 83,000 lbs for Gulf of Mexico and South Atlantic vessels, respectively. The losses in gross revenue increase by almost $6.8 million and $221,000 for Gulf of Mexico and South Atlantic vessels, respectively. The number of TEDs needed decreases by about 10,900 and 320 for Gulf of Mexico and South Atlantic vessels, respectively. In turn, TED costs decrease by about $3.6 million and $100,000 for Gulf of Mexico and South Atlantic vessels, respectively. Thus, the total adverse effects in the first year increase by about $3.2 million and $116,000 for Gulf of Mexico and South Atlantic vessels, respectively. The adverse effect per vessel as a percentage of gross revenue in the first year differs somewhat from the initial estimates when certain vessels were not assumed to shut down, as the average is noticeably less in the Gulf of Mexico and slightly less in the South Atlantic because some vessels are not incurring TED costs, but the total adverse effect as a percentage of gross revenue in the long-term is significantly higher at 50% and 47% compared to 5% and 2% for Gulf of Mexico and South Atlantic vessels, respectively. However, the economic performance of the vessels that remain is markedly better compared to the situation where vessels experienced the adverse effects but none stopped operating. Specifically, when vessels did not shut down, the aggregate net revenues for this group of vessels were losses of about $43 million and $1.3 million for Gulf of Mexico and South Atlantic vessels in the first year, respectively. The average net revenues per vessel in the first year were losses of about $7,600 for both Gulf of Mexico and South

Atlantic vessels. Conversely, these losses are reduced to $14.4 million and $492,000 for Gulf of Mexico and South Atlantic vessels in the aggregate, respectively. On a per-vessel basis, the average losses are reduced to about $4,900 and $5,200 for Gulf of Mexico and South Atlantic vessels, respectively.

Table 103. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels, net revenue post-effects year 1, and number of TEDs needed under Alternative 3 if vessels shut down. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT YEAR 1	PERCENT GROSS REVENUE LOSS YEAR 1	PERCENT GROSS REVENUE LOSS LONG-TERM	NET REVENUE YEAR 1	NUMBER OF TEDS
NUMBER OF VESSELS	5,660	5,660	2,932	5,660	5,660	5,660	2,932	2,932
AVERAGE TOTAL GULF	5,614,803	$12,939,647	$3,799,900	$16,739,547	N/A	N/A	-$14,435,274	11,692
AVERAGE PER VESSEL GULF	992	$2,286	$1,296	$2,958	52.7	50.2	-$4,923	4.0
NUMBER OF VESSELS	177	177	95	177	177	177	95	95
AVERAGE TOTAL SA	98,475	$246,860	$111,800	$358,660	N/A	N/A	-$491,674	344
AVERAGE PER VESSEL SA	556	$1,395	$1,177	$2,026	50.5	46.8	-$5,176	3.6

Results under Alternative 4 are illustrated in in Table 104 and similar to results under Alternative 2. If certain vessels shut down, the losses in food shrimp landings increase by about 1.2 million lbs and 35,000 lbs for Gulf of Mexico and South Atlantic vessels, respectively. The losses in gross revenue increase by almost $2.7 million and $80,000 for Gulf of Mexico and South Atlantic vessels, respectively. The number of TEDs needed decreases by about 3,300 and 100 for Gulf of Mexico and South Atlantic vessels, respectively. In turn, TED costs decrease by about $3.6 million and $100,000 for Gulf of Mexico and South Atlantic vessels, respectively. Thus, the total adverse effects in the first year increase by about $1 million and $27,000 for Gulf of Mexico and South Atlantic vessels, respectively. The adverse effect per vessel as a percentage of gross revenue in the first year differs slightly from the initial estimates when certain vessels were not assumed to shut down, as the average is slightly less in the Gulf of Mexico, but the total adverse effect as a percentage of gross revenue in the long-term is significantly higher at 30% and 39% compared to 5% and 2% for Gulf of Mexico and South Atlantic vessels, respectively. However, the economic performance of the vessels that remain is markedly better compared to the situation where vessels experienced the adverse effects but none stopped operating. Specifically, when vessels did not shut down, the aggregate net revenues for this group of vessels were losses of about $15.7 million and $228,000 for Gulf of Mexico and South Atlantic vessels in the first year, respectively. The average net revenues per vessel in the first year were losses of about $5,500 and $3,500 for Gulf of Mexico and South Atlantic vessels, respectively. Conversely, these losses are reduced to $7.5 million for Gulf of Mexico vessels while South Atlantic vessels earn positive net revenues of about $31,000 in the aggregate. On a per-vessel basis, the average loss is reduced to $3,600 for Gulf of Mexico vessels while South Atlantic vessels earn positive net revenue of about $760, or just above break-even.

Table 104. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels, net revenue post-effects year 1, and number of TEDs needed under Alternative 4 if vessels shut down. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT YEAR 1	PERCENT GROSS REVENUE LOSS YEAR 1	PERCENT GROSS REVENUE LOSS LONG-TERM	NET REVENUE YEAR 1	NUMBER OF TEDS
NUMBER OF VESSELS	2,847	2,847	2,069	2,847	2,847	2,847	2,069	2,069
AVERAGE TOTAL GULF	3,316,785	$7,774,222	$2,684,500	$10,458,722	N/A	N/A	-$7,484,630	8,260
AVERAGE PER VESSEL GULF	1,165	$2,731	$1,297	$3,674	33.5	30.4	-$3,618	4.0
NUMBER OF VESSELS	66	66	41	66	66	66	41	41
AVERAGE TOTAL SA	41,628	$97,222	$53,300	$150,522	N/A	N/A	$31,192	164
AVERAGE PER VESSEL SA	631	$1,473	$1,300	$2,281	41.8	38.7	$761	4

Results under Alternative 5 are illustrated in in Table 105, and are comparable to the results for Alternative 3. If certain vessels shut down, the losses in food shrimp landings increase by about 32.9 million lbs and 65,000 lbs for Gulf of Mexico and South Atlantic vessels, respectively. The losses in gross revenue increase by almost $6.3 million and $186,000 for Gulf of Mexico and South Atlantic vessels, respectively. The number of TEDs needed decreases by about 10,200 and about 270 for Gulf of Mexico and South Atlantic vessels, respectively. In turn, TED costs decrease by about $3.3 million and $92,000 for Gulf of Mexico and South Atlantic vessels, respectively. Thus, the total adverse effects in the first year increase by about $3 million and $87,000 for Gulf of Mexico and South Atlantic vessels, respectively. The adverse effect per vessel as a percentage of gross revenue in the first year differs somewhat from the initial estimates when certain vessels were not assumed to shut down, as the average is noticeably less in the Gulf of Mexico and slightly less in the South Atlantic because some vessels are not incurring TED costs, but the total adverse effect as a percentage of gross revenue in the long-term is significantly higher at 50% and 44% compared to 5% and 2% for Gulf of Mexico and South Atlantic vessels, respectively. However, the economic performance of the vessels that remain is markedly better compared to the situation where vessels experienced the adverse effects but none stopped operating. Specifically, when vessels did not shut down, the aggregate net revenues for this group of vessels were losses of about $33.9 million and $1.1 million for Gulf of Mexico and South Atlantic vessels in the first year, respectively. The average net revenues per vessel in the first year were losses of about $6,300 and $6,100 for Gulf of Mexico and South Atlantic vessels, respectively. Conversely, these losses are reduced to $13.5 million and $452,000 for Gulf of Mexico and South Atlantic vessels in the aggregate, respectively. On a per-vessel basis, the average losses are reduced to $4,900 for both Gulf of Mexico and South Atlantic vessels.

Table 105. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels, net revenue post-effects year 1, and number of TEDs needed under Alternative 5 if vessels shut down. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT YEAR 1	PERCENT GROSS REVENUE LOSS YEAR 1	PERCENT GROSS REVENUE LOSS LONG-TERM	NET REVENUE YEAR 1	NUMBER OF TEDS
NUMBER OF VESSELS	5,269	5,269	2,743	5,269	5,269	5,269	2,743	2,743
AVERAGE TOTAL GULF	5,270,230	$12,137,550	$3,554,850	$15,692,400	N/A	N/A	-$13,463,011	10,938
AVERAGE PER VESSEL GULF	1,000	$2,304	$1,296	$2,978	52.5	50.0	-$4,908	4.0
NUMBER OF VESSELS	163	163	92	163	163	163	92	92
AVERAGE TOTAL SA	80,084	$211,365	$107,900	$319,265	N/A	N/A	-$452,296	332
AVERAGE PER VESSEL SA	491	$1,297	$1,173	$1,959	47.9	44.1	-$4,916	3.6

Results under Alternatives 6 and 7 are illustrated in in Table 106, though at a much higher scale compared to the other alternatives. If certain vessels shut down, the losses in food shrimp landings increase by about 4.1 million lbs and 350,000 lbs for Gulf of Mexico and South Atlantic vessels, respectively. The losses in gross revenue increase by almost $9.6 million and $1.3 for Gulf of Mexico and South Atlantic vessels, respectively. The number of TEDs needed decreases by about 15,100 and 1,700 for Gulf of Mexico and South Atlantic vessels, respectively. In turn, TED costs decrease by about $2 million and $520,000 for Gulf of Mexico and South Atlantic vessels, respectively. Thus, the total adverse effects in the first year increase by about $4.5 million and $760,000 for Gulf of Mexico and South Atlantic vessels, respectively. The adverse effect per vessel as a percentage of gross revenue in the first year differs significantly from the initial estimates when certain vessels were not assumed to shut down, as the average is noticeably less in the Gulf of Mexico and South Atlantic because many vessels are not incurring TED costs, but the total adverse effect as a percentage of gross revenue in the long-term is significantly higher at 47% and 35% compared to 5% and 3% for Gulf of Mexico and South Atlantic vessels, respectively. However, the economic performance of the vessels that remain is markedly better compared to the situation where vessels experienced the adverse effects but none stopped operating. Specifically, when vessels did not shut down, the aggregate net revenues for this group of vessels were losses of about $61.7 million and $5.3 million for Gulf of Mexico and South Atlantic vessels in the first year, respectively. The average net revenues per vessel in the first year were losses of about $7,700 and $4,100 for Gulf of Mexico and South Atlantic vessels, respectively. Conversely, these losses are reduced to $25.2 million and $827,000 for Gulf of Mexico and South Atlantic vessels in the aggregate, respectively. On a per-vessel basis, the average losses are only about $5,400 and $940 for Gulf of Mexico and South Atlantic vessels, respectively.

Table 106. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels, net revenue post-effects year 1, and number of TEDs needed under Alternatives 6 and 7 if vessels shut down. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT YEAR 1	PERCENT GROSS REVENUE LOSS YEAR 1	PERCENT GROSS REVENUE LOSS LONG-TERM	NET REVENUE YEAR 1	NUMBER OF TEDS
NUMBER OF VESSELS	8,401	8,401	4,683	8,401	8,401	8,401	4,683	4,683
AVERAGE TOTAL GULF	11,207,686	$34,291,301	$8,987,700	$43,279,001	N/A	N/A	-$25,221,169	22,260
AVERAGE PER VESSEL GULF	1,334	$4,082	$1,919	$5,152	49.1	46.7	-$5,386	4.8
NUMBER OF VESSELS	1310	1310	876	1310	1310	1310	876	876
AVERAGE TOTAL SA	1,481,907	$4,177,487	$1,781,000	$5,958,487	N/A	N/A	-$827,232	4,184
AVERAGE PER VESSEL SA	1,131	$3,189	$2,033	$4,548	43.8	35.0	-$944	4.8

Because reductions in gross revenue in the harvesting sector indirectly affect dealers and processors, and those reductions increase under Alternatives 2-7 if vessels shut down, the indirect adverse effects to those entities are also expected to increase if vessels shut down. The affected dealers and processors are not expected to change regardless of whether vessels shut down, so the characteristics of the affected dealers and processors described in Sections 4.3.9 and 4.3.10 would also not change and are therefore incorporated here by reference. Table 107 illustrates the expected percentage reductions in gross sales to Gulf of Mexico and South Atlantic dealers and processors under each alternative using the expected reductions in gross revenue to the harvesting sector as described in Tables 102-106.

Table 107. Percent reduction in gross sales for Gulf of Mexico and South Atlantic dealers and processors if vessels shut down, by alternative.

	ALTERNATIVE					
	1	2	3	4	5	6-7
GULFDEALERS	0	3.3	5.2	3.4	5.2	5.5
SA DEALERS	0	.4	1	.4	.9	7.4
GULF PROCESSORS	0	1.1	1.7	1.1	1.7	4.6
SA PROCESSORS	0	.1	.3	.1	.2	4.5

Although the percentage reductions in gross sales for South Atlantic dealers and processors are higher under Alternatives 2-5 if certain vessels shut down, all of the reductions are still 1% or less and thus the sector as a whole and the "average" South Atlantic dealer and processor should be able to absorb these reductions or compensate by shifting to purchases of other domestic seafood products or imports. The same cannot be said for Gulf of Mexico processors and dealers. When vessels were not assumed to shut down, the expected percentage losses in gross sales for Gulf processors were 0.7-0.8%, whereas they are now between 1.1% under Alternatives 2 and 4 and 1.7% under Alternatives 3 and 5. Keeping in mind the relatively low marketing margins for processors in recent years (0.3%), these higher reductions would increase the risk of processors shutting down, particularly smaller processors, and also make it more likely and difficult to substitute imported product in place of lost domestic production. More pronounced are the greater adverse effects on Gulf of Mexico dealers. When vessels were not assumed to shut down, the reductions in gross sales ranged from 2.2% under Alternatives 2 and 4 to 2.5% under Alternatives 3 and 5. Although the reductions under Alternatives 2 and 4 are not significantly greater when vessels do shut down (3.3-3.4%), the reductions are more than 5% and thus considerably greater under Alternatives 3 and 5 if vessels shut down. Even if some dealers are able to compensate by shifting to other domestic production, it is unlikely all of them will be able to do so and thus these reductions would be expected to cause some Gulf of Mexico dealers to shut down, particularly vessel owners that act as their own dealers and other small dealers.

Under Alternatives 6 and 7, the higher reductions in gross revenues for the harvesting sector when vessels shut down exacerbate the relatively high reductions in gross sales to dealers and processors in both regions. The percentage losses to Gulf of Mexico and South Atlantic processors increase from 3.3% and 3.6% to 4.6% and 4.5%, respectively. Similarly, the percentage losses to Gulf of Mexico and South Atlantic dealers increase from 4% and 5% to 5.5% and 7.4%. All of these reductions are sufficiently high to cause some processors and particularly dealers to stop operating. Most susceptible to this outcome are vessel owners that act as their own dealers, other smaller dealers, and relatively small processors. In short, these reductions would lead to consolidation and restructuring in the onshore sector.

With respect to TED manufacturers and retailers, as discussed above, the number of TEDs needed and the resulting expenditures on those TEDs are expected to be significantly less under Alternatives 2-7 if vessels shut down relative compared to the expected values if they do not shut down. Thus, the increases in gross revenues and, likely, net revenues/profits would not be nearly as great for these businesses if vessels shut down. This is particularly the case under Alternatives 3, 5, and 6-7. In addition, the time to produce the needed number of TEDs is also considerably lower if certain vessels shut down. However, the time necessary to produce TEDs in the Gulf of Mexico is still more than 1.5 years under Alternatives 2 and 4, more than 2 years under Alternatives 3 and 5, and is 4 years or more in both the Gulf of Mexico and South Atlantic under Alternatives 6 and 7. These outcomes are reflected in Table 108.

Table 108. Number of TEDs and TED expenditures (in millions) if vessels shut down by region and alternative.

	ALTERNATIVE					
	1	2	3	4	5	6-7
NUMBER OF TEDS - GULF	0	8,782	11,696	8,260	10,942	22,264
NUMBER OF TEDS - SA	0	172	344	164	332	4,184
NUMBER OF TEDS - TOTAL	0	8,954	12,040	8,424	11,274	26,448
TED EXPENDITURES - GULF	0	$2.8	$3.8	$2.7	$3.6	$9.0
TED EXPENDITURES - SA	0	$.06	$.11	$.05	$.11	$1.8
TED EXPENDITURES - TOTAL	0	$2.9	$3.9	$2.8	$3.7	$10.8
TIME TO PRODUCE - GULF	N/A	1.7 YEARS	2.3 YEARS	1.6 YEARS	2.1 YEARS	5.1 YEARS
TIME TO PRODUCE - SA	N/A	2 MONTHS	5 MONTHS	2 MONTHS	4 MONTHS	4 YEARS

4.4 DIRECT AND INDIRECT EFFECTS ON THE SOCIAL ENVIRONMENT

Effects from fishery management changes on the social environment are difficult to analyze due to complex human-environment interactions and a lack of quantitative data about those interactions.

Generally, social effects can be categorized according to changes in: human behavior (what people do), social relationships (how people interact with one another), and human-environment interactions (how people interact with other components of their environment, including enforcement agents and fishery managers). It is generally accepted that a positive correlation exists between economic effects and social effects. Thus, proposed alternatives predicting positive or negative economic effects as discussed in Section 4.3 are expected to have correlating positive or negative social effects.

All of the proposed alternatives with the exception of the no-action alternative (Alternative 1) would directly impact Gulf of Mexico and South Atlantic commercial shrimp trawl vessel owners, fishers, and commercial shrimp trawl fishing operations in a negative manner. Associated communities could experience indirect negative effects. In addition, all of the proposed alternatives with the exception of Alternative 1 would indirectly impact Gulf of Mexico and South Atlantic shrimp dealers and processors in a negative manner.

Alternatives 2-7 include a range of affected shrimp trawl vessels, which is determined by the gear type, vessel size, and fishing areas included in each alternative. A variety of factors influence the effects on each vessel and are dependent on vessel size, gear, and geographic location and include: price of TEDs, number of TEDs required, shrimp loss, allowable gear, length of time to build the required TEDs, and safety. These details are discussed below.

If one of the alternatives (Alternatives 2-7) is selected, shrimp vessels included in that alternative would be required to purchase TEDs designed to exclude small turtles for each trawl net. TED costs vary according to small (quoted prices range from $241 to $400), medium ($280 to $400), and large ($360 to $605) grid size. Larger offshore vessels will likely use larger grids and most skimmer trawlers and smaller otter trawlers fishing inshore waters could use smaller grids. In order to provide estimates of costs in Section 4.3, costs for new TEDs are estimated at $325 for smaller vessels and $550 for larger vessels using larger TEDs.

Shrimp trawl vessels have a varying number of nets. In general, skimmer trawls have 2 nets per vessel. Otter trawls can have 2 or 4 nets; many vessels use quad rigs with 4 nets, but some small boats may only drag 2 nets. Furthermore, most vessels will want an extra set of TEDs in case a TED is damaged during fishery operations.

Shrimp vessels experience loss of shrimp catch and a resulting loss of revenue stemming from the use of TEDs. Skimmers, pusher-heads, and wing nets are not currently required to use TEDs. The range of shrimp loss for skimmers, pusher-heads, and wing nets is estimated to be 6.21% on average. Because otter trawlers are already required to use TEDs with a larger bar spacing (i.e., 4-in) than that which would be required to exclude small turtles and already have experienced shrimp loss from the installation of the old, larger TED, the revenue loss for otter trawlers is estimated to be less than that of skimmers, 4.43%. Shrimp dealers and processors would be negatively impacted through the loss in shrimp resulting from the loss experienced by shrimp vessels with TEDs.

The number of net shops prepared to build TEDs designed to exclude small turtles and the production capability of those shops varies by state. Production capability is roughly 60 TEDs per week in Louisiana, 60 per week in North Carolina, 20 per week in Alabama, and 20 per week in Florida (J. Gearhart, NMFS, pers. comm., Oct. 6, 2016). This production capability could impact how quickly the portion of the fleet affected by an alternative becomes compliant with the requirement to use TEDs designed to exclude small turtles. In addition, the production capability could possibly impact fishers if they were to receive a sub-par TED in an attempt to quickly produce them to meet the needs of the fleet. The production capability and length of time for the fleet to become compliant is discussed in detail in the Economic Effects in Section 4.3.10.

Safety at sea could be an issue, particularly under Alternatives 3, 5, 6, and 7, which include small vessels. Small vessels have limited deck space and could be operated by a single individual. Possible issues related to TED use, such as a TED clogged by debris or net entanglement in the motor due to a lengthened net to accommodate the TED extension, could contribute to an issue with safety at sea, such as a man overboard.

The shrimp fisheries face current challenges such as fuel costs, competition from foreign imports, low product prices, impact from the DWH oil spill, and lingering effects on fishing infrastructure due to past hurricanes. Comments received on this action expressed concern that any additional burden could jeopardize the fisheries.

Additionally, Alternatives 2-7 could indirectly impact TED manufacturers and retailers in the Southeastern U.S. that have the ability to build TEDs designed to exclude small turtles. TED manufacturers and retailers would be impacted in a positive manner through business generated by building TEDs. The public could also be impacted in a positive manner through the conservation benefit to sea turtles from TEDs designed to exclude small sea turtles.

4.4.1 Effects of Alternative 1: No Action

The continuation of effects of current TED requirements for Southeastern U.S. shrimper fishers would continue under the status quo alternative. Under Alternative 1, no additional shrimp trawl vessels would be required to use TEDs. Shrimp trawl vessels in the Gulf of Mexico and South Atlantic would continue to be required to use TEDs; whereas vessels exempt to TED requirements (vessels that have no power or mechanical-advantage trawl retrieval system; are bait shrimpers that retain all live shrimp on board with a recirculating seawater system; fish with a pusher-head trawl, skimmer trawl, or wing net; or use a single try net with a headrope 12 ft or less in length) could continue to use alternative tow times in lieu of TEDs. Shrimp trawlers currently required to use TEDs would continue to be required to maintain them and, therefore, continue to incur the cost of maintenance. In addition, shrimp trawls vessels with current TEDs would continue to experience a loss in shrimp catch and revenue from the use of TEDs. Net shops would continue to benefit from the requirement to use current TEDs (through their production of these TEDs) and the public would continue to experience the conservation benefits to sea turtles from the use of current TEDs. Shrimp dealers and processors would continue to operate with the amount of shrimp landed by shrimp vessels.

4.4.2 Effects of Alternative 2: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

Skimmer trawl and wing net (butterfly) vessels operate in Louisiana (3,651 skimmer trawls and 960 wing nets), Mississippi (150 skimmer trawls and 50 skimmer-otter trawls), Florida (1 skimmer trawl and 103 wing nets) and North Carolina (75 skimmer trawls) (Table 2). Shrimp vessel owners, fishers, and shrimp fishing operations in these states and which operate skimmer trawls, pusher-head trawls, and wing nets on vessels 26 ft and greater in length, with the exception of the Biscayne Bay wing net fishery, would experience negative effects under this alternative.

Communities or parishes that would experience the greatest effects from this alternative can be gleaned from information presented in Section 3.5, on the top communities or parishes by state-licenses or active fishers. Top communities are included by state for Louisiana (Table 24, includes top communities by skimmer trawl and wing net licenses), Mississippi (Table 25), Florida (Table 28 and description in Section 3.5.3.2), and North Carolina (Tables 32 and 33).

Alternative 2 ranks fifth (effects range from 1=most to 7=least) in terms of the number of impacted vessels. As reported in Table 45, approximately 3,103 vessels including 3,032 Gulf of Mexico vessels and 71 South Atlantic vessels are expected to be impacted under this alternative. The majority (68.6%, 2,130 vessels) of vessels affected under Alternative 2 are part-time. The number of full-time vessels affected under Alternative 2 is 973 vessels. Economic effects are described in Section 4.4 and include revenue loss and TED costs which impact the net revenue from operations of a shrimp trawler. Effects include average total costs of $3,062 for Gulf of Mexico vessels (revenue loss of $1,764 and $1,298 for TED costs) (Table 46) and average total costs of $1,569 for South Atlantic vessels (revenue loss of $269 and TED costs of $1,300) for the first year. Average revenue loss for the first year for Gulf of Mexico vessels is 43.3% gross and 54.4% net revenue; whereas the average expected loss for South Atlantic vessels is 40% gross and 21.9% net (Table 47). As reported in Table 47, vessels would experience a loss of revenue in the long term including an average 4.6% gross and 34.4% net for Gulf of Mexico vessels and an average 1.8% gross and 4.5% net for South Atlantic vessels. As described in Section 4.3, under this alternative the average net revenue is already negative from operations for affected Gulf of Mexico (-$2,419) and South Atlantic (-$2,494) vessels and additional costs would increase the losses that these vessels are already incurring. Greater negative effects will be experienced for those vessels with negative net revenues. However, the economic effects vary depending categories of vessels based on particular types of vessels (see Section 4.3 for a detailed description of these effects).

Under Alternative 2, it is expected that some vessels and particularly smaller and part-time operations would stop shrimping because of the negative effects due to requirement to use TEDs designed to exclude small turtles. As described in Section 4.3, the majority (80%) of Gulf of Mexico vessels affected under Alternative 2 falls into the categories (Q1 = 1,212 vessels, Q2 = 359 vessels, and Q3 = 501 vessels) that have the lowest average annual gross revenue and lowest average annual net revenue (Table 48). The relative effects on these vessels are greater. It is highly likely that many of the vessels with the smallest cash inflow (Q1 vessels) would stop shrimping under Alternative 2. And some Q2 and Q3 vessels would also stop shrimping. As described in Section 4.3 regarding South Atlantic vessels, RSLA (3 vessels) and SPA Secondary vessels (1 vessel) may choose not to harvest shrimp in the future using skimmer trawls and wing nets, some and possibly many Q1 vessels would stop shrimping, and some Q2 and Q3 vessels may stop shrimping. Under Alternative 2, the total number of South Atlantic Q1, Q2, and Q3 vessels is 38, 7, and 13 vessels, respectively (Table 51). The total number of vessels included in all impacted categories which are likely to or may choose to stop shrimping under Alternative 2 is 2,134 vessels. As reported in Section 4.3.11, the number of part-time vessels projected to shut down under Alternative 2 is 860 vessels (27.7% of affected vessels).

Negative economic effects to a fishing vessel can be tied to social effects. A loss in revenue or income could result in negative impacts to the vessels owner or fisher and his/her fishing family. Or it could result in the inability of a vessel owner to remain in the fishery. This could result in negative social effects to the fisher and fishing family. As was mentioned above, comments were received regarding the challenges facing the shrimp fisheries and concern was expressed that any additional burden could jeopardize it.

Under Alternative 2, shrimp dealers and processors would be negatively impacted in an indirect manner from a loss of shrimp passed on from the vessels impacted under this alternative. Only shrimp dealers and processors that receive shrimp from affected vessels under Alternative 2 would be impacted by this alternative. The magnitude of the economic effects is discussed in detail in Sections 4.3.9 and 4.3.11.

Under Alternative 2, TED manufacturers and retailers would benefit from the production of TEDs for skimmer trawls, pusher-head trawls, and wing nets on vessels 26 ft and greater in length except for in the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida. Because this alternative is ranked fourth by the total number of TEDs and TED expenditures (Tables 100 and 108), it would also be ranked fourth for overall positive effects to TED manufacturers and retailers. However, the effects differ according to sub-region and the number of impacted vessels under Alternative 2 (see Sections 4.3.10 and 4.3.11 for a detailed description of these effects). As discussed in Section 4.3.10, assuming all vessels remained in the fisheries, it could take approximately 2.3 years for the vessels affected under Alternative 2 to become compliant with the requirement to use TEDs designed to exclude small sea turtles because of the production capability of TED manufacturers and retailers.

Under Alternative 2, the public would benefit through the conservation benefit to sea turtles from TEDs designed to exclude small sea turtles being required on skimmer trawls, pusher-head trawls, and wing nets on vessels 26 ft and greater in length, except for in the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida.

4.4.3 Effects of Alternative 3 (Preferred Alternative): Amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles

Similar to the discussion for Alternative 2, shrimp vessel owners, fishers, and shrimp fishing operations in states that operate skimmer trawls, pusher-head trawls, and wing nets, with the exception of the Biscayne Bay wing net fishery, would experience negative effects under this alternative. Communities or parishes that would experience the greatest effects from this alternative can be gleaned from information presented in Section 3.5, on the top communities or parishes by state-licenses or active fishermen. Top communities are included by state for Louisiana (Table 24 includes top communities by wing net licenses and skimmer trawl licenses), Mississippi (Tables 25-26), Florida (Table 28 and description in east and west Florida portion of Section 3.5.3.2), and North Carolina (Tables 32-34).

Alternative 3 (Preferred Alternative) ranks third (effects range from 1=most to 7=least) in terms of the number of impacted vessels. As reported in Table 54 approximately 5,837 vessels including 5,660 Gulf of Mexico vessels and 177 South Atlantic vessels are expected to be impacted under this alternative. The majority (81.1%, 4,734 vessels) of vessels affected under Alternative 3 (Preferred Alternative) are part-time. The number of full-time vessels affected under Alternative 3 (Preferred Alternative) is 1,103 vessels. Economic effects are described in Section 4.3 and include revenue loss and TED costs which impact the net revenue from operations of a shrimp trawl vessel. Effects include average total costs of $2,383 for Gulf of Mexico vessels (revenue loss of $1,085 and $1,298 for TED costs) (Table 55) and average total costs of $1,365 for South Atlantic vessels (revenue loss of $146 and TED costs of $1,219) for the first year. Average revenue loss for the first year for Gulf of Mexico vessels is 122.1% gross and 38.3% net revenue; whereas the average expected loss for South Atlantic vessels is 68.3% gross and 17.3% net (Table 56). As reported in Table 56, vessels would experience revenue loss in the long term including an average 4.6% gross and 20.4% net for Gulf of Mexico vessels and an average 1.5% gross and 2.2% net for South Atlantic vessels. Under this alternative, the average net revenue is negative from operations for affected Gulf of Mexico (-$5,214) and South Atlantic (-$6,198) vessels. Greater negative effects will be experienced for those vessels with negative net revenues. However, the economic effects vary depending categories of vessels based on particular types of vessels (see Section 4.3 for a detailed description of these effects).

Under Alternative 3 (Preferred Alternative), it is expected that some vessels and particularly smaller and part-time operations would stop shrimping because of the negative effects due to requirement to use TEDs designed to exclude small turtles. As described in Section 4.3, the majority of Gulf of Mexico vessels adversely affected under Alternative 3 (Preferred Alternative) are the least able to absorb reductions in revenue and cost increases. Many and possibly most of the vessels with the smallest cash inflow (Q1 vessels) would likely choose to stop shrimping under Alternative 3 (Preferred Alternative). The total number of Gulf of Mexico Q1 vessels is 3,386 vessels under Alternative 3 (Preferred Alternative) (Table 57). And some Q2 and Q3 vessels would likely also stop shrimping. The total numbers of Gulf of Mexico Q2 and Q3 vessels under Alternative 3 (Preferred Alternative) are 534 and 655 vessels, respectively (Table 57). As described in Section

4.3 regarding South Atlantic vessels, the majority of vessels adversely affected under Alternative 3 (Preferred Alternative) are the least able to absorb reductions in revenue and cost increases. Many and possibly most Q1 vessels would likely choose to stop shrimping under Alternative 3 (Preferred Alternative). The total number of South Atlantic Q1 vessels is 123 vessels under Alternative 3 (Preferred Alternative) (Table 60). And it is possible that some Q2 and Q3 vessels would also stop shrimping. The total numbers of South Atlantic Q2 and Q3 vessels under Alternative 3 (Preferred Alternative) are 19 and 17 vessels, respectively (Table 60). The total number of vessels included in all impacted categories which are likely to or may choose to stop shrimping under Alternative 3 (Preferred Alternative) is 4,734 vessels. As reported in Section 4.3.11, the number of part-time vessels projected to shut down under Alternative 3 is 2,810 vessels (48.1% of affected vessels).

Negative economic effects to a fishing vessel can be tied to social effects. A loss in revenue or income could result in negative impacts to the vessels owner or fisher and his/her fishing family. Or it could result in the inability of a vessel owner to remain in the fisheries. This could result in negative social effects to the fisher and fishing family. Because this alternative includes small skimmer trawls, pusher-head trawls, and wing nets, it's likely that these small vessels are more vulnerable (i.e., than vessels which were over 26 ft and included under Alternative 2 or Alternative 4) to additional burden from the requirement of TEDs designed to exclude small turtles. As described in the text above, 81.1% of impacted vessels under this alternative are part-time and the majority of adversely affected vessels are the least able to absorb revenue reductions and cost increases.

Because this alternative includes small skimmer trawl, pusher-head trawl, and wing net vessels, safety at sea issues could occur under Alternative 3 (Preferred Alternative), such as a man overboard. Small vessels have limited deck space and could be operated by a single individual.

Under Alternative 3 (Preferred Alternative), shrimp dealers and processors would be negatively impacted in an indirect manner from a loss of shrimp passed on the vessels impacted under this alternative. Only shrimp dealers and processors that receive shrimp from affected vessels under Alternative 3 (Preferred Alternative) would be impacted by this alternative. The magnitude of the economic effects is discussed in detail in Sections 4.3.9 and 4.3.11.

Under Alternative 3 (Preferred Alternative), TED manufacturers and retailers would benefit from the production of TEDs for skimmer trawls, pusher-head trawls, and wing nets except for in the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida. Because this alternative is ranked third by the total number of TEDs and TED expenditures if all vessels remained in the fisheries (Table 100) and ranked second of vessels shut down (Table 108), it would also be ranked third and second, respectively, for the positive effects to TED manufacturers and retailers. However, the effects differ according to sub-region and the number of impacted vessels under Alternative 3 (Preferred Alternative) (see Sections 4.3.10 and 4.3.11 for a detailed description of these effects). As discussed in Section 4.3.10, assuming all vessels remained in the fisheries, it could take approximately 4.3 years for the vessels affected under Alternative 3 (Preferred Alternative) to become compliant with the requirement to use TEDs designed to exclude small sea turtles because of the production capability of TED manufacturers and retailers.

Under Alternative 3 (Preferred Alternative), the public would also benefit through the conservation benefit to sea turtles from TEDs designed to exclude small sea turtles being required on skimmer trawls, pusher-head trawls, and wing nets on vessels, except for in the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida.

4.4.4 Effects of Alternative 4: Amend the existing TED regulations to require vessels 26 ft and greater in length using skimmer trawls to use TEDs designed to exclude small turtles

Skimmer trawl vessels operate in Louisiana (3,651 skimmer trawls), Mississippi (150 skimmer trawls and 50 skimmer-otter trawls), Florida (1 skimmer trawl) and North Carolina (75 skimmer trawls) (Table 2). Shrimp vessel owners, fishermen, and shrimp fishing operations in states which operate skimmer trawls 26 ft and greater in length, would experience negative effects under this alternative. We anticipate social effects to be largely similar to those discussed for other alternatives in regards to vessel owners, fishers, and fishing families. Communities or parishes that would experience the greatest effects from this alternative can be gleaned from information presented in Section 3.5, on the top communities or parishes by state-licenses or active fishermen. Top communities are included by state for Louisiana (Table 24, includes top communities by skimmer licenses), Mississippi (Table 25), Florida (description in east Florida portion of Section 3.5.3.2), and North Carolina (Table 33).

After Alternative 1 (which would not impact additional vessels than those already required to use TEDs), Alternative 4 would impact the fewest number of shrimp trawl vessels and is ranked sixth (effects range from 1=most to 7=least) in terms of the number of impacted vessels. As reported in Table 63, approximately 2,913 vessels including 2,847 Gulf of Mexico vessels and 66 South Atlantic vessels are expected to be impacted under this alternative. The majority (68.4%, 1,993 vessels) of vessels affected under Alternative 4 are part-time. The number of full-time vessels affected under Alternative 4 is 920 vessels. Economic effects are described in Section 4.3 and include revenue loss and TED costs which impact the net revenue from operations of a shrimp trawl vessel. Effects include average total costs of $3,076 for Gulf of Mexico vessels (revenue loss of $1,778 and $1,298 for TED costs) (Table 64) and average total costs of $1,586 for South Atlantic vessels (revenue loss of $286 and TED costs of $1,300) for the first year. Average revenue loss for the first year for Gulf of Mexico vessels is 40% gross and 55% net revenue; whereas the average expected loss for South Atlantic vessels is 38.6% gross and 22.6% net (Table 65). As reported in Table 65, vessels would experience revenue loss in the long term including an average 4.6% gross and 34.9% net for Gulf of Mexico vessels and an average 1.8% gross and 4.8% net for South Atlantic vessels. Under this alternative, the average net revenue is negative from operations for affected Gulf of Mexico (-$2,425) and South Atlantic (-$1,874) vessels. Greater negative effects will be experienced for those vessels with negative net revenues. However, the economic effects vary depending categories of vessels based on particular types of vessels (see Section 4.3 for a detailed description of these effects).

Under Alternative 4, it is expected that some vessels and particularly smaller and part-time operations would stop shrimping because of the negative effects due to requirement to use TEDs designed to exclude small turtles. As described in Section 4.3, about 40% (1,134 vessels) of Gulf of Mexico vessels affected under Alternative 4 are Q1 vessels, vessels with the lowest average annual gross and net revenues. The relative effects on these vessels are greater. It is highly likely that many of the Q1 vessels would stop shrimping under Alternative 4. Some Q2 and Q3 vessels would also stop shrimping because they are already earning negative net revenues and the relative effects on their revenues are greater. The total number of Gulf of Mexico Q2 and Q3 vessels under Alternative 4 is 337 and 469 vessels, respectively (Table 66). As described in Section 4.3 regarding South Atlantic vessels, RSLA (3 vessels) and SPA Secondary vessels (1 vessel) may choose not to harvest shrimp in the future using skimmer trawls and wing nets, some and possibly many Q1 vessels would stop shrimping, and some Q2 and Q3 vessels may stop shrimping. Under Alternative 4, the total number of South Atlantic Q1, Q2, and Q3 vessels is 38, 7, and 13 vessels, respectively (Table 70). The total number of vessels included in all impacted categories which are likely to or may choose to stop shrimping under Alternative 4 is 1,997 vessels. As reported in Section 4.3.11, the number of part-time vessels projected to shut down under Alternative 4 is 803 vessels (27.6% of affected vessels).

Under Alternative 4, shrimp dealers and processors would be negatively impacted in an indirect manner from a loss of shrimp passed on from the vessels impacted under this alternative. Only shrimp dealers and processors that receive shrimp from affected vessels under Alternative 4 would be impacted by this alternative. The magnitude of the economic effects is discussed in detail in Sections 4.3.9 and 4.3.11.

Under Alternative 4, TED manufacturers and retailers would benefit from the production of TEDs for skimmer trawls 26 ft and greater in length. Because this alternative is ranked fifth by the total number of TEDs and TED expenditures (Tables 100 and 108), it would also be ranked fifth for the positive effects to TED manufacturers and retailers. However, the effects differ according to sub-region and the number of impacted vessels under Alternative 4 (see Sections 4.3.10 and 4.3.11 for a detailed description of these effects). As discussed in Section 4.3.10, assuming all vessels remained in the fisheries, it could take approximately 2.3 years for the vessels affected under Alternative 4 to become compliant with the requirement to use TEDs designed to exclude small sea turtles because of the production capability of TED manufacturers and retailers.

Under Alternative 4, the public would also benefit through the conservation benefit to sea turtles from TEDs designed to exclude small sea turtles being required on skimmer trawls on vessels 26 ft and greater in length.

