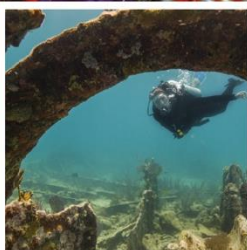
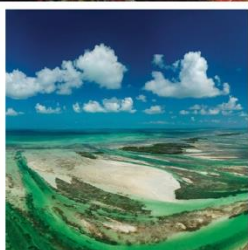




Florida Keys National Marine Sanctuary: Restoration Blueprint

Final Environmental Impact Statement: Volume I



U.S. Department of Commerce
Gina Raimondo, Secretary

National Oceanic and Atmospheric Administration
Richard W. Spinrad, Ph.D., Under Secretary of Commerce for Oceans and Atmosphere and
NOAA Administrator

National Ocean Service
Nicole LeBoeuf, Assistant