4.4.5 Effects of Alternative 5: Amend the existing TED regulations to require all vessels using skimmer trawls to use TEDs designed to exclude small turtles

Similar to the discussion for Alternative 4, shrimp vessel owners, fishermen, and shrimp fishing operations in states which operate skimmer trawls, would experience negative effects under Alternative 5. Communities or parishes that would experience the greatest effects from this alternative can be gleaned from information presented in Section 3.5, on the top communities or parishes by state-licenses or active fishermen. Top communities are included by state for Louisiana (Table 24, includes top communities by skimmer licenses), Mississippi (Tables 25-26), Florida (description in east Florida portion of Section 3.5.3.2), and North Carolina (Tables 33-34).

Alternative 5 ranks fourth (effects range from 1=most to 7=least) in terms of the number of impacted vessels. As reported in Table 72, approximately 5,432 vessels including 5,269 Gulf of Mexico vessels and 163 South Atlantic vessels are expected to be impacted under this alternative. The majority (80.8%, 4,391 vessels) of vessels affected under Alternative 5 are part-time. The number of full-time vessels affected under Alternative 5 is 1,041 vessels. Economic effects are described in Section 4.3 and include revenue loss and TED costs which impact the net revenue from operations of a shrimp trawl vessel. Effects include average total costs of $2,392 for Gulf of Mexico vessels (revenue loss of $1,094 and $1,298 for TED costs) (Table 73) and average total costs of $1,368 for South Atlantic vessels (revenue loss of $155 and TED costs of $1,212) for the first year. Average revenue loss for the first year for Gulf of Mexico vessels is 120.3% gross and 38.8% net revenue; whereas the average expected loss for South Atlantic vessels is 69.6% gross and 17.5% net (Table 74). As reported in Table 74, vessels would experience revenue loss in the long term including an average 4.5% gross and 20.8% net for Gulf of Mexico vessels and an average 1.5% gross and 2.4% net for South Atlantic vessels. Under this alternative, the average net revenue is negative from operations for affected Gulf of Mexico (-$5,178) and South Atlantic (-$5,905) vessels. Greater negative effects will be experienced for those vessels with negative net revenues. However, the economic effects vary depending categories of vessels based on particular types of vessels (see Section 4.3 for a detailed description of these effects).

Under Alternative 5, it is expected that some vessels and particularly smaller and part-time operations would stop shrimping because of the negative effects due to requirement to use TEDs designed to exclude small turtles. As described in Section 4.3, almost 60% (3,137 vessels) of Gulf of Mexico vessels affected under Alternative 5 are Q1 vessels, 9.4% (497) are Q2 vessels, and 11.6% (612) are Q3 vessels, vessels with the lowest average annual gross and net revenues (Table 75). The relative effects on these vessels are greater. Many and possibly most of the Q1 vessels would likely stop shrimping under Alternative 5. Some Q2 and Q3 vessels would also stop shrimping. As described in Section 4.3 regarding South Atlantic vessels, RSLA (3 vessels) and SPA Secondary vessels (1 vessel) may choose not to harvest shrimp in the future using skimmer trawls and wing nets, many and possibly most Q1 vessels would stop shrimping, and some Q2 and Q3 vessels may stop shrimping. Under Alternative 4, the total number of South Atlantic Q1, Q2, and Q3 vessels is 111, 17, and 17 vessels, respectively (Table 78). The total number of vessels included in all impacted categories which are likely to or may choose to stop shrimping under Alternative 5 is 4,395 vessels. As reported in Section 4.3.11, the number of part-time vessels projected to shut down under Alternative 5 is 2,567 vessels (47.8% of affected vessels).

Because this alternative includes small skimmer trawl vessels, safety at sea issues could occur under Alternative 5, such as a man overboard. Small vessels have limited deck space and could be operated by a single individual.

Under Alternative 5, shrimp dealers and processors would be negatively impacted in an indirect manner from a loss of shrimp passed on from the vessels impacted under this alternative. Only shrimp dealers and processors that receive shrimp from affected vessels under Alternative 5 would be impacted by this alternative. The magnitude of the economic effects is discussed in detail in Sections 4.3.9 and 4.3.11.

Under Alternative 5, TED manufacturers and retailers would benefit from the production of TEDs for skimmer trawls. Because this alternative is ranked second by the total number of TEDs and TED expenditures if all vessels remained in the fisheries (Table 100) and ranked third if vessels shut down (Table 108), it would also be ranked second and third, respectively, for the positive effects to TED manufacturers and retailers. However, the effects differ according to sub-region and the number of impacted vessels under Alternative 5 (see Sections 4.3.10 and 4.3.11 for a detailed description of these effects). As discussed in Section 4.3.10, assuming all vessels remained in the fisheries, it could take approximately 4.3 years for the vessels affected under Alternative 5 to become compliant with the requirement to use TEDs designed to exclude small sea turtles because of the production capability of TED manufacturers and retailers.

Under Alternative 5, the public would also benefit through the conservation benefit to sea turtles from TEDs designed to exclude small sea turtles being required on skimmer trawls.

4.4.6 Effects of Alternative 6: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers fishing within state waters

Vessel owners, fishermen, and shrimp fishing operations in these states and which operate skimmer trawls, would experience negative effects under Alternative 6. Shrimp trawlers are located in Texas (total of 995 vessels), Louisiana (total of 6,227 vessels), Mississippi (total of 474 vessels), Alabama (total of 552 vessels), Florida (total of 665 vessels), Georgia (total of 208 vessels), South Carolina (total of 292 vessels) and North Carolina (total of 451 vessels) (Table 2). Shrimp trawler owners, fishers on shrimp trawl vessels, and shrimp trawl fishing operations fishing in state waters would experience negative effects under Alternative 6.

Communities or parishes that would experience the greatest effects from this alternative can be gleaned from information presented in Section 3.5, on the top communities or parishes by federal-permits or state-licenses or active fishers. Top communities are included by federal permits (Tables 20-21). Top communities are included by state for Texas (Table 22), Louisiana (Tables 23-24), Mississippi (Tables 25-26), Alabama (Table 27), Florida (Tables 28-29 and the description in east and west Florida portions of Section 3.5.3.2), Georgia (Table 30), South Carolina (Table 31) and North Carolina (Tables 32-34).

Alternative 6 ranks second (effects range from 1=most to 7=least) in terms of the number of impacted vessels. It is not possible to separate out the vessels that fish in state or federal waters and therefore the number of vessels contained here includes the total number in state and federal waters. As reported in Table 81, approximately 9,711 vessels including 8,401 Gulf of Mexico vessels and 1,310 South Atlantic vessels are expected to be impacted under this alternative. The majority (73.2%, 7,108 vessels) of vessels affected under Alternative 6 are part-time. The number of full-time vessels affected under Alternative 6 is 2,603 vessels. Economic effects are described in Section 4.3 and include revenue loss and TED costs which impact the net revenue from operations of a shrimp trawl vessel. Effects include average total costs of $4,249 for Gulf of Mexico vessels (revenue loss of $2,941 and $1,308 for TED costs) (Table 81) and average total costs of $3,921 for South Atlantic vessels (revenue loss of $2,166 and TED costs of $1,755) for the first year. Average revenue loss for the first year for Gulf of Mexico vessels is 65.4% gross and 57.6% net revenue; whereas the average expected loss for South Atlantic vessels is 74.8% gross and 45.1% net (Table 83). As reported in Table 83, vessels would experience revenue loss in the long term including an average 4.7% gross and 40% net for Gulf of Mexico vessels and an average 2.9% gross and 22.2% net for South Atlantic vessels. Under this alternative, the average net revenue is negative from operations for affected Gulf of Mexico (-$3,091) and South Atlantic (-$154) vessels. Greater negative effects will be experienced for those vessels with negative net revenues. However, the economic effects vary depending categories of vessels based on particular types of vessels (see Section 4.3 for a detailed description of these effects).

Under Alternative 6, it is expected that some vessels and particularly smaller and part-time operations, but also possibly some federal vessels would stop shrimping because of the negative effects due to requirement to use TEDs designed to exclude small turtles. As described in Section 4.3, about 73% of affected Gulf of Mexico vessels under Alternative 6 are Q1 vessels (4565 vessels), Q2 vessels (725 vessels), and Q3 vessels (872 vessels), vessels with the lowest average annual gross and net revenues (Table 85). The relative effects on these vessels are greater. Many of the Q1 vessels would likely stop shrimping under Alternative 6. Some Q2 and Q3 vessels would also stop shrimping. In addition, as described in Section 4.3, it's possible that some federal vessels would choose to stop shrimping under Alternative 6 because of the percentage loss in net revenue. Under Alternative 6, the total number of Gulf of Mexico federal vessels is 670 vessels (Table 85). As described in Section 4.3 regarding South Atlantic vessels, it is likely that many Q1 vessels would choose stop shrimping and some Q2 and Q3 vessels may stop shrimping. Under Alternative 6, the total number of South Atlantic Q1, Q2, and Q3 vessels is 692, 130, and 124 vessels, respectively (Table 87). The total number of vessels included in all impacted categories which are likely to or may choose to stop shrimping under Alternative 6 is 7,778 vessels. As reported in Section 4.3.11, the number of part-time vessels projected to shut down under Alternative 6 is 4,152 vessels (42.8% of affected vessels).

We anticipate social effects to be largely similar to those discussed for other alternatives in regards to vessel owners, fishers, and fishing families. However, because this alternative includes small trawl vessels, it's likely that these small vessels are more vulnerable (i.e., than vessels which were over 26 ft and included under Alternative 2 or Alternative 4) to additional burden from the requirement of TEDs designed to exclude small turtles.

Because this alternative includes small trawl vessels, safety at sea issues could occur under Alternative 6, such as a man overboard. Small vessels have limited deck space and could be operated by a single individual.

Under Alternative 6, shrimp dealers and processors would be negatively impacted in an indirect manner from a loss of shrimp passed on from the vessels impacted under this alternative. Shrimp dealers and processors that receive shrimp from affected vessels under Alternative 6 would be impacted by this alternative. The magnitude of the economic effects is discussed in detail in Sections 4.3.9 and 4.3.11.

Under Alternative 6, TED manufacturers and retailers would benefit from the production of TEDs by all shrimp trawls fishing within state waters. Because this alternative is ranked first by the total number of TEDs and TED expenditures, it would also be ranked first for the positive effects to TED manufacturers and retailers. However, the effects differ according to sub-region and the number of impacted vessels under Alternative 6 (see Sections 4.3.10 and 4.3.11 for a detailed description of these effects). As discussed in Section 4.3.10, assuming all vessels remained in the fisheries, it could take approximately 7.2 years for the vessels affected under Alternative 6 to become compliant with the requirement to use TEDs designed to exclude small sea turtles because of the production capability of TED manufacturers and retailers.

Under Alternative 6, the public would also benefit through the conservation benefit to sea turtles from TEDs designed to exclude small sea turtles being required on all shrimp trawls fishing within state waters.

4.4.7 Effects of Alternative 7: Amend the existing TED regulations and require the use of TEDs designed to exclude small turtles by all shrimp trawlers

Alternative 7 ranks first (effects range from 1=most to 7=least) in terms of the number of impacted vessels. The number of impacted vessels in this alternative is the same as the number presented under Alternative 6 because it is not possible to separate out the vessels that fish in state or federal waters; however the number of impacted vessels in Alternative 7 is likely greater than in Alternative 6. Regardless, for purposes of evaluating this alternative, we anticipate the number of vessels and associated economic and social effects resulting from this alternative to be the same as those discussed for Alternative 6 and, therefore, to have the same effects on the social environment.

4.5 DIRECT AND INDIRECT EFFECTS ON THE ADMINISTRATIVE ENVIRONMENT

With the exception of Alternative 1 (status quo), all of the considered alternatives will have effects on the administrative environment. Depending on which alternative is pursued, there will be varying costs of regulatory development and implementation, outreach, monitoring, and enforcement. For instance, as Alternatives 6-7 (Preferred Alternative) impact the most number of vessels and, therefore, we anticipate it would take longer for industry to fabricate the necessary amount of TEDs, it would take us longer to conduct outreach and training activities to encompass more fishers over a greater area, and there would be more vessels that enforcement entities would potentially need to inspect. And because these fisheries don’t have much, if any, prior experience using TEDs, enforcement entities may experience more issues in the near term due to implementation of a TED requirement on skimmer trawl, pusher-head trawl, and wing net vessels. As fishers become more familiar and fluent on TED installation and use, these burdens may lessen over time.

In general, the regulatory burden would be greatest for Alternatives 6 and 7, followed by Alternatives 3, 5, 2, and 4; all of these alternatives would result in significantly more costs than those under the status quo in Alternative 1. These effects would not just be limited to our agency (i.e., NOAA), but potentially could affect resource agencies in all Southeastern U.S. states if

Alternatives 6-7 are selected. If Alternatives 4 or 5 are selected, the impacts would be strictly related to states that authorize skimmer trawls as an allowable gear type (e.g., Louisiana, Mississippi, Alabama, Florida, and North Carolina) and states that don't authorize that gear type would not be impacted.

Enforcement and training costs would not simply increase due to an increase in affected fishers. Because all of the alternatives aside from Alternative 1 would require TEDs in shrimp fisheries that have not previously utilized TEDs (i.e., skimmer trawl, pusher-head trawl, and wing net vessels), new training materials for fishers and industry will need to be developed on the installation and inspection of TEDs. Our administrative costs will likely increase also due to the need to consider non-otter trawl vessels separately when estimating TED compliance.

4.6 SUMMARY COMPARISON OF ENVIRONMENTAL CONSEQUENCES

The proposed alternatives considered within this DEIS would require TED use by various types and/or size shrimp trawlers to reduce the incidental bycatch and mortality of small sea turtles in the shrimp fisheries. Relative to Alternative 1 (No-Action), Alternatives 2-7 have positive effects on sea turtles, listed fish species and other marine life, and EFH. All of the alternatives would have negative effects on the economics of the shrimp fisheries. A summary comparison of the proposed alternatives is included in Table 101 below.

Table 109. Summary of primary effects resulting from each alternative.

	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVES 6-7
SEA TURTLES PROTECTED	1,509 - 2,179	1,730 - 2,500	1,412 - 2,040	1,624 - 2,348	1,730 - 2,500+
TOTAL VESSELS AFFECTED	3,103	5,837	2,913	5,432	9,711
FULL-TIME VESSELS AFFECTED	973	1,103	920	1,041	2,603
PART-TIME VESSELS AFFECTED[1]	2,130	4,734	1,993	4,391	7,108
TOTAL ADVERSE EFFECT[2]	$9.4 MILLION	$13.7 MILLION	$8.9 MILLION	$12.8 MILLION	$44.0 MILLION
TOTAL REVENUE LOSS	$5.4 MILLION	$6.2 MILLION	$5.1 MILLION	$5.8 MILLION	$27.5 MILLION
TOTAL TED COSTS	$4.0 MILLION	$7.5 MILLION	$3.8 MILLION	$7.0 MILLION	$16.5 MILLION
AVERAGE ADVERSE EFFECT	$3,029	$2,347	$3,055	$2,356	$4,530
AVERAGE REVENUE LOSS	$1,740	$1,062	$1,751	$1,068	$2,830
AVERAGE TED COSTS	$1,289	$1,285	$1,304	$1,288	$1,697
AVERAGE ADVERSE EFFECT (% OF TOTAL REVENUE) - YEAR 1[3]	40% - 43%	68% - 122%	39% - 40%	70% - 120%	80% - 131%
AVERAGE ADVERSE EFFECT (% OF TOTAL REVENUE) - LONG-TERM[3]	1.8% - 4.6%	1.5% - 4.6%	1.8% - 4.6%	1.5% - 4.5%	2.9% - 4.7%
NUMBER OF TEDS NEEDED	12,392	23,266	11,836	21,650	43,228
TIME TO PRODUCE TEDS	2.3 YEARS	4.3 YEARS	2.3 YEARS	4.3 YEARS	7.2 YEARS

[1] High probability that many (i.e., 50% or more) part-time vessels will stop operating due to TED costs.
[2] Does not include additional losses if part-time vessels stop operating.
[3] Low end of range is for South Atlantic and high end is for Gulf of Mexico.

We estimate 5,837 non-otter trawl vessels result in 2,165-2,942 annual sea turtle mortalities due to fisheries bycatch under the status quo. In the following table, annual sea turtle conservation is based on ultimately anticipated returns; we do not expect these benefits to occur immediately following a TED requirement. Fishers will have to learn to effectively fish with TEDs in their nets and TED compliance and effectiveness rates will likely take significant time (i.e., years) to rise to the high levels (i.e., 94%) we currently see in the otter trawl fisheries. The "average adverse effect - year 1" relates to the effects encountered during the first year due to initial TED purchase; this would not be an annual economic effect, at least not to this degree (i.e., there may be annual maintenance costs associated with TEDs). The "average adverse effect - long term" relates to ongoing effects due to shrimp loss resulting from required TED use and would be an annual effect.

In general, Alternative 1 (no action) provides the least conservation benefit to sea turtles, but also does not introduce any new effects on the economic or human environment. Conversely, Alternatives 6-7 are expected to result in the most conservation benefit to sea turtles, but also introduce the greatest overall economic impact and affect the largest number of fishers. Alternatives 2-5 provide varying levels of conservation to sea turtle populations, which are largely dependent on the number of vessels we anticipate would be required to use TEDs under each alternative. Likewise, differences in the anticipated economic effects are associated with the number of vessels affected.

4.7 CUMULATIVE EFFECTS ANALYSIS (CEA)

As directed by NEPA, federal agencies are mandated to assess not only the indirect and direct impacts, but cumulative impacts of actions as well. NEPA defines a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 C.F.R. 1508.7). Cumulative effects can either be additive or synergistic. A synergistic effect is when the combined effects are greater than the sum of the individual effects.

This section uses an approach for assessing cumulative effects that is based upon guidance offered in CEQ (1997). The report outlines 11 items for consideration in drafting a CEA for a proposed action:

1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals.
2. Establish the geographic scope of the analysis.
3. Establish the timeframe for the analysis.
4. Identify the other actions affecting the resources, ecosystems, and human communities of concern.
5. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stress.
6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds.
7. Define a baseline condition for the resources, ecosystems, and human communities.
8. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities.
9. Determine the magnitude and significance of cumulative effects.

10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.
11. Monitor the cumulative effects of the selected alternative and adapt management.

Cumulative effects on the biophysical environment, socio-economic environment, and administrative environments are analyzed below.

4.7.1 Significant Cumulative Effects Issues Associated With the Proposed Action and Assessment Goals

The CEQ cumulative effects guidance states this step is accomplished through 3 activities as follows:

A. The direct and indirect effects of the proposed actions (Section 4);
B. Which resources, ecosystems, and human communities are affected (Section 3); and
C. Which effects are important from a cumulative effects perspective (information revealed in this CEA)

Valued environmental components (VECs) are "any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern" (CEAA 1999). Specifically, the important VECs for this analysis include: (1) sea turtles; (2) other ESA- and MMPA-listed species; (3) EFH; and (4) participants and communities associated with the shrimp fisheries. These are discussed in the sections that follow.

4.7.1.1 Cumulative Effects on Sea Turtles

Section 1.2.3 presents the numerous actions that cause injuries or mortalities to sea turtles, establishing the baseline. Below are past and present actions that are likely to continue to affect sea turtles in the foreseeable future.

4.7.1.1.1 Vessel Operations

There is the potential for adverse effects from vessels operating in the geographic area of the Southeastern U.S. shrimp fisheries from the shoreline to the outer boundary of the EEZ. These include federal, private, and commercial vessels. Federal vessels include the U.S. Navy (USN) and USCG, who maintain the largest federal fleet, as well as the EPA, NOAA, and the U.S. Army Corps of Engineers. Formal consultations pursuant to Section 7 of the ESA have been conducted with the USCG and the USN, and we are currently in the early phases of consultation with other federal agencies on their vessel operations. These consultations have evaluated the impacts of vessel operations on listed species throughout the Atlantic. The operation of federal vessels in the area may result in collisions with sea turtles resulting in subsequent injury or mortality.

Private and commercial vessels also have the potential to interact with sea turtles. These activities may result in the lethal (e.g., boat strike) and non-lethal (e.g., harassment) takes of listed species that could prevent or slow a species' recovery. The magnitude of these interactions is not currently known. The STSSN's reports include evidence of vessel interactions (e.g., carapace damage from propeller and skeg impact injuries) with sea turtles. It is not known how many of these injuries occur pre- or post-mortem. It is likely that the interactions with commercial and recreational vessels result in a higher level of sea turtle mortality than what is documented, since some carcasses would not reach the beach. Minor vessel collisions may cause injuries that weaken or otherwise affect sea turtles that can then become vulnerable to predation, disease, and other natural or anthropogenic hazards.

Collisions between commercial fishing vessels and sea turtles, or adverse effects resulting from disturbance, have been documented. However, fishing vessels represents only a portion of marine vessel activity. Due to reduction in vessel speed during fishing operations, collisions are more likely when vessels are in transit. As fishing vessels are smaller than large commercial tankers and container ships, and less fast and agile than recreational speed boats, collisions are less likely to result in mortality.

Commercial fishing vessel activity is not likely to increase in the foreseeable future within the Gulf of Mexico or along the Atlantic coast. While allowable catch levels may increase as fish stocks are rebuilt, associated increases in catch rates may preclude the need to increase effort to obtain allowable catch. Conversely, recreational vessel activity may increase as populations on the coast continue to grow and access to the ocean increases. Vessels (federal and private, commercial and recreational) will continue to operate in the area for the foreseeable future, and the impacts described above will likely persist.

Sea turtles may also be affected directly or indirectly by fuel oil spills. Fuel spills involving fishing vessels are common events. However, these spills are typically small amounts that are unlikely to affect listed species unless they occur adjacent to nesting beaches or in foraging habitats. Larger spills may result from accidents, although these events are rare and generally involve small areas. Fuel spills may impact nesting beaches, bottom habitat and benthic resources, but it is unknown to what extent oil releases from recreational and commercial vessels or shoreline activities such as fueling facilities may affect sea turtles in migratory or foraging areas. Immediately after an oil release, direct contact with petroleum compounds or dispersants used to respond to spills may cause skin irritation, chemical burns, and infections (Lutcavage et al. 1995). Inhalation of volatile petroleum vapors can irritate lungs and dispersants have a surfactant effect that may further irritate or injure the respiratory tract, which may lead to inflammation or pneumonia (Shigenaka et al. 2010). Ingestion of petroleum compounds may remain in the turtle's digestive system for days (Van Vleet and Pauly 1987), which may affect the animals' ability to absorb or digest foods. Absorption of petroleum compounds or dispersants may damage liver, kidney, and brain function as well as causing anemia and immune suppression as seen in seabirds that have ingested and absorbed petroleum compounds (Shigenaka et al. 2010). Exposure to an oil release can cause long-term chronic effects such as decreased survival and lowered reproductive success may occur.

Persistent petrochemical products in the marine environment are frequently encountered by sea turtles. Tarballs are frequently observed sealing the mouths and nostrils of small sea turtles. Witherington (1994) found evidence of tar in the gastro-intestinal tracts of over one-third of the post-hatchling sea turtles examined offshore of Florida in 1993 and evidence of tar ingestion was documented in 20% of neonate loggerhead sea turtles examined along the Gulf Stream (Witherington 2002). Van Vleet and Pauly (1987) concluded that the source of tar observed on stranded sea turtles the Gulf of Mexico originated from crude oil tanker discharges and have a significant impact on marine turtles in the eastern Gulf of Mexico.

Threats of oil releases and discharges from vessels are greatest in port areas, shipping lanes, and areas of heavy recreational vessel use. Oil releases caused by oil and gas development and transportation activities, as well as oil releases from vessels or shoreline activities such as fueling facilities adjacent to nesting beaches, may directly affect sea turtles and nesting beaches. During the decade between 1992 and 2001, sea turtles were identified as resources at risk in 73 oil releases. Nine of these releases occurred along Florida's Atlantic coast (Milton et al. 2003). The continued exposure of sea turtles and other living marine resources due to vessel and land based oil releases is likely to continue into the future. There is no basis to conclude that the level of interaction represented by the various vessel activities that would occur under the preferred alternative would be detrimental to the existence of biological resources considered with the proposed action.

4.7.1.1.2 Fisheries Operations

Several commercial fisheries in the broader geographical area use gear that is known to capture, injure, and/or kill sea turtles. Many of these fisheries have been considered in Section 7 consultations and in some cases have been regulated (Table 5) to reduce their effects on sea turtles and other listed species; these are discussed in Section 3.3.3.7. In general, fisheries that use gillnet, hook and line, longline, trawl, seine, dredge, and trap gear have been documented as unintentionally capturing or entangling sea turtles.

Specific to the Gulf of Mexico, several commercial fisheries use gear that are known to interact with sea turtles. For all fisheries for which there is an FMP or for which any federal action has been taken to manage the fishery, impacts have been evaluated through the ESA Section 7 process. Formal opinions conducted on Gulf of Mexico fisheries include: Southeast shrimp trawl; Atlantic HMS pelagic longline; HMS directed shark; Gulf of Mexico reef fish; and coastal migratory pelagic resources fisheries. Anticipated take levels associated with these actions are presented in Table 110; the take levels reflect the impact on sea turtles and other listed species of each activity anticipated from the date of the ITS forward in time. However, there are other fisheries in the area not subject to Section 7 consultations as they operate solely in state waters or have not been subject to a federal management action. Various fishing methods used in state fisheries are known to incidentally take listed species, including trawls, pot and trap, flynets, and gillnets (NMFS 2001). At this time, the past and current effects of these fisheries on sea turtles cannot be quantified.

Table 110. Summary of sea turtle incidental take levels authorized under incidental take statements (ITS) associated with our opinions for current federal fisheries occurring in the Gulf of Mexico and South Atlantic EEZ.

FISHERY	OPINION	ITS PERIOD	SEA TURTLE TAKE (LETHAL) BY SPECIES				
			LOGGERHEAD	LEATHERBACK	KEMP'S RIDLEY	GREEN	HAWKSBILL
Southeastern U.S. Shrimp[1]	2014	3-Year	Effort: 132,900 days in Gulf of Mexico and 14,560 trips in South Atlantic Combined TED Effectiveness Rate: ≥88%				
Atlantic Pelagic Longline[3]	2004	3-Year	1,905 (339)	1,764 (252)	105 combined (18)		
Atlantic HMS Shark Fisheries[3]	2012	3-Year	126 (78)	18 (9)	36 (21)	57 (33)	18 (9)
South Atlantic Snapper Grouper	2006	3-Year	202 (67)	25 (15)	19 (8)	39 (14)	4 (3)
Gulf of Mexico Reef Fish	2011	3-Year	1,044 (572)	11 (11)	108 (41)	116 (75)	9 (8)
Coastal Migratory Pelagic[4]	2015	3-Year	27 (7)	1 (1)	8 (2)	31 (9)	1 (1)
South Atlantic/Gulf of Mexico Spiny Lobster[5]	2009	3-Year	3 (3)	1 (1)	1 (1)	3 (3)	1 (1)

[1] The Southeastern U.S. shrimp fisheries analyzed for its effects on sea turtles occurs in state and federal (i.e. EEZ) waters in both the Atlantic and Gulf of Mexico.
[2] The incidental take authorized in this opinion is based on 1997-2001 effort; current effort in the Gulf of Mexico is at least 50% less; estimates do not include skimmer trawl captures or effects of poor compliance.
[3] The Atlantic pelagic longline fishery and Atlantic shark fisheries action areas both include the Atlantic, Gulf of Mexico, and Caribbean EEZ.
[4] The coastal migratory pelagic fishery action area includes Atlantic and Gulf of Mexico EEZ waters.
[5] The federal spiny lobster fishery, managed jointly by the GMFMC and SAFMC under the SLFMP, occurs throughout the South Atlantic and Gulf of Mexico regions.

Sea turtles have also been caught on recreational hook and line gear. While most interactions are likely not reported, over 800 sea turtles were documented as incidentally captured by recreational anglers in the Mississippi Sound alone; the majority of these hook and line captures were immature Kemp's ridley sea turtles and most incidents occurred at coastal fishing piers (Coleman et al. 2016). These animals were typically reported alive, and while the hooks should be removed whenever possible if it would not further injure the turtle, we suspect that the turtles are probably often released with fishing tackle still hooked in the animal. Entanglement in monofilament left behind by recreational fishers is commonly reported for sea turtles stranded in Florida (STSSN database). In a Section 7 consultation on the recreational component of SAFMC's Snapper Grouper FMP, analysis of private angler and charter boat (non-headboat) snapper-grouper fishing effort (MRFSS and Headboat Survey 2001-2003 data) resulted in an estimate that the fishery could take (by entanglement or ingested hook) up to 185 hardshell sea turtles in 3 years of effort (NMFS 2006b).

While most turtles are released alive, post release mortality, particularly when hooks have been ingested, is possible.

Summary of Fisheries Interactions

A wide range of fisheries in the region employ gear that is known to capture, injure, and/or kill sea turtles. Due to the complex life history of sea turtles, these fisheries impact different life stages of sea turtles depending on the temporal and spatial extent of the fishery. The Loggerhead Biological Review Team determined that the greatest threat to the Northwest Atlantic loggerhead DPS was cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009). Cumulative impacts from fisheries operations have had a negative impact on sea turtle populations in the past and present, and are likely to continue to impact sea turtles in the reasonably foreseeable future.

4.7.1.1.3 Dredging Operations and Beach Nourishment

The construction and maintenance of federal navigation channels have caused sea turtle mortalities. Hopper dredges can entrain and kill sea turtles. Dredging may also alter foraging habitat and relocation trawling associated with the project may injure or kill sea turtles and displace the turtles out of their preferred habitat. Whole sea turtles and sea turtle parts have been taken in hopper dredging operations from New York through Florida. Between 1980 and 2003, the last time a comprehensive report was prepared by the COE, 475 documented incidents of sea turtle interactions during dredging activities in 34 channels from New York to Texas were documented. Most sea turtle encounters with hopper dredges result in serious injuries or mortalities. Through the Section 7 consultation process, seasonal restrictions have been implemented on dredging have been required, observers monitor hopper dredge activities to ensure projects stay within incidental take estimates, and hopper dredge deflectors and relocation trawling are conducted to reduce sea turtle captures, injuries and mortalities.

The shorelines from North Carolina through Texas provide important nesting habitat for sea turtles; particularly for loggerheads. Due to beach erosion in some winters, dredged materials are commonly borrowed from offshore shoals to deposit onto beaches, generally for recreational purposes. Sea turtles can be impinged by the dredges at the borrow sites, nesting success can be reduced by inappropriate quality sand deposited onto nesting beaches, or nests can be directly injured by sand deposited over nests. Georgia, South Carolina, Florida and the USFWS have implemented seasonal restrictions and other protective conditions to reduce the effects of dredging, beach stabilization, and nourishment projects on sea turtles. Dredging and beach nourishment impacts to sea turtles are likely to continue into the foreseeable future.

4.7.1.1.4 Power Plants

Power plants can pose a danger of injury and mortality to sea turtles. In Florida, for example, thousands of sea turtles have been entrained with cooling water pulled in from the Atlantic Ocean in the St. Lucie Nuclear Power Plant’s intake canal over the past couple of decades (Bresette et al. 2003). Most of the entrained turtles are net captured and released, and mortality rates have remained below 1% since 1990 (Bresette et al. 2003). Based on past levels of impingement, the distribution of the species, and the operation of the facility, we anticipate that hundreds of sea turtles will continue to be entrained at the St. Lucie Plant annually, but with few mortalities. There are numerous other power plants throughout the Southeast U.S. that have these types of interactions with sea turtles, although the numbers of turtles impacted is highly variable.

4.7.1.1.5 Marine Pollution and Water Quality Issues, Including the DWH Oil Spill Event

Sources of pollutants within the geographic scope of the proposed action include atmospheric loading of pollutants such as polychlorinated biphenyls (PCBs), storm water runoff, groundwater discharges, sewage treatment effluent, and oil spills. Chemical contaminants may have an effect on marine species' reproduction and survival. It has been well established that organochlorine (OC) compounds, including PCBs and OC pesticides, bioaccumulate in animal tissues. A study of 48 loggerhead sea turtles collected in Core Sound, North Carolina, provided the first evidence that OC contaminants may be affecting sea turtle health. Significant correlations between OC levels and health parameters for a wide range of biological functions were found. This relationship is strictly correlative and further studies are required to determine precise causal relationships between the contaminants and health effects in sea turtles (Keller et al. 2004a, 2004b, 2004c). While the effects of contaminants on sea turtles are relatively unclear at this time, pollution may also make sea turtles more susceptible to disease by weakening their immune system.

Marine debris (discarded fishing line, lines from boats, plastics) can entangle sea turtles and drown them. Turtles commonly ingest plastic or mistake debris as food, as observed with the leatherback sea turtle. The leatherback's preferred diet includes jellyfish, but similar looking plastic bags are often found in the turtle's stomach content.

Excessive turbidity due to coastal development and/or construction could influence marine resources, including the sea turtle foraging ability. Turtles are not very easily directly affected by changes in water quality or increased suspended sediments, but if these alterations make habitat less suitable for turtles and hinder their capability to forage, they might eventually tend to leave or avoid these less desirable areas (Ruben and Morreale 1999).

The Gulf of Mexico is a particularly active area for oil and gas exploration and extraction. As a result, oil and chemical spills have occurred over the years that have impacted the environment. Numerous small-scale releases have occurred within the region over the past, and are likely to continue into the future. Significant, large-scale events also occur on occasion. The April 2010 DWH oil spill event is one of the most significant events to occur in recent years. Official estimates are that 4.9 million barrels of oil were released into the Gulf of Mexico during this event, with some experts estimating even higher volumes. Additionally, approximately 1.84 million gallons of chemical dispersant was applied both subsurface and on the surface to attempt to break down the oil. There is no question that the unprecedented DWH oil spill event and associated response activities (e.g., skimming, burning, and application of dispersants) have resulted in adverse effects on listed sea turtles. Gulf sturgeon and smalltooth sawfish may also be adversely affected by oil, but at this time there is no evidence documenting effects on these species from this particular oil spill.

Estimates of between 4,900 and up to 7,600 large juvenile and adult sea turtles (Kemp's ridley, loggerhead, and unidentified hardshell sea turtles), and between 55,000 and 160,000 small juvenile sea turtles (Kemp's ridley, green, loggerhead, hawksbill, and unidentified hardshell sea turtles) were killed by the DWH oil spill (DWH Trustees 2016) Nearly 35,000 hatchling sea turtles (Kemp's ridleys, loggerheads, and green sea turtles) were also estimated to have been injured by response activities. For an extensive discussion on the impacts of the DWH oil spill to sea turtle populations, please refer to DWH Trustees (2016). The following information provides additional summary documentation of observed effects to sea turtles from the DWH oil spill event.

A total of 1,146 sea turtles were documented as stranded or collected during response efforts in the spill area. Up through October 20, 2010, all stranded or distressed turtles found in the area were included on the list, regardless of evidence of oil exposure. Subsequent to that, only confirmed visibly-oiled animals were added to the list. The available data on sea turtle strandings and response collections during the time of the spill are expected to represent an unknown fraction of the actual losses to the species, as most individuals likely were never recovered. It also does not provide insights into potential sub-lethal impacts that could reduce long-term survival or fecundity of individuals affected. However, it does provide some insight into the potential relative scope of the impact among the sea turtle species in the area. It appears that Kemp's ridley sea turtles may have been the hardest hit species, as they accounted for almost 71% of all stranded/collected turtles, and 79% of all dead turtles. Green sea turtles represented the second highest number of total individuals found, at 17.5%, but only 4.8% of the dead individuals. Loggerheads comprised only 7.7% of the total individuals, and 11% of the total dead. The remaining turtles were hawksbills and dead unidentified turtles; no leatherbacks were counted among the stranded/collected turtles in the spill area. Table 111 summarizes the sea turtles documented during the DWH oil spill event.

Table 111. Sea turtles documented in the DWH oil spill area.

SEA TURTLE SPECIES	ALIVE	DEAD	TOTAL
GREEN	172	29	201
HAWKSBILL	16	0	16
KEMP'S RIDLEY	328	481	809
LOGGERHEAD	21	67	88
UNIDENTIFIED	0	32	32
TOTAL	537	609	1,146

(http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm)

In addition to the direct effects on subadult and adult sea turtles, the 2010 May through September sea turtle nesting season in the Northern Gulf of Mexico may also have been adversely affected by the DWH oil spill event. Setting booms to protect beaches may have had unintended effects, such as preventing females from reaching nesting beaches and thereby reducing nesting. However, there is almost no sea turtle nesting in Louisiana, and limited nesting in Mississippi, which is where most of the booming of the coastline in response to the oils spill occurred, thus such effects were likely very minimal.

The oil spill may also have adversely affected hatchling success. In the Northern Gulf of Mexico, approximately 700 nests are laid annually in the Florida Panhandle and up to 80 nests are laid annually in Alabama. Most nests are made by loggerhead sea turtles; however, a few Kemp's ridley and green sea turtle nests have also been documented in 2010. Hatchlings begin emerging from nests in early to mid-July, with approximately 50,000 hatchlings anticipated to be produced from Northern Gulf of Mexico nests in 2010. To avoid the loss of most, if not all, of this year's Northern Gulf of Mexico hatchling cohort, all sea turtle nests laid along the Northern Gulf of Mexico coast were visibly marked to ensure that nests were not harmed during oil spill cleanup operations that are undertaken on beaches. Additionally, a late-term nest collection and hatchling release plan was implemented to provide the best possible protection for sea turtle hatchlings emerging from nests in Alabama and the Florida Panhandle. Starting in June, these nests were relocated to the Atlantic to provide the highest probability of reducing the anticipated risks to hatchlings as a result of the DWH oil spill event. A total of 274 nests, all loggerheads except for 4 green and 5 Kemp's ridley sea turtle nests, were translocated from the Northern Gulf of Mexico to the east coast of Florida so that the hatchlings could be released in areas not affected by the oil spill. In mid-August, it was determined that the risks to hatchlings emerging from beaches and entering waters off the coast of Franklin and Gulf Counties (Florida) had diminished significantly. Nest excavations continued west of the St. Joseph Peninsula for several more weeks. Table 112 summarizes the number of translocated nets and released hatchlings.

Table 112. Number of turtle nests translocated from the Northern Gulf of Mexico coast and hatchlings released in the Atlantic Ocean. The data does not include 1 nest that included a single hatchling and no eggs. The sea turtle nest translocation effort ceased on August 19, 2010.

TURTLE SPECIES	TRANSLOCATED NESTS	HATCHLINGS RELEASES
GREEN	4	455
KEMP'S RIDLEY	5	125
LOGGERHEAD	265*	14,216

(http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm)

The survivorship and future nesting success of individuals from one nesting beach being transported to and released at another nesting beach is unknown. Although the loggerheads nesting and emerging from nests in the Florida Panhandle and Alabama are part of the Northern Gulf of Mexico Recovery Unit and differ genetically from loggerheads produced along the Atlantic Coast of Florida, they are part of the same Northwest Atlantic DPS. Evidence suggests that some portion of loggerheads produced on Northern Gulf of Mexico beaches are transported naturally into the Atlantic by currents and spend portions of their life cycle away from the Gulf of Mexico. This is based on the presence of some loggerheads with a Northern Gulf of Mexico genetic signature in the Atlantic. These turtles are assumed to make their way back to the Gulf of Mexico as subadults and adults. Therefore it was determined that transporting them would provide at least some possibility of success, versus a likely complete loss of the nests on the natal beaches due to oil impacts.

Gulf of Mexico loggerhead nesting represents a small proportion of overall Florida loggerhead nesting and an even smaller proportion of the Northwest Atlantic DPS. For comparison, the 5-year average (2006-2010) for the statewide number of loggerhead nests in the state of Florida is 56,483 nests annually (FWC nesting database). As previously stated, we do not know what the impact of relocating 265 nests from 6 years ago will be on this year's nesting cohort compared to the total of approximately 700 nests laid on Northern Gulf of Mexico beaches. Although some additional mortality beyond natural levels must be expected, translocating these nests has given the greatest number of hatchlings the best opportunity to survive and contribute to the ongoing recovery of their species. While there may be a risk of possible increased gene flow across loggerhead recovery units, it is not outside the Northwest Atlantic DPS and would likely not be on a scale of conservation concern.

Kemp's Ridley Sea Turtles

As noted earlier, the vast majority of sea turtles collected in relation to the DWH oil spill event were Kemp's ridleys, including 328 live and 481 dead individuals. The total high-end mortality estimate of 86,500 small juvenile turtles and 3,100 large juvenile and adult turtles (DWH Trustees 2016) makes the species the most impacted by the DWH oil spill event on a population level. Relative to the other species, Kemp's ridley populations are much smaller, yet observed higher strandings and collections related to the DWH oil spill event. The location and timing of the DWH oil spill event were also an important factor. Although significant seasonal juvenile populations occur in some areas of the U.S. Atlantic coast, Kemp's ridley sea turtles utilize the Gulf of Mexico as their primary habitat for most life stages, including all of the nesting and mating. As a result, all mating and nesting adults in the population necessarily spend significant time in the Gulf of Mexico, as do all hatchlings as they leave the beach and enter the currents. However, not all of those individuals will necessarily have encountered oil and/or dispersants, depending on the timing and location of their movements relative to the location of the subsurface and surface oil. In addition to mortalities, the effects of the spill may have included disruptions to foraging and resource availability, migrations, and other unknown effects as the spill began in late April just before peak mating/nesting season (May-July). But DWH oil did not arrive on the continental shelf of the northern Gulf of Mexico until late May or early June 2010. By that time, adult Kemp's ridley turtles that were going to breed in 2010 would likely have already departed the northern Gulf of Mexico for their breeding and nesting areas in the western Gulf. Therefore, DWH oil was unlikely to have had a direct impact on Kemp's ridley nesting in 2010 (DWH Trustees 2016). However, DWH oil could have contributed to the reduced numbers of nests in subsequent years (2011-2014) through direct and indirect pathways. Nesting rebounded in 2011 through 2013, but experienced another significant drop in 2014, and there may yet be long-term population impacts resulting from these reduced nesting years. Preliminary simple population impact modeling has suggested that the DWH oil spill event will likely slow the population recovery that we have been seeing, but that there is reason for cautious optimism for the resilience of the species if high survival rates can be quickly restored (Crowder and Heppell 2011). How quickly the species returns to the previous fast pace of recovery may also depend in part on how much of an impact the DWH oil spill event has had on Kemp's ridleys' food resources (Crowder and Heppell 2011). Nesting increased in 2015-2016, but it is uncertain if that trend will continue into the future.

Loggerhead Sea Turtles

As presented earlier, 88 loggerhead sea turtles were documented within the designated spill area; 67 were dead and 21 were alive. There were likely additional mortalities that were undetected and, therefore, currently unquantifiable. Although it is expected that the effects of the DWH oil spill event on loggerheads was significant (high-end total mortality estimates of 10,400 small juvenile and 3,600 large juvenile and adult sea turtles; DWH Trustees 2016), it was not as severe on a population level as it was for Kemp's ridleys. In comparison to Kemp's ridleys, the population size is many times larger, the observed strandings and mortalities linked to the DWH oil spill event were much smaller in absolute numbers, and the relative proportion of the population exposed to the effects of the event was much smaller. Additionally, unlike Kemp's ridleys, the majority of nesting for the Northwest Atlantic loggerhead DPS occurs on the Atlantic coast. It is possible that impacts to the Northern Gulf of Mexico Recovery Unit of the Northwest Atlantic loggerhead DPS would be proportionally much greater than the impacts occurring to other recovery units because of impacts to nesting (as described above) and a larger proportion of that recovery unit, especially mating and nesting adults, being exposed to the spill. However, the impacts to that recovery unit, and the possible effect of such a disproportionate impact on that small recovery unit to the Northwest Atlantic DPS and the species, remain unknown.

Green Sea Turtles

Green sea turtles comprised the second-most common species collected as part of the DWH oil spill response, with 201 individuals. However, only 29 of those were found dead or later died during attempts at rehabilitation. The mortality number is lower than that for loggerheads despite loggerheads having far fewer total strandings. While green turtles regularly utilize the Northern Gulf of Mexico, they have a wide spread distribution throughout the entire Gulf of Mexico, Caribbean, and Atlantic. As described in Section 3.3.3.2, nesting is also relatively rare along the Northern Gulf of Mexico beaches. Therefore, similar to loggerhead sea turtles, while it is expected that impacts were significant, the relative proportion of the population that is expected to have been exposed to and impacted by the DWH oil spill event, and thus the population-level impact, is much smaller than for Kemp's ridleys.

Hawksbill and Leatherback Sea Turtles

Presently available information indicates hawksbill and leatherback sea turtles appear to be least affected by the DWH oil spill event. No leatherbacks and only 16 hawksbills (all alive) were counted among the stranded and response-collected sea turtles. Hawksbills do not typically utilize the Northern Gulf of Mexico in large numbers, and thus population-level effects from the spill are expected to be negligible. Leatherbacks rarely nest along the Gulf of Mexico coast, but do utilize the offshore waters. Potential DWH oil spill event related impacts to leatherback sea turtles could include ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources. There is no information available to determine the extent of those impacts, if they occurred. However, leatherback prey species are typically jellyfish and other cnidarians, salps, and tunicates, which occur in great abundance throughout much of the Gulf of Mexico and tend to be fast-reproducing species.

4.7.1.1.6 Climate Change

We introduced the potential effects of climate change on sea turtle populations in Section 3.3.3.7. Additional potential effects of climate change, which are anticipated to affect sea turtles in the Northwest Atlantic (including the Gulf of Mexico) are discussed herein. Changes in water circulation may occur. Changes in the Gulf Stream would have profound effects on every aspect of Northwest Atlantic sea turtle life history from hatching success, oceanic migrations at all life stages, foraging, and nesting (Gagosian 2003; NMFS and USFWS 2007a, 2007b, 2007c, 2007d, 2007e; Rahmstorf 1997, 1999; Stocker and Schmittner 1997). Thermocline circulation patterns are expected to change in intensity and direction with changes in temperature and freshwater input at the poles (Rahmstorf 1997; Stocker and Schmittner 1997). This will potentially affect not only hatchlings that rely on passive transport in surface currents for migration and dispersal but also pelagic adults (e.g., leatherbacks) and juveniles that depend on current patterns and major frontal zones in obtaining suitable prey, such as jellyfish (Hamann et al. 2007; Hawkes et al. 2007).

Prey availability may also be affected by changes in water temperatures and currents. Seagrasses could ultimately be negatively affected by increased temperatures, salinities, and acidification of coastal waters (Short and Neckles 1999; Bjork 2008), as well as increased runoff due to the expected increase in extreme storm events as a result of global climate change. These alterations of the marine environment due to global climate change could ultimately affect the distribution, physiology, and growth rates of seagrasses, potentially eliminating them from particular areas. However, the magnitude of these effects on seagrass beds, and on the herbivorous green sea turtles that forage on them are difficult to predict. Some populations of green sea turtles appear to specialize in the consumption of algae (Bjorndal 1997) and mangroves (Limpus and Limpus 2000), suggesting green turtles may be able to substitute other available forage species. Changes to benthic communities as a result of changes to water temperature may affect omnivorous species such as Kemp's ridley and loggerhead sea turtles; however, these species are less likely to suffer shortages of prey than species like green sea turtles with more specific diets (Hawkes et al. 2007).

Several studies have also investigated the effects of changes in SST and air temperatures on turtle reproductive behavior. For loggerhead sea turtles, warmer SSTs in the spring have been correlated to an earlier onset of nesting (Weishampel et al. 2004; Hawkes et al. 2007), shorter internesting intervals (Hays et al. 2002), and a decrease in the length of the nesting season (Pike et al. 2006). Green sea turtles also exhibited shorter internesting intervals in response to warming water temperatures (Hays et al. 2002).

Ocean acidification related to global climate change would also reasonably be expected to negatively affect sea turtles. The term "ocean acidification" describes the process of ocean water becoming corrosive as a result of CO_2 being absorbed from the atmosphere. The absorption of atmospheric CO_2 into the ocean lowers the pH of the waters, decreasing the effects of global climate change; however the resulting change in ocean chemistry could adversely affect marine life, particularly organisms with calcium carbonate shells such as corals, mussels, mollusks, small creatures in the lower levels of the food chain, (reviewed in Guinotte and Fabry 2008), affecting as well the higher organisms such as sea turtles that rely on these species as prey. Sea grasses may benefit from extra atmospheric $CO_{2,}$ affording some benefit to green turtles (Guinotte and Fabry 2008).

The IPCC (2007) has indicated greenhouse gas emissions are one of the most important drivers of recent changes in climate. Wilson et al. (2014) inventoried the sources of greenhouse gases in the Gulf of Mexico from sources associated with oil platforms and other activities such as fishing. Their study concluded commercial fishing and recreational vessels make up a small percentage of the total estimated greenhouse gas emissions in the Gulf of Mexico (1.43% and 0.59%, respectively).

Fully monitoring ocean acidification in the Atlantic and understanding the effects of climate change on listed species of sea turtles will require expansion of existing monitoring programs and development of conceptual and predictive models. Continued acquisition and maintenance of long-term data sets on sea turtle life history and responses to environmental changes will be needed to apply and maintain these models. At this time, the type and extent of effects to sea turtles of ocean acidification and other results of global climate change on sea turtles cannot, for the most part, be accurately predicted.

4.7.1.1.7 Conservation and Recovery Actions Impacting Sea Turtles

In addition to the sea turtle conservation measures listed in Table 5 (Section 3.3.3.2), a number of activities are in progress that ameliorate some of the negative impacts on marine resources, sea turtles in particular, posed by the activities summarized above. Education and outreach are considered one of the primary tools to reduce the risk of collision represented by the operation of federal, private, and commercial vessels.

Our regulations require fishers to handle sea turtles in such a manner as to prevent injury. Any sea turtle taken incidentally during fishing or scientific research activities must be handled with due care to prevent injury to live specimens, observed for activity, and returned to the water according to a series of procedures (50 CFR 223.206(d)(1)). We have been active in public outreach efforts to educate fishers regarding sea turtle handling and resuscitation techniques. We have also developed a recreational fishing brochure that outlines what to do should a sea turtle be hooked and includes recommended sea turtle conservation measures. These outreach efforts will continue in an attempt to increase the survival of protected species through education on proper release guidelines.

There is an extensive network of STSSN participants along the Atlantic and Gulf of Mexico coasts. This network not only collects data on dead sea turtles but also rescues and rehabilitates live stranded turtles. Data collected are used to monitor stranding levels and identify areas where unusual or elevated mortality is occurring. The data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All states that participate in the STSSN are collecting tissue for genetic studies to better understand the population dynamics of the northern subpopulation of nesting loggerheads. These states also tag live turtles when encountered through the stranding network or in-water studies. Tagging studies help provide an understanding of sea turtle movements, longevity, and reproductive patterns, all of which contribute to our ability to reach recovery goals for the species.

There is an organized formal program for at-sea disentanglement of sea turtles. Entangled sea turtles found at sea in recent years have been disentangled by STSSN members, the whale disentanglement team, the USCG, and fishers. We have developed a wheelhouse card to educate fishers and recreational boaters on the sea turtle disentanglement network and disentanglement guidelines. A final rule published on July 25, 2005 (70 FR 42508), allows any agent or employee of ours, the USFWS, the USCG, 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 entangled sea turtle, or salvage a dead endangered sea turtle for scientific or education purposes. We afford the same protection to sea turtles listed as threatened under the ESA (50 CFR 223.206(b)).

Sea turtle nest and beach habitat protection efforts in the United States occur from North Carolina through Texas, particularly on the most valuable nesting areas. Important sea turtle nesting beaches, encompassing 25% of all U.S. loggerhead sea turtle nesting, has been acquired and designated as the Archie Carr National Wildlife Refuge in Florida. South Carolina, Georgia, and Florida have developed lighting ordinances and voluntary measures to reduce the disorienting effects of artificial lights on hatchlings. Most major nesting beaches within the continental United States employ predator control measures to protect sea turtle nests. Additionally, throughout the southern United States, efforts to eradicate exotic plants that contribute to beach erosion or that diminish nesting beach suitability are ongoing. Beach cleaning activities, which require state permits, are conditioned to minimize their effects on nesting sea turtles, nests, and hatchlings. Beach vehicular driving is prohibited on most U.S. nesting beaches. In Volusia County, Florida, where beach driving is still allowed, driving is restricted to daylight hours, in areas where nest densities are lowest and on the lower beach below sea turtle nests which must be well marked.

4.7.1.2 Cumulative Effects on Marine Mammals

As discussed in Section 3.3.4.1, marine mammal interactions in the shrimp fisheries are infrequent events. While effort may decrease or be redistributed under the alternatives considered within this DEIS, none of the alternatives are expected to result in additional impacts to marine mammals, aside from the potential chance for increased interactions between dolphins and shrimp trawlers (i.e., TED escape openings) should TED use be required in other sectors of the shrimp fisheries.

There are many other fisheries aside from the Southeastern U.S. shrimp fisheries that may impact marine mammal species within the Gulf of Mexico and Atlantic Ocean. While some marine mammal species, such as the North Atlantic right whale, may be especially vulnerable to incremental effects due to low stock size, because they generally do not occur in areas and times where the shrimp fisheries are prosecuted this does not appear to be a significant concern, either singularly (i.e., shrimp fisheries as a whole) or when combined with other anthropogenic effects.

4.7.1.3 Cumulative Effects on Listed Fish and Other Marine Species

There have been documented take of Atlantic, Gulf, and shortnose sturgeon, as well as smalltooth sawfish, in the shrimp fisheries. The proposed alternatives may have beneficial effects on these listed (or proposed for listing) species, as well as other marine species. While effort may decrease or be redistributed under the alternatives considered within this DEIS, none of the alternatives are expected to result in additional impacts to listed fish species.

There are many other fisheries aside from the Southeastern U.S. shrimp fisheries that may impact listed fish and other marine species within the Gulf of Mexico and Atlantic Ocean. While some listed fish species, such as the Gulf sturgeon, may be especially vulnerable to incremental effects due to constricting habitat availability, it is expected that the alternatives considered in this DEIS would be beneficial in light of cumulative effects and mitigate other actions in the region impacting these species. We anticipate juvenile and adult Gulf sturgeon could be excluded from trawl nets due to the use of TEDs. We don't anticipate much benefit to smalltooth sawfish due to the fact skimmer trawl, pusher-head trawl, and wing net fisheries generally don't operate in areas where sawfish occur in high-abundance, and due to the fact the toothed rostrum of sawfish generally get entangled in trawl netting, inhibiting their escape through the TED opening. In summary, the shrimp fisheries have historically impacted sturgeons and smalltooth sawfish, as well as other species such as red snapper, but effort reduction due to the economic environment and other management actions (e.g., TEDs and BRDs) have reduced some of these effects.

4.7.1.4 Cumulative Effects on EFH

While effort may decrease or be redistributed under the alternatives considered within this DEIS, shrimp trawling will continue to occur in areas that have been trawled for decades, rather than over undisturbed, and potentially more ecologically sensitive, habitats. Overall effort is expected to stay within levels fished within the past several years. None of the areas that have been closed to bottom trawling to protect EFH will be opened by any of the alternatives.

Although fishing continues to negatively affect habitat, the cumulative effect of implementation of EFH closed and regulated areas, as well as effort reduction that has occurred for the purposes of rebuilding stocks to sustainable levels, have likely had a generally positive effect on habitat. Other actions in the Gulf of Mexico and Atlantic Ocean, such as dredging projects, estuarine habitat modification, and natural storm impacts, also impact EFH and, in some cases, could be considered to have similar effects. Since any direct or indirect impacts to EFH under the proposed alternatives are expected to be minimal and temporary, significant negative cumulative effects on habitat are unlikely.

4.7.1.5 Cumulative Effects on the Shrimp Fisheries

A detailed discussion of the economic and social environments for the shrimp fisheries is provided in Sections 3.4 and 3.5. These sections also include references to other documents that describe the regulatory history of vessels that commercially harvest shrimp in federal waters of the Gulf of Mexico and South Atlantic. The shrimp fisheries have struggled under pressures from both natural (e.g., hurricanes) and man-made (e.g., the DWH oil spill in the Gulf of Mexico) disasters, variable shrimp productivity independent of specific disasters, unfavorable input costs (notably, fuel prices), stiff competition with imports (e.g., in 2014, domestic shrimp production was less than 150 million lbs compared to imports of approximately 1,251 million lbs), and general difficult competition for the consumers dollar under the recession and slow economic recovery.

The information in Section 3.4 demonstrates the relatively fragile financial condition of the average federally-permitted vessel in the Gulf of Mexico between 2007 and 2013, notably in the early years, with improving conditions seen in 2014. Improvements seen in 2011-2013 relative to earlier years were a consequence of non-shrimping receipts associated with post-DWH activities. Examination of the average economic performance of the non-federally-permitted vessels in the Gulf of Mexico, which are the vessels primarily expected to be affected by this proposed action, suggests a more challenging economic picture for these vessels. This sector is less frequently evaluated and only performance data for 2012 is available for this discussion. As detailed in Section 3.4, the net cash flow for approximately 40% of the vessels surveyed was negative in 2012 and the average net income from operation across all vessels surveyed was negative, with only vessels in the highest income category—those with cash inflow of more than $110,000 (2014 dollars)—averaging a positive net income. It is noted, however, that 2012 was the worst year for federally-permitted shrimp vessels, and the only year from 2010-2014 these vessels had an average negative net revenue. Thus, the economic performance of the non-federally-permitted vessels may have similarly improved after 2012.

For the South Atlantic, only information of federally-permitted vessels is available because economic surveys of non-federally-permitted shrimp vessels have not been conducted. For the federally-permitted vessels, over the period 2011-2014, the average net cash flow and net income from operation was positive.

As detailed in Sections 4.3 and 5, this proposed action would be expected to substantially challenge the ability of part-time shrimp vessels, defined as those vessels averaging less than $65,000 in fishing revenues per year. This proposed action would be expected to result in a loss of approximately $13.7 million (2014 dollars) in the first year, assuming no vessels cease operation, as a result of lower shrimp harvest and increased gear costs. The effects in subsequent years would be less because the gear costs would not be recurrent on an annual basis. Because these costs would be expected to be particularly onerous for the part-time vessels, up to half of the affected vessels could potentially cease fishing. If this occurs, this would increase the total loss the first year to approximately $16.7 million because, although the new gear expenses would decrease, all fishing revenue for the exiting vessels would be lost and not just the revenue associated with escapement from the TEDs.

The expected social effects of this proposed action are discussed in Section 4.4. The social effects would be expected to mirror, in direction and magnitude, as the economic effects. As economic conditions worsen, so do social conditions. Communities substantially engaged in the shrimp fisheries have struggled under uncertain and variable operating and production conditions. As a result of the projected reductions in revenue, increased operating costs, and the potentially high number of shrimp vessels expected to cease operation, this proposed action would be expected to increase the associated adverse social effects on fishermen, their families, and associated communities. In addition to the adverse social effects associated with income and job loss, fishermen would be expected to experience an increased loss of personal identity, freedom, and pleasure. As discussed in Sections 4.3, 5, and 6, economic data suggest that many, if not most, of the part-time vessels are, on average, not profitable, indicating that the motivation for continued operation is for non-economic reasons, such as pleasure, lifestyle, or personal identity. As important as these other motivations may be, it would likely be infeasible to continue to bear increasing monetary losses such that, at some point, the activity must cease. When this occurs, the individual loses more than the business and activity, losing also a bit of their identity, their aspirations, and their role in their community.

4.7.1.6 Summary

Sea turtles, marine mammals, listed fish and other marine species, EFH and designated critical habitat, and the human environment have been impacted by past and present actions in the region and are likely to continue to be impacted by these actions in the future. The measures implemented under the preferred alternative are not expected to result in substantial direct or indirect impacts to marine mammals, EFH, or designated critical habitat and are not, consequently, expected to contribute to cumulative effects on these ecosystem components. Therefore, there is no net beneficial or adverse effect on these ecosystem components.

Sea turtles have been, are, and will continue to be negatively impacted by a variety of past, present, and future activities. These cumulative impacts impact the recovery of the species, although the extent cannot be quantified. Vessel and fishing operations, dredging activities, and marine pollution have had a net negative impact to sea turtles found in the area and are likely to continue to impact these ecosystem components in the future. Sea turtle conservation measures under the preferred alternative will reduce the effects of the shrimp fisheries on Kemp's ridley and other sea turtle populations, benefiting these species. These positive impacts are expected to mitigate to a certain extent the negative cumulative impacts to sea turtle populations.

The other activities that are negatively impacting sea turtles should continue to be addressed to ensure sea turtles are protected. We also intend to continue outreach efforts to educate fishers regarding sea turtles to help conserve and recover sea turtles. Future anticipated research will likely further our knowledge on the details of the interactions between sea turtles and fisheries, will likely improve target catch retention in trawls equipped with TEDs, and may result in new technologies that will reduce the capture of sea turtles in fisheries. The continued implementation of outreach efforts and anticipated research address activities that negatively impact sea turtles and are expected to have a beneficial impact on sea turtles.

For listed fish and other marine species (e.g., bycatch species), the escapement that occur in trawls equipped with TEDs could contribute to the rebuilding of listed or overfished stocks. Additionally, the loss of unwanted bycatch species through TEDs may improve the quality of landed fish, and reduce the time needed to sort and process target species. Potential beneficial impacts to Gulf sturgeon, and to a lesser extent, Atlantic and shortnose sturgeon may also occur as a result of TED use in the skimmer trawl fisheries (i.e., anticipated differential due to a greater number of skimmer trawl vessels in the Northern Gulf of Mexico versus North Carolina).

The human community will experience negative economic impacts from the implementation of the preferred alternative. It is possible these adverse effects will cause some participants already struggling in the fisheries to leave entirely. Therefore, it is expected that the additive effects of this action will contribute to or result in significant adverse cumulative impacts on the human community.

In conclusion, while the preferred alternative is expected to benefit sea turtles by reducing the capture of and mortality of small sea turtles in the Southeastern U.S. shrimp fisheries, the cumulative effects of this action are not likely to have a significant impact on any of the ecosystem components associated with the fisheries, with the notable exception of the human community.

4.7.2 Geographic Scope of the Analysis

The geographic scope affected by this action includes areas of tidally influenced waters and substrates of the Gulf of Mexico and South Atlantic in Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina, extending out to the limit of the U.S. Exclusive Economic Zone. This area is described in detail in Section 3.2, and represents the entire area in which shrimp trawling activities could be affected by the alternatives analyzed in this DEIS.

4.7.3 Timeframe for the Analysis

In the Gulf of Mexico, the shrimp fisheries originated as an inshore fishery using cast nets, haul seines, and bar nets. In 1902, fishers first began going into deeper water, pulling a haul seine from a power-driven boat. In 1913, the first otter trawl was used to catch shrimp. As the shrimp trawl fishery developed, so too did its impact on incidental bycatch and mortality of sea turtles.

While it would be advantageous to go back to a time when sea turtle populations, the shrimp fisheries, and the overall marine environment were natural and unmodified, information on many of these attributes were not available until after many significant changes had occurred (e.g., anthropogenic impacts on sea turtles, initial prosecution and expansion of the shrimp fisheries, etc.). Landings data employed in annual Gulf of Mexico shrimp assessments uses data from 1960 to present. In determining how far into the future to analyze cumulative effects, the length of the effects would depend on the species, fisheries, etc. The preferred alternative would require all skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs in their nets. This requirement would be expected to take place upon the effective date specified in the final rule. The effectiveness of this action regarding sea turtle conservation should continue to be monitored indefinitely to ensure that management measures are adequate to protect the subject species. Acknowledging sea turtle populations fluctuate over time, and the preferred alternative may result in effort reduction and other human community impacts, all of which may affect the accuracy of our conclusions projected into the future, we anticipate the general accuracy of these analyses will be valid for at least 5 years.

4.7.4 Other Actions Affecting the Resources, Ecosystems, and Human Communities of Concern

Past and present actions affecting the sea turtle populations are discussed throughout Section 3, and Appendix II specifically details the history of TED requirements within the shrimp fisheries. Additional actions that can affect sea turtle populations in the reasonably foreseeable future include development of rulemaking through the Atlantic Sea Turtle Strategy process, which would implement additional conservation requirements in various fisheries to reduce incidental bycatch and mortality of sea turtles. Conversely, continued development in coastal areas around the globe could negatively affect sea turtle populations, particularly nesting populations.

Past and present actions affecting the shrimp fisheries are discussed throughout Sections 3. Additional actions that can affect the shrimp fisheries in the reasonably foreseeable future include the implementation of annual catch limits for the non-annual crop species, annual catch targets, and accountability measures.

4.7.5 Characterization of the Resources, Ecosystems, and Human Communities Identified in Scoping in Terms of Their Response to Change and Capacity to Withstand Stress

This step should identify the trends, existing conditions, and the ability to withstand stresses of the environmental components. As previously described, the shrimp trawl fisheries have been in a long-term decline due to economic conditions and competition from inexpensive foreign imports, as well as by the hurricanes that struck in the Gulf of Mexico during 2004 and 2005. Therefore, it is likely that the human communities associated with the shrimp fisheries have little capacity to withstand additional stress. As a result of this decline, however, reductions in effort have, and are, occurring that have resulted in reductions of incidental sea turtle bycatch and mortality, likely benefiting sea turtle populations and the associated ecosystems.

4.7.6 Characterization of the Stresses Affecting These Resources, Ecosystems, and Human Communities and Their Relation to Regulatory Thresholds

This section examines whether resources, ecosystems, and human communities are approaching conditions where additional stresses could have an important cumulative effect beyond any current plan, regulatory, or sustainability threshold (CEQ 1997). Sustainability thresholds can be identified for some resources, which are levels of impact beyond which the resources cannot be sustained in a stable state. Other thresholds are established through numerical standards, qualitative standards, or management goals. The CEA should address whether thresholds could be exceeded because of the contribution of the proposed action to other cumulative activities affecting resources.

While this DEIS primarily deals with the state shrimp fisheries, quantitative definitions of overfishing and overfished for managed shrimp species are included in the respective GMFMC and SAFMC shrimp FMPs, which are incorporated by reference. Generally, sea turtle species are listed as either threatened or endangered. A threatened species, the less severe threshold category, is any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. An endangered species means any species which is in danger of extinction throughout all or a significant portion of its range. Information on listed sea turtle species, including threats affecting these species, is included in Section 3.3 as well as cited status reviews, recovery plans, and biological reports, and are incorporated herein by reference.

4.7.7 Baseline Condition for the Resources, Ecosystems, and Human Communities

Gulf of Mexico shrimp stocks are assessed each year and current assessment methods are based on Nichols (1984). The assessments show trends in catch, effort, CPUE, and recruitment. For these assessments, reliable data are available back to 1960. Discussions on the condition and current status of sea turtle populations and other marine resources are included in Section 3.3. Information on the condition of the economic environment and human communities is included in Sections 3.4 and 3.5.

4.7.8 Important Cause-and-Effect Relationships Between Human Activities and Resources, Ecosystems, and Human Communities

The relationship between human activities and resources, ecosystems, and human communities within the context of this DEIS is solely related to the Southeastern U.S. shrimp fisheries and the implementation of sea turtle conservation requirements. Appendix II details the history of TED requirements within the shrimp fisheries. Various biological opinions conducted on the fisheries have concluded that the regulations would have a positive impact on sea turtles by substantially reducing mortalities. Conversely, the effects of some conservation regulations (e.g., TED and BRD requirements) have had negative impacts on human communities (e.g., loss in net revenue).

4.7.9 Magnitude and Significance of Cumulative Effects

Past, present, and reasonably foreseeable future actions probably have not and would not have a significant, adverse effect on the shrimp resource. The preferred alternative in this DEIS would be expected to yield beneficial cumulative effects on the biological environment, specifically on sea turtle populations. There may be an increase of fishing effort or fishing pressure on target species as a result of the preferred alternative to offset catch loss. Conversely, overall fishing effort may decrease if participants exit a fishery due to cumulative impacts. Moreover, the social and economic environments of the Southeastern U.S. shrimp fisheries have been impacted by numerous natural (e.g., hurricanes) and anthropogenic (e.g., shrimp imports) that have reduced net revenue for many individuals and led to an overall shrinking of fisheries participation. As presented in Section 4.3, we anticipate the effects of the preferred alternative will likely result in additional economic effects that will compound other past and current impacts. As a result, it may further reduce participation in the fisheries. This would be considered a significant effect to those individuals, particularly if they are unable to find income elsewhere.

4.7.10 Alternatives to Avoid, Minimize, or Mitigate Significant Cumulative Effects

Various management measures other than the preferred alternative were considered in this DEIS that could avoid, minimize, or mitigate significant cumulative effects. Specifically, alternatives requiring TEDs for a smaller universe of individuals were considered.

4.7.11 Monitoring of the Cumulative Effects of the Preferred Alternative and Modification of Management as Necessary

The effects of the proposed action are, and will continue to be, monitored through collection of data by us, the states, stock assessments, stock assessment updates, life history studies, and other scientific observations.

4.8 UNAVOIDABLE ADVERSE EFFECTS

A detailed discussion of the expected economic effects of the proposed action is provided in Sections 4.3, 5, and 6. A detailed discussion of the expected social effects is provided in Section 4.4. The preferred alternative would require all skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) rigged for fishing to use TEDs in their nets, with the exception of vessels participating in the Biscayne Bay wing net fishery that primarily occurs in Miami-Dade County, Florida. This would be expected to result in a negative economic effect of approximately $13.7 million to the shrimp vessels directly regulated by this proposed action in the first year due to reduced shrimp harvests and TED purchase costs. In subsequent years, the recurrent cost of reduced shrimp harvest would be approximately $6.2 million. Recurrent costs for TED purchase would also be expected, but the amount and timing of these costs would be dependent on gear loss, repair, and replacement schedules, noting that the expected useful life of a TED is estimated to be at least 3 years. These estimated costs do not reflect projections of any shrimp harvesters ceasing operation as a commercial fishing business as a result of the estimated increase in costs for these businesses. It is estimated that approximately half of the affected vessels could cease fishing. The adverse effects of this proposed action would increase relative to the estimates provided if business failure occurs because all harvest activity and associated revenue would be lost for these businesses. These losses would trickle through the seafood industry, potentially adversely affecting up to approximately 800 jobs, and approximately 1,700 jobs if the projected potential vessel shut-down occurs.

4.9 SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

We weighed the short-term impacts upon the shrimp fisheries against the long-term productivity and stability of sea turtle populations and concluded that the proposed action would result in net benefits to society. While this action would have negative impacts on state shrimp fishers due to the cost of TED purchase and target catch loss, it is not expected to reduce overall effort or landings. Therefore, no impact to the long-term stability of the shrimp fisheries is expected as a result of implementation of the preferred alternative. The required use of TEDs in skimmer, pusher-head, and butterfly trawls is expected to reduce incidental bycatch and mortality of sea turtles, benefiting sea turtle conservation. These benefits are expected to aid in recovery goals for sea turtle species, potentially expediting their delisting from the ESA.

4.10 MITIGATION AND MONITORING

The preferred alternative in this DEIS would not result in any specific mitigation or monitoring requirements. Monitoring of the implemented TED requirements in the skimmer, pusher-head, and butterfly trawl fisheries would occur through regular, ongoing law enforcement activities, as well as supplementary outreach efforts (e.g., TED workshops, Gear Monitoring Team (GMT) voluntary inspections, etc.).

4.11 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible commitments are defined as commitments which cannot be reversed, except perhaps in the extreme long-term, whereas irretrievable commitments are lost for a period of time. The preferred alternative in this DEIS would not result in irreversible or irretrievable commitment of resources (i.e., nothing precludes future changes in approaches to managing the associated resources).

5 REGULATORY IMPACT REVIEW

5.1 INTRODUCTION

We prepare Regulatory Impact Reviews (RIRs) for applicable regulatory actions to satisfy our obligations under Executive Order (E.O.) 12866, as amended. The RIR: (1) provides a comprehensive review of the incidence and level of impacts associated with a proposed or final regulatory action; (2) provides a review of the problems and the policy objectives prompting the regulatory proposals and an evaluation of alternatives that could be used to solve the problem; and (3) ensures that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost-effective way. The RIR also serves as the basis for determining whether the proposed regulations constitute a "significant regulatory action" under the criteria provided in E.O. 12866 and provides some information that may be used in conducting an analysis of the effects on small entities pursuant to the Regulatory Flexibility Act (RFA). This RIR analyzes the expected effects of the action to amend the existing TED regulations to require all vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls)—with the exception of the Biscayne Bay wing net fishery prosecuted in Miami-Dade County, Florida—to use TEDs designed to exclude small turtles.

5.2 PROBLEMS AND OBJECTIVES

Problems that prompted the development of this DEIS and the objectives of the various management alternatives considered herein are discussed in Section 1.

5.3 DESCRIPTION OF THE FISHERIES

An economic description of the Gulf of Mexico and South Atlantic shrimp fisheries and the affected economic environment can be found in Section 3.4 of this DEIS and are incorporated herein by reference. Historical descriptions of the fisheries can be found in the GMFMC's Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters (GMFMC 1981) and its subsequent plan amendments, as well as the SAFMC's Fishery Management Plan for the Shrimp Fishery of the South Atlantic Region (SAFMC 1993) and its subsequent plan amendments, which are incorporated herein by reference.

5.4 ECONOMIC EFFECTS OF THE MANAGEMENT MEASURES

A comparative analysis of the expected economic effects under all of the alternatives considered in this DEIS is provided in Section 4.3. Thus, this analysis only examines the direct and indirect effects of the proposed regulatory action (i.e., Preferred Alternative 3), in relation to the appropriate "no action" baseline or status quo conditions for those entities affected by Preferred Alternative 3. Entities that are involved in the Gulf of Mexico and South Atlantic food shrimp fisheries but are not affected under Preferred Alternative 3 are not germane as their operations and thus their economic performance are not expected to change as a result of the proposed regulatory action. As such, they are not considered in this analysis.

The RIR is intended to estimate net economic benefits and, more generally, net benefits to society of the proposed regulatory action relative to the status quo. Net economic benefits are generally measured as the combination of consumer surplus and producer surplus. Consumer surplus (CS) is the difference between the price actually paid for a good or service and what the consumer would have been willing and able to pay. "Consumer" is broadly interpreted to mean any individual who places value on a particular good, service, asset, or resource. Thus, CS should account for all market and non-market values, including use and non-use values. CS is a measure of net economic benefits to consumers. Producer surplus (PS) is the difference between the amount a producer is paid for a unit of a good and the minimum amount the producer would accept to supply that unit (i.e., marginal cost). Total PS in a market or industry is the difference between total gross revenue and total variable costs. PS is a measure of net economic benefits to producers. When estimates of PS are not available, the best available proxy is used, which could be estimates of economic profit, various measures of net revenue, or changes in gross revenue if the former measures are not available. However, changes in gross revenue will overstate changes in net revenue and profit.

For the past decade or so, analyses of regulatory changes in the Gulf of Mexico and South Atlantic shrimp fisheries have assumed that changes in domestic landings would not cause any change in consumer surplus because the demand for shrimp in the U.S. has historically been shown to be highly elastic. Thus, decreases in Gulf of Mexico and South Atlantic landings are generally not expected to cause retail prices to increase (and consumer surplus to decrease) because consumers can readily substitute to other options (shrimp imports, cold-water domestic shrimp, other seafood such as fish and lobster, etc.). Related, the increases in imports over the past decade or so have caused domestic production to represent an ever smaller percentage of the domestic market, generally thought to be only between 7% and 11%. Thus, unless they are very significant, changes in domestic production are generally not expected to affect prices to consumers. Recent research continues to support those expectations (Poudel and Keithly 2008; Huang et al. 2012). Therefore, this analysis assumes that landings reductions that are expected to occur under the proposed regulatory action will not cause any change in CS with respect to the consumption of shrimp.

Thus, the primary source of CS and the primary benefit of the proposed regulatory action is the reduction in mortalities of small sea turtles (i.e., the number of small sea turtles saved). Under no action (the status quo), the number of small sea turtle mortalities is estimated to be between 2,165 and 2,942. Under the proposed regulatory action, the reduction in sea mortalities is estimated to be between 1,730 and 2,500 turtles. The mid-point of these estimates is 2,115 turtles, which represents an 83% decrease in small sea turtle mortalities. We think that approximately 80% of these sea turtle mortalities are Kemp's ridleys, which are endangered, while the other 20% are green sea turtles, which are threatened. Applying these same percentages to the reductions in mortalities results in a decrease of 1,692 Kemp's ridley sea turtle mortalities and a decrease of 423 green sea turtle mortalities. The ultimate objective of the proposed action and the respective recovery plans more generally is to recover these species. We think the proposed action is critical and necessary to achieving that objective, even if it may be insufficient by itself to do so (i.e., additional actions may be necessary).

Economic theory suggests that society places some level of non-use value on threatened and endangered species such as sea turtles (i.e., society derives benefits from these species). Non-use value can be estimated using a variety of approaches. In general, economists measure this value by estimating the public's willingness to pay (WTP) for increasing the population of these species and, more specifically, improving their status (e.g., from endangered to threatened or recovered, or from threatened to recovered). Our economists have generated several estimates of the public's WTP for improving the status of endangered and threatened sea turtles, most of which are in the published literature (Wallmo and Lew 2012, 2016; Lew 2015) while others were presented at a NMFS workshop (Wallmo and Lew 2014). Among other findings, their research indicates the value placed on improving the status of listed species depends on: 1) the specific species, 2) whether the listed species is endangered or threatened, and 3) whether the species is recovered or downlisted (i.e., status improves from endangered to threatened, endangered to recovered, or from threatened to recovered). The applicable findings from their research are provided in Table 113.

Table 113. Average (mean) WTP for improving the status of listed sea turtles. All values are in 2014 dollars.

SPECIES	STATUS	MEAN WTP TO IMPROVE TO THREATENED	MEAN WTP TO RECOVER
HAWKSBILL	ENDANGERED	$54.75 ($2.49)	$91.97 ($4.18)
LEATHERBACK	ENDANGERED	$41.12 ($1.87)	$73.61 ($3.35)
LOGGERHEAD	THREATENED	N/A	$47.35 ($2.15)

The estimated average WTP for improving the status of endangered sea turtles represents the average (mean) annual value a household is willing to pay to improve the species status over a 10-year time period. The estimates in Table 113 are also national as opposed to region-specific estimates. Although these estimates are not specific to Kemp's ridleys or green sea turtles, they represent the best available estimates of the public's WTP for improving the status of listed species. However, the public's WTP for improving the status of hawksbill as opposed to leatherback sea turtles is fairly different, with hawksbills apparently having greater value to the public. It is not known whether the public's WTP for improving the status of Kemp's ridleys is closer to the value for hawksbill sea turtles or leatherback sea turtles. Thus, it seems reasonable to use the estimates for each species as upper and lower bound estimates for Kemp's ridleys.[25] The estimate for loggerheads is used as a proxy for valuing an improvement in the status of green sea turtles as both species are threatened. The associated confidence interval for the mean WTP to improve their status from threatened to recovered is $44.54-$50.28.

According to Wallmo and Lew (pers. comm., November 15, 2016), the estimates from this research are representative of the households that participated in the surveys rather than all households in the U.S. In short, many households place less value on improving the status of these species compared

25 Wallmo and Lew provide confidence intervals for all of the Hawksbill and Leatherback estimates as well.

to those that responded to the surveys. In order to generate an estimate that would apply to all households, adjustments need to be made that correct for the recruitment rate of households into the panel of potential respondents (assumed to be 7%) and the cooperation rate of those who were selected (assumed to be 65%). These adjustments lead to what is referred to here as the "effective" average WTP for all U.S. households. The effective average WTP estimates are the values in parentheses in Table 113. The effective WTP estimates for the confidence interval associated with mean WTP for improving loggerheads from threatened to recovered is $2.03-$2.29.

Further, the data used to generate these estimates was collected in 2009 and 2010. To estimate the total economic value of improving the status of these species to the nation, the number of U.S. households in those years should be used rather than the current number of households. In 2009 and 2010, there were approximately 117.18 and 117.54 million households in the U.S.[26] To simplify, the appropriate number of households is assumed to be the average of those two years, which is 117.36 million households.

Based on the information above, the expected annual benefit to U.S. consumers for improving the status of Kemp's ridleys from endangered to threatened would be between $219.46 million and $292.23 million. If Kemp's ridleys are recovered, the expected annual benefit to U.S. consumers increases to between $393.16 million and $490.56 million. If the status of green sea turtles improves from threatened to recovered, the expected annual benefit to U.S. consumers would be between $238.24 million and $268.75 million. Given that 80% of the saved turtles are Kemp's ridleys, an improvement of their status from endangered to threatened seems likely. Conversely, the improvement in the status of green sea turtles is much less certain. Thus, in the aggregate, the total benefits could be as low as $219.46 million if only Kemp's ridleys improve from endangered to threatened, to as high as $759.31 million if both species are recovered. If the proposed action results in an improved status for these species, these benefits would be foregone under Alternative 1 (status quo, no action). If the action does not improve their status, then these benefits would not be attained as the estimates represent the public's WTP for improving their status. Estimates of how much the public may be willing to pay to save one or more sea turtles without improving their status are not currently available. However, it is likely the benefits are far less, as the public appears to place value on the status of a population rather than individuals within a population.

In order to analyze the expected changes in producer surplus, the effects on the harvesting and onshore sectors (dealers, processors, and TED manufacturers/retailers) are discussed below. This analysis is generally a restatement and summarization of the effects discussed in Section 4.3, supplemented with additional information and conclusions.

The important baseline economic conditions for vessels directly affected under Preferred Alternative 3 are presented in Table 114, the expected economic effects of Preferred Alternative 3 on these vessels in the first year and the long term are presented in Table 115, and the resulting change in net revenue and percentage losses in gross revenue and net revenue for these vessels in the first year and in the long term are presented in Table 116.

26 https://www.statista.com/statistics/183635/number-of-households-in-the-us/

Table 114. Average annual aggregate (total) and per vessel baseline economic conditions for vessels affected under Preferred Alternative 3 in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE	NET REVENUE[1]
AVERAGE TOTAL GULF	5,660	61,406,340	$158,180,716	$180,333,757	-$29,511,663
AVERAGE PER VESSEL GULF		10,847	$27,942	$31,861	-$5,214
AVERAGE TOTAL SA	177	1,617,282	$3,990,566	$6,593,228	-$1,096,981
AVERAGE PER VESSEL SA		9,137	$22,546	$37,250	-$6,198

[1] Aggregate net revenues are estimated by applying available average annual net revenue per vessel estimates to all vessels within a particular vessel category.

Table 115. Average annual aggregate (total) and per vessel effects on Gulf of Mexico and South Atlantic shrimp vessels under Preferred Alternative 3. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF VESSELS	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT (YEAR 1)
AVERAGE TOTAL GULF	5,660	2,538,252	$6,142,573	$7,345,650	$13,488,223
AVERAGE PER VESSEL GULF		448	$1,085	$1,298	$2,383
AVERAGE TOTAL SA	177	15,441	$25,880	$215,800	$241,680
AVERAGE PER VESSEL SA		87	$146	$1,219	$1,365

Table 116. Net revenue post-effects and average percentage loss in gross and net revenue per vessel for Gulf of Mexico and South Atlantic shrimp vessels under Preferred Alternative 3, first year and long term. Dollars are in 2014 dollars.

	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
GULF	-$7,588	-$6,290	122.1	4.6	38.3	20.4
SA	-$7,563	-$6,344	68.3	1.5	17.3	2.2

For the 5,660 vessels in the Gulf of Mexico that are expected to be affected by Preferred Alternative 3, the aggregate loss in gross revenue from shrimp loss is about $6.14 million, which represents about 3.4% of their gross revenue. Including the costs of purchasing TEDs, which is about $7.35 million, the total adverse effect in the first year is about $13.49 million, which represents about 7.5% of their gross revenue in the aggregate. These vessels are already earning losses of about

$29.5 million in the aggregate, and these adverse effects would increase those losses to about $43 million. The same percentages apply to an "average" vessel in the aggregate (i.e., assuming all vessels are the same). However, even in the aggregate, net revenue for an average vessel is currently negative (-$5,214). Additional costs and revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,588 in the first year and -$6,290 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

However, the adverse effects are considerably larger in relative terms for the average Gulf of Mexico vessel. Although the average loss in gross revenue in the long term is still only around 4.6% on average, the loss of gross revenue in the first year is more than 122% on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels. This outcome is not economically sustainable and would likely cause "average" vessels to stop operating. The percentage reductions in net revenue are also relatively large, about 38% in the first year and about 20% in the long term, because many vessels are already earning negative net revenues or slightly positive net revenues.

The adverse effects on South Atlantic vessels under Preferred Alternative 3 are much smaller in absolute terms. Only 177 vessels are expected to be adversely affected under this alternative. The aggregate loss in gross revenue from shrimp loss is around $26,000, which represents only 0.4% of their gross revenue. Including the costs of purchasing TEDs, which is about $216,000, the total adverse effect in the first year is about $242,000, which represents about 3.7% of their gross revenue in the aggregate. These vessels are already earning losses of about $1.1 million in the aggregate, and these adverse effects would increase those losses to about $1.34 million. The same percentages apply on an average per vessel basis in the aggregate. Thus, for the South Atlantic vessels, the costs associated with buying TEDs are the primary source of the adverse effects under this alternative. Also, as in the Gulf of Mexico, even in the aggregate, net revenue for an average vessel is currently negative (-$6,198). Additional costs or revenue reductions would increase the losses these vessels are already incurring, specifically to -$7,563 in the first year and -$6,344 in the long term. Vessels can continue to operate while earning negative net revenue in the short term, but they generally cannot continue operating in the long term earning negative net revenues.

As in the Gulf of Mexico, the adverse effect on the average South Atlantic vessel is considerably larger in relative terms. Although the average loss in gross revenue in the long term is still only around 1.5% on average, and even the loss in net revenue in the long term is only about 2.2%, the loss of gross revenue in the first year is 68% on average and the loss in net revenue is more than 38% in the first year on average. This is because a relatively large number of vessels earn relatively small average annual gross revenues and are already earning negative net revenues or slightly positive net revenues, and thus the costs associated with purchasing TEDs are relatively large for those vessels.

The vessels affected under Preferred Alternative 3 are heterogeneous with respect to their average annual gross revenue and net revenue. Some vessels are also different with respect to their dependence on revenue from food shrimp, particularly in the South Atlantic. Even though the estimates above accurately represent the expected adverse economic effects on Gulf of Mexico and South Atlantic vessels in the aggregate, for an "average" vessel, as well as in absolute and relative terms, the expected economic effects will also vary across different types of vessels, or rather, by vessel "category."

In other words, the effects will differ depending on a vessel's economic characteristics. The categorization of vessels under Preferred Alternative 3 is explained in Section 4.3. In both the Gulf of Mexico and South Atlantic, vessels in the Q1, Q2, and Q3 categories are considered part-time vessels while vessels in all other categories are considered full-time vessels. The expected economic effects by vessel category for the Gulf of Mexico under Preferred Alternative 3 are presented in Tables 117-119, and the expected economic effects by vessel category for the South Atlantic under Preferred Alternative 3 are presented in Tables 120-122.

Table 117. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Preferred Alternative 3 in the Gulf of Mexico. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	72	232	781	655	534	3,386
TOTAL GROSS REVENUE	$29,207,782	$37,336,213	$60,682,376	$25,629,880	$12,160,637	$15,316,870
AVERAGE GROSS REVENUE	$405,664	$160,932	$77,698	$39,130	$22,773	$4,524
AVERAGE NET REVENUE	$8,257	$44,032	$2,953	-$7,754	-$13,173	-$9,012

Table 118. Aggregate (total) and average vessel level effects on Gulf of Mexico shrimp vessels by vessel category under Preferred Alternative 3. Dollars are in 2014 dollars.

	FEDERAL	Q5	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	72	232	781	655	534	3,386
TOTAL GROSS REVENUE LOSS	$144,200	$1,198,782	$2,557,040	$994,285	$481,233	$715,532
TOTAL TED COSTS	$93,600	$301,600	$1,010,750	$848,250	$693,550	$4,396,600
TOTAL ADVERSE EFFECT	$237,800	$1,500,382	$3,567,790	$1,842,535	$1,174,783	$5,112,132
AVERAGE GROSS REVENUE LOSS	$2,003	$5,167	$3,274	$1,518	$901	$211
AVERAGE TED COSTS	$1,300	$1,300	$1,294	$1,295	$1,299	$1,298
AVERAGE ADVERSE EFFECT	$3,303	$6,467	$4,568	$2,813	$2,200	$1,510

Table 119. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for Gulf of Mexico vessels under Preferred Alternative 3, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
FEDERAL	$4,954	$6,254	1.0	0.6	40.0	24.3
Q1	-$10,522	-$9,223	199.4	5.1	16.8	2.3
Q2	-$15,373	-$14,074	9.8	4.0	16.7	6.8
Q3	-$10,567	-$9,272	7.3	3.9	36.3	19.6
Q4	-$1,615	-$321	6.0	4.2	154.7	110.9
Q5	$37,565	$38,865	4.2	3.4	14.7	11.7

In general, these results indicate that relatively few of the vessels affected under Preferred Alternative 3 in the Gulf of Mexico are federal (1.2%) or Q5 (4.1%) vessels. Many more vessels are affected in the other categories. Specifically, almost 60% of the vessels affected are Q1 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. The other affected vessels are distributed as follows: Q4 (13.8%), Q3 (11.6%), and Q2 (9.4%). Thus, the vast majority of the affected vessels are vessels that are the least able to absorb revenue reductions and cost increases.

In absolute terms, the average adverse effects per vessels on Q5 and Q4 vessels are greater than the effects on vessels in the other categories, while the effects on vessels in the Q1 and Q2 categories are much smaller in absolute terms. However, in general, the relative magnitude of the adverse effects is much less for federal and Q5 vessels compared to the vessels in the Q4, Q3, Q2, and particularly the Q1 category. In the long term, the average loss in gross revenue per vessel is lowest for the federal and Q5 vessels, though not considerably lower. Further, although the total adverse effect for Q1 vessels is about one-third of their total gross revenue in the aggregate, which is considerable, the average loss in gross revenue per vessel in year 1 for the Q1 vessels is nearly 200% of their gross revenue. This outcome is not economically sustainable and it is highly likely that many and possibly most owners of these vessels would choose to stop shrimping. Further, because Q3, Q2, and Q1 vessels are already earning negative net revenues, the relative effects on their net revenues are greater on average. Therefore, it is likely that some of the Q3 and Q2 vessels would also stop shrimping. Although the percentage loss in gross revenue for Q4 vessels is not relatively high, those vessels were operating on relatively small but positive net revenues. Thus, the percentage loss in net revenue terms is relatively high and sufficient to cause their net revenues to become negative as well, though likely not sufficiently negative to stop operating.

Table 120. Aggregate (total) and average per vessel baseline economic conditions by vessel category for vessels affected under Preferred Alternative 3 in the South Atlantic. Dollars are in 2014 dollars.

	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	1	3	13	17	19	123
TOTAL GROSS REVENUE	N/A[1]	N/A[1]	$2,505,811	$933,956	$668,595	$433,142	$658,000
AVERAGE TOTAL REVENUE	N/A[1]	N/A[1]	$835,270	$71,843	$39,329	$22,797	$5,350
AVERAGE NET REVENUE	$80,221	$23,374	$83,872	$2,953	-$7,754	-$13,173	-$9,012

[1] Redacted due to data confidentiality.

Table 121. Aggregate (total) and average vessel level effects on South Atlantic shrimp vessels by vessel category under Preferred Alternative 3. Dollars are in 2014 dollars.

	SPA SECONDARY	AS	RSLA	Q4	Q3	Q2	Q1
NUMBER OF VESSELS	1	1	3	13	17	19	123
TOTAL REVENUE LOSS	N/A[1]	N/A[1]	$818	$4,907	$7,535	$3,439	$9,169
TOTAL TED COSTS	$1,300	$1,300	$3,900	$16,250	$20,800	$22,750	$149,500
TOTAL ADVERSE EFFECT	N/A[1]	N/A[1]	$4,718	$21,157	$28,335	$26,189	$158,669
AVERAGE GROSS REVENUE LOSS	N/A[1]	N/A[1]	$273	$377	$443	$181	$75
AVERAGE TED COSTS	$1,300	$1,300	$1,300	$1,250	$1,224	$1,197	$1,215
AVERAGE ADVERSE EFFECT	N/A[1]	N/A[1]	$1,573	$1,627	$1,667	$1,378	$1,290

[1] Redacted due to data confidentiality.

Table 122. Net revenue post-effects and average percentage loss in gross and net revenue per vessel by vessel category for South Atlantic vessels under Preferred Alternative 3, first year and long term. Dollars are in 2014 dollars.

VESSEL CATEGORY	NET REVENUE YEAR 1	NET REVENUE LONG TERM	PERCENT LOSS GROSS REVENUE YEAR 1	PERCENT LOSS GROSS REVENUE LONG TERM	PERCENT LOSS NET REVENUE YEAR 1	PERCENT LOSS NET REVENUE LONG TERM
Q1	-$10,302	-$9,087	96.5	1.9	14.3	0.8
Q2	-$14,551	-$13,354	6.2	0.8	10.5	1.4
Q3	-$9,421	-$8,197	4.4	1.1	21.5	5.7
Q4	$1,326	$2,576	2.4	0.6	55.1	12.8
RSLA	$82,299	$83,599	0.2	0.0	1.9	0.3
AS	$22,070	$23,370	0.3	0.0	5.6	0.0
SPA SECONDARY	$78,913	$80,213	0.1	0.0	1.6	0.0

Though at a much smaller scale, similar results to the Gulf of Mexico are seen in the South Atlantic. In the South Atlantic, there are very few RSLA (3), SPA Secondary (1), and average federally-permitted South Atlantic penaeid (1) vessels affected. The average adverse effect per vessel for these vessels differs little from the effects on vessels in the other categories because the costs of purchasing TEDs represent the majority of the adverse effects in all categories. Because their reliance on shrimp harvested using skimmer trawls and wing nets is minimal at best, the RSLA, SPA Secondary, average federally-permitted South Atlantic penaeid vessels may choose to forego the expense and not harvest shrimp using those gears in the future.

Almost 70% of the South Atlantic vessels affected under Preferred Alternative 3 fall in the Q1 category, while 20% are Q2 and Q3 vessels. These are the vessels with the lowest average annual gross revenues and net revenues. Thus, the vast majority of affected vessels are vessels that are the least able to absorb revenue reductions and cost increases.

The percent loss in gross revenue in the long term is relatively low in general, and compared to the Gulf of Mexico, for the Q4, Q3, Q2, and Q1 vessels. However, the total adverse effect on Q1 vessels represents about 24% of their average annual gross revenues and the percent loss in gross revenue per vessel in the first year is nearly 97% for these vessels on average. This outcome is not economically sustainable and it is highly likely many and possibly most owners of these vessels would choose to stop shrimping. The relative effects for Q3 and Q2 vessels are also relatively high in the first year compared to other categories with respect to losses in gross revenue, but they are even higher in terms of net revenue because those vessels are already earning negative net revenues on average. Thus it is possible some of these vessels will also stop shrimping. The percentage loss in net revenue for Q4 vessels is even higher because they were already earning slightly positive net revenues, though their net revenues remain positive and thus they would likely continue shrimping with skimmer trawls and wing nets.

Any expected annual revenue losses incurred by vessels because of shrimp loss resulting from new TED requirements would be passed on to associated dealers and would be expected to continue into the future. Dealers are only indirectly affected if they purchase shrimp from a vessel that is directly affected under Preferred Alternative 3. The economic characteristics of the dealers indirectly affected under Preferred Alternative 3 are presented in Table 123 while the expected effects on these dealers are presented in Table 124.

Table 123. Average annual aggregate (total) and per dealer baseline economic conditions for dealers indirectly affected under Alternative 3 (Preferred Alternative) in the Gulf of Mexico (Gulf) and South Atlantic (SA). Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS	FOOD SHRIMP REVENUE	GROSS REVENUE
AVERAGE TOTAL GULF	612	117,845,052	$214,425,779	$247,876,873
AVERAGE PER DEALER GULF		192,872	$350,942	$405,028
AVERAGE TOTAL SA	91	6,880,775	$17,390,942	$25,355,298
AVERAGE PER DEALER SA		75,613	$191,109	$278,630

Table 124. Average annual aggregate (total) and per dealer effects on Gulf of Mexico and South Atlantic shrimp vessels under Alternative 3 (Preferred Alternative). Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	NUMBER OF DEALERS	FOOD SHRIMP LANDINGS LOSS	PERCENT LOSS FOOD SHRIMP LANDINGS	GROSS REVENUE LOSS	PERCENT LOSS GROSS REVENUE
AVERAGE TOTAL GULF	612	2,538,252	2.2	$6,142,573	2.5
AVERAGE PER DEALER GULF		4,147	2.2	$10,037	2.5
AVERAGE TOTAL SA	91	15,441	0.2	$25,880	0.1
AVERAGE PER DEALER SA		170	0.2	$284	0.1

The estimated annual losses in food shrimp landings and gross revenues under Preferred Alternative 3 are directly derived from the losses to the harvesting sector (i.e., they are equivalent). Thus, for example, the number of Gulf of Mexico dealers expected to be adversely affected is considerably greater than the number of South Atlantic dealers. Similarly, the magnitude of these adverse effects is considerably larger for Gulf of Mexico dealers than for South Atlantic dealers in the aggregate (2.5 million lbs and $6.1 million for Gulf dealers but only about 15,000 lbs and $26,000 for South Atlantic dealers).

The total number of dealers expected to be adversely affected is 703 (612 in the Gulf of Mexico and 91 in the South Atlantic) under Preferred Alternative 3. In absolute terms, the expected average losses in annual average food shrimp landings and gross revenues are very small at 170 lbs and $284. The percentage losses in annual average food shrimp landings and gross revenues to South Atlantic shrimp dealers are relatively small (0.1-0.2%). Although we do not possess estimates of profitability specifically for South Atlantic shrimp dealers, these losses are not expected to be significant for these dealers with respect to reductions in gross or net revenues, and thus are also unlikely to cause any of these dealers to stop operating. Many of these dealers purchase other seafood and may be able to replace these minor reductions with other seafood purchases.

In absolute terms, the expected average losses in annual average food shrimp landings and gross revenues to Gulf of Mexico shrimp dealers are somewhat greater at about 4,200 lbs and $10,000 per dealer. The percentage losses in annual average food shrimp landings and gross revenues are also somewhat higher at 2.2% and 2.5% respectively under Preferred Alternative 3. Estimates of net revenues or profits are not available for Gulf of Mexico shrimp dealers. However, given what is known about profit margins in the harvesting and processing sectors, such losses in gross revenue may be sufficient to force some dealers to stop operating if they cannot readily replace the lost purchases of shrimp with other seafood. For businesses that are both harvesters and dealers, if the losses to the harvesting component of the business are sufficient to cause the vessel(s) to stop operating, then it is highly likely the dealer component of the business would also be forced to shut down. Larger dealers that are also processors will be somewhat better able to absorb such losses, though profit margins in the processing sector have been very low in recent years (0.3% or $0.30/lb). "Traditional" dealers may be in the best position to absorb these losses depending on how big their business is and how readily they can replace lost shrimp purchases with other seafood.

For reasons discussed in Section 4.3, we cannot determine how the adverse effects caused by Preferred Alternative 3 will be distributed across processors. Thus, estimates of adverse effects on the processing sector can only be analyzed in the aggregate and with respect to the "average" shrimp processor in the Gulf of Mexico and in the South Atlantic. Further, all processors in each region are assumed to be affected under Preferred Alternative 3.

Between 2011 and 2014, there was an average of 9 food shrimp processors in the South Atlantic. South Atlantic shrimp processors processed an average of about 26.8 million lbs of shrimp, with an average processed value of $78.7 million. The total average value of all their processed products was about $93.6 million. Thus, the average volume of shrimp processed, average processed value of shrimp, and average value of all processed products per processor were about 2.98 million lbs, $8.74 million, and $10.4 million, respectively.

The total expected annual loss in food shrimp landings is about 15,000 lbs, or around 0.06% of the food shrimp processed in the South Atlantic, respectively. On a per-processor basis, the average annual loss in pounds is around 1,700 lbs, or about 0.06% of their processed shrimp. Similarly, the expected average annual loss in revenues/sales of processed food shrimp is approximately $26,000, or about 0.02% of their processed products' value. On a per-processor basis, the expected average annual loss in processed value is around $2,900, about 0.03% of their processed value. Such losses will be imperceptible to the South Atlantic processing sector as a whole, and to the operations of individual processors. Thus, Preferred Alternative 3 is not expected to generate significant adverse effects on South Atlantic processors and losses in net revenue or profits are likely negligible.

Between 2011 and 2014, there was an average of 55 food shrimp processors in the Gulf of Mexico. Gulf of Mexico shrimp processors processed an average of about 313.9 million lbs of shrimp, with an average processed value of $691.6 million. The total average value of all their processed products was about $738 million. Thus, the average volume of shrimp processed, average processed value of shrimp, and average value of all processed products per processor were about 5.7 million lbs, $12.6 million, and $13.4 million,[27] respectively.

[27] Because average effects on processors could only be estimated at the mean, the averages for Gulf of Mexico and South Atlantic processors used here are based on means, and thus differ from the median values in Section 3.4.

The total expected annual loss in food shrimp landings 2.5 million lbs under Preferred Alternative 3, or about 0.8% of the food shrimp processed in the Gulf of Mexico, respectively. On a per-processor basis, the average annual loss is about 46,150 lbs, or about 1.8% of their processed shrimp. Similarly, the expected average annual loss in revenues/sales of processed food shrimp is about $6.1 million, or about 0.8% of their processed products' value. On a per-processor basis, the expected average annual loss in processed value is about $111,000, or about 0.8% of their processed value. Over the past several years, marketing margins for shrimp processors have been 0.3% or less, or about $0.30/lb. Marketing margins (the difference between ex-vessel/raw import prices and processed prices) are a proxy for profit margins in the processing sector. Given reductions are less than 1%, it is assumed that most and possibly all Gulf of Mexico processors would choose and be able to switch to imports rather than shut down. On the other hand, given their high reliance on processing shrimp in recent years, such losses may be sufficient to force some of the smaller Gulf of Mexico shrimp processors to shut down if they are highly dependent on domestic product and cannot replace the lost value with imports of comparable value. Even if all Gulf of Mexico processors do switch to imported product, imports' share of the supply of shrimp in the U.S. would increase above its already currently high level of 93% (NMFS 2015).

Although the costs associated with purchasing TEDs represent an adverse economic effect to vessels and the harvesting sector in general, these costs represent expenditures that would result in additional economic activity for TED manufacturers and retailers and therefore be expected to significantly increase their gross revenues and likely net revenues/profits. The number of TEDs needed and the associated expenditures would be 22,600 in the Gulf of Mexico and 664 in the South Atlantic, for a total of about 23,300. Expenditures on TEDs would be around $7.35 million in the Gulf of Mexico and $0.21 million in the South Atlantic, for a total of $7.56 million. In general, expenditures on TEDs would be expected to partially offset the adverse economic impacts to affected communities and regions resulting from reductions in gross revenues/sales in the onshore sector, though these countervailing positive effects would only be temporary.

There are currently 5 TED manufacturers and 10 TED retailers in the Gulf of Mexico, but only 1 manufacturer and retailer in the South Atlantic. Given their relatively small numbers, the manufacturers could become overwhelmed by the level of demand, resulting in production bottlenecks and disruptions to their operations. The manufacturers in the Gulf of Mexico are estimated to only be able to produce about 100 TEDs per week and the manufacturer in the South Atlantic can only produce 20 TEDs per week. It would take the Gulf of Mexico manufacturers approximately 52 months—more than 4 years—to produce the number of TEDs necessary for all affected Gulf of Mexico vessels to comply with the new TED requirement. Conversely, it would take about 8 months for the single TED manufacturer in the South Atlantic to produce the necessary number of TEDs by South Atlantic vessels. If these estimates are accurate, the single manufacturer in the South Atlantic would see an increase in gross revenue of about $220,000 each year, while the 5 manufacturers in the Gulf would see an increase of about $355,000 in each year. These results suggest that, given the current capacity to produce new TEDs, a delay in the effectiveness of the new requirements will likely be needed, particularly in the Gulf of Mexico.

The estimates discussed above assume that all vessels continue to operate after the proposed management measures take effect. The analysis in Section 4.3 noted the strong possibility that certain vessels could be forced to shut down due to the relatively large adverse effects in the first year (i.e., the combination of TED costs and losses in gross revenue due to shrimp loss). It was also noted that, in general, the vessels most likely to shut down as a result of these adverse effects are the part-time vessels, i.e., the vessels in the Q1, Q2, and Q3 categories. These vessels have the lowest average annual gross revenues per vessel ($4,424, $22,876, and $39,364, respectively), earn relatively high negative net revenues on average, and are therefore the least able to absorb revenue reductions and cost increases.

In theory, vessels and businesses in general are expected to shut down when they cannot cover their variable costs. However, data on variable costs is not available for all vessels potentially affected by the considered alternatives. Estimates of average variable costs for certain vessels are available, as are estimates of net revenues, but those estimates are not helpful with respect to estimating how many and which vessel owners will likely choose to stop operating. Thus, the most appropriate measure to use for projecting how many and which vessels may stop operating is the percentage loss in average annual gross revenue, estimates of which are available for all of the potentially affected vessels.

There is no single “hard and fast” decision rule for determining what percentage loss in gross revenue will definitively cause a vessel to stop operating. However, given the characteristics of these part-time vessels as noted above, it seems reasonable to assume that an adverse effect in the first year that represents more than 20% of their average annual gross revenue would be sufficient to cause them to shut down. If vessels choose to shut down rather than continue operating, the losses to the harvesting sector would change, as would the indirect effects to the onshore sector (dealers, processors, and TED manufacturers and retailers). As there is some uncertainty with respect to this outcome, only certain changes in the effects are explored below.

Applying the shut-down decision rule described above to Preferred Alternative 3 results in the following findings. The number of part-time vessels projected to shut down in the Gulf of Mexico is 2,728, or approximately 48.2% of all the affected vessels in the Gulf of Mexico and nearly 60% of the 4,575 part-time vessels affected in the Gulf of Mexico. The number of part-time vessels projected to shut down in the South Atlantic is only 82, or approximately 46.3% of all the affected vessels in the South Atlantic and nearly 52% of the 159 part-time vessels affected in the South Atlantic.

If vessels shut down, the estimates of adverse effects change significantly, but differently as well depending on the measure. In general, if vessels shut down, they will no longer be landing shrimp or other species, nor will they be generating gross revenues or net revenues associated with those landings (i.e., their loss in landings and gross revenue is 100%). Thus, those landings and gross revenues will be lost to the fisheries, all other things being equal. Further, the average percentage loss in gross revenue per vessel will in turn increase, particularly in the long term because shutting down causes a long-term reduction in landings and gross revenue for the vessels that shut down. In theory, the loss of net revenues may improve or worsen economic conditions within the affected group of vessels depending on whether the economic performance (as measured by net revenues) of the vessels that shut down is better or worse than the average vessel. Because the vessels shutting down are thought to earn relatively high losses in net revenue terms, economic performance for the group would be expected to improve in the aggregate and on average.

On the other hand, because vessels that shut down will no longer require TEDs, the number of TEDs needed and the total costs of purchasing those TEDs will decrease. The decrease in TED costs will help to mitigate the total adverse effects in the aggregate, but the losses in gross revenue would generally be expected to far outweigh the reductions in aggregate TED costs and thus the total adverse effects would be expected to increase. Further, the reductions in TED costs do not mitigate such costs for the vessels that continue operating.

Expected effects under Preferred Alternative 3 are illustrated in Table 125. If certain vessels shut down, the losses in food shrimp landings increase by about 3.1 million lbs and 83,000 lbs for Gulf of Mexico and South Atlantic vessels, respectively. The losses in gross revenue increase by almost $6.8 million and $221,000 for Gulf of Mexico and South Atlantic vessels, respectively. The number of TEDs needed decreases by about 10,900 and 320 for Gulf of Mexico and South Atlantic vessels, respectively. In turn, TED costs decrease by about $3.6 million and $100,000 for Gulf of Mexico and South Atlantic vessels, respectively. Thus, the total adverse effects in the first year increase by about $3.2 million and $116,000 for Gulf of Mexico and South Atlantic vessels, respectively. The adverse effect per vessel as a percentage of gross revenue in the first year differs somewhat from the initial estimates when certain vessels were not assumed to shut down, as the average is noticeably less in the Gulf of Mexico and slightly less in the South Atlantic because some vessels are not incurring TED costs, but the total adverse effect as a percentage of gross revenue in the long-term is significantly higher at 50% and 47% compared to 5% and 2% for Gulf of Mexico and South Atlantic vessels, respectively. However, the economic performance of the vessels that remain is markedly better compared to the situation where vessels experienced the adverse effects but none stopped operating. Specifically, when vessels did not shut down, the aggregate net revenues for this group of vessels were losses of about $43 million and $1.3 million for Gulf of Mexico and South Atlantic vessels in the first year, respectively. The average net revenues per vessel in the first year were losses of about $7,600 for both Gulf of Mexico and South Atlantic vessels. Conversely, these losses are reduced to $14.4 million and $492,000 for Gulf of Mexico and South Atlantic vessels in the aggregate, respectively. On a per vessel basis, the average losses are reduced to about $4,900 and $5,200 for Gulf of Mexico and South Atlantic vessels, respectively.

Table 125. Average annual aggregate (total) and per vessel effects on Gulf of Mexico (Gulf) and South Atlantic (SA) shrimp vessels, net revenue post-effects year 1, and number of TEDs needed under Preferred Alternative 3 if vessels shut down. Dollars are in 2014 dollars. Gulf of Mexico landings are tail weight, South Atlantic landings are whole weight.

	FOOD SHRIMP LANDINGS LOSS	GROSS REVENUE LOSS	TED COSTS	TOTAL ADVERSE EFFECT YEAR 1	PERCENT GROSS REVENUE LOSS YEAR 1	PERCENT GROSS REVENUE LOSS LONG-TERM	NET REVENUE YEAR 1	NUMBER OF TEDS
NUMBER OF VESSELS	5,660	5,660	2,932	5,660	5,660	5,660	2,932	2,932
AVERAGE TOTAL GULF	5,614,803	$12,939,647	$3,799,900	$16,739,547	N/A	N/A	-$14,435,274	11,692
AVERAGE PER VESSEL GULF	992	$2,286	$1,296	$2,958	52.7	50.2	-$4,923	4.0
NUMBER OF VESSELS	177	177	95	177	177	177	95	95
AVERAGE TOTAL SA	98,475	$246,860	$111,800	$358,660	N/A	N/A	-$491,674	344
AVERAGE PER VESSEL SA	556	$1,395	$1,177	$2,026	50.5	46.8	-$5,176	3.6

Because reductions in gross revenue in the harvesting sector indirectly affect dealers and processors, and those reductions increase under Preferred Alternative 3 if vessels shut down, the indirect adverse effects to those entities are also expected to increase if vessels shut down. The affected dealers and processors are not expected to change regardless of whether vessels shut down, so the characteristics of the affected dealers and processors described above would also not change. Using the expected reductions in gross revenue to the harvesting sector as described in Table 125, the expected percentage reductions in gross sales to Gulf of Mexico dealers, South Atlantic dealers, Gulf of Mexico processors, and South Atlantic processors under Preferred Alternative 3 are 5.2%, 1%, 1.7%, and 0.3%, respectively.

Although the percentage reductions in gross sales for South Atlantic dealers and processors are higher if certain vessels shut down, the reductions are still 1% or less and thus the sector as a whole and the “average” South Atlantic dealer and processor should be able to absorb these reductions or compensate by shifting to purchases of other domestic seafood products or imports. The same cannot be said for Gulf of Mexico processors and dealers. When vessels were not assumed to shut down, the expected percentage losses in gross sales for Gulf of Mexico processors was 0.8%, whereas it is 1.7% when certain vessels shut down. Keeping in mind the relatively low marketing margins for processors in recent years (0.3%), these higher reductions would increase the risk of processors shutting down, particularly smaller processors, and also make it more likely and difficult to substitute imported product in place of lost domestic production. More pronounced is the greater adverse effect on Gulf of Mexico dealers. The reduction is more than 5% and thus considerably greater if vessels shut down. Even if some dealers are able to compensate by shifting to other domestic production, it is unlikely all of them will be able to do so and thus these reductions would be expected to cause some Gulf of Mexico dealers to shut down, particularly vessel owners that act as their own dealers and other small dealers.

With respect to TED manufacturers and retailers, the number of TEDs needed and the resulting expenditures on those TEDs are expected to be significantly less if vessels shut down compared to the expected values if they do not shut down. These results are reflected in Table 126. Thus, the increases in gross revenues and, likely, net revenues/profits would not be nearly as great for these businesses if vessels shut down. We do not possess any economic data on these businesses' operations. However, the available information does suggest that gross revenue for the single manufacturer in the South Atlantic should increase by about $110,000 and, on average, gross revenues for the 5 manufacturers in the Gulf of Mexico should increase by $760,000 on average in the first year after implementation. In addition, the time to produce the needed number of TEDs is also considerably lower if certain vessels shut down. However, the time necessary to produce TEDs in the Gulf of Mexico is still more than 2 years and, thus, a delay in the effectiveness of the new requirements will likely be necessary.

Table 126. Number of TEDs and TED expenditures (in millions) if vessels shut down by region.

NUMBER OF TEDS - GULF	11,696
NUMBER OF TEDS - SA	344
NUMBER OF TEDS - TOTAL	12,040
TED EXPENDITURES - GULF	$3.8
TED EXPENDITURES - SA	$.11
TED EXPENDITURES - TOTAL	$3.9
TIME TO PRODUCE - GULF	2.3 YEARS
TIME TO PRODUCE - SA	5 MONTHS

5.5 ECONOMIC IMPACTS OF THE MANAGEMENT MEASURES

The determination of economic impacts is separate from the determination of changes in net benefits to society. Economic impacts are generally characterized in terms of the levels of output, employment, and income that accrue to local, state, regional and the national economy as a result of expenditures or gross revenues. Economic impact models are used to determine the current economic impacts of an industry or sector, as reflected by these measures, as well as changes that are expected to occur if expenditures or gross revenues change in a particular industry or sector.

Table 127 describes the current economic impacts of entities in the Gulf of Mexico and South Atlantic shrimp fisheries that are expected to be affected under the proposed regulatory action (i.e., the baseline or "status quo" economic impacts). According to this information, the affected fisheries generate employment, income, and output impacts of 24,472 jobs, $637.78 million, and $1.81 billion, respectively.

Table 127. Economic impacts of the affected Gulf of Mexico and South Atlantic shrimp fisheries.

INDUSTRY SECTOR	DIRECT	INDIRECT	INDUCED	TOTAL
Harvesters				
Employment impacts (FTE jobs)	3,437	670	775	4,881
Income Impacts (000 of dollars)	77,738	21,959	38,266	137,963
Output Impacts (000 of dollars)	186,927	181,672	127,016	495,615
Primary dealers/processors				
Employment impacts (FTE jobs)	929	371	644	1,945
Income Impacts (000 of dollars)	32,930	30,347	28,703	91,980
Output Impacts (000 of dollars)	105,988	79,831	105,632	291,451
Secondary wholesalers/distributors				
Employment impacts (FTE jobs)	235	52	227	513
Income Impacts (000 of dollars)	10,667	3,173	11,219	25,058
Output Impacts (000 of dollars)	28,572	10,417	37,267	76,256
Grocers				
Employment impacts (FTE jobs)	1,446	163	319	1,928
Income Impacts (000 of dollars)	31,586	10,424	15,746	57,756
Output Impacts (000 of dollars)	53,983	27,281	52,337	133,601
Restaurants				
Employment impacts (FTE jobs)	12,389	816	2,000	15,205
Income Impacts (000 of dollars)	174,213	52,207	98,601	325,021
Output Impacts (000 of dollars)	339,559	146,033	327,828	813,420
Harvesters and seafood industry				
Employment impacts (FTE jobs)	18,435	2,071	3,966	24,472
Income Impacts (000 of dollars)	327,134	118,110	192,535	637,779
Output Impacts (000 of dollars)	715,028	445,235	650,080	1,810,343

The proposed regulatory action is expected to result in reduced gross revenues in the harvesting sector that will in turn reduce economic impacts in the onshore sector and related industries. Although new expenditures on TEDs would be expected to partially offset the impacts of the reductions in gross revenues, those impacts are expected to be temporary for reasons previously explained and thus are not accounted for in the following economic impact estimates.

In the long-term, the proposed regulatory action is expected to result in an annual gross revenue reduction of approximately $6.168 million in the harvesting sector if certain vessels do not shut down. Based on the information in Table 128, the expected decrease in annual gross revenue is expected to decrease employment, income, and output by 808 jobs, $30.15 million, and $59.74 million, respectively.

Table 128. Economic impact reductions due to the proposed action (no vessels shut down).

INDUSTRY SECTOR	DIRECT	INDIRECT	INDUCED	TOTAL
Harvesters				
Employment impacts (FTE jobs)	113	22	26	161
Income Impacts (000 of dollars)	2,565	725	1,263	4,552
Output Impacts (000 of dollars)	6,168	5,995	4,191	16,354
Primary dealers/processors				
Employment impacts (FTE jobs)	31	12	21	64
Income Impacts (000 of dollars)	1,087	1,001	947	3,035
Output Impacts (000 of dollars)	3,497	2,634	3,486	9,617
Secondary wholesalers/distributors				
Employment impacts (FTE jobs)	8	2	8	17
Income Impacts (000 of dollars)	352	105	370	827
Output Impacts (000 of dollars)	943	344	1,230	2,516
Grocers				
Employment impacts (FTE jobs)	48	5	11	64
Income Impacts (000 of dollars)	1,042	344	520	1,906
Output Impacts (000 of dollars)	1,781	900	1,727	4,408
Restaurants				
Employment impacts (FTE jobs)	409	27	66	502
Income Impacts (000 of dollars)	5,748	1,723	3,254	10,725
Output Impacts (000 of dollars)	11,204	4,819	10,817	26,840
Harvesters and seafood industry				
Employment impacts (FTE jobs)	608	68	131	808
Income Impacts (000 of dollars)	10,794	3,897	6,353	21,045
Output Impacts (000 of dollars)	23,594	14,691	21,451	59,736

In the long-term, the proposed regulatory action is expected to result in an annual gross revenue reduction of approximately $13.186 million in the harvesting sector if certain vessels do not shut down. Based on the information in Table 129, the expected decrease in annual gross revenue is expected to decrease employment, income, and output by 1,726 jobs, $45 million, and $127.73 million, respectively. As expected, the reductions in jobs, income and output are significantly greater if some vessels shut down.

Table 129. Economic impact reductions due to the proposed action (some vessels shut down).

INDUSTRY SECTOR	DIRECT	INDIRECT	INDUCED	TOTAL
Harvesters				
Employment impacts (FTE jobs)	242	47	55	344
Income Impacts (000 of dollars)	5,484	1,549	2,699	9,732
Output Impacts (000 of dollars)	13,186	12,815	8,960	34,961
Primary dealers/processors				
Employment impacts (FTE jobs)	66	26	45	137
Income Impacts (000 of dollars)	2,323	2,141	2,025	6,488
Output Impacts (000 of dollars)	7,476	5,631	7,451	20,559
Secondary wholesalers/distributors				
Employment impacts (FTE jobs)	17	4	16	36
Income Impacts (000 of dollars)	752	224	791	1,768
Output Impacts (000 of dollars)	2,015	735	2,629	5,379
Grocers				
Employment impacts (FTE jobs)	102	11	23	136
Income Impacts (000 of dollars)	2,228	735	1,111	4,074
Output Impacts (000 of dollars)	3,808	1,924	3,692	9,424
Restaurants				
Employment impacts (FTE jobs)	874	58	141	1,073
Income Impacts (000 of dollars)	12,289	3,683	6,955	22,927
Output Impacts (000 of dollars)	23,953	10,301	23,125	57,379
Harvesters and seafood industry				
Employment impacts (FTE jobs)	1,300	146	280	1,726
Income Impacts (000 of dollars)	23,076	8,332	13,582	44,989
Output Impacts (000 of dollars)	50,439	31,407	45,857	127,703

5.6 PRIVATE AND PUBLIC COSTS OF THE REGULATIONS

The preparation, implementation, enforcement, and monitoring of this or any federal action involves the expenditure of public and private resources that can be expressed as costs associated with the regulations. Costs associated with this specific action will include:

Our administrative costs of DEIS preparation, meetings, and review	$270,000
Law enforcement costs	Unknown
Outreach costs	Unknown
TOTAL	**$270,000**

Federal costs of DEIS preparation are based on staff time, travel, printing, and any other relevant items where funds were expended directly for this specific action. There are no permit requirements in this proposed action. Based on past experience with requiring TEDs in shrimp trawls, it is expected that additional enforcement activity by OLE and outreach efforts by the agency (e.g., TED workshops, GMT activity) will be required, at least in the first year or two following implementation, to insure the effectiveness of the preferred alternative. Additionally, the increased number of vessels that would be required to use TEDs would likely increase the number of inspections, with attendant increase in OLE costs. However, an estimate of the increased costs necessary to support this activity is not available at this time. Additionally, law enforcement typically operates in an environment of fixed to minimal budgetary increases from year to year. As a result, much, if not most, of any increased inspection and enforcement activity would likely have to be borne through existing budgets. Finally, outreach efforts and associated costs have not been determined at this time.

5.7 NET BENEFITS OF THE PROPOSED ACTION

The information in Sections 5.4 and 5.6 can be used to make a reasonable assessment of whether net benefits to society would be expected to increase or decrease under the proposed action and, possibly, the magnitude of that change. For reasons previously explained, no changes in CS to consumers of shrimp products are expected as a result of this action. TED manufacturers are also expected to benefit from the proposed action. The total increase in gross revenue to the 6 manufacturers is expected to be about $7.5 million if vessels do not shut down, though this would be spread across approximately 4 years, and thus the annual increase would be about $1.88 million. If vessels shut down, the increase would be significantly less at only about $3.9 million, and likely spread out over about 2 years, and thus the annual increase would be about the same at $1.95 million. Although the increase in net revenue would be less than the increase in gross revenue under either scenario, these businesses would still likely experience a significant increase in net revenue.

However, the primary benefit of the proposed action is the expected reduction in sea turtle mortalities. The annual benefit of saving more than 2,200 endangered and threatened sea turtles is expected to be at least $219.46 million if only the status of Kemp's ridleys improve from endangered to threatened, to as high as $759.31 million if both Kemp's ridleys and green sea turtles are recovered in the next 10 years. These constitute significant benefits to the nation, but will only accrue if the statuses of these sea turtles are, in fact, improved. If their statuses are not improved as a result of the proposed action, then these benefits will not be realized. Estimates of how much the public may be willing to pay to save one or more sea turtles without improving their status are not currently available. However, it is likely the benefits are far less, as the public appears to place value on the status of a population rather than individuals within that population.

With respect to costs or adverse effects of the proposed action, based on the above information, the total reduction in gross revenue to the harvesting sector is expected to be about $6.2 million, total TED costs are about $7.5 million, and total adverse effects in the first year are therefore $13.7 million. This is the best available estimate of the expected reduction in net revenue in the first year if vessels do not shut down as a result of these effects. Losses in gross revenue are expected to recur on an annual basis. TED costs are assumed not to recur on an annual basis given that they have relatively long lifespans if cared for properly and, in general, can often be repaired rather than replaced if the owner or operator has the proper knowledge. Thus, annual adverse effects in the long-term are estimated to be $6.2 million per year if vessels do not shut down.

If certain vessels shut down, the total reduction in gross revenue to the harvesting sector is expected to be significantly higher at $13.2 million (i.e., more than double), total TED costs are somewhat lower at $3.9 million, and the total adverse effect in the first year is therefore somewhat higher at $17.1 million. This is the best available estimate of the expected reduction in net revenue in the first year if vessels do not shut down as a result of these effects. Losses in gross revenue are expected to recur on an annual basis. TED costs are assumed not to recur on an annual basis given that they have relatively long lifespans if cared for properly and, in general, can often be repaired rather than replaced if the owner or operator has the proper knowledge. Thus, annual adverse effects in the long-term are estimated to be $13.2 million per year if vessels do not shut down.

Reductions in gross revenue in the harvesting sector are overestimates of reductions in net revenue and, thus, economic costs. However, these reductions in gross revenue will be passed along to dealers and processors, resulting in reductions in gross sales for these businesses. Again, the reductions in net revenue for these businesses will be less than the reductions in gross sales. Given the lack of detailed economic data for dealers and processors, it is not possible to accurately estimate the reductions in net revenue to these businesses. However, it is clear that the reductions for these dealers will be significantly greater if vessels in the harvesting sector shut down rather than absorb the adverse effects and continue to operate.

Based on the above, although the long-term costs of this action to the harvesting and onshore sectors are relatively large, and the government will incur non-trivial costs in the short-term as a result of this action, the long-term benefits from improving the status of endangered and threatened sea turtles are significantly greater. Thus, it can be reasonably concluded that net benefits to society would increase and increase significantly in the long term if the status of Kemp's ridleys and Green sea turtles is improved. If they are not improved as a result of the proposed action, the benefits from saving a particular number of sea turtles are unknown and, thus, the net benefits of the proposed action to society are unknown.

5.8 DETERMINATION OF A SIGNIFICANT REGULATORY ACTION

Pursuant to E.O. 12866, a regulation is considered a "significant regulatory action" if it is likely to result in: (1) an annual effect of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights or obligations of recipients thereof; or (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this executive order.

The information provided above regarding the benefit of improving the status of threatened and endangered sea turtles indicates the annual effect would exceed the $100 million threshold based on the public's WTP for improving their status. These benefits, however, are only realized if the status of threatened and endangered sea turtles improves as a result of the proposed action. While we believe this action is necessary to aid in the recovery of threatened and endangered sea turtles, we do not expect this action, in and of itself, will result in recovery; instead, it is part of a larger recovery program. If the status of threatened and endangered sea turtle species does not change as a result of this action, the benefits cannot be estimated and are, therefore, unknown. Therefore, we have determined this action would not be expected to be economically significant for purposes of E.O. 12866.

6 INITIAL REGULATORY FLEXIBILITY ACT ANALYSIS

6.1 INTRODUCTION

The purpose of the Regulatory Flexibility Act (RFA) is to establish a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes to fit regulatory and informational requirements to the scale of businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure such proposals are given serious consideration. The RFA does not contain any decision criteria; instead the purpose of the RFA is to inform the agency, as well as the public, of the expected economic effects of various alternatives contained in the regulatory action and to ensure the agency considers alternatives that minimize the expected economic effects on small entities while meeting the goals and objectives of the applicable statutes (e.g., ESA).

With certain exceptions, the RFA requires agencies to conduct an initial regulatory flexibility analysis (IRFA) for each proposed rule; thus, the following IRFA was prepared. The IRFA is designed to assess the effects various regulatory alternatives would have on small entities, including small businesses, and to determine ways to minimize those effects. An IRFA is primarily conducted to determine whether the proposed regulatory action would have a significant economic effect on a substantial number of small entities. In addition to analyses conducted for the RIR, the IRFA provides: 1) a description of the reasons why action by the agency is being considered; 2) a succinct statement of the objectives of, and legal basis for, the proposed regulatory action; 3) a description and, where feasible, an estimate of the number of small entities to which the proposed regulatory action will apply; 4) a description of the projected reporting, record-keeping, and other compliance requirements of the proposed regulatory action, including an estimate of the classes of small entities which will be subject to the requirements of the report or record; 5) an identification, to the extent practicable, of all relevant federal rules, which may duplicate, overlap, or conflict with the proposed rule; and 6) a description of any significant alternatives to the proposed regulatory action which accomplish the stated objectives of applicable statutes and would minimize any significant economic effects of the proposed regulatory action on small entities.

In addition to the information provided in this chapter, additional information on the expected economic effects of this proposed action is included in Sections 4.3 and 5.4.

6.2 STATEMENT OF THE NEED FOR, OBJECTIVES OF, AND LEGAL BASIS FOR THE ACTION

A discussion of the need for and objectives of this action is provided in Section 1.1. In summary, the purpose of this action is to expand the required use of TEDs designed to exclude small sea turtles when commercially fishing for shrimp in order to aid in the protection and recovery of sea turtle populations listed under the ESA (16 USC. 1531 et seq.). The objective of this action is to reduce the incidental bycatch and mortality of sea turtles, particularly small sea turtles, in the Southeastern U.S. shrimp fisheries. The ESA provides the statutory basis for this action.

6.3 DESCRIPTION AND ESTIMATE OF THE NUMBER OF SMALL ENTITIES TO WHICH THE PROPOSED ACTION WOULD APPLY

This proposed action is expected to directly regulate businesses that use skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) in the Southeastern U.S. shrimp fisheries (North Carolina through Texas), with the exception of businesses that use wing nets in Biscayne Bay in Miami-Dade County, Florida. An estimated 5,837 vessels have been identified that use this gear (5,660 vessels in the Gulf of Mexico and 177 vessels in the South Atlantic). Although some vessels are known to be held by businesses with the same, or substantially same, individual owners and, thus, would be considered affiliated, ownership data is incomplete and it is not currently feasible to accurately determine the number of individual businesses these 5,837 vessels represent. As a result, although it will result in an overestimate of the actual number of businesses directly regulated by this proposed action, for the purposes of this analysis, it is assumed that each vessel is independently owned by a single business. Therefore, this proposed action would be expected to directly regulate 5,837 businesses.

The average annual gross revenue (2014 dollars) over the period 2011-2014 for vessels that harvested shrimp using skimmer trawls, pusher-head trawls, or wing nets (butterfly trawls) was approximately $31,861 for vessels in the Gulf of Mexico (5,660 vessels) and $37,250 for vessels in the South Atlantic (177 vessels). The largest average annual gross revenue earned by a single business over this period was approximately $1.85 million.

We have not identified any other small entities that might be directly affected by this proposed action.

On December 29, 2015, we issued a final rule establishing a small business size standard of $11 million in annual gross receipts (revenue) for all businesses primarily engaged in the commercial fishing industry (NAICS code 114111) for RFA compliance purposes only (80 FR 81194, December 29, 2015). The $11 million standard became effective on July 1, 2016, and is to be used in place of the prior Small Business Administration standards of $20.5 million, $5.5 million, and $7.5 million for the finfish (NAICS 114111), shellfish (NAICS 114112), and other marine fishing (NAICS 114119) sectors of the U.S. commercial fishing industry in all NMFS rules subject to the RFA after July 1, 2016 (Id. at 81194). In addition to this gross revenue standard, a business primarily involved in commercial fishing is classified as a small business if it is independently owned and operated, and is not dominant in it field of operations (including its affiliates). Based on the information above, all businesses directly regulated by this proposed action are determined to be small businesses for the purpose of this analysis.

6.4 DESCRIPTION OF THE PROJECTED REPORTING, RECORD-KEEPING AND OTHER COMPLIANCE REQUIREMENTS OF THE PROPOSED ACTION, INCLUDING AN ESTIMATE OF THE CLASSES OF SMALL ENTITIES WHICH WILL BE SUBJECT TO THE REQUIREMENT AND THE TYPE OF PROFESSIONAL SKILLS NECESSARY FOR THE PREPARATION OF THE REPORT OR RECORDS

This proposed action would not establish any new reporting, record-keeping, or other compliance requirements beyond the requirement to use a TED when using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls). TEDs are typically installed by the net manufacturer, so no special skills would be expected to be required of fishers for TED installation. Some learning would be expected to be necessary for the maintenance and routine use of TEDs by fishers who have not historically had to use these devices. However, TEDs have been required in otter trawls for many years. A majority of the vessels directly regulated by the proposed action also used otter trawls between 2011 and 2014 and thus are expected to be knowledgeable of how to maintain and use TEDs (M. Travis, pers. comm., November 17, 2016). Thus, the skills required for TED use is thought to be consistent with the skillset and capabilities of commercial shrimp fishers in general. As a result, special professional skills would not be expected to be necessary.

6.5 IDENTIFICATION OF ALL RELEVANT FEDERAL RULES, WHICH MAY DUPLICATE, OVERLAP OR CONFLICT WITH THE PROPOSED ACTION

No duplicative, overlapping, or conflicting federal rules have been identified.

6.6 SIGNIFICANCE OF ECONOMIC EFFECTS ON SMALL ENTITIES

Substantial Number Criterion

This proposed action would be expected to directly regulate all commercial fishing entities using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) in the Southeastern U.S. shrimp fisheries, or an estimated 5,837 businesses. As previously discussed, all of these affected entities have been determined, for the purpose of this analysis, to be small entities. Therefore, it is determined that this proposed action, if implemented, would affect a substantial number of small entities.

Significant Economic Effects

The outcome of “significant economic effect” can be ascertained by examining 2 factors: disproportionality and profitability.

<u>Disproportionality</u>: Do the regulations place a substantial number of small entities at a significant competitive disadvantage to large entities?

All entities expected to be directly affected by the measures in this proposed action are determined for the purpose of this analysis to be small business entities, so the issue of disproportionality does not arise in the present case.

Profitability: Do the regulations significantly reduce profits for a substantial number of small entities?

This proposed action would require all commercial fishing entities using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) in the Southeastern U.S. shrimp fisheries (North Carolina through Texas), with the exception of businesses that use wing nets in Biscayne Bay in Miami-Dade County, Florida, to use TEDs designed to exclude small sea turtles when shrimping. Although these TEDs, as designed, successfully result in the reduced bycatch of small sea turtles, they also result in shrimp loss and reduced shrimp harvest per tow. Conceptually, it may be possible to compensate for this reduction in harvest with additional tows; however, such would require an attendant increase in operating costs, likely rendering increased activity unprofitable (i.e., if additional tows were cost-effective/profitable, this effort would already be occurring and part of baseline fishing behavior). As a result, vessels affected by this proposed action would be expected to experience economic losses from two sources, reduced shrimp revenue and increased gear costs associated with the purchase, installation, maintenance, and replacement of newly required TEDs. Revenue loss from reduced shrimp harvest would be expected to be recurrent (yearly), barring changes in fishing practices, and the increased gear costs would recur periodically based on loss, maintenance, and replacement cycles (under normal use and proper maintenance, a TED would be expected to last at least 3 years).

In this analysis, the average shrimp loss is assumed to be 6.21% (estimated range of 3.07-10.61%), the estimated cost per TED is $325 for small vessels (vessels less than 60 ft) and $550 for large vessels (vessels 60 ft or longer), and vessels are assumed to purchase/carry enough TEDs for the nets towed plus 1 spare set. Therefore, the actual effects of this proposed action on individual vessels will vary based on individual performance (higher or lower shrimp loss than projected; because these fishermen have not traditionally had to use TEDs, initial shrimp loss may be higher than projected and persist until greater familiarity with the gear use is acquired), and gear purchase decisions (how many TEDs are purchased/carried).

Additionally, in this analysis, neither the ex-vessel price per pound of shrimp nor the expected cost per TED is modeled to change in response to supply/demand conditions. Specifically, the estimated decrease in the harvest of domestic shrimp (as a result of increased shrimp loss due to this proposed action) is not modeled to result in an increase in the ex-vessel price of domestically-harvested shrimp, nor has the projected increase in the demand for TEDs (the estimated number of TEDs necessary to outfit all of the vessels regulated by this proposed action is 23,266) been modeled to result in an increase in the average cost of a TED. The assumed lack of change in shrimp ex-vessel prices is likely more realistic than the assumed constant cost of a TED because imported shrimp dominate the U.S. market and available evidence suggests the demand for shrimp is highly elastic. Upward price pressure on TEDs will be affected by the number of available suppliers (there are currently 6 suppliers), their capacity to meet production demand (each can currently produce 20 TEDs per week), the timeframe for compliance, and the total number of TEDs needed. The total number of TEDs needed will be affected by vessel purchase decisions (i.e., how many spares vessels chose to carry), and the number of vessels that can successfully remain in operation in the face of the higher operating costs and reduced revenue. Though not expected, if the ex-vessel price of shrimp increases as a result of reduced supply, the effects provided in this analysis will be overstated. Conversely, if the price of a TED increases, then the adverse economic effects associated with this component of this analysis will be understated.

Because the increased gear costs (associated with TED purchase) would be periodic, whereas the shrimp loss would be annual, the following analysis just presents first-year results (i.e., results that include both TED purchase costs and shrimp revenue reduction). The adverse effects in subsequent years will be less than those in the first year and, as previously stated, would be expected to vary with fishing adaptations (fishermen may become more skilled in how the nets with TEDs are fished, thereby reducing shrimp loss), and TED replacement schedules (both planned and unplanned). All of the monetary effects provided in this analysis are in 2014 dollars.

Over all of the businesses expected to be affected (5,837 vessels), this proposed action would be expected to result in a reduction in gross revenue of approximately $6.2 million and TED costs of approximately $7.5 million, thereby resulting in a total adverse effect of approximately $13.7 million in the first year. The average adverse effects per vessel would be $1,062, $1,285, and $2,347 with respect to lost gross revenue, TED costs, and total adverse effects, respectively. These effects would not be expected to be uniform across Gulf of Mexico and South Atlantic vessels. Gulf of Mexico vessels would be expected to experience average adverse effects of $1,085, $1,298, and $2,383 with respect to lost gross revenue, TED costs, and total adverse effects, respectively. The comparable values for South Atlantic vessels would be $146, $1,219, and $1,365.

These values, however, insufficiently capture the range of differences in the economic performance of vessels across the fisheries. To examine these differences, vessels were placed in a category based on their average annual gross (total) revenue from 2011-2014. These categories are based on vessel categories developed for or derived from the annual economic reports for federally-permitted vessels in the Gulf of Mexico, federally-permitted vessels in the South Atlantic, and non-federally-permitted vessels in the Gulf of Mexico. Vessels were placed in the category that their average annual gross revenue most closely approximated. In the South Atlantic, the distribution of gross revenue between shrimp and non-shrimp species was also taken into account.

In the Gulf of Mexico, vessels were placed into one of 6 categories: average federally-permitted vessel (federal Gulf of Mexico), Q5, Q4, Q3, Q2, and Q1. Specifically, in the Gulf of Mexico, the average annual gross revenue ranges for the federal Gulf, Q5, Q4, Q3, Q2, and Q1 categories are as follows: >/= $255,000, < $255,000 and >/= $119,000, < $119,000 and >/= $52,000, < $52,000 and >/= $29,000, < $29,000 and >/= $17,000, and < $17,000. In the South Atlantic, vessels were placed into 9 categories: rock shrimp (RSLA), primary penaeid (SPA Primary), secondary penaeid (SPA Secondary), average federally-permitted South Atlantic penaeid vessel (AS), Q5, Q4, Q3, Q2, and Q1. A vessel was placed in the RSLA category if 50% or more of its gross revenue came from shrimp and its average annual gross revenue was >/= $456,000. A vessel was placed in the AS category if 50% or more of its gross revenue came from shrimp and its average annual gross revenue was < $456,000 and >/= $216,000. A vessel was placed in the SPA Primary category if

50% or more of its gross revenue came from shrimp and its average annual gross revenue was < $216,000 and >/= $119,000. Finally, a vessel was placed in the SPA Secondary category if < 50% of its gross revenue came from shrimp and its average annual gross revenue was >/= $119,000. The ranges are the same as in the Gulf of Mexico for the Q5, Q4, Q3, Q2, and Q1 categories.

These categories should not be presumed to imply that every vessel in a particular category has a particular permit associated with the category name, as that is not always the case. Among these vessel categories for vessels in both areas, vessels in the Q1, Q2, and Q3 categories are considered, for the purpose of this analysis, as part-time vessels (i.e., vessels that are only engaged in commercial fishing part-time) and vessels in each of the other categories are considered full-time vessels.

For Gulf of Mexico vessels, the number of vessels expected to be directly affected by this proposed action and their average annual gross fishing revenue for 2011-2014 are 3,386 vessels and $4,524 for Q1 vessels, followed by 534 vessels and $22,773 (Q2), 655 vessels and $39,130 (Q3), 781 vessels and $77,698 (Q4), 232 vessels and $160,932 (Q5), and 72 vessels and $405,664 (federal Gulf of Mexico). The expected average adverse effect (reduced shrimp revenue and TED cost) of the proposed action in the first year for these vessels by category is $1,510, $2,200, $2,813, $4,568, $6,467, and $3,303 for vessels in each category, Q1-Q5 and federal Gulf of Mexico, respectively. Although the average adverse effects of the proposed action could be compared to the average gross revenue to generate an estimate of the average relative (percent) effect of the proposed action by category, this “average to average” approach (average adverse effect/average gross revenue for each category) would provide a distorted perspective of the actual expected effects of this proposed action at the vessel level. For example, using this approach (“average to average”) for category Q1, the average estimated effect of the cost of the proposed action would be approximately 33.4% ($1,510/$4,524; the projected average adverse effect per vessel of this proposed action would be 33.4% of average annual gross revenue). Although this outcome would not likely be considered insignificant, examination of the adverse effectby vessel (adverse effect/average gross revenue for that vessel), then averaged across all vessels, provides a much clearer picture of the expected economic burden of this proposed action. Using this approach, the relative adverse effect of this proposed action as a percentage of average annual gross revenue increases to 199.4% for vessels in the Q1 category. This result demonstrates that most of these vessels generate minimal fishing revenue year-to-year, and the costs of the TEDs alone are likely to be financially unbearable even before factoring in the loss of shrimp revenue. Applying this approach (analysis at the vessel level, then averaging across all vessels) to all revenue categories for Gulf of Mexico vessels, the percent loss relative to gross revenue would be expected to be 199.4% for Q1 vessels, 9.8% (Q2), 7.3% (Q3), 6.0% (Q4), 4.2% (Q5), and 1.0% (federal Gulf of Mexico). These results demonstrate that, although the expected effects in absolute monetary terms are greater for the vessels in categories Q4, Q5, and federal Gulf of Mexico, (i.e., vessels that generate the highest average annual gross revenues and are considered full-time vessels), the relative effect of this proposed action would be greater on vessels in the Q1, Q2, and Q3 categories (i.e., part-time vessels that havethe lowest average annual gross revenues).

For South Atlantic vessels, the number of vessels expected to be directly affected by this proposed action and their average gross revenue for 2011-2014 are 123 vessels and $5,350 for Q1 vessels, followed by 19 vessels and $22,797 (Q2), 17 vessels and $39,329 (Q3), 13 vessels and $717,843 (Q4), 3 vessels and $835,270 (RSLA), and 1 vessel for each of the SPA Secondary and AS categories. Because the expected number of entities affected by the proposed action in the SPA Secondary and AP categories is so small, neither baseline economic information nor expected economic effects can be reported for them due to confidentiality restrictions. The expected average adverse effect (reduced shrimp revenue and TED cost) of this proposed action in the first year for these vessels is $1,290, $1,378, $1,667, $1,627, $1,573 for vessels in the Q1, Q2, Q3, Q4 and RSLA categories, respectively. The percent loss relative to gross revenue for South Atlantic vessels (using the same vessel-level analytical approach discussed in the previous paragraph and applied to Gulf of Mexico vessels) would be expected to be 96.5% for Q1 vessels, 6.2% (Q2), 4.4% (Q3), 2.4% (Q4), and 0.2% (RSLA). Although the expected effects in absolute monetary terms for the South Atlantic vessels do not follow as markedly the same pattern as those for Gulf of Mexico vessels (full-time vessels in the South Atlantic would generally be expected to experience greater average adverse effects than part-time vessels, but range of the difference is only a couple hundred dollars for South Atlantic vessels and not thousands of dollars, as expected in the Gulf of Mexico) and the relative effects are not expected to be as great, the relative effects on the part-time vessels in the South Atlantic continues to exceed that of full-time vessels. Also, similar to the results for Gulf of Mexico vessels, the effects on the South Atlantic Q1 vessels may be so great as to render continued operation as a commercial fishing vessel economically infeasible.

In spite of the results presented above, this analysis does not assume nor conclude that any specific individual or total number of vessels would be expected to cease operation as a commercial fishing business as a result of the proposed action. The results suggest that it may be logical to conclude that a high number of the part-time vessels may not continue operation as a result of the proposed action. However, based on available data, a general economic assessment utilizing gross revenue and operating cost information suggests that the financial conditions for many vessels are and have been poor, to say the least, particularly part-time vessels (the average net revenue for Q1, Q2, andQ3 vessels was negative based on 2012 data for non-permitted vessels in the Gulf of Mexico), yet at least some of these vessels continue to commercially harvest shrimp. This suggests either available data incompletely captures the "economics" of these operations, or the decision to harvest shrimp is based on criteria other than, or in addition to, considerations of profit and loss (e.g., personal consumption of harvested shrimp and associated value, lifestyle bonus, etc.). Thus, despite acknowledgement that imposing additional costs on businesses that have an already tenuous financial situation will, with some unknown degree of certainty, result in some vessels exiting the commercial shrimp industry, this analysis does not forecast how many vessels may do so. Instead, as previously discussed, this analysis simply notes that the total economic losses associated with this proposed action will increase the more vessels cease operation. Conversely, the more vessels that cease commercial fishing, the more likely that demand pressure on TED prices will be reduced (i.e., TED prices will not increase over the assumed costs utilized in this analysis and the costs of this proposed action worsen) and, potentially, some portion of the shrimp traditionally harvested by these vessels may be harvested by vessels than continue to fish, thereby mitigating some of the shrimp loss to these vessels as a result of TED use.

6.7 DESCRIPTION OF SIGNIFICANT ALTERNATIVES TO THE PROPOSED ACTION AND DISCUSSION OF HOW THE ALTERNATIVES ATTEMPT TO MINIMIZE ECONOMIC EFFECTS ON SMALL ENTITIES

Seven alternatives, including no action, were considered for the proposed action (Alternative 3). The first alternative (Alternative 1, no action) to the proposed action would not expand the required use of TEDs and, as a result, would not achieve the objective of reducing the incidental bycatch and mortality of sea turtles in the Southeastern U.S. shrimp fisheries.

The second alternative (Alternative 2) to the proposed action would have expanded the required use of TEDs to only vessels using skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) that were 26 ft and greater in length. This alternative would have been expected to affect fewer vessels (3,103) and reduce the total expected increase in TED costs and shrimp revenue loss compared to the proposed action. However, this alternative was not selected because it would be expected to result in less protection of sea turtles (1,509-2,179 turtles, or a mid-point estimate of 1,844 turtles) than the proposed action (1,730-2,500 turtles, or a mid-point estimate of 2,115 turtles).

The third alternative (Alternative 4) to the proposed action would have expanded the required use of TEDs to only vessels using skimmer trawls that were 26 ft and greater in length. This alternative would have been expected to affect fewer vessels (2,913) and reduce the total expected increase in TED costs and the shrimp revenue loss compared to the proposed action. However, this alternative was not selected because it would be expected to result in less protection of small sea turtles (1,412-2,040 turtles, or a mid-point estimate of 1,726 turtles) than the proposed action.

The fourth alternative (Alternative 5) to the proposed action would have expanded the required use of TEDs to all vessels using skimmer trawls regardless of vessel length. This alternative would, similar to Alternative 4, have been expected to affect fewer vessels (5,432) and reduce the total expected increase in TED costs and shrimp revenue loss compared to the proposed action. However, this alternative was not selected because it would be expected to result in less protection of small sea turtles (1,624-2,348 turtles, or a mid-point estimate of 1,986 turtles) than the proposed action.

The fifth and sixth alternatives (Alternatives 6 and 7) to the proposed action would have expanded the required use of TEDs to all shrimp vessels regardless of trawl type but varying by fishing location (Alternative 6, state waters only; Alternative 7, all waters). These alternatives were not selected because they would have been expected to affect more vessels (9,711, both alternatives) and result in greater expected increases in TED costs and shrimp revenue loss, with a relatively minor increase in expected protection of small sea turtles compared to the proposed action.

7 OTHER APPLICABLE LAWS

7.1 ADMINISTRATIVE PROCEDURE ACT (APA)

The federal Administrative Procedure Act (APA) establishes procedural requirements applicable to informal rulemaking by federal agencies. The purpose of the APA is to ensure public access to the federal rulemaking process and to give the public notice and an opportunity to comment before the agency promulgates new regulations. Specifically, the APA requires us to solicit, review, and respond to public comments on actions. Development of the alternatives considered for the sea turtle conservation measures in the Southeastern U.S. shrimp fisheries provided several opportunities for public review, input, and access to the rulemaking process. For example, during the public scoping process, we requested suggestions and information from the public on the range of issues that should be addressed and alternatives that should be considered in the DEIS. A summary of the scoping comments is included in Section 1.3 and Table 1. Public comments will also be accepted on the DEIS and the proposed rule. These comments, along with those received to date, will be considered in developing the final action.

7.2 COASTAL ZONE MANAGEMENT ACT (CZMA)

The Coastal Zone Management Act (CZMA) is designed to encourage and assist states in developing coastal management programs, to coordinate state activities, and to safeguard regional and national interests in the coastal zone. Section 307(c) of the CZMA requires that any federal activity affecting the land or water uses or natural resources of a state's coastal zone be consistent with the state's approved coastal management program, to the maximum extent practicable. We have determined that the implementation of the preferred alternative would be consistent to the maximum extent practicable with the approved coastal management programs of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. This determination will be submitted, along with a copy of this document, for review and concurrence by the responsible state agencies under Section 307 of the CZMA. A list of the specific state contacts and a copy of the letters are available upon request.

7.3 ENDANGERED SPECIES ACT (ESA)

Section 7 of the ESA requires federal agencies conducting, authorizing, or funding activities that may affect threatened or endangered species to ensure that those impacts do not jeopardize the continued existence of listed species or result in the destruction or adverse modification of habitat determined to be critical. This document analyzes the potential impacts of the preferred alternative on ESA-listed species in Section 4. Upon publication of any final rule, we will reinitiate Section 7 consultation on the effects of the shrimp fisheries in both the South Atlantic and Gulf of Mexico areas; this consultation will also address the effects of sea turtle conservation regulations, including TED use.

7.4 INFORMATION QUALITY ACT (SECTION 15)

The Information Quality Act directed the Office of Management and Budget to issue government wide guidelines that "provide policy and procedural guidance to federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by federal agencies." Under the NOAA guidelines, the conservation measures included in the DEIS are considered a Natural Resource Plan. It is a composite of several types of information, including scientific, management, and stakeholder input, from a variety of sources. Compliance of this document with NOAA guidelines is evaluated below.

7.4.1 Utility

The information disseminated is intended to describe proposed management actions and the impacts of those actions. The information is intended to be useful to: (1) industry participants, conservation groups, and other interested parties so they can understand the management action, its effects, and its justification, and can provide informed comments on the alternatives considered; and (2) managers and policy makers so they can choose an alternative for implementation.

7.4.2 Integrity

Information and data, including statistics, that may be considered confidential, were used in the analysis of impacts associated with this document. This information was necessary to assess the biological, social, and economic impacts of the alternatives considered. We complied with all relevant statutory and regulatory requirements as well as NOAA policy regarding confidentiality of data. For example, confidential data were only accessible to authorized federal employees and contractors for the performance of required analyses. Additionally, confidential data are safeguarded to prevent improper disclosure or unauthorized use. Finally, the information to be made available to the public was done so in aggregate, summary, or other such form, that does not disclose the identity or business of any person.

7.4.3 Objectivity

The NOAA Information Quality Guidelines for Natural Resource Plans state that plans must be presented in an accurate, clear, complete, and unbiased manner. We strive to draft and present proposed management measures in a clear and easily understandable manner with detailed descriptions that explain the decision making process and the implications of management measures on marine resources and the public. Although the alternatives considered in this document rely upon scientific information, analyses, and conclusions, clear distinctions are drawn between policy choices and the supporting science. Additionally, the scientific information relied upon in the development, drafting, and publication of this DEIS is properly cited. Finally, this document was reviewed by a variety of biologists, economists, and policy analysts from SERO, SEFSC, and Headquarters offices.

7.5 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT (MSA)

The EFH provisions of the MSA require us to provide recommendations to federal and state agencies for conserving and enhancing EFH if a determination is made that an action may adversely impact EFH. Our policy regarding the preparation of NEPA documents recommends incorporating EFH assessments into environmental impact statements; therefore, this DEIS will also serve as an EFH assessment. Pursuant to these requirements, Section 2 of this document provides a description of the alternatives considered for sea turtle conservation measures in the Southeastern U.S. shrimp fisheries. Sections 3 and 4.2 provide a description of the affected environment, including the identification of areas designated as EFH, HAPC, and an analysis of the impacts of fishing gear on that environment.

7.6 MARINE MAMMAL PROTECTION ACT (MMPA)

Under the MMPA, federal responsibility for protecting and conserving marine mammals is vested with the Departments of Commerce (NMFS) and Interior (USFWS). The primary management objective of the MMPA is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in cooperation with the applicable provisions of the ESA. The species of marine mammals that occur in the proposed action area are discussed in Section 3 of the DEIS. The potential impact of the alternatives on marine mammals is provided in Section 4. The alternatives considered would not adversely affect marine mammals.

7.7 NATIONAL MARINE SANCTUARIES ACT (NMSA)

Under the National Marine Sanctuaries Act (NMSA) (also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972), as amended, the U.S. Secretary of Commerce is authorized to designate National Marine Sanctuaries to protect distinctive natural and cultural resources whose protection and beneficial use requires comprehensive planning and management. The Office of National Marine Sanctuaries of NOAA administers the National Marine Sanctuary Program. The Act provides authority for comprehensive and coordinated conservation and management of these marine areas. The National Marine Sanctuary Program currently comprises 13 sanctuaries around the country. There are no marine sanctuaries in the geographic area that would be affected by the preferred alternative.

7.8 PAPERWORK REDUCTION ACT (PRA)

The collection of information for or by the federal government is subject to the requirements of the PRA) of 1995. PRA establishes a process for the review and approval of information collections by the Office of Management and Budget (OMB), in an effort to minimize the paperwork burden resulting from federal information collection efforts. This action includes no new collection of information and further analysis is not required. The proposed action would require no additional reporting burdens by permit holders, dealers, or other entities in the Southeastern U.S. shrimp fishing industry.

7.9 REPORTING, RECORDKEEPING, AND OTHER COMPLIANCE REQUIREMENTS

This action does not introduce any new reporting, recordkeeping, or other compliance requirements.

7.10 DUPLICATION, OVERLAP, OR CONFLICT WITH OTHER FEDERAL RULES

The proposed action does not duplicate, overlap, or conflict with other federal rules.

7.11 EXECUTIVE ORDER 13158 (MARINE PROTECTED AREAS)

E.O. 13158 requires each federal agency whose actions affect the natural or cultural resources that are protected by a Marine Protected Area (MPA) to identify such actions, and, to the extent permitted by law and to the extent practicable, avoid harm to the natural and cultural resources that are protected by an MPA. E.O. 13158 promotes the development of MPAs by enhancing or expanding the protection of existing MPAs and establishing or recommending new MPAs. The E.O. defines an MPA as "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." All national marine sanctuaries are listed under the National Registry. There are no marine sanctuaries in the geographic area that would be affected by the preferred alternative.

7.12 NATIONAL HISTORIC PRESERVATION ACT

There are several submerged cultural resources listed in the *National Register of Historic Places* in the action area that could be affected by the alternatives described in this EIS. These include the shipwrecks of the GENERAL C.B. COMSTOCK off the Brazos River, USS HATTERAS and SELMA off Galveston, and the Mansfield Cut Underwater Archaeological District off Padre Island Texas; the JOSEPHINE off Biloxi, Mississippi; the USS TECUMSEH, which rests in Mobile Bay, Alabama; the VAMAR, TARPON, and USS MASSACHUSETTS off Florida; QUEEN ANNE'S REVENGE and the Civil War Shipwreck District (discontinuous) off North Carolina. There are other registered shipwreck sites in the action area, but they are unlikely to be affected by the shrimp fisheries as they are outside known shrimp fishing areas (e.g., USS MONITOR off North Carolina). Conversely, there are likely numerous other currently unidentified sites within the action area that could be eligible for listing should proper documentation occur.

Implementation of any of the alternatives will not change the shrimp fisheries' effects on cultural resources in the area. The use of a TED would not significantly add or modify any impacts that may occur from gear interaction with submerged cultural resources; the trawl doors or skids and footrope are the significant interactive agents. We have determined that the proposed action and alternatives have no potential to cause effects on historic properties. Therefore, coordination with the State Historic Preservation Officer under the National Historic Preservation Act is not required.

7.13 EXECUTIVE ORDER 12898 (ENVIRONMENTAL JUSTICE)

The EPA defines environmental justice as, "the fair treatment for all people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies." E.O. 12898 was implemented in response to the growing need to address the impacts of environmental pollution on particular segments of our society. This order requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority and low-income populations." In furtherance of this objective, the EPA developed an Environmental Justice Strategy that focuses the action agency's efforts in addressing these concerns. For example, to determine whether environmental justice concerns exist, the demographics of the affected area should be examined to ascertain whether minority populations and low-income populations are present, and, if so, a determination must be made as to whether implementation of the alternatives may cause disproportionately high and adverse human health or environmental effects on these populations. Environmental justice concerns typically relate to pollution and other environmental health issues, but the EPA has stated that addressing environmental justice concerns is consistent with NEPA; therefore, all federal agencies are required to identify and address these issues.

Information on the race and income status for groups at the different participation levels (vessel owners, crew, dealers, processors, employees, employees of associated support industries, etc.) in the shrimp fisheries is not available. The shrimp fisheries and its supporting industries are not disproportionately identified with a given ethnic or economic minority. Nonetheless, many of the participants may come from lower income and/or ethnic minority populations. For example, in many port groups, crew includes ethnic minorities (e.g., Hispanic, Vietnamese, etc.), and many regions in which bottom trawl fishing is an important livelihood are economically impoverished. These populations may be more vulnerable to the associated costs of regulatory implementation. Additional discussion on environmental justice issues within the shrimp fisheries can be found in Section 3.7.

Although economic impacts are likely to occur to persons employed in the shrimp fisheries, as well as associated businesses and communities, it is not expected nor can it be shown at this time that there would be a disproportionately high and adverse effect on the health or environment of minority and low-income populations. The proposed alternatives evaluated in this DEIS were determined to be viable measures to reduce incidental bycatch and mortality of sea turtles in the shrimp fisheries. The measures do not specifically target any one community, although due to the preferred alternatives focus on skimmer trawl vessels and the fact these vessels dominate Louisiana's inshore shrimp fisheries, communities in that state may be more likely to be affected than others. Regardless, adverse economic impacts are expected under all but the no action alternative. These impacts are not expected to be localized and limited to or focused on specific minority or poor neighborhoods. Rather, they would be distributed throughout the entire Northern Gulf of Mexico region and North Carolina, and the respective local economies. Therefore, within each community, the economic impacts of the proposed action would not likely disproportionately affect minority or low-income populations.

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10 PERSONS OR AGENCIES RECEIVING COPIES OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

Environmental Protection Agency
Gulf of Mexico Fishery Management Council
South Atlantic Fishery Management Council
Gulf States Marine Fisheries Commission
Atlantic States Marine Fisheries Commission
Texas Parks and Wildlife Department
Louisiana Department of Wildlife and Fisheries
Mississippi Department of Marine Resources
Alabama Department of Conservation and Natural Resources
Florida Fish and Wildlife Conservation Commission
Georgia Department of Natural Resources
South Carolina Department of Natural Resources
North Carolina Division of Marine Fisheries
Oceana

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APPENDIX I: RECOVERY PLANS, STATUS REVIEWS, AND INTERAGENCY COORDINATION

We and the USFWS share responsibility for implementing the ESA. Generally, USFWS manages land and freshwater species, while we manage marine and anadromous species. Because sea turtles depend upon both the beach and the ocean for their survival, and because of programs and expertise that existed within the agencies when the ESA was implemented, we signed a Memorandum of Understanding (MOU) with USFWS in 1977 to jointly administer the ESA for sea turtles. We have responsibility for the conservation and recovery of sea turtles in the marine environment and USFWS has responsibility for the conservation and recovery of sea turtles on nesting beaches. The agencies work together to develop overarching programs and policies, consult on major activities, and are co-authors on listing decisions, sea turtle recovery plans, 5-year and status reviews, and critical habitat decisions.

Sea Turtle Recovery Plans

Section 4(f) of the ESA directs us and the USFWS to develop and implement recovery plans “for the conservation and survival of endangered species and threatened species,” unless “…such a plan will not promote the conservation of the species.” The ESA defines “conservation” as “the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary.” Each plan must include a description of management actions necessary to ensure the conservation and survival of the species; recovery criteria that must be met to delist the species; an estimate of the time and costs required to achieve the recovery plan goal; and intermediate steps towards the goal.

The ESA does not explicitly require any agency or entity to implement recovery plans; they are guidance documents rather than regulatory tools. However, by synthesizing the best available information to determine the relative effects of existing threats, and by prioritizing recovery actions needed to reduce those threats, recovery plans assist federal agencies in fulfilling their obligations under section 7(a)(1) of the ESA, which requires all federal agencies to “utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species....” Additionally, recovery plans provide the context from which we and the USFWS can assess the effects of federal agency actions and can conditionally authorize incidental takes of listed species that occur during these federal activities, following the requirements of Section 7(a)(2) of the ESA. Recovery plans provide state and local agencies and private entities with guidance to help them minimize takes of listed species in programs they conduct or authorize, and to develop ESA Section 10 Conservation Plans with NMFS and the USFWS. Recovery plans also guide us and USFWS in determining research, management, and regulatory priorities, and provide a framework from which to authorize takes under ESA Section 10 research and enhancement permits.

Recovery plans have been developed for all sea turtle species that occur in U.S. waters, and can be found in their entirety on our Office of Protected Resources (OPR) website, at: http://www.nmfs.noaa.gov/pr/recovery/plans.htm#turtles. Most of the recovery plans for sea turtles in the Atlantic published in the early 1990s. However, the “Recovery Plan for the Northwest Atlantic Loggerhead Sea Turtle” was revised in 2008 (NMFS and USFWS 2008), and the

“Recovery Plan for the Kemp’s Ridley Sea Turtle” was revised in 2011 (NMFS, USFWS, and SEMARNAT 2011). Incidental catch in commercial fisheries is identified as a threat in all sea turtle recovery plans, and takes in demersal trawl fisheries beyond the Southeastern U.S. shrimp fisheries is specifically identified as a threat in the Kemp’s ridley and loggerhead recovery plans. Recovery actions included in the Northwest Atlantic loggerhead plan include expanding the TED requirements in other U.S. trawl fisheries. Similarly, the draft Kemp’s ridley plan includes recovery actions related to expanding the TED requirements, or implementing other equally effective bycatch reduction measures as appropriate.

Although some of the plans may appear dated, new information regarding biology, status, and threats to each species, is evaluated as part of the 5-year reviews required by Section 4(c)(2) of the ESA. In addition to considering whether recovery criteria have been met, for species with recovery plans that are not up to date, these reviews analyze new information to determine whether the status and threats have changed since the last review and whether a change in classification is warranted.

Five-Year Reviews

Once a species is listed, a review of the species status must be conducted every 5 years, under Section 4(c)(2) of the ESA to determine whether a change in listing classification is warranted. As described in the guidance document developed by USFWS and NMFS (2006), a 5-year review summarizes new information and evaluates how the species status and threats have changed in comparison to the last status review. Regardless of the recommendations resulting from the status review, the review does not involve rulemaking. A species classification is not changed until the rulemaking process is completed.

The 5-year review tracks the progress of a species towards recovery and may identify the next steps required for the species conservation. Like recovery plans, the reviews assist us, USFWS, federal action agencies, and others, in prioritizing conservation actions. Five-year reviews on the status of all of the species of sea turtles discussed in this EIS were completed in 2007 and can be found at: http://www.nmfs.noaa.gov/pr/listing/reviews.htm#species. Of particular note, incidental capture in fisheries, including trawl fisheries, is identified in the status reviews as an important factor affecting the conservation and recovery of all the sea turtle species, and as the most important anthropogenic factor affecting loggerhead sea turtles.

Section 7 Consultations

Section 7 of the ESA (16 USC. 1536) requires federal agencies to protect listed species and designated critical habitat. Section 7(a)(2) of the ESA (16 USC. 1536(a)(2)) directs federal agencies, in consultation with and with the assistance of the Secretaries of the Interior and Commerce (delegated to the respective Services), to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of habitat of such species that has been designated as critical (i.e., “critical habitat”). In keeping with the 1977 MOU between the Services, action agencies consult with USFWS on actions that affect sea turtles on land and with us for those activities that affect sea turtles in the marine environment.

The regulations implementing Section 7, found at 50 CFR part 402 (subparts A and B), require action agencies to consult with the Services on any federal action that "may affect" a listed species or critical habitat. A Consultation Handbook elaborating the procedures followed by the Services when conducting section 7 consultations can be found at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esa_section7_handbook.pdf. Briefly, a consultation may be concluded "informally" if the action agency determines that the federal action under consideration is "not likely to adversely affect" a listed species or critical habitat and the Service gives written concurrence. Formal consultation is required if the action is likely to adversely affect a listed species or critical habitat. During formal consultation, the action agency and the Service examine the effects of the proposed action and the Service determines whether the proposed federal action is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat and whether incidental take of listed species is anticipated.

A formal consultation concludes with a biological opinion issued by the Service detailing the effects of the action on the listed species or critical habitat. If the Service finds a federal agency action is likely to jeopardize a species or cause adverse modification of critical habitat, the biological opinion must also include reasonable and prudent alternatives to the proposed action, if any are available, to avoid jeopardy. Where jeopardy or adverse modification of critical habitat is not likely to occur, but incidental take of listed species is expected, the Service issues an incidental take statement (ITS) that specifies the amount of take anticipated. Incidental take is defined as take that is incidental to, and not the purpose of, the execution of an otherwise lawful activity. Incidental take statements include reasonable and prudent measures and terms and conditions necessary to minimize the effects of the action. According to ESA Sections 7(b)(4) and 7(o)(2), when the terms and conditions of the ITS are followed and takes do not exceed the level identified within the ITS, the incidental takings that occur are not subject to any prohibition against take that may otherwise apply. That is, incidental takes of listed species during an otherwise lawful activity that would be prohibited under ESA Section 9 and Section 4(d) rules are allowed if the takes do not exceed the level anticipated in the consultation and if the terms and conditions of the ITS are followed. Following the consultation, the action agency is responsible implementing the requirements of the ITS which may include monitoring takes. Failure to implement the terms and conditions through enforceable measures may result in a lapse of the protective coverage of Section 7(o)(2).

We have conducted Section 7 consultations on the effects of federal actions, and has identified the associated anticipated take levels of sea turtles. Consultations have been conducted on federally managed fisheries and research activities; with the U.S. Army Corps of Engineers on channel dredging and beach deposition projects; with the U.S. Navy on vessel, aircraft, and training activities; with the Nuclear Regulatory Commission on the effects of cooling water intake and discharges; and with Bureau of Ocean Energy Management, Regulation, and Enforcement, formerly known as Mineral Management Services, on oil and gas development activities. Approximately 90 biological opinions have been issued for current (through 2009) federally conducted, funded, or authorized activities in the Northeast and Southeast Region that may result in sea turtle takes in the marine environment (NMFS unpublished data). The resulting ITSs are as varied as the activities themselves. Some ITSs identify take levels anticipated for multiple years (up to 30) or for the life of the project, rather than identifying an annual estimate of take. Some identify the anticipated number of sea turtle takes based on observed takes, while other consultations identify the anticipated number of sea turtle takes based on estimates extrapolated from observer data.

Reasonable and prudent measures are required with all ITSs and may include, among others, monitoring requirements, seasonal restrictions, handling and resuscitation measures, measures to analyze characteristics of observed sea turtles takes, and research to develop measures to reduce takes.

The most commonly requested biological opinions issued by SERO can be found at: http://sero.nmfs.noaa.gov/pr/Section7FisheryBiologicalOpinions.htm.
Recent biological opinions issued by our Office of Protected Resources are found at: http://www.nmfs.noaa.gov/pr/consultation/opinions.htm.

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USFWS and NMFS. 2006. 5-Year Review Guidance: Procedures for Conducting 5-Year Reviews Under the Endangered Species Act. 54 pp.

APPENDIX II: DEVELOPMENT OF TURTLE EXCLUDER DEVICES

Trawling is a method of fishing that involves actively pushing or towing a net through the water. Trawls can be unselective and have the capability to incidentally capture sea turtles and other species that are not the intended target of the fishery. Sea turtles captured in commercial trawl fisheries may drown due to forced submergence over long periods. Even when drowning does not occur, the stress of forced submergence has been shown to result in various negative physiological consequences (Henwood and Stuntz 1987; Lutcavage and Lutz 1997) that can make the turtles susceptible to delayed mortality, predation, boat strike or other sources of injury and mortality.

We began developing physical barriers in trawl nets to deflect sea turtles from trawl codends in the 1970s. Briefly, according to Watson et al. (1986), soft panel separator gear for trawls, designed originally for cold-water shrimp fisheries in the 1960s, were the first turtle excluder gear evaluated for the shrimp fisheries. Testing and development in commercial fishing conditions in the Gulf of Mexico indicated a rigid grid was needed due to the diversity in the sizes and types of fish bycatch that clogged or ripped soft panels (Watson and McVea 1977). Oravetz and Grant (1986) describe the adaptation of the "jellyball" shooter, a hooped grid with a slit at the top inserted by Georgia shrimp fishers ahead of the codend of the trawl to exclude jellyfish. By 1980, a rigid grid TED was developed and shown to be effective at eliminating sea turtles, as well as finfish, jellyfish, sharks, rays, sponge and other large bycatch (Watson et al. 1986).

Turtle Excluder Device Regulation History

1970: Hawksbill, Kemp's ridley, and leatherback sea turtles are listed by USFWS as endangered species under the Endangered Species Conservation Act of 1969.

December 28, 1973: Enactment of the ESA.

May 20, 1975: NMFS and USFWS publish a proposal to list green, loggerhead, and (Pacific) olive ridley sea turtles as threatened species under the ESA (40 FR 21982, 40 FR 21974). The proposal includes an exception to the ESA takings prohibitions for incidental catch of threatened sea turtles in fishing gear if: (a) the fishing is not in an area of substantial sea turtle breeding or feeding, and (b) the turtles are immediately returned to the water.

July 28, 1978: NMFS and USFWS publish final regulations (43 FR 32800) listing loggerhead, green, and olive ridley sea turtles as threatened species, except for Florida green turtle breeding colony populations and Pacific coast of Mexico olive ridley and green turtle breeding colony populations, which were listed as endangered. Many commenters on the proposal had objected to the "areas of substantial breeding and feeding" language, fearing that a strict interpretation could put many shrimpers out of business. In the final rule, incidental capture of threatened turtles with fishing gear is exempted from the ESA takings prohibitions in all areas, if turtles are returned to the water following resuscitation attempts for unconscious animals. The rule also states that we have developed and is testing a turtle excluder panel installed across the mouth of a shrimp trawl to prevent or substantially reduce the capture of sea turtles, with the objective of completing the development and testing of the panel by the end of the 1978 shrimp season. We state its "goal is to promulgate regulations requiring the use of the panel to prevent, or substantially reduce, incidental catch of sea turtles without significantly reducing shrimp production."

1978: Testing of the turtle excluder panels resulted in preventing 75% of encountered turtles from entering the trawls, but shrimp losses (15 to 30%) were unacceptable. Research was then directed towards releasing turtles once they entered the trawl versus preventing them from entering the trawl (NMFS 1987).

1978-1981: Our attention is turned toward testing and development of a rigid turtle excluder device (TED) that can be inserted farther back in the net. Turtle exclusion and shrimp retention results for the TED are positive. By 1981, the our TED—a large, cage-like device with a metal-framed trap door—has been developed and found to release 97% of the turtles caught in shrimp trawls with no loss of shrimp (52 FR 24244, June 29, 1987).

1981-1983: We encourage voluntary use of TEDs in the shrimp fisheries.

1983-1986: We operate a formal program which builds and delivers TEDs to shrimp fishers who agree to use them voluntarily in commercial shrimping operations. The program proves ineffective. As of late 1986, less than 3% of the shrimp fleet had used TEDs (Oravetz 1986).

October-December 1986: We sponsor mediated sessions involving environmental and shrimp industry groups. The negotiations attempt to develop a mutually acceptable implementation of TED requirements and avert threatened litigation from environmental groups. One party to the mediation sessions, the Concerned Shrimpers of Louisiana, refuses to sign the developed agreement and negotiations break down.

1987: A report (Henwood and Stuntz 1987) analyzing observer data from the Southeastern U.S. shrimp fisheries from 1973-1984 conservatively estimates that the shrimp fisheries in offshore waters kills 9,874 loggerhead, 767 Kemp's ridley, and 229 green turtles annually.

March 2, 1987: We develop and publish proposed regulations to require the use of TEDs in most offshore shrimp trawlers (52 FR 6179).

June 29, 1987: We publish final regulations implementing TED requirements (52 FR 24244). The regulations are codified at 50 CFR parts 217, 222, and 217. Many of the provisions of the rule phase in over a 20-month period. Ultimately, TEDs are required seasonally aboard all shrimp trawlers over 25 ft in length in offshore waters of the Gulf of Mexico and South Atlantic, except for southwest Florida and the Canaveral area, where they are required year-round. Shrimp trawlers less than 25 ft in length and all trawlers in inshore waters are required to limit their tow-times to a maximum of 90 minutes seasonally, except in southwest Florida and the Canaveral area, where tow-times are required year-round. Exemptions to the TED requirement are included for trawlers fishing for royal red shrimp and rock shrimp. Try nets up to 20 ft in headrope length are also exempted. Four specific designs of hard TEDs—our TED, the Cameron TED, the Matagorda TED, and the Georgia TED—are included in the regulations as qualified TEDs. The minimum size of the TED escape openings is specified as 32 in in the Gulf of Mexico and 35 in in the Atlantic, but how this opening is measured is not specified. The regulations make provisions for testing and approving additional TED designs that may be developed by us or the shrimping industry. An appendix published with the regulations specifies a scientific protocol for evaluating new TEDs in the Cape Canaveral shipping channel. Candidate TEDs must demonstrate a reduction in the catch of wild turtles, compared to a net with no TED, of greater than 96%.

September 30, 1987: We complete a biological opinion on the implementation of the 1987 regulations. The 1987 opinion addresses the potential adverse effects to listed species of implementation of the rule, and concludes that the regulations would have a positive impact on sea turtles by substantially reducing mortalities. At that time, our policy on ESA section 7 consultation is to address the potential impacts to listed species of management actions and not to address potential adverse effects of the fishery itself. The policy is ultimately changed on October 18, 1990, when the Assistant Administrator for Fisheries advises all our Regional Directors that future ESA consultations on fishery management actions would address both the fishery and the proposed management action.

October 5, 1987: We issue a final rule/technical amendment (52 FR 37152) to authorize an additional type of TED, the Morrison TED, which is the first soft TED. It uses an upward-sloping panel of flexible webbing instead of the rigid grid used in hard TEDs.

October 1987 - May 1990: A chaotic array of lawsuits, injunctions, suspensions of law enforcement, legislative actions by several states, legislation by Congress, and temporary rules issued by us and the Department of Commerce follows the initial effective date of the 1987 regulations. The result is a patchwork of times and areas where TEDs are and are not required/enforced.

October 7, 1988: President Reagan signs a bill that requires a study by the National Academy of Sciences to review the question of sea turtle conservation status and the significance of mortality from commercial trawling.

September 1, 1988: We issue a final rule/technical amendment (53 FR 33820) to authorize an additional soft TED, the Parrish TED. It uses a downward-sloping webbing panel leading to a rigid frame.

November 21, 1989: President G. Bush signs Public Law 101-162. Section 609 requires the Department of State, in consultation with the Department of Commerce, to initiate negotiations with foreign countries to develop agreements for sea turtle conservation, with emphasis on countries that have commercial fishing fleets that adversely affect sea turtles. It further requires the United States to ban the importation of commercially harvested shrimp unless the exporting country has been certified by the Department of State as having a regulatory program for sea turtle incidental capture in shrimp trawls that is comparable to the United States' requirements. The certification is due on May 1, 1991, and annually thereafter.

May 1990: The report, "Decline of the Sea Turtles: Causes and Prevention," is released (National Research Council 1990). The report concludes that: (1) combined annual counts of nests and nesting females indicate that nesting sea turtles continue to experience population declines in most of the United States. Declines of Kemp's ridleys on the nesting beach in Mexico and of loggerheads on South Carolina and Georgia nesting beaches are especially clear; (2) natural mortality factors—such as predation, parasitism, diseases and environmental changes—are largely unquantified, so their respective impacts on sea turtle populations remain unclear; (3) sea turtles can be killed by several human activities, including the effects of beach manipulations on eggs and hatchlings and several phenomena that affect juveniles and adults at sea, collisions with boats, entrapment in fishing nets and other gear, dredging, oil-rig removal, power plant entrainment, ingestion of plastics and toxic substances, and incidental capture in shrimp trawls; (4) shrimp trawling kills more sea turtles than all other human activities combined, and the annual mortality estimate from Henwood and Stuntz (1987) may be low by as much as a factor of four; (5) shrimp trawling can be compatible with the conservation of sea turtles if adequate controls are placed on trawling activities, especially the mandatory use of TEDs in most places at most times of the year; and (6) the increased use of conservation measures on a worldwide basis would help to conserve sea turtles.

October 9, 1990: We issue a final rule/technical amendment (55 FR 41088) to authorize an additional soft TED, the Andrews TED. It uses a net-within-a-net design.

October 9, 1990: We publish an alternative scientific protocol (55 FR 41092) to the Canaveral test for approving new TED designs. In 1989, there were not enough turtles in the Canaveral Channel to conduct TED testing, necessitating the development of a new protocol. The new small turtle test protocol overcomes some of the other concerns over the Canaveral test. In particular, it uses turtles that are similar in size to wild Kemp's ridleys, the species of greatest conservation concern at the time, and it allows divers to videotape every turtle's encounter with the candidate TED, greatly increasing the understanding of the factors in a TED's design that affect sea turtle exclusion. The small turtle test's limitation, however, is that, since captive animals are used under experimental conditions, the metric used for decisions is a candidate TED's performance relative to a control TED, rather than its straight reduction in sea turtle captures.

April 1992: The SAFMC requests consultation on the Shrimp Fishery Management Plan for the South Atlantic, and the GMFMC requests consultation on Amendment 6 to the Gulf of Mexico Shrimp Fishery Management Plan.

April 30, 1992: We propose to amend the sea turtle conservation regulations to strengthen their effectiveness and enforceability (57 FR 18446). The proposal would require essentially all shrimp trawlers in the southeast U.S. to use TEDs year-round, even in inshore waters, with only limited exemptions.

August 19, 1992: We complete section 7 consultation and issues a biological opinion that considers the 2 Councils' FMPs, the shrimp fisheries in the Gulf of Mexico and South Atlantic, and the implementation of the 1992 revised sea turtle conservation regulations. The opinion concludes that shrimp trawling, as managed by the Councils and in compliance with the proposed sea turtle conservation regulations, is not likely to jeopardize the continued existence of listed species under our jurisdiction. With respect to leatherback turtles, however, the opinion states, "leatherback mortalities remain a problem that must be addressed to avoid jeopardizing the recovery of this species." The opinion's incidental take statement includes 6 reasonable and prudent measures (RPMs). Three have to do with items that are implemented through the regulations (required use of

TEDs, limitations on the use of tow-times, and resuscitation of comatose turtles). A fourth is the requirement to implement an observer program to monitor turtle take whenever tow-times are authorized as an alternative to TEDs. We never implement such an observer program. Instead, on the future occasions when we do subsequently issue tow-time authorizations because of hurricane debris or algae blooms, we consult with the state fisheries directors who agree to provide elevated enforcement to ensure compliance with tow-times. A fifth reasonable and prudent measure states that we should develop a program so that all turtle mortalities are reported to SERO in person, by phone, or by letter, within 10 days of return from the fishing trip during which the incidental take occurred. This reporting program is never implemented. The final requirement is to develop and implement a contingency plan to eliminate the episodic take of leatherback turtles by shrimp trawlers. A contingency plan addressing some months along the Atlantic coast is ultimately developed.

September 8, 1992: We publish an interim final rule implementing some of the provisions of the April 1992 proposed rule.

December 4, 1992: We publish a final rule (57 FR 57348) implementing the April proposal. The rule includes a phase-in period for inshore vessels with small nets until December 1, 1994. The rule requires all shrimp trawlers in inshore and offshore waters from North Carolina to Texas to have TEDs installed in all nets that are rigged for fishing. Exempted from the TED requirements are: (1) royal red shrimp trawlers; (2) beam and roller trawls, if vertical bars on 4-in spacings are attached across the mouth of the trawl; and (3) a single try net, up to 20 ft in headrope length, per boat. Also exempted from the TED requirements, if fishers follow tow-time limits of 55 minutes from April-October and 75 minutes from November-March, are: (1) trawls that are entirely hand-hauled; (2) bait shrimpers, if all shrimp are kept in a live-well with no more than 32 lb of dead shrimp aboard; (3) pusher-head trawls (i.e., chopsticks rigs), skimmer trawls, and wing nets (i.e., butterfly nets); (4) trawlers in an area and at a time where the Assistant Administrator determines that special environmental conditions make TED use impracticable; and (5) if the Assistant Administrator determines that TEDs are ineffective. Resuscitation measures that fishers must follow for incidentally caught turtles that come aboard in a comatose condition are modified, and fishers are allowed to hold turtles on board under certain conditions, while they are being resuscitated. The technical specifications for hard TEDs are rewritten to create more explicit and more flexible descriptions of the required construction characteristics of hard TEDs, rather than require shrimpers to use 1 of the 4 named styles of hard TEDs from the 1987 regulation. The specifications for the TED opening dimensions are clarified for single-grid hard TEDs: 35 in horizontal and, simultaneously, 12 in vertical in the Atlantic, and 32 in horizontal and, simultaneously, 10 in vertical in the Gulf of Mexico. Descriptions of accelerator funnels and webbing flaps—optional modifications to increase shrimp retention—are added. A framework and procedures are established whereby the Assistant Administrator may impose additional restrictions on shrimping, or any other fishing activity, if the incidental taking of sea turtles in the fishery would violate an incidental take statement, biological opinion, or incidental take permit or may be likely to jeopardize the continued existence of a listed species.

May 17, 1993: We issue a final rule/technical amendment (58 FR 28795) to authorize an additional soft TED, the Taylor TED. It is similar to the Morrison TED, but uses a smaller panel of smaller-mesh webbing and a flap over the escape opening. A modification of the Morrison TED to use a larger escape opening covered with a flap is also approved. The Taylor TED and modified Morrison TED have escape openings that are large enough to release leatherback turtles.

October 20, 1993: We issue a final rule/technical amendment (58 FR 54066) to create a new category of hard TEDs—special hard TEDs—and to authorize a new special hard TED for the shrimp fisheries, the Jones TED. The Jones TED features bars that are set diagonally, rather than vertically, in the face of the grid, and whose bar ends are not attached to other bars or to the TED frame.

May 18, 1994: We issue a final rule/technical amendment (59 FR 25827) to specify a modification that can be made to the escape opening of single grid hard TEDs that will allow the TEDs to exclude leatherback turtles.

June 29, 1994: We issue an interim final rule (59 FR 33447) to require bottom-opening hard TEDs to be modified by attaching floats to the TEDs to keep them from riding hard on the sea floor. Major increases in sea turtle strandings were observed in early 1994 in Texas, and the absence of floats on bottom-opening TEDs was determined to be 1 contributing factor.

November 14, 1994: We complete section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1994). Consultation on the shrimp fisheries had been reinitiated as the result of extraordinarily high strandings of sea turtles, particularly the critically endangered Kemp’s ridley turtle, in Texas and Louisiana corresponding to periods of heavy nearshore shrimping effort. The opinion concludes that “continued long-term operation of the shrimp fishery in the southeastern U.S., resulting in mortalities of Kemp’s ridley turtles at levels observed in the Gulf of Mexico in 1994, is likely to jeopardize the continued existence of the Kemp’s ridley population.” The jeopardy opinion included a reasonable and prudent alternative (RPA) that would allow the shrimp fisheries to continue and avoid the likelihood of jeopardizing Kemp’s ridley sea turtles. The RPA specified the following measures that we must take to improve TED regulation compliance: (1) develop an emergency response plan (ERP) to address increases in sea turtle strandings or TEDs noncompliance; (2) deploy a specially trained law enforcement team to respond to high strandings, TEDs noncompliance, or intensive shrimping effort in areas of expected sea turtle abundance; (3) develop and implement a TED enforcement training program for U.S. Coast Guard boarding parties; (4) amplify domestic TED technology programs; and (5) develop a permitting or registration system for offshore shrimpers that would allow sanctioning the permit for TED violations and failing to pay assessed fines. We also were required to re-examine the effectiveness of bottom-shooting hard TEDs and soft TEDs, and mitigate the impacts of intensive nearshore shrimping effort through the identification of areas requiring special turtle management. We ultimately implemented all the elements of the RPA, with the exception of the shrimp fisheries permitting/registration system. The opinion’s incidental take statement, in addition to establishing incidental take levels based on observer coverage, sets indicated take levels, based on historical stranding levels. The ITS incorporates all of the RPMs from the 1992 opinion and also adds a number of new RPMs, such as improving the overall observer coverage in the shrimp fisheries and stranding network coverage in poorly covered states. We must use this observer and stranding information to implement the actions of the ERP. We must also convene a team of population biologists, sea turtle scientists, and life history specialists to compile and examine information on the status of sea turtle species. The team should attempt to determine the maximum number of individual sea turtles of each species that can be taken incidentally to commercial fishing activities without jeopardizing the continued existence of the species and what the corresponding level of strandings would be. Lastly, we are required to evaluate other human-caused sources of sea turtle mortality and identify measure to reduce those sources of mortality.

March 14, 1995: We issue the details of the ERP, required under the RPA of the 1994 opinion. The ERP is issued to identify monitoring, reporting and enforcement actions, as well as associated management measures that we would consider implementing by emergency rulemaking if strandings become elevated. Briefly, the ERP identifies interim sea turtle management areas (ISMAs) within which enforcement would be elevated from April through November. Two ISMAs were identified: Atlantic Interim Special Management Area, including shrimp fishery statistical Zones 30 and 31 (i.e., northeast Florida and Georgia) and the Northern Gulf Interim Special Management Area, including statistical Zones 13 through 20 (i.e., Louisiana and Texas from the Mississippi River to North Padre Island). We would implement gear restrictions on shrimp trawling through existing rulemaking authority (codified at 50 CFR 227.72(e)(6)) in response to 2 weeks of elevated strandings at levels approaching (within 75% of) the indicated take levels or higher in the ISMAs when no other likely causes of mortality were evident. Outside of the ISMA, implementation of similar restrictions would be considered after 4 weeks of elevated strandings. Areas monitored were delineated as our shrimp fishery statistical areas, and restrictions would be implemented within zones of elevated strandings out to 10 nmi offshore.

March 24, 1995: We issue a final rule/technical amendment (60 FR 15512) to finalize the float requirement and implement a variety of other minor changes to TED technical specifications. One of these specifies that the width of the cut for a hard TED's escape opening must extend at least from the outermost bar of the grid to the opposite outermost bar of the grid.

May-August 1995: We implement gear restrictions based on the ERP through temporary rulemaking 4 times during 1995: twice in the Gulf of Mexico and twice in the Atlantic (60 FR 21741, May 3, 1995; 60 FR 26691, May 18, 1995; 60 FR 31696, June 16, 1995; 60 FR 32121, June 20, 1995; 60 FR 42809, August 17, 1995; 60 FR 43106, August 18, 1995; 60 FR 44780, August 29, 1995).

May 12, 1995: We issue an interim rule (60 FR 25620) to establish all inshore and offshore waters from Cape Canaveral, Florida (28° 24.6'N) to the North Carolina-Virginia border (36° 30.5'N) as the leatherback conservation zone and to provide for short-term closures of areas in that zone when high abundance levels of leatherback turtles are documented (i.e., "the leatherback contingency plan"). Upon such documentation, we would prohibit, in the closed areas, fishing by any shrimp trawler required to have a TED installed in each net that is rigged for fishing, unless the TED installed is specified in the regulations as having an escape opening large enough to exclude leatherback turtles. We also propose (60 FR 25663) to adopt as final this interim rule establishing the leatherback conservation zone.

June 2, 1995: We temporarily amend the regulations (60 FR 28741) protecting sea turtles to allow compliance with tow-time limits as an alternative to the use of TEDs in a 30-square mile (48.3-square km) area off the coast of North Carolina to allow shrimp fishers to fish under conditions of high concentrations of red and brown algae that make trawling with TEDs impracticable while maintaining adequate protection for sea turtles in this area.

September 14, 1995: We issue a final rule (60 FR 47713) establishing the leatherback conservation zone and leatherback contingency plan in the Atlantic.

April 24, 1996: We propose (61 FR 18102) prohibiting the use of all previously approved soft TEDs; requiring the use of approved hard TEDs in try nets with a headrope length greater than 12 ft (3.6 m) or a footrope length greater than 15 ft (4.6 m); establishing Shrimp Fishery Sea Turtle Conservation Areas (SFSTCAs) in the northwestern Gulf of Mexico and in the Atlantic along the coasts of Georgia and South Carolina; and, within the SFSTCAs, prohibiting soft TEDs, imposing the new try net restrictions, and prohibiting the use of bottom-opening hard TEDs.

June 11, 1996: We complete section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1996). Consultation on the shrimp fisheries had been reinitiated to evaluate the effects of the April 24, 1996 proposed rule, a plan to implement a shrimp vessel registration system, and to consider the effects of strandings-based incidental take levels that had been exceeded. The opinion concludes that continued operation of the shrimp fisheries is not likely to jeopardize listed sea turtles, with implementation of the proposed TED rule changes and of a shrimp vessel registration system, which the opinion requires to be proposed formally by the end of 1996. The opinion also eliminates the strandings-based incidental take levels that had been in place since the introduction of the ERP in March 1995. The ERP is replaced instead with a more flexible requirement for us to consult with state stranding coordinators to identify significant local stranding events and to implement 30-day restrictions on shrimping in response, as appropriate.

June 27, 1996: We, in response to elevated strandings, issue temporary additional restrictions (61 FR 33377) on shrimp trawlers fishing in the Atlantic Area in inshore waters and offshore waters out to 10 nmi (18.5 km) from the COLREGS line between the Georgia-Florida border and the Georgia-South Carolina border. The restrictions include prohibitions on the use of soft TEDs and try nets with a headrope length greater than 12 ft (3.6 m) or a footrope length greater than 15 ft (4.5 m), unless the try nets are equipped with approved TEDs other than soft TEDs. The restrictions are in response to elevated sea turtle mortality.

November 13, 1996: We complete section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1996). Consultation on the shrimp fisheries had been reinitiated to evaluate the effects of the final rule implementing the April 24, 1996 proposed rule and of elevated loggerhead strandings that occurred during 1996. The opinion concludes that continued operation of the shrimp fisheries is not likely to jeopardize listed sea turtles, with the publication of the final rule, which implements the RPA component of the 1994 opinion requiring us to address mortalities resulting from incorrect installation of TEDs and the certification of TEDs which do not effectively exclude sea turtles. The opinion extends the deadline for finalizing the shrimp vessel registration requirement through February 1997.

December 19, 1996: We issue a final rule (61 FR 66933) requiring that TEDs be installed in try nets with a headrope length greater than 12 ft (3.6 m) and a footrope length greater than 15 ft (4.6 m);

removing the approval of the Morrison, Parrish, Andrews, and Taylor soft TEDs; establishing SFSTCAs, and within the SFSTCAs, imposing the new TED requirement for try nets, removing the approval of soft TEDs, and modifying the requirements for bottom-opening hard TEDs.

March 24, 1998: We complete section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1998). Consultation on the shrimp fisheries had been reinitiated to evaluate the effects of approving the use of a new soft TED, to discuss the decision not to implement a mandatory shrimp vessel registration system (part of the 1994 biological opinion's RPA), and to evaluate recent data on sea turtle populations and strandings. The opinion concludes that continued operation of the shrimp fisheries is not likely to jeopardize listed sea turtles, with continued improved enforcement of the sea turtle conservation regulations and expanded education and outreach programs.

April 13, 1998: We issue an interim final rule (63 FR 17948) authorizing the use of a new soft TED—the Parker TED—in certain trawl net styles for an 18-month trial period, during which its performance will be evaluated to ensure that it remains effective at excluding sea turtles during extended commercial use.

October 14, 1998: We issue a temporary rule (63 FR 55053) effective through November 6, 1998, to allow the temporary use of limited tow times by shrimp trawlers in Alabama inshore waters as an alternative to the requirement to use TEDs in order to address difficulty with TED performance due to large amounts of debris in Alabama's bays in the aftermath of a hurricane.

May-June 1999: We issue 4 temporary rules (64 FR 25460, May 12, 1999; 64 FR 27206, May 19, 1999; 64 FR 28761, May 27, 1999; 64 FR 29805, June 3, 1999) to protect leatherback sea turtles within the leatherback conservation zone.

October 13, 1999: We issue an interim final rule (64 FR 55434) extending the authorized use of the Parker TED for an additional 12 months, as the results of the Parker TED's evaluation have been inconclusive.

December 13, 1999: We issue a 30-day rule (64 FR 69416) imposing an additional restriction on shrimp trawlers required to have a TED installed in each net that is rigged for fishing, operating in Atlantic offshore waters out to 10 nmi from the coast of Florida between 28°N latitude and the Georgia-Florida border. Shrimp vessels operating in this area must use the leatherback modification for hard TEDs or the leatherback modification for the Parker soft TED. The restrictions are in response to greatly elevated leatherback sea turtle strandings in the area. The strandings occur during a time when the leatherback contingency plan does not apply, necessitating the use of the 30-day rule.

October 25, 1999: We issue a temporary rule (64 FR 57397) to allow the use of limited tow times by shrimp trawlers as an alternative to the use of TEDs in the Matagorda Bay area of Texas. This action is required due to extraordinarily high concentrations of a bryozoan lodging in TEDs, rendering them ineffective in expelling sea turtles as well as negatively impacting fishers' catches.

April 5, 2000: We issue an advance notice of proposed rulemaking to announce that it is considering technical changes to the requirements for TEDs. We propose to modify the size of the TED escape opening, modify or decertify hooped hard TEDs and weedless TEDs, and change the requirements for the types of flotation devices allowed. We also propose to consider modifications to the leatherback conservation zone regulations to provide better protection to leatherback turtles.

April 25, 2000: We issue a 30-day rule (65 FR 24132) imposing an additional restriction on shrimp trawlers required to have a TED installed in each net that is rigged for fishing, operating in Gulf of Mexico offshore waters out to 10 nmi between Port Mansfield Channel and Aransas Pass, Texas. Shrimp vessels operating in this area must use the leatherback modification for hard TEDs or the leatherback modification for the Parker soft TED. The restrictions are in response to leatherback sea turtle strandings in the area. The strandings occur in an area where the leatherback contingency plan does not apply, necessitating the use of the 30-day rule.

May 2000: We issue 2 temporary rules (65 FR 25670, May 3, 2000; 65 FR 33779, May 25, 2000) to protect leatherback sea turtles within the leatherback conservation zone.

August 29, 2000: We issue a temporary rule (65 FR 52348) to allow the use of limited tow times by shrimp trawlers as an alternative to the use of TEDs in inshore waters of Galveston Bay, Texas. Dense concentrations of marine organisms documented in this area were clogging TEDs, rendering them ineffective in expelling sea turtles from shrimp nests as well as negatively impacting fishers' catches.

January 9, 2001: We issue a final rule (66 FR 1601) permanently approving the use of the Parker soft TED. Although industry use of the Parker TED is extremely low, our evaluation of its effectiveness does not find significant problems with compliance with the TED's specifications or with sea turtle captures.

May 14, 2001: We issue an interim final rule (66 FR 24287) approving the use of an additional style of single-grid hard TED—the double cover flap TED.

October 2, 2001: We issue a proposed rule (66 FR 50148) to amend the sea turtle conservation regulations to enhance their effectiveness in reducing sea turtle mortality resulting from shrimp trawling in the South Atlantic and Gulf of Mexico areas of the Southeastern United States. We determine that modifications to the design of TEDs need to be made to exclude leatherbacks and large loggerhead and green turtles; several approved TED designs are structurally weak and do not function properly under normal fishing conditions; and modifications to the trynet and bait shrimp exemptions to the TED requirements are necessary to decrease lethal takes of sea turtles.

December 20, 2001: We issue a 30-day rule (66 FR 65658) imposing an additional restriction on shrimp trawlers required to have a TED installed in each net that is rigged for fishing, operating in Atlantic offshore waters out to 10 nmi from the coast of Florida between 28°N latitude and the Georgia-Florida border. Shrimp vessels operating in this area must use the leatherback modification for hard TEDs or the leatherback modification for the Parker soft TED. The restrictions are in response to greatly elevated leatherback sea turtle strandings in the area. The strandings occur during a time when the leatherback contingency plan does not apply, necessitating the use of the 30-day rule.

December 31, 2001: We issue a final rule (66 FR 67495) amending the sea turtle handling and resuscitation regulation.

April-May 2002: We issue 3 temporary rules (67 FR 20054, April 24, 2002; 67 FR 21585, May 1, 2002; 67 FR 34622, May 15, 2002) to protect leatherback sea turtles within the leatherback conservation zone.

May 30, 2002: We issue a 30-day rule (67 FR 37723) imposing additional restrictions on shrimp trawlers in offshore Atlantic waters west of approximately Cape Fear, North Carolina and north of approximately St. Augustine, Florida. Shrimp fishers operating in this area are required to use TEDs with escape openings modified to exclude leatherback turtles and are prohibited from fishing at night between 1 hour after sunset and 1 hour before sunrise. These restrictions are implemented in response to greatly elevated strandings of loggerhead turtles and an apparent change in effort and behavior of the local fishery.

November 7, 2002: We issue a temporary rule (67 FR 67793) effective through December 2, 2002, to allow the temporary use of limited tow times by shrimp trawlers in Louisiana state waters east of 92° 20'W (approximately at Fresh Water Bayou in Vermilion Parish, Louisiana) and inshore Alabama waters of Bon Secour Bay, Mobile Bay, and Mississippi Sound, south of the ICW, due to large amounts of debris in the wake of Tropical Storm Isidore and Hurricane Lili.

February 21, 2003: We publish a final rule amending sea turtle conservation measures to reduce sea turtle mortality in the shrimp trawl fisheries (68 FR 8456). Specifically, it requires the use of larger TEDs to allow the escapement of leatherback and large loggerhead and green sea turtles. The effective date is April 15, 2003, for the South Atlantic, and August 21, 2003, in the Gulf of Mexico.

September 28, 2005: We issue a temporary rule (70 FR 56593) effective through October 24, 2005, to allow the temporary use of limited tow times by shrimp trawlers in state and federal waters from the Florida/Alabama border, westward to the boundary of Cameron Parish, Louisiana (approximately 92°37'W), and extending offshore 50 nm. This action is necessary because environmental conditions resulting from Hurricane Katrina are preventing some fishers from using TEDs effectively.

October 14, 2005: We issue a temporary rule (70 FR 60013) effective through November 10, 2005, to allow the temporary use of limited tow times by shrimp trawlers in state and federal waters off Cameron Parish, Louisiana (approximately 92°37'W), westward to the boundary shared by Matagorda and Brazoria Counties, Texas, and extending offshore 50 nm. This action is necessary because environmental conditions resulting from Hurricane Rita are preventing some fishers from using TEDs effectively.

October 27, 2005: We issue a temporary rule (70 FR 61911) effective through November 23, 2005, to allow the temporary use of limited tow times by shrimp trawlers in inshore and offshore waters from the Florida/Alabama border, westward to the boundary shared by Matagorda and Brazoria

Counties, Texas, and extending offshore 50 nm. This action is necessary because environmental conditions resulting from Hurricanes Katrina and Rita are preventing some fishers from using TEDs effectively.

November 24, 2005: We issue a temporary rule (70 FR 71406) effective through December 23, 2005, to allow the temporary use of limited tow times by shrimp trawlers in inshore and offshore waters from the Florida/Alabama border, westward to the boundary shared by Matagorda and Brazoria Counties, Texas, and extending offshore 20 nm. This action is necessary because environmental conditions resulting from Hurricanes Katrina and Rita are preventing some fishers from using TEDs effectively.

December 29, 2005: We issue a temporary rule (70 FR 77054) effective through January 23, 2006, to allow the temporary use of limited tow times by shrimp trawlers in inshore and offshore waters from the Florida/Alabama border, westward to the Louisiana/Texas border, and extending offshore 20 nm. This action is necessary because environmental conditions resulting from Hurricanes Katrina and Rita are preventing some fishers from using TEDs effectively.

February 22, 2006: We issue a temporary rule (71 FR 8990) effective through March 20, 2006, to allow the temporary use of limited tow times by shrimp trawlers in inshore and offshore waters from the Florida/Alabama border, westward to the Louisiana/Texas border, and extending offshore 10 nm. This action is necessary because environmental conditions resulting from Hurricanes Katrina and Rita are preventing some fishers from using TEDs effectively.

October 1, 2008: We issue a temporary rule (73 FR 57010) effective through October 27, 2008, to allow the temporary use of limited tow times by shrimp trawlers in state and federal waters offshore of Louisiana (from the Mississippi/Louisiana boundary to the Texas/Louisiana boundary) extending offshore 20 nm. This action is necessary because environmental conditions resulting from Hurricanes Gustav and Ike are preventing some fishers from using TEDs effectively.

October 14, 2008: We issue a temporary rule (73 FR 60038) effective through November 7, 2008, to allow the temporary use of limited tow times by shrimp trawlers in state and federal waters offshore of Texas (from the Texas/Louisiana boundary southward to the boundary shared by Matagorda and Brazoria Counties; approximately 95° 32’W) extending offshore 20 nm. This action is necessary because environmental conditions resulting from Hurricane Ike are preventing some fishers from using TEDs effectively.

November 3, 2008: We issue a temporary rule (73 FR 65277) effective through November 28, 2008, to allow the temporary use of limited tow times by shrimp trawlers in state and federal waters off Louisiana from the western end of Timbalier Island (approximately 90° 33’W) eastward to the Plaquemines/Jefferson Parish line (approximately 89° 54’W), and extending offshore 15 nm. This action is necessary because environmental conditions resulting from Hurricanes Gustav and Ike are preventing some fishers from using TEDs effectively.

November 12, 2008: We issue a temporary rule (73 FR 66803) effective through December 7, 2008, to allow the temporary use of limited tow times by shrimp trawlers in state and federal waters offshore of Texas (from the Texas/Louisiana boundary southward to the boundary shared by

Matagorda and Brazoria Counties; approximately 95° 32'W) extending offshore 9 nm. This action is necessary because environmental conditions resulting from Hurricane Ike are preventing some fishers from using TEDs effectively.

September 2, 2010: We issue a proposed rule (75 FR 53925) to revise TED requirements to allow the use of new materials and modifications to existing approved TED designs. Specifically, proposed allowable modifications include the use of flat bar, rectangular pipe, and oval pipe as construction materials in currently-approved TED grids; an increase in maximum mesh size on escape flaps from 1⅝ to 2 in (4.1 to 5.1 cm); the inclusion of the Boone Big Boy TED for use in the shrimp fisheries; the use of 3 large TED and Boone Wedge Cut escape openings; and the use of the Chauvin shrimp deflector to improve shrimp retention. We also propose to allow a new TED for use in the summer flounder fishery. Additionally, there are proposed corrections to the TED regulations to rectify an oversight regarding the maximum size chain that can be used on the Parker TED escape opening flap, and the proposed addition of a brace bar as an allowable modification to hard TEDs.

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APPENDIX III: FISH SPECIES LISTED UNDER THE ENDANGERED SPECIES ACT

Gulf sturgeon (*Acipenser oxyrinchus desotoi*), shortnose sturgeon (*Acipenser brevirostrum)*, Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and smalltooth sawfish (*Pristis pectinata)*, occur within the area encompassed by the alternatives analyzed within this DEIS. The 5-year review for Gulf sturgeon (USFWS and NMFS 2009) note that bycatch in shrimp trawls has been documented but has likely been mitigated by TEDs and BRDs. However, informal conversations with shrimpers suggest that Gulf sturgeon are commonly encountered in Choctawhatchee Bay, Florida, during nocturnal commercial fishing (USFWS and NMFS 2009). The recovery plan for shortnose sturgeon (NMFS 1998) states incidental take of shortnose sturgeon has been documented in shrimp trawls. As noted in the Status Review of Atlantic Sturgeon (NMFS 2007), Atlantic sturgeon have been reportedly captured in shrimp trawls, though TED and BRD requirements may reduce incidental take of Atlantic sturgeon in this fishery.

The shrimp fisheries may directly affect smalltooth sawfish that are foraging within or moving through an active trawling location via direct contact with the gear. The long, toothed rostrum of the smalltooth sawfish causes this species to be particularly vulnerable to entanglement in any type of netting gear, including the netting used in shrimp trawls. The saw penetrates easily through nets, causing the animal to become entangled when it attempts to escape. Mortality of entangled smalltooth sawfish is believed to occur as a result of the net being out of the water for a period of time with the smalltooth sawfish hanging from it before being disentangled (Simpfendorfer pers. comm. 2005). Despite increased effort placed on collecting smalltooth sawfish data since we were petitioned to list the smalltooth sawfish in 1999 (e.g., Simpfendorfer and Wiley 2004; Poulakis and Seitz 2004), records of incidental capture in shrimp trawls are rare. The recovery plan for smalltooth sawfish (NMFS 2009) documents that the species was documented as bycatch in the shrimp fisheries, with the greatest amount of data available from Louisiana (this does not mean the greatest catches were made in Louisiana, only that this is where the best records were kept). One data set from shrimp trawlers off Louisiana from the late 1940s through the 1970s (Simpfendorfer 2002) suggests a rapid decline in the species from the period 1950-1964. Anecdotal information collected by our port agents indicates that smalltooth sawfish are now taken very rarely in the Louisiana shrimp trawl fishery.

While noting that there have been documented interactions between the above mentioned species and shrimp trawls, none of the actions considered in the proposed alternatives are likely to increase the likelihood of incidental take of these listed species.

1 Gulf sturgeon

NMFS and the USFWS jointly listed the Gulf sturgeon as a threatened species throughout its range on September 30, 1991 (56 CFR 49653). The 1991 listing rule cited the following impacts and threats: (1) habitat curtailment and alteration from dams that prevent use of upstream areas for spawning; dredging, desnagging, and spoil deposition carried out in connection with channel improvement and maintenance; poor water quality from heavy pesticides, and contamination from heavy metals and industrial contaminants; (2) overutilization in commercial fisheries from large commercial harvests in the late 1800s through the early 1900s; and (3) the potential threat of hybridization with the white sturgeon should they be introduced for aquaculture.

The Gulf sturgeon Recovery Plan (USFWS et al. 1995) identified reasonable actions believed to be required to recover and/or protect the species. Five recovery tasks were identified. The short-term recovery objective was to prevent further reduction of existing wild populations. The long-term recovery objective was to establish population levels that would allow delisting of the Gulf sturgeon in discrete management units. Most recently, NMFS and USFWS prepared a 5-year review for the Gulf sturgeon in 2009 (USFWS and NMFS 2009) wherein no changes to the ESA listing was identified. The 5-year review also summarized recent research, identified new threats, and suggested updating the recovery plan to include new recovery criteria. New threats to Gulf sturgeon included: climate change, point and non-point discharges, hurricanes, collisions with boats, red tide, and aquaculture (USFWS and NMFS 2009).

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*), also known as the Gulf of Mexico sturgeon, is a primitive fish inhabiting coastal rivers from Louisiana to Florida during the warmer months and over-wintering in estuaries, bays, and the Gulf of Mexico. The Gulf sturgeon is an anadromous fish – adults migrate between fresh and estuarine/marine habitats during their life cycle. Spawning occurs in freshwater in the spring, adults move downstream and spend summers in the lower rivers before moving into estuarine/marine waters in the fall to feed and grow. Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age (Huff 1975). Sturgeon are characterized by a heterocercal tail (upper lobe is longer than the lower lobe) a ventral protrusible tubular mouth, a row of 4-long unfringed barbels present anterior to mouth, and a mostly cartilaginous skeleton. The head is covered with bony plates, and the body is brown dorsally and pale ventrally with 5 rows of bony keeled scutes, and small bony scales between the scute rows. While sturgeon possess a primitive body plan (heterocercal tail, spiral-valve intestine, pelvic fin insertion ventroanterior to dorsal fin, and nearly immobile pectoral fins), they are perhaps the earliest group of fishes to evolve protrusile jaws, which is a distinguishing hallmark of advanced teleosts. Adults usually range between 1.2 to 2.4 m in length with females growing larger than males. The Gulf sturgeon is distinguished from the geographically disjunct Atlantic sturgeon (*A. o. oxyrinchus*) by its longer head, pectoral fins, and spleen (Vladykov 1955; Wooley and Crateau 1985). Microsatellite DNA analyses has indicated substantial genetic divergence between Atlantic and Gulf sturgeon (King et al. 2001).

Historically, Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Sporadic occurrences were recorded as far west as the Rio Grande River in Texas and Mexico, and as far east and south as Florida Bay (Wooley and Creteau 1985; Reynolds 1993). The present range of the Gulf sturgeon extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida.

Foraging and Diet

The Gulf sturgeon is a benthic suction feeder. This suction feeding requires an expandable mouth that extends downward and a relatively narrow mouth through which to funnel water and food items (Westneat 2001). Success of suction feeding relies on the ability of the predator’s mouth to protrude into the proximity of prey (Westneat 2001) and vacuum up sediments containing their prey (infaunal macro invertebrates). Findeis (1997) described sturgeon (*Acipenseridae*) as exhibiting evolutionary traits adapted for benthic cruising. As benthic cruisers, sturgeon forage by feeding focally from the substrate while their mouth maintains contact with the benthos. The sturgeon’s heterocercal tail produces both lift and thrust; the beating of the tail tends to pitch the head downward (Vecsei and Peterson 2004) and hypochordal lobe is often reduced to allow sweeping of the tail while close to the substrate (Findeis 1997).

As benthic cruisers, sturgeon forage extensively in an area, presumably until preferred prey is depleted/reduced, relocate, and resume foraging. Tracking observations by Sulak and Clugston (1999), Fox et al. (2002), and Edwards et al. (2003) support that individual Gulf sturgeon move over an area until they encounter suitable prey type and density, at which time they forage for extended periods of time. Individual Gulf sturgeon often remain in localized areas (less than 1 square kilometer) for extended periods of time (greater than 2 weeks) and then move rapidly to another area where localized movements occurred again (Fox et al. 2002). While the exact amount of benthic area required to sustain Gulf sturgeon health and growth is unknown (and likely dependent on prey density, fish size, and reproductive status), Gulf sturgeon have been known to travel long distances (greater than 161 kilometers) during their winter feeding period.

Few data have been collected on the food habits of Gulf sturgeon; their threatened status limits sampling efforts and gastric lavage techniques have only recently become successful. Gulf sturgeon have been described as opportunistic and indiscriminate benthivores; their guts generally contain benthic marine invertebrates including amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans (Huff 1975; Mason and Clugston 1993; Carr et al. 1996; Fox et al. 2000; Fox et al. 2002). Generally, Gulf sturgeon prey are burrowing species (e.g., polychaetes and oligochaetes, amphipods, isopods, and lancelets) that feed on detritus and/or suspended particles, and inhabit sandy substrate.

Adult Gulf sturgeon are known to forage sparingly in freshwater and depend almost entirely on estuarine and marine prey for their growth (Gu et al. 2001). Adults and subadults can lose up to 30% of their total body weight while in freshwater, and subsequently compensate for the loss during winter feeding in marine areas (Wooley and Crateau 1985; Clugston et al. 1995; Sulak and Clugston 1999). Gu et al. (2001) compared stable carbon isotope ratios of tissue samples from subadult and adult Suwannee River Gulf sturgeon with their potential freshwater and marine food sources and found a large difference in isotope ratios between freshwater food sources and fish muscle tissue. Results indicate that subadult and adult Gulf sturgeon do not feed significantly in freshwater and the isotope similarity between Gulf sturgeon and marine food resources strongly indicates that this species relies almost entirely on the marine food web for its growth (Gu et al. 2001).

During the early fall and winter, immediately following downstream migration, Gulf sturgeon are most often located in nearshore (depth less than 6.1m), sandy areas that support burrowing macro invertebrates, where the fish are presumably foraging (Fox et al. 2002). Based on distribution and density of infaunal macro invertebrates, Gulf sturgeon have been found to forage in the shallow (2 to 4 meters) shoreline areas of the bays and sounds rather than the deeper portions where low dissolved oxygen levels and the high percentage of silt in the sediments are the probable causes for the observed low abundance of infaunal macroinvertebrates (Livingston 1986). Tracking data indicate Gulf sturgeon typically forage in depths greater than 1 meter perhaps to avoid the higher wave energy of the swash zone from the downward cycloidal movement of waves (wave energy is exponentially dissipated with depth).

Young-of-the-year (YOY) Gulf sturgeon remain in freshwater feeding on aquatic invertebrates, mostly insect larvae, and detritus for about a year after spawning occurs (Mason and Clugston 1993; Sulak and Clugston 1999). Juveniles (i.e., age 1 to 6 years and less than 5 kg) are believed to forage extensively and exploit scarce food resources throughout the river, including aquatic insects (e.g., mayflies and caddis flies), oligochaetes, and bivalve mollusks (Huff 1975; Mason and Clugston 1993). Juvenile sturgeon collected in the Suwannee River are trophically active (foraging) near the river mouth at the estuary, but trophically dormant (not foraging) in summer holding areas upriver; however, a portion of the juvenile population reside and feed year round near the river mouth (K. Sulak, USGS, pers. comm.). In the Choctawhatchee River, juvenile Gulf sturgeon do not remain at the river mouth for the entire year; instead they are located during winter months throughout Choctawhatchee Bay and moved to riverine aggregation areas in the spring (Fox et al. 2002). Subadults (age 6 to sexual maturity) and adult (sexually mature) Gulf sturgeon do not feed in freshwater (Wooley and Crateau 1985; Mason and Clugston 1993).

After fasting for at least 6 months in the riverine habitat, adult Gulf sturgeon are presumed to begin feeding immediately in the adjacent estuarine habitat when they exit the river. Adult and subadult Gulf sturgeon forage opportunistically (Huff 1975), primarily on benthic invertebrates. Gut content analyses have indicated that the Gulf sturgeon's diet is predominantly amphipods, lancelets, polychaetes, gastropod mollusks, shrimp, isopods, bivalve mollusks, and crustaceans (Huff 1975; Mason and Clugston 1993; Carr et al. 1996; Fox et al. 2000; Fox et al. 2002). Ghost shrimp (*Lepidophthalmus louisianensis*) and haustoriid amphipods (e.g., *Lepidactylus* spp.) are strongly suspected to be important prey for adult Gulf sturgeon over 1 m (Heard et al. 2000; Fox et al. 2002). Harris et al. (2005) reported that the Gulf sturgeon's major prey resources in the Suwannee River consisted of brachiopods, amphipods, and brittle stars. Distribution of Gulf sturgeon in the spring and fall appear to be associated with sandy areas on which brachiopods settle (Harris et al. 2005). It is unknown how much benthic area is needed to sustain Gulf sturgeon health and growth, but Gulf sturgeon are known to travel long distances (greater than 161 km) during the winter, which suggests that significant resources must be necessary.

Reproduction and Habitat

Currently Gulf sturgeon are known to spawn in 7 rivers: Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and Suwannee. Adult Gulf sturgeon spawn in the upper reaches of rivers, at least 100 km upstream of the river mouth during the spring when water temperature rises to between 17° and 25°C (Sulak et al. 2004). Similar to shortnose sturgeon, Randall and Sulak (2007) found some evidence to suggest an additional fall spawning event for Gulf sturgeon in the Suwannee River. Age at sexual maturity ranges from 8 to 17 years for females and 7 to 21 years for males (Huff 1975). Spawning periodicity is thought to be similar to Atlantic sturgeon with a long inter-spawning period for females at every 3 to 5 years, and males every 1 to 5 years (Smith 1985). Both Huff (1975) and Fox et al. (2000) indicate Gulf sturgeon males are capable of annual spawning, but females require more than 1 year between spawning events.

Gulf sturgeon eggs are demersal, adhesive, and vary in color from gray to brown to black (Vladykov and Greeley 1963; Huff 1975). Chapman et al. (1993) estimated that mature female Gulf sturgeon weighing between 29 and 51 kg produce an average of 400,000 eggs. Eggs hatch after 2 to 4 days as artificially spawned Gulf sturgeon eggs hatched between 86 hours at 18.4°C to about 54 hours at about 23.0°C (Parauka et al. 1991). Chapman et al. (1993) reported that artificially spawned Gulf sturgeon eggs incubated at 20°C hatched in 3.5 days.

Habitat at egg collection sites consists of one or more of the following: limestone bluffs and outcroppings, cobble, limestone bedrock covered with gravel and small cobble, gravel, and sand (Marchant and Shutters 1996; Sulak and Clugston 1999; Heise et al. 1999; Fox et al. 2000; Craft et al. 2001; Pine et al. 2006). A dense matrix of gravel or cobble is likely essential for Gulf sturgeon egg adhesion in the Suwannee River and the sheltering of the yolk sac larvae, and is a habitat spawning adults apparently select (Sulak and Clugston 1999). Other substrates identified as possible spawning habitat include marl (clay with substantial calcium carbonate), soapstone, or hard clay (T. Slack, ERDC, pers. comm.; F. Parauka, USFWS, pers. comm.). Water depths at egg collection sites range between 1.4 to 7.9 m, and temperatures range between 18.2° and 25.3°C (Fox et al. 2000; Ross et al. 2000; Craft et al. 2001; Pine et al. 2006).

Laboratory experiments indicated optimal water temperature for survival of Gulf sturgeon larvae is between 15°C and 20°C, with low tolerance to temperatures above 25°C (Chapman and Carr 1995). While Sulak and Clugston (1999) suggested that sturgeon spawning activity in the Suwannee River is related to the phase of the moon after the water temperature has risen to 17°C, other researchers (Slack et al. 1999; Fox et al. 2000) have found little evidence of lunar influence. Ion conductivity and calcium ion concentrations associated with the spring high water may influence egg development and adhesion in the Suwannee River (Sulak and Clugston 1999). Fox et al. (2002) found no clear pattern between timing of Gulf sturgeon entering the river and flow patterns on the Choctawhatchee River. Ross et al. (2001) surmised that high flows in early March were a cue for sturgeon to begin their upstream movement in the Pascagoula River.

Similar to other sturgeons, larvae initiate downstream drift about 9-12 days after hatching and are extremely sensitive to saline habitat. Laboratory experiments on shortnose sturgeon indicate larvae are nocturnal and preferred deep water, grey color, and a silt substrate (Richmond and Kynard 1995). When small, sturgeons are especially sensitive to saline habitat and oxygen levels. This sensitivity is likely a result of the sturgeon's limited behavioral and physiological capacity to respond to hypoxia (Secor and Niklitschek 2001). Jenkins et al. (1993) examined environmental tolerance of dissolved oxygen on shortnose sturgeon and found that younger fish were differentially susceptible to low oxygen levels in comparison to older juveniles. Shortnose sturgeon older than 77 days experienced minimal mortality at nominal levels >2.5 mg/L; mortality at 2.0 mg/L increased to 24-38%. Dissolved oxygen at 3.0 mg/L resulted in 18-38% mortality of fish less than 78 days old; increasing to 80% at 2.5mg/L.

During early life history stages, sturgeon require bedrock and clean gravel or cobble as a substrate for egg adhesion and a shelter for developing larvae (Sulak and Clugston 1999). In the Suwannee river, YOY disperse widely downstream of spawning sites, using extensive portions of the river as nursery habitat. These YOY are typically found in open sand-bottom habitat away from the shoreline and vegetated habitat. The wide dispersal of YOY fish in the river may be an adaptation to exploit scarce food resources in these sandy habitat types (Randall and Sulak 1999). Clugston et al. (1995) reported that young Gulf sturgeon in the Suwannee River, weighing between 0.3 and 2.4 kg, remained in the vicinity of the river mouth and estuary during the winter and spring. Sulak et al. (2004) noted that the apparent preference of juvenile sturgeon for sandy main channel habitats enable sturgeon to exploit a unique niche with little competition.

In the Pascagoula and the Apalachicola Rivers, some adult and subadult Gulf sturgeon remain near the spawning grounds throughout the summer months (Wooley and Crateau 1985; Ross et al. 2001), but the majority move downstream to areas referred to as summer resting or holding areas. Notably upstream migration in both the Pascagoula and Apalachicola is limited due to impediments and therefore spawning occurs lower in the river compared to the Suwannee and Choctawhatchee. A few Gulf sturgeon have been documented remaining at or near their spawning grounds throughout the winter (Wooley and Crateau 1985; Slack et al. 1999; Heise et al. 1999). Within the river adults and subadults are not distributed uniformly, instead telemetry data indicate a preference for discrete areas usually located in lower and middle river reaches (Hightower et al. 2002). Often, these areas are located near natural springs throughout the warmest months of the year, but are not located within a spring or thermal plume emanating from a spring (Clugston et al. 1995; Foster and Clugston 1997; Hightower et al. 2002) and often include holes along straight-aways ranging from 2 to 19 m in depth (Wooley and Crateau 1985; Ross et al. 2001; Craft et al. 2001; Hightower et al. 2002). Substrate in these resting holes include limestone and sand (Clugston et al. 1995), sand and gravel (Wooley and Crateau 1985), or sand (Hightower et al. 2002).

Upstream migration and spawning are both likely cued by river flow (Chapman and Carr 1995; Ross et al. 2001), however strong flow can exceed sturgeon's swimming ability. In the Suwannee River, data strongly indicates that Gulf sturgeon cannot continuously swim against prevailing currents of greater than 1 to 2 m per second (K. Sulak, USGS, pers. comm., cited in Wakeford 2001). If flow is too strong at the spawning location, eggs might not be able to settle on and adhere to suitable substrate (Wooley and Crateau 1985). Low flows at the spawning site can cause clumping of eggs that leads to increased mortality from asphyxiation and fungal infection (Wooley and Crateau 1985). Flow velocity requirements for YOY sturgeon may vary depending on substrate type. Chan et al. (1997) found that YOY Gulf sturgeon under laboratory conditions exposed to water velocities over 12 cm/s sought cobble substrate, but when velocity was less than 12 cm/s, a variety of substrates including sand, gravel, and cobble were used.

Gulf sturgeon require large areas of diverse habitat that have natural variations in water flow, velocity, temperature, and turbidity (USFWS et al. 1995; Wakeford 2001). Laboratory experiments indicate that Gulf sturgeon eggs, embryos, and larvae have the highest survival rates when temperatures are between 15° and 20°C. Mortality rates of Gulf sturgeon gametes and embryos are highest when temperatures are 25°C and above (Chapman and Carr 1995). Researchers have documented temperature ranges at Gulf sturgeon resting areas between 15.3° and 33.7°C with dissolved oxygen levels between 5.6 - 9.1 mg/l (Hightower et al. 2002).

Most subadult and adult Gulf sturgeon spend the cooler winter months in estuarine areas, bays, or in the Gulf of Mexico (Clugston et al. 1995; Fox et al. 2002). Most (i.e., 78%) subadult Gulf sturgeon in Choctawhatchee Bay remained in the bay the entire winter, some (13%) moved into the connecting bay, and the others (9%) possibly overwintered in the Gulf of Mexico. On the other hand, adult Gulf sturgeon are more likely to overwinter in the Gulf of Mexico, as 45% of those tagged left Choctawhatchee Bay and spent extended periods of time in the Gulf of Mexico (Fox et al. 2002). There has been 1 report of adult sturgeon overwintering in freshwater in the

Apalachicola River (Wooley and Crateau 1985); however, it is likely the result of a shed tag and not actual overwintering in freshwater as no movement occurred (F. Parauka, USFWS, pers. comm.).

Gulf sturgeon winter movements are a pattern of directed slow, steady travel over several kilometers followed by periods of randomly directed travel (Edwards et al. 2003). This pattern is consistent with the benthic cruising foraging strategy that is adapted to a patchy distribution of food resources by an animal that lacks advance knowledge of the location of the patches or an ability to detect the patches from afar. Both Edwards et al. (2007) and Ross et al. (2009) describe broad mixing of Gulf sturgeon from different riverine populations at winter foraging areas.

Migration

In the spring (March to May), most adult and subadult Gulf sturgeon return to their natal river, where sexually mature sturgeon spawn and reside until October or November in freshwater although some individuals enter later during the summer (Clugston et al. 1995; Fox et al. 2000). Migratory behavior of the Gulf sturgeon seems influenced by sex, reproductive status, water temperature, and possibly river flow. Carr et al. (1996) reported that male Gulf sturgeon initiate migration to the river earlier in spring than females. Fox et al. (2000) found no significant difference in the timing of river entry due to sex, but reported that males migrate further upstream than females and that ripe (in reproductive condition) males and females enter the river earlier than non reproductive fish. Change in temperature is thought to be an important factor in initiating sturgeon migration (Wooley and Crateau 1985; Chapman and Carr 1995; Foster and Clugston 1997). Most adults and subadults begin moving from estuarine and marine waters into the coastal rivers in early spring when river water temperatures range from 16.0° to 23.0°C (Sulak and Clugston 1999), while others may enter the rivers during summer months (Fox et al. 2000). Some research supports the theory that spring migration coincides with the general period of spring high water (Chapman and Carr 1995; Sulak and Clugston 1999; Ross et al. 2001), however, other observations have not found a clear relationship between the timing of river entrance and flow patterns (Fox et al. 2002).

Downstream migration from fresh to saltwater begins in September (at about 23°C) and continues through November (Huff 1975; Wooley and Crateau 1985; Foster and Clugston 1997) and may be related to discharge. Parauka et al. (2001) reported that tagged sub adult Gulf sturgeon departed the Choctawhatchee River in early October 1998 as river discharge increased and water temperature was 24.5°C. These fish migrated from the river to the marine system 2-4 weeks earlier than sub adults monitored in 1996 and 1997. Heise et al. (1999) found that the greatest seaward movement of Gulf sturgeon in the Pascagoula River in 1998 corresponded with elevated river flows associated with Hurricane Georges.

During the fall migration from fresh to saltwater, Gulf sturgeon may require a period of physiological acclimation to changing salinity levels, referred to as osmoregulation or staging (Wooley and Crateau 1985). This period may be short (Fox et al. 2002) as sturgeon develop an active mechanism for osmoregulation and ionic balance by age 1 (Altinok et al. 1998). On some river systems, timing of the fall migration appears to be associated with pulses of higher river discharge (Heise et al. 1999; Ross et al. 2000, 2001; Parauka et al. 2001).

Juvenile sturgeon have been found to remain in the mouth of the Suwannee River over winter and YOY migrate downstream in late January to early February (Sulak and Clugston 1999). Huff (1975) noted that juvenile Gulf sturgeon in the Suwannee River most likely participated in pre- and post-spawning migrations, along with the adults. Parauka et al. (2001) relocated sub adult Gulf sturgeon overwintering in Choctawhatchee Bay in lower (6.3 ppt) saline areas found in the eastern portion of the bay. Fox et al. (2002) reported that most male Gulf sturgeons (60%) overwintered exclusively in Choctawhatchee Bay while most females (60%) were found in adjacent bays, the Gulf of Mexico, or were not located.

Findeis (1997) described sturgeon (*Acipenseridae*) as exhibiting evolutionary traits adapted for benthic cruising. Tracking observations indicate individuals travel until they encounter suitable prey type and density, at which time they forage in that area for extended periods of time (Sulak and Clugston 1999; Fox et al. 2002; Edwards et al. 2007). Individual fish often remained in localized areas (less than 1 km^2) for extended periods of time (greater than 2 weeks), and then moved rapidly to another area where localized movements occurred again (Fox et al. 2002). When temperatures drop in the fall, often associated with major cold fronts, Gulf sturgeon from the Escambia, Yellow, and Suwannee Rivers are no longer relocated within estuarine bays (Craft et al. 2001; Edwards et al. 2003). It is suggested the sudden drop in water temperature disperses sturgeon from the bays to the nearshore coastal foraging grounds. It is uncertain if Gulf sturgeon undertake extensive offshore migrations into the Gulf of Mexico; further study is needed to determine whether Gulf sturgeon utilize offshore winter-feeding habitat.

Population Structure and Riverine Fidelity

Stabile et al. (1996) analyzed tissue from Gulf sturgeon in 8 drainages along the Gulf of Mexico for genetic diversity. They noted significant differences among Gulf sturgeon stocks and suggested that they displayed region-specific affinities and may exhibit river-specific fidelity. Stabile et al. (1996) identified 5 regional or river-specific stocks: (1) Lake Pontchartrain and Pearl River; (2) Pascagoula River; (3) Escambia and Yellow Rivers; (4) Choctawhatchee River; and (5) Apalachicola, Ochlockonee, and Suwannee Rivers. Mark-recapture studies have confirmed the general fidelity of individual Gulf sturgeon returning to particular rivers (NMFS and USFWS 2003), presumably their natal rivers. Preliminary results from microsatellite analysis indicate there are likely 2 (west and east) or 3 (Pearl/Pascagoula; Pensacola/Choctawhatchee; and Apalachicola/Ochlockonee/Suwannee) distinct groups of Gulf sturgeon; while the greatest differences are between the west and the east; the 3 group scenario is also strongly supported (B. Krieser, USM, pers. comm.).

Both genetic and tagging data supports Gulf sturgeon river fidelity. Ongoing standardized field studies should provide important movement data to inform inter-basin transfers. DNA indicates high river fidelity (ranging from 75 to 98% in the spawning rivers) and coupled with the strong levels of differentiation, at least at the regional scale, suggests that most movement is not effective as genetic material is not being exchanged. On smaller spatial scales, some gene flow might be taking place and this is producing a smaller level of differentiation between any 2 particular drainages. The gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than 1 mature female per generation (Waldman and Wirgin 1998).

Abundance and Population Trends

Currently, 7 rivers are known to support reproducing populations of Gulf sturgeon. Although variable, most populations appear relatively stable with a few exceptions (Table 1). The status of Gulf sturgeon is considered to be stable (USFWS and NMFS 2009). The number of Gulf sturgeon in the Escambia River system may have recently declined due to hurricane impacts, and the Suwannee River population appears to be slowly increasing. Due to lack of research since Hurricanes Ivan and Katrina, no data are available to determine the current size of the Gulf sturgeon populations within the Pearl and Pascagoula Rivers; however a recent release from a paper mill on the Pearl River killed at least 22 Gulf sturgeon. A complete summary of Gulf sturgeon population estimates was presented in the 5-year review (USFWS and NMFS 2009).

Table 1. Gulf sturgeon abundance estimates with confidence intervals (CI) for the 7 know reproducing populations. Notably all estimates listed apply to only a portion of the population exceeding a minimum size, which varies between researchers according to sampling method used.

RIVER	STATES	ABUNDANCE ESTIMATE (CI)	SOURCE
Pearl	LA, MS	430 (323 - 605)	Rogillio et al. 2002
Pascagoula	MS	216 (124 - 429)	Ross et al. 2001
Escambia	AL, FL	451 (338 - 656)	USFWS 2007
Yellow	AL, FL	911 (550 - 1,550)	Berg et al. 2007
Choctawhatchee	AL, FL	3314 (N/A)	USFWS 2000
Apalachicola	FL	144 (83 - 205)	Zehfuss et al. 1999
Suwannee	FL	9,728 (6,487 - 14,664)	Randall 2008

Population modeling by Pine and Martell (2009) found a general trend of gradually increasing abundance is apparent in the Apalachicola River. Similarly, for the Suwannee River data, estimated abundance in the early 1980s of about 3,000 age 1+ sturgeon, increasing to about 10,000 in 2004. Pine et al. (2001) found a positive population growth of about 5% annually for adults within the Suwannee River Gulf sturgeon population, and therefore in number to about 10,000 individuals in 2004.

Few data are available to assess Gulf sturgeon age structure and recruitment. The age structure evident from mark/recapture studies of the Apalachicola River sturgeon population suggests variable recruitment over time (Pine and Allen 2005), but the factors influencing this variability have not yet been investigated. Randall and Sulak (2007) examined variable recruitment in the Suwannee River and suggested that it may be due to flow in fall and amount of estuarine habitat of moderate salinity. Flowers (2008) describes the rapid decline in Gulf sturgeon landings as likely reflective of rapid erosion of the population age-structure of the large, older, highly fecund individuals being removed which led to a rapid change in the age-structure of the population and thereby reducing annual reproductive output and population recovery.

Threats

The 1991 listing rule cited the following impacts and threats: (1) dams on the Pearl, Alabama, and Apalachicola rivers; also on the North Bay arm of St. Andrews Bay; (2) channel improvement and maintenance activities: dredging and de-snagging; (3) water quality degradation; and (4) contaminants. Additional information on Gulf sturgeon threats included in the 5-year status review (USFWS and NMFS 2009) is discussed below.

All of the dams noted in the listing rule continue to block passage of Gulf sturgeon to historical spawning habitats and thus either reduce the amount of available spawning habitat or entirely impede access to it. Since Gulf sturgeon were listed, several new dams have been proposed on rivers that support Gulf sturgeon, including the Pearl, Escambia/Conecuh, Choctawhatchee, Yellow, and Apalachicola River drainages (USFWS and NMFS 2009). Maintenance dredging occurs regularly in numerous navigation channels that traverse the bays, passes, and river mouths of all 7 river drainages that are used by Gulf sturgeon. Most of this dredging occurs within designated Gulf sturgeon critical habitat and may modify foraging habitat as well as causing injury or killing Gulf sturgeon.

Berg (2006) found that loss of habitat associated with pollution and contamination has been documented for sturgeon species. Several characteristics of the Gulf sturgeon (i.e., long lifespan, extended residence in riverine and estuarine habitats, benthic predator) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants. Chemicals and metals such as chlordane, DDE, DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later incorporated into the food web as they are consumed by benthic feeders, such as sturgeon or macroinvertebrates. Some of these compounds may affect physiological processes and impede the ability of a fish to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing dissolved oxygen, altering pH, and altering other water quality properties.

Climate change has potential implications for the status of the Gulf sturgeon through alteration of its habitat. The Intergovernmental Panel on Climate Change (IPCC 2007) concluded that it is very likely that heat waves, heat extremes, and heavy precipitation events over land will increase during this century. Warmer water, sea level rise and higher salinity levels could lead to accelerated changes in habitats utilized by Gulf sturgeon.

While overutilization due to directed harvest is no longer a threat, some Gulf sturgeon researchers offer that possibly significant Gulf sturgeon mortality occurs as bycatch in fisheries directed at other species. In particular, fisheries that employ trawl and entanglement gear in areas that sturgeon regularly occupy pose a risk of incidental bycatch.

2 Shortnose sturgeon

The shortnose sturgeon was originally listed as an endangered species by the USFWS on March 11, 1967 under the Endangered Species Preservation Act (32 FR 4001). Shortnose sturgeon continued to meet the listing criteria as “endangered” under subsequent definitions specified in the 1969 Endangered Species Conservation Act. We assumed jurisdiction for shortnose sturgeon from the USFWS under a 1970 government reorganization plan. The ESA was enacted in 1973 and all species that were listed as endangered species threatened with extinction in the 1969 Endangered Species Conservation Act were deemed endangered species under the ESA (39 FR 41370). Shortnose sturgeon currently remains listed as an endangered species throughout all of its range along the U.S. East Coast.

Life History and Distribution

The shortnose sturgeon is the smallest of the 3 sturgeon species that occur in eastern North America: they attain a maximum length of about 120 cm, and a weight of 24 kg (Dadswell et al. 1984). Adults resemble similar-sized juvenile Atlantic sturgeon (*A. oxyrinchus oxyrinchus*) that historically co-occurred in the lower mainstem rivers of major basins along the Atlantic coast. The shortnose sturgeon is distinguished from other North American sturgeons by a wide mouth, absence of a fontanelle, nearly complete absence of postdorsal scutes, and preanal scutes often arranged in a single row (Scott and Crossman 1973; Dadswell et al. 1984). Morphological differences between shortnose and Atlantic sturgeon have been discussed (Vecsei and Peterson 2004); most researchers in the field use mouth width versus interorbital width to separate species. Coloration varies but adult shortnose sturgeons are generally dark dorsally and are lighter ventrally, usually white to yellow in color beginning at the row of lateral scutes. All of the fins are pigmented, and the paired fins are outlined in white. There is no external sexual dimorphism in morphology.

Shortnose sturgeon migrate seasonally between upstream freshwater spawning habitat and downstream foraging mesohaline areas within the river based on water temperature, flow and salinity cues. Shortnose sturgeon have generally been described as being anadromous but freshwater amphidromous may be a better description for the fish occurring in the southern rivers because they rarely leave their natal rivers or associated estuaries (Kieffer and Kynard 1993).

Shortnose sturgeon inhabit large coastal rivers of eastern North America. Although it is considered an anadromous species, shortnose sturgeon distributed in the southern areas of the United States are more properly characterized as “freshwater amphidromous” meaning that they move between fresh and salt water during some part of their life cycle, but not necessarily for spawning. Historically, shortnose sturgeon were found in the coastal rivers along the east coast of North America from the Saint John River in Canada, to perhaps as far south as the Indian River in Florida (Gilbert 1989). Currently, the distribution of shortnose sturgeon across their range is disjunct, with northern populations separated from southern populations by a distance of about 400 km near their geographic center in Virginia. In the southern portion of its range, they are currently found in the Altamaha, Ogeechee, and Savannah Rivers in Georgia. They are thought to be extremely rare or possibly extirpated from the St. Johns River in Florida as only a single specimen was found by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002-2003. Shortnose sturgeon prefer nearshore marine, estuarine, and riverine habitat of these large river systems. The species is significantly more abundant in some rivers in northern portions of its range than it is in the south. Bycatch in commercial fisheries and increased industrial uses of the nation’s large coastal rivers during the 20th century (e.g., hydropower, nuclear power, port dredging) have contributed to the further decline and slow recovery of shortnose sturgeon.

While adult shortnose sturgeon may occasionally be found in marine waters during the summer, they typically are found in more estuarine waters, and in rivers near the saltwater-freshwater interface. There are spawning populations in the Savannah River, and Hall et al. (1991) and Collins and Smith (1993), using telemetry techniques, identified 2 distinct spawning locations. However, the status of stocks is poorly understood and survival of juveniles and recruitment to the adult population has been identified as a potential limiting factor in population growth (Smith et al.

1992). According to historical distribution records much of the spawning and nursery habitat formerly available to sturgeon in the Savannah River is inaccessible (USFWS et al. 2001).

Spawning migration and cues

Initiation of the upstream movement of shortnose sturgeon to spawn is likely triggered partially by water temperatures above 8°C (Dadswell 1979; Kynard 1997) during late winter/early spring (southern rivers) to mid-to-late spring (northern rivers); specifically occurring in the southern range (North Carolina and south) between late December and March. Southern populations of shortnose sturgeon usually spawn at least 200 km upriver (Kynard 1997) or throughout the fall zone, if they are able to reach it. Spawning areas are usually associated with areas where the substrate is composed of gravel, rubble, cobble, or large rocks (Dadswell 1979; Kynard 1997), or timber, scoured clay, and gravel (Hall et al. 1991). Water depth and flow are also important parameters for spawning site (Kieffer and Kynard 1996). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall et al. 1991; Kieffer and Kynard 1996; NMFS 1998). Spawning in the southern rivers has been reported at water temperatures of 10.5°C in the Altamaha River (Heidt and Gilbert 1978) and 9-12°C in the Savannah River (Hall et al. 1991). In the southern portion of the range, adults typically spawn well upriver in the late winter to early spring and spend the rest of the year in the vicinity of the fresh/brackish water interface (Collins and Smith 1993).

Shortnose sturgeon vary in pre-spawning migration patterns that may reflect energetic adaptations to migration distance, river discharge and temperature, and physiological condition of fish (Kieffer and Kynard 1993). The 3 patterns of migrations are: (1) a rapid, 1-step migration in spring only a few weeks before spawning; (2) a longer, 1-step migration many weeks in late winter and spring before spawning; and (3) a 2-step migration composed of a long fall migration, which places fish near the spawning site for overwintering, then a short migration in spring to spawn.
Following the spring spawning period, adult shortnose sturgeon move rapidly and directly downstream to freshwater reaches of rivers or river reaches that are influenced by tides; as a result, they often inhabit only a few short reaches of a river's entire length (Buckley and Kynard 1985). Adult shortnose sturgeon are usually located in deeper downstream areas with soft substrate and vegetated bottom areas where their prey are present. Juvenile (non-spawning, sexually immature) shortnose sturgeon generally move lesser distances upstream for the spring and summer seasons and downstream for fall and winter; however, these movements usually occur above the salt/freshwater interface of the rivers they inhabit (Dadswell et al. 1984; Hall et al. 1991).

Age and Growth

Dadswell et al. (1984) reviewed shortnose sturgeon growth throughout the latitudinal range. Growth of all juveniles is rapid, attaining lengths of 14-30 cm during the first year. Fish in the southern portion of the range grow the fastest, but do not reach the larger size of fish in the northern part of the range that continue to grow throughout life. This phenomenon may be related to different bioenergetic styles of southern and northern shortnose sturgeon, but sufficient data are not available for conclusions. The land-locked shortnose sturgeon population located upstream of Holyoke Dam at river km 140 of the Connecticut River has the slowest growth rate of any surveyed (Taubert 1980); growth rates of the other land-locked population in Lakes Marion and Moultrie are not available for comparison. The slower growth rate of this land-locked population suggests bioenergetic consequences to foraging in freshwater habitat and advantages associated with foraging in the lower river or fresh/saltwater interface.

Length at maturity (45-55 cm FL) is similar throughout the latitudinal range of shortnose sturgeon, but growth rate, maximum age, and maximum size vary with latitude. Fish in the southern areas grow more rapidly and mature at younger ages but attain smaller maximum sizes than those in the north (Dadswell et al. 1984). Maximum age of shortnose sturgeon in the northern portion of the species' range is greater than the southern portion of the species' range (Gilbert 1989). The maximum age reported for a shortnose sturgeon in the Saint John River in New Brunswick is 67 years (for a female), 40 years for the Kennebec River, 37 years for the Hudson River, 34 years in the Connecticut River, 20 years in the Pee Dee River, and 10 years in the Altamaha River (Gilbert 1989 using data presented in Dadswell et al. 1984).

Shortnose sturgeon also exhibit sexually dimorphic growth patterns across latitude: males mature at 2-3 years in Georgia, 3-5 years in South Carolina, and 10-11 years in the Saint John River, Canada; females mature at 4-5 years in Georgia, 7-10 years in the Hudson River, and 12-18 years in the Saint John River. Males begin to spawn 1-2 years after reaching sexual maturity and spawn every other year and perhaps annually in some rivers (Dadswell 1979; Kieffer and Kynard 1996; NMFS 1998). Age at first spawning for females is about approximately 5 years post-maturation (Dadswell 1979) with spawning occurring about every 3 years although spawning intervals may be as infrequent as every 5 years for some females (Dadswell 1979). Female shortnose sturgeon apparently grow larger than and outlive males (Dadswell et al. 1984; Gilbert 1989). Fecundity of shortnose sturgeon ranges between approximately 30,000-200,000 eggs per female (Gilbert 1989). Substrates commonly used by spawning shortnose sturgeon include gravel, rubble, large rock, sand, logs, and cobble (Dadswell 1979; Taubert 1980; Kieffer and Kynard 1996; Kynard 1997).

Research indicates that yearlings are the primary migratory stage (Kynard 1997), while juveniles (3-10 year olds) reside near the saltwater/freshwater interface in most rivers (Dadswell 1979; Hall et al. 1991). Juveniles regularly move throughout the saline portions (0-16 ppt) of the salt wedge during summer (Pottle and Dadswell 1979) and are more active when water temperatures are cooler (<16°C) (Weber 1996). Juveniles have been found congregating in deeper sand/mud substrate in depths of 10-14 m (Hall et al. 1991). Due to their low tolerance for high temperatures, warm summer temperatures (above 28°C) may severely limit available juvenile rearing habitat in some rivers in the southeastern United States. Juveniles in the Altamaha and Ogeechee Rivers have been found in a single area with cool and deep water (Flournoy et al. 1992; Weber 1996). In the Southeast, juveniles age 1 and older make seasonal migrations like adults, moving upriver during warmer months where they shelter in deep holes, before returning to the fresh/salt water interface when temperatures cool (Flournoy et al. 1992). Telemetry studies have identified nursery habitats for juveniles, a primary example being just inside the mouth of the Middle River branch of the lower Savannah River, and near the Kings Island Turning Basin.

Little is known about YOY behavior and movements in the wild but shortnose sturgeon at this age are believed to remain in channel areas within freshwater habitats upstream of the salt wedge for about 1 year (Dadswell et al. 1984; Kynard 1997). Residence of YOY in freshwater is supported by several studies on cultured shortnose sturgeon. Jenkins et al. (1993) found that salinity tolerances of young shortnose sturgeon improve with age; individuals 76 days old suffered 100% mortality in a 96-hour test at salinities ≥15 ppt while those 330 days old tolerated salinities as high as 20 ppt for 18 hours but experienced 100% mortality at 30 ppt. Jarvis et al. (2001) demonstrated that 16-month old juveniles grew best at 0% salinity and poorest at 20% salinity. Lastly, Ziegeweid et al. (2008) demonstrated that salinity and temperature interact, affecting survival of YOY shortnose sturgeon. As salinity and temperature increased, survival decreased; however, as body size increased, individuals were better able to tolerate higher temperatures and salinities (Ziegeweid et al. 2008).

Foraging

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning and move rapidly to downstream feeding areas in the spring (Dadswell et al. 1984; Kieffer and Kynard 1993; Collins and Smith 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Shortnose sturgeon are benthic carnivores throughout their life who locate prey by using their barbels as tactile receptors and vacuuming either the substrate or plant surfaces with their protuberant mouth (Dadswell et al. 1984; Gilbert 1989). Shortnose sturgeon feed opportunistically on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell et al. 1984). Studies of gut contents show that the diet of adult shortnose sturgeon typically consists of small bivalves, gastropods, polychaetes, and even small benthic fish (Dadswell 1979; Dadswell et al. 1984; Gilbert 1989; Collins et al. 2002), and they have also been observed feeding off plant surfaces and may take fish bait (Collins et al. 2002). Some reports indicate that female adult shortnose sturgeon have been found to feed throughout the year; however, Dadswell (1979) found that females ceased feeding nearly 8 months before spawning. Conversely, males continue to feed throughout the fall and winter as long as they are located in saline waters (Dadswell et al. 1984). Dadswell (1979) documented individuals of both sexes actively feeding immediately after spawning. Limited observations indicate that feeding occurs primarily at night (Dadswell et al. 1984; Gilbert 1989). Juveniles feed indiscriminately, often ingesting large amounts of mud, stone, and plant material along with prey items (Dadswell 1979). Because substrate type strongly affects composition of benthic prey, both juvenile and adult shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Kynard 1997).

In the southern part of their range, shortnose sturgeon are known to forage widely throughout the estuary during the winter, fall, and spring (Collins and Smith 1993). During the hotter months of summer, foraging may taper off or cease as shortnose sturgeon take refuge from high water temperatures by congregating in cool, deep areas of rivers (Flournoy et al. 1992; Weber 1996). During winter months, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith 1993). Older juveniles likely inhabit the same areas as adults, but younger juveniles primarily remain in freshwater habitats perhaps due to low salinity tolerances (Jenkins et al. 1993; Jarvis et al. 2001).

Threats

As noted in the shortnose sturgeon recovery plan (NMFS 1998), habitat degradation or loss resulting from dams, bridge construction, channel dredging, and pollutant discharges, and mortality from impingement on cooling water intake screens, dredging, and incidental capture in fisheries are principal threats to the species' survival.

Summary of Status of Shortnose Sturgeon

The shortnose sturgeon is a freshwater amphidromous fish inhabiting large coastal rivers along the eastern seaboard of North America from the Saint John River in New Brunswick, Canada, south to the St. Johns River in Florida. Clinal differences in growth and behavior are obvious for shortnose sturgeon: fish in the north grow slower but reach larger size, timing of spawning migration is earlier in the south, etc. Genetic analysis has indicated that at least 2 or perhaps 3 metapopulations of shortnose sturgeon exist across the range of shortnose sturgeon. Within a metapopulation, individual populations interact at some level via movement, but not effectively (i.e., reproduction). Shortnose sturgeon from North Carolina south through Florida are part of a single metapopulation, the Southern (also "Carolinian Province") metapopulation. There are markedly fewer shortnose sturgeon in the southern United States compared to the north. No recent population trend data exist.

3 Atlantic Sturgeon

On October 6, 2010, we published 2 *Federal Register* notices (75 FR 61872 and 61904) proposing their determination that the anadromous Atlantic sturgeon is made up of 5 DPSs that qualify as species under the ESA, and proposing to list 1 DPS as threatened and 4 as endangered. The comment period on these listing determinations was extended to February 30, 2011. On February 6, 2012, we published a *Federal Register* notice (77 FR 5914) listing the Carolina and South Atlantic DPS of Atlantic sturgeon as endangered. Information summarized below is taken from the *Federal Register* notices and the Atlantic Sturgeon Status Review (NMFS 2007), which provide extensive reviews of the literature and data on Atlantic sturgeon.

Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from the St. Croix in Maine to the Saint Johns River in Florida. Thirty-five of these rivers have been confirmed to have had historical spawning populations. Atlantic sturgeon are currently present in approximately 36 U.S. rivers, including 18 in which spawning is believed to occur (NMFS 2007). Atlantic sturgeon show a high degree of reproductive isolation, spawning exclusively in ecologically unique natal rivers (NMFS 2007). We evaluated the life history and genetics of Atlantic sturgeon and proposes 5 discrete Atlantic sturgeon population segments in the U.S; 3 in the Northeast Region (Gulf of Maine population segment that originates from the Kennebec River; the New York Bight population segment that originates from the Hudson and Delaware Rivers; and the Chesapeake Bay population that originates from the James and York Rivers), and 2 in the Southeast Region (the Carolina population segment originating from the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, Pee Dee, and Santee-Cooper Rivers; and the South Atlantic population segment originating from the Ashepoo, Combahee, and Edisto River Basin and the Savannah, Ogeechee, Altamaha, and Saltilla Rivers). The Gulf of Maine population segment of Atlantic sturgeon has been proposed for threatened species status. The other 4 proposed DPSs have been proposed for endangered listing status.

Atlantic sturgeon are omnivorous benthic feeders that forage on mollusks, gastropods, amphipods, isopods, and fish. Juvenile sturgeon feed on aquatic insects and other invertebrates (NMFS 2007).

They may live up to 60 years, maturing late in life, reaching a length of up to 14 ft (4.26 m) and over 800 lbs (<364 kg). Female Atlantic sturgeon can produce (depending on age and size) from 400,000 to 4 million eggs every 2 to 5 years (75 FR 61872, October 6, 2010). Atlantic sturgeon are dependent on estuaries; with spawning believed to occur in flowing waters of 18° to 20°C between the salt front of estuaries and the fall line of large rivers. Sturgeon eggs are highly adhesive, requiring a hard bottom substrate. Hatching occurs after 4 to 7 days, followed by a brief demersal stage before the larvae move downstream, using rough bottom for protection. Juvenile sturgeon move into brackish waters, where they may reside in estuaries for months or years before moving to open ocean as subadults (NMFS 2007). The timing of spawning migration, and growth rates of sturgeon are specific to the different river systems, with spawning occurring generally earlier in the year and faster growth rates in the southern rivers.

Tracking and tagging studies have shown that subadult and adult Atlantic sturgeon that originate from different rivers mix within the marine environment, utilizing ocean and estuarine waters for life functions such as foraging and overwintering (NMFS 2007). Fishery-dependent data, as well as fishery-independent data, demonstrate that Atlantic sturgeon use relatively shallow inshore areas of the continental shelf, primarily waters less than 50 m in depth (Stein et al. 2004b; ASMFC 2007; Dunton et al. 2010). The data also suggests regional differences in Atlantic sturgeon depth distribution, with sturgeon observed in waters primarily less than 20 m in the Mid-Atlantic Bight and in deeper waters of the Gulf of Maine (Stein et al. 2004b; ASMFC 2007; Dunton et al. 2010). Information on population sizes for each Atlantic sturgeon DPS is very limited. Based on the best available information, we have concluded that bycatch, vessel strikes, water quality and availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon.

Although landing Atlantic Sturgeon has been prohibited since 1998, continued incidental capture in Atlantic bottom trawl fisheries is well documented (Stein et al. 2004a; ASMFC 2007). Stein et al. (2004b) reviewed Northeast Fisheries Observer Program (NEFOP) data on Atlantic Sturgeon bycatch in commercial fisheries between 1989 and 2000 to identify bycatch and mortality rates by different fishing gear. Significant takes were documented in sink gillnet, drift gillnet, and otter trawl gear (Stein et al. 2004b; ASMFC 2007). It was also noted that bycatch rates in all gear increased from north to south, with the highest rates offshore of Maryland, Virginia, and North Carolina. However, because fishing effort was higher farther north, the highest cumulative sturgeon catches were offshore of New Jersey and Massachusetts. Seasonally, bycatch rates were lowest during summer months, highest during the winter and spring. Sink and drift gillnet gears showed higher bycatch rates, but because bottom trawling effort is much higher, actual captures in bottom trawl gear was also higher. Additionally, the mean size of Atlantic sturgeon captured by bottom trawls was much larger than the size captured on sink and drift gillnets (Stein 2004b). None of the Atlantic sturgeon captured between 1989 and 2000 were reported as dead upon landing, however, some post-release mortalities due to stress and injury is likely (Stein 2004b). Coast wide, Stein (2004b) estimated a total capture of Atlantic sturgeon in otter trawls between 1989 and 2000, declining from 200,000 lb (90,718 kg) per year to 150,000 lbs (68,039 kg) per year.

A subsequent review of NEFOP data for the years 2001-2006 indicated sturgeon bycatch occurred in statistical areas abutting the coast from Massachusetts (statistical area 514) to North Carolina (statistical area 635) (ASMFC 2007). Based on the available data, participants in an a bycatch workshop (ASMFC 2007) concluded that there were some seasonal patterns to sturgeon encounters, which tended to occur in waters less than 50 m (164 ft) throughout the year, with 84% found at depths of less than 20 m (66 ft). Otter trawl captures of Atlantic sturgeon ranged from 2,167 fish in 2005 to 7,210 fish in 2002, with a mean for these years of about 3,800 sturgeon, which were about one third of the captures estimated by Stein (2004b) for the earlier period (ASMFC 2007).

Declines in Atlantic sturgeon populations were likely caused primarily by the directed fisheries that ceased in 1999. Continued threats to Atlantic sturgeon include barriers in rivers such as dams or turbines, and the impacts of climate change. Additionally, for all proposed DPS, bycatch in commercial fisheries has been identified as a major threat. Recovery of Atlantic sturgeon populations likely depends on reductions in bycatch mortality. Steps to reduce mortalities will likely be required if final listing rules are published. The ASMFC Technical Committee calculated an annual average bycatch of approximately 3,800 sturgeon in otter trawl gear between 2001 and 2006 (ASMFC 2007); the rate of release mortality from the gear is unknown (Stein et al. 2004b).

4 Smalltooth Sawfish

The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA on April 1, 2003 (68 FR 15674). The smalltooth sawfish is the first elasmobranch to be listed in the United States. Critical habitat for the species was designated on September 2, 2009 (74 FR 45353). The 2 units are located along the southwestern coast of Florida between Charlotte Harbor and Florida Bay and will be discussed in more detail in Section 3.3. Historically, smalltooth sawfish occurred commonly in the inshore waters of the Gulf of Mexico and the U.S. Eastern Seaboard up to North Carolina, and more rarely as far north as New York. Today, smalltooth sawfish remain in the United States typically in protected or sparsely populated areas off the southern and southwestern coasts of Florida; the only known exception is the nursery area in the Caloosahatchee River in an area of waterfront residences and seawalls (NMFS 2010).

Life History and Distribution

Smalltooth sawfish are approximately 31 in (80 cm) in total length at birth and may grow to a length of 18 ft (540 cm) or greater. A recent study by Simpfendorfer suggests rapid juvenile growth occurs during the first 2 years after birth (Simpfendorfer et al. 2008). First year growth is 26-33 in (65-85 cm) and second year growth is 19-27 in (48-68 cm). Growth rates beyond 2 years are uncertain; however, the average growth rate of captive smalltooth sawfish has been reported between 5.8 in (13.9 cm) and 7.7 in (19.6 cm) per year. Apart from captive animals, little is known of the species' age parameters (i.e., age-specific growth rates, age at maturity, and maximum age). Simpfendorfer (2000) estimated age at maturity between 10 and 20 years, and a maximum age of 30 to 60 years. Simpfendorfer et al. (2008) reported that males appear to mature between 100-150 in (253-381 cm) total length, and unpublished data from Mote Marine Laboratory (MML) and our agency indicates male smalltooth sawfish do not reach maturity until they reach 133 in (340 cm) total length.

No directed research on smalltooth sawfish feeding habits exists. Reports of sawfish feeding habits suggest they subsist chiefly on small schooling fish, such as mullets and clupeids. They are also reported to feed on crustaceans and other bottom-dwelling organisms. Observations of sawfish feeding behavior indicate that they attack fish by slashing sideways through schools, and often impale the fish on their rostral (saw) teeth (Breder 1952). The fish are subsequently scraped off the teeth by rubbing them on the bottom and then ingested whole. The oral teeth of sawfish are ray-like, having flattened cusps that are better suited to crushing or gripping.

Very little is known about the specific reproductive biology of the smalltooth sawfish. No confirmed breeding sites have been identified to date since directed research began in 1998. As with all elasmobranchs, fertilization occurs internally. Development in sawfish is believed to be ovoviparous. The embryos of smalltooth sawfish, while still bearing the large yolk sac, resemble adults relative to the position of their fins and absence of the lower caudal lobe. During embryonic development, the rostral blade is soft and flexible. The rostral teeth are also encapsulated or enclosed in a sheath until birth. Shortly after birth, the teeth become exposed and attain their full size, proportionate to the size of the saw. (Bigelow and Schroeder 1953) reported gravid females have been documented carrying between 15-20 embryos; however, the source of their data is unclear and may represent an over-estimate of litter size. Studies of largetooth sawfish in Lake Nicaragua (Thorson 1976) report brood sizes of 1-13 individuals, with a mean of 7 individuals. The gestation period for largetooth sawfish is approximately 5 months, and females likely produce litters every second year. Although there are no such studies on smalltooth sawfish, their similarity to the largetooth sawfish implies that their reproductive biology may be similar. Genetic research currently underway may assist in determining reproductive characteristics (i.e., litter size and breeding periodicity). Research is also underway to investigate areas where adult smalltooth sawfish have been reported to congregate along the Everglades coast to determine if breeding is occurring in the area.

Life history information on the smalltooth sawfish has been evaluated using a demographic approach and life history data on largetooth sawfish and similar species from the literature. Simpfendorfer estimates intrinsic rates of natural population increase as 0.08 to 0.13 per year and population doubling times from 5.4 to 8.5 years (Simpfendorfer 2000). These low intrinsic rates of population increase are associated with the life history strategy known as “k-selection.” K-selected animals are usually successful at maintaining relatively small, persistent population sizes in relatively constant environments. Consequently, they are not able to respond effectively (rapidly) to additional and new sources of mortality resulting from changes in their environment. Musick (1999) noted that intrinsic rates of increase less than 10% were low, and such species are particularly vulnerable to excessive mortalities and rapid population declines, after which recovery may take decades. Thus, smalltooth sawfish populations are expected to recover slowly from depletion. Simpfendorfer concluded that recovery was likely to take decades or longer, depending on how effectively sawfish could be protected (Simpfendorfer 2000). However, if ages at maturity for both sexes prove to be lower than those previously used in demographic assessments, then population growth rates are likely to be greater and recovery times shorter (Simpfendorfer et al. 2008).

Smalltooth sawfish are tropical marine and estuarine elasmobranch (e.g., sharks, skates, and rays) fish that are reported to have a circumtropical distribution. The historic range of the smalltooth sawfish in the United States extends from Texas to New York (NMFS 2009). The U.S. region has historically harbored the largest number of smalltooth sawfish is south and southwest Florida from Charlotte Harbor to the Dry Tortugas. Most capture records along the Atlantic coast north of

Florida are from spring and summer months and warmer water temperatures. Most specimens captured along the Atlantic coast north of Florida have also been large (greater than 10 ft or 3 m) adults and are thought to represent seasonal migrants, wanderers, or colonizers from a core or resident population(s) to the south rather than being resident members of a continuous, even-density population (Bigelow and Schroeder 1953). Historic records from Texas to the Florida Panhandle suggest a similar spring and summer pattern of occurrence. While less common, winter records from the Northern Gulf of Mexico suggest a resident population, including juveniles, may have once existed in this region. The Status Review Team (NMFS 2000) compiled information from all known literature accounts, museum collection specimens, and other records of the species. The species suffered significant population decline and range constriction in the early to mid 1900s. Encounters with the species outside of Florida have been rare since that time.

Since the 1990s, the distribution of smalltooth sawfish in the United States has been restricted to peninsular Florida (Seitz and Poulakis 2002; Simpfendorfer and Wiley 2005; National Sawfish Encounter Database). The Florida Museum of Natural History manages the National Sawfish Encounter Database and is currently under contract with us for smalltooth sawfish research. Encounter data indicates smalltooth sawfish encounters can be found with some regularity only in south Florida from Charlotte Harbor to Florida Bay. A limited number of reported encounters (one in Georgia, 1 in Alabama, 1 in Louisiana, and 1 in Texas) have occurred outside of Florida since 1998.

Peninsular Florida is the main U.S. region that historically and currently hosts the species year-round because the region provides the appropriate climate (subtropical to tropical) and contains the habitat types (lagoons, bays, mangroves, and nearshore reefs) suitable for the species. Encounter data and research efforts indicate a resident, reproducing population of smalltooth sawfish exists only in southwest Florida (Simpfendorfer and Wiley 2005).

General habitat use observations

Encounter databases have provided some general insight into the habitat use patterns of smalltooth sawfish. Poulakis and Seitz (2004) reported that where the substrate type of encounters was known 61% were mud, 11% sand, 10% seagrass, 7% limestone, 4% rock, 4% coral reef, and 2% sponge. Simpfendorfer and Wiley (2005) reported closer associations between encounters and mangroves, seagrasses, and the shoreline than expected at random. Encounter data have also demonstrated that smaller smalltooth sawfish occur in shallower water, and larger sawfish occur regularly at depths greater than 32 ft (10 m). Poulakis and Seitz (2004) reported that almost all of the sawfish <10 ft (3 m) in length were found in water less than 32 ft (10 m) deep and 46% of encounters with sawfish >10 ft (3 m) in Florida Bay and the Florida Keys were reported to occur at depths between 200 to 400 ft (70 to 122 m). Simpfendorfer and Wiley (2005) also reported a substantial number of larger sawfish in depths greater than 32 ft (10 m). Simpfendorfer and Wiley (2005) demonstrated a statistically significant relationship between the estimated size of sawfish and depth, with smaller sawfish on average occurring in shallower waters than large sawfish. There are few verified depth encounters for adult smalltooth sawfish and more information is needed to verify the depth distribution for this size class of animals.

Encounter data has also identified river mouths as areas where many people observe sawfish. Seitz and Poulakis (2002) noted that many of the encounters occurred at or near river mouths in southwest Florida. Simpfendorfer and Wiley (2005) reported a similar pattern of distribution along the entire west coast of Florida. Information on juvenile smalltooth sawfish indicates that they prefer shallow euryhaline habitats adjacent to red mangroves (NMFS 2009).

Very small juveniles (< 39 in (100 cm) in length) habitat use

Very small sawfish are those that are less than 39 in (100 cm), and are young-of-the-year. Like all elasmobranchs of this age, they are likely to experience relatively high levels of mortality due to factors such as predation (Heupel and Simpfendorfer 2002) and starvation (Lowe 2002). Many elasmobranchs utilize specific nursery areas that have lower numbers of predators and abundant food resources (Simpfendorfer and Milward 1993). Acoustic tracking results for very small smalltooth sawfish indicate that shallow depths and red mangrove root systems are likely important in helping them avoid predators (Simpfendorfer 2003). At this size smalltooth sawfish spend the vast majority of their time on shallow mud or sand banks that are less than 1 ft (30 cm) deep. Since water depth on these banks varies with the tide, the movement of the very small sawfish appears to be directed towards remaining in shallow water. It is hypothesized that by staying in these very shallow areas the sawfish are inaccessible to predators (mostly sharks) and increase their chances of survival. The dorso-ventrally compressed body shape helps them in inhabiting these shallow areas, and they can often be observed swimming in only a few inches of water.

The use of red mangrove prop root habitat is also likely to aid very small sawfish in avoiding predators. Simpfendorfer (2003) observed very small sawfish moving into prop root habitats when shallow habitats were less available (especially at high tide). One small animal tracked over 3 days moved into a small mangrove creek on high tides when the mud bank on which it spent low tide periods was inundated at depths greater than 1 ft (30 cm). While in this creek it moved into areas with high prop root density. The complexity of the prop root habitat likely restricts the access of predators and so protects the sawfish.

Very small sawfish show high levels of site fidelity, at least over periods of days and potentially for much longer. Acoustic tracking studies have shown that at this size sawfish will remain associated with the same mud bank over periods of several days. These banks are often very small and daily home range sizes can be of the magnitude of 100-1,000 m^2 (Simpfendorfer 2003). Acoustic monitoring studies have shown that juveniles have high levels of site fidelity for specific nursery areas for periods up to almost 3 months (Wiley and Simpfendorfer 2007). The combination of tracking and monitoring techniques used expanded the range of information gathered by generating both short- and long-term data (Wiley and Simpfendorfer 2007) and further analysis of these data is currently underway.

Small juveniles (39-79 in (100–200 cm) in length) habitat use

Small juveniles have many of the same habitat use characteristics seen in the very small sawfish. Their association with very shallow water (< 1 ft deep) is weaker, possibly because they are better suited to predator avoidance due to their larger size and greater experience. They do still have a preference for shallow water, remaining in depths mostly less than 3 ft (90 cm). They will, however, move into deeper areas at times. One small sawfish acoustically tracked in the Caloosahatchee River spent the majority of its time in the shallow waters near the riverbank, but for a period of a few hours it moved into water 4-6 ft deep (Simpfendorfer 2003). During this time, it was constantly swimming, a stark contrast to active periods in shallow water that lasted only a few minutes before resting on the bottom for long periods.

Site fidelity has been studied in more detail in small sawfish. Several sawfish approximately 59 in (150 cm) in length fitted with acoustic tags have been relocated in the same general areas over periods of several months, suggesting a high level of site fidelity (Simpfendorfer 2003). The daily home ranges of these animals are considerably larger (1-5 km^2) than for the very small sawfish and there is less overlap in home ranges between days. The recent implementation of acoustic monitoring systems to study the longer-term site fidelity of sawfish has confirmed these observations, and also identified that changes in environmental conditions (especially salinity) may be important in driving changes in local distribution and, therefore, habitat use patterns (Simpfendorfer et al. 2011). Salinity electivity analysis results from Simpfendorfer et al. (2011) indicate an affinity for salinities between 18 and at least 24 psu, suggesting movements are likely made in part, to remain within this range.

Juveniles (≤ 79 in (200 cm) in length) habitat use

Using the Heupel et al. (2007) framework for defining nursery areas for sharks and related species such as sawfish, and juvenile smalltooth sawfish encounter data, we identified 2 nursery areas (Charlotte Harbor Estuary and Ten Thousand Islands/Everglades Units) for juvenile smalltooth sawfish in south Florida. Heupel et al. (2007) argue that nursery areas are areas of increased productivity, which can be evidenced by natal homing or philopatry (use of habitats year after year), and that juveniles in such areas should show a high level of site fidelity (remain in the area for extended periods of time). Heupel et al. (2007) proposed that shark nursery areas can be defined based on 3 primary criteria: (1) juveniles are more common in the area than other areas (i.e., density in the area is greater than the mean density over all areas); (2) juveniles have a tendency to remain or return for extended periods, such as weeks or months (i.e., site fidelity is greater than the mean site fidelity for all areas); and (3) the area or habitat is repeatedly used across years whereas other areas are not. We analyzed juvenile smalltooth sawfish encounter data and mapped the location of the areas that met the Heupel et al. (2007) criteria for defining a nursery area. Two nursery areas were identified as meeting these criteria and were included in a critical habitat designation in 2009 (74 FR 45353). The northern nursery area is located within the Charlotte Harbor Estuary and the southern nursery area is located in the Ten Thousand Islands area south into the ENP. The habitats within the nursery areas are characterized as having red mangroves and shallow euryhaline habitats with water depths less than 3 ft in depth.

Large juveniles (>79 in (200 cm) in length) habitat use

There are few data on the habitat use patterns of large juvenile sawfish. No acoustic telemetry or acoustic monitoring studies have examined this size group. Thus there is no detailed tracking data to identify habitat use and preference. However, some data are available from the deployment of pop-up archival transmitting (PAT) tags. These tags record depth, temperature, and light data, which is stored on the tag until it detaches from the animal, floats to the surface, and sends data summaries back via the ARGOS satellite system. More detailed data can be obtained if the tag is recovered. A PAT tag deployed on a 79 in (200 cm) sawfish in the Marquesas Keys collected 120 days of data. The light data indicated that the animal had remained in the general vicinity of the outer Keys for this entire period. Depth data from the tag indicated that this animal remained in depths less than 17 ft (5 m) for the majority of this period, making only 2 excursions to water down to 50 ft (15 m) in depth. There is no information on site fidelity in this size class of sawfish. More data is needed from large juveniles before conclusions about their habitat use and preferences can be made.

Adult habitat use

Information on the habitat use of adult smalltooth sawfish comes from encounter data, observers aboard fishing vessels, and from PAT tags. The encounter data suggest that adult sawfish occur from shallow coastal waters to deeper shelf waters. Poulakis and Seitz (2004) observed that nearly half of the encounters with adult-sized sawfish in Florida Bay and the Florida Keys occurred in depths from 200 to 400 ft (70 to 122 m). Simpfendorfer and Wiley (2005) also reported encounters in deeper water off the Florida Keys, noting that these were mostly reported during winter. Observations on commercial longline fishing vessels and fishery independent sampling in the Florida Straits report large sawfish in depths up to 130 ft (~40 m) (National Sawfish Encounter Database). Little information is available on the habitat use patterns of the adults from the encounter data.

PAT tags have been successfully deployed on several sawfish and have provided some data on movements and habitat use. One large mature female was fitted with a tag near East Cape Sable in November 2001. The tag detached from this animal 60 days later near the Marquesas Keys, a straight-line distance of 80 nmi (148 km). The data from this tag indicated that the fish most likely traveled across Florida Bay to the Florida Keys and then along the island chain until it reached the outer Keys. The depth data indicated that it spent most of its time at depths less than 30 ft (10 m), but that once it arrived in the outer Keys it made excursions (1-2 days) into water as deep as 180 ft (60 m).

Limited data are available on the site fidelity of adult sawfish. Seitz and Poulakis (2002) reported that 1 adult-sized animal with a broken rostrum was captured in the same location over a period of a month near Big Carlos Pass suggesting that they may have some level of site fidelity for relatively short periods. However, historic occurrence of seasonal migrations along the U.S. east coast also suggests that adults may be more nomadic than the juveniles with their distribution controlled, at least in part, by water temperatures.

Population Dynamics and Status

Despite being widely recognized as common throughout their historic range (Texas to North Carolina) up until the middle of the 20th century, the smalltooth sawfish population declined dramatically during the middle and later parts of the century. The decline in the population of smalltooth sawfish is attributed to fishing (both commercial and recreational), habitat modification, and sawfish life history. Large numbers of smalltooth sawfish were caught as bycatch in the early part of this century. Smalltooth sawfish were historically caught as bycatch in various fishing gears throughout their historic range, including gillnet, otter trawl, trammel net, seine, and to a lesser degree, handline. Frequent accounts in earlier literature document smalltooth sawfish being entangled in fishing nets from areas where smalltooth sawfish were once common but are now rare (Evermann and Bean 1898). There are few long-term abundance data sets that include smalltooth sawfish. One dataset from shrimp trawlers off Louisiana from the late 1940s through the 1970s suggests a rapid decline in the species from the period 1950-1964 (NMFS 2009). However, this dataset has not been validated nor subjected to statistical analysis to correct for factors unrelated to abundance.

The Everglades National Park has established a fisheries monitoring program based on sport fisher dock-side interviews since 1972. An analysis of these data using a log-normal generalized linear model to correct for factors unrelated to abundance (e.g., change in fishing practices) indicate that the population in the ENP is stable and may be increasing (Carlson et al. 2007). From 1989-2004, smalltooth sawfish relative abundance has increased by about 5% per year.
There is currently no estimate of smalltooth sawfish abundance throughout its range. Although smalltooth sawfish encounter databases may provide a useful future means of measuring changes in the population and its distribution over time, including the current range, areas where recovery may be expected to occur, and the habitat needs of various size classes. Conclusions about the current abundance of smalltooth sawfish cannot be made because outreach efforts and observation effort have not expanded evenly across each study period. However, based on genetic sampling, the estimates of current effective population size are 269.6-504.9 individuals (95% confidence interval 139.3-1515; e-mail communication between D. Chapman and T. Wiley, April 11, 2010). Chapman also states that this number is usually 1/2 - 1/4 census population size (breeding adults, male and female) in elasmobranchs, so it appears high hundreds to low thousands is probably the estimated range expected for the extant breeders

Threats

Smalltooth sawfish are threatened today by the loss of southeastern coastal habitat through such activities as agricultural and urban development, commercial activities, dredge-and-fill operations, boating, erosion, and diversions of freshwater runoff. Dredging, canal development, seawall construction, and mangrove clearing have degraded a significant proportion of the coastline. Smalltooth sawfish have been found near warm water discharge areas near power plants. Power plant discharges may provide a warm water refuge for the species during cold weather conditions. Smalltooth sawfish, especially small juveniles, are vulnerable to coastal habitat degradation due to their use of shallow, red mangrove, estuarine habitats for foraging and to avoid predation from sharks.

Recreational and commercial fisheries also still pose a threat to smalltooth sawfish. Although changes over the past decade to U.S. fishing regulations such as Florida’s “Net Ban,” which includes both a prohibition on the use of gill and entangling nets in all state waters and a size limit on other nets such as seines, have reduced these threats to the species over parts of its range; however, smalltooth sawfish are still incidentally caught in commercial shrimp trawls, bottom longlines, and by recreational rod-and-reel fisheries.

The current and future abundance of the smalltooth sawfish is limited by its life history characteristics (NMFS 2000). Slow-growing, late-maturing, and long-lived, these combined characteristics result in a very low intrinsic rate of population increase and are associated with the life history strategy known as "K-selection." As noted earlier in this section, K-selected animals are usually successful at maintaining relatively small, persistent population sizes in relatively constant environments. Consequently, they are not able to respond effectively (rapidly) to additional and new sources of mortality resulting from changes in their environment (Musick 1999). Simpfendorfer demonstrated that the life history of this species makes it impossible to sustain any significant level of fishing and makes it slow to recover from any population decline (Simpfendorfer 2000). Thus, the species is susceptible to population decline, even with relatively small increases in mortality.

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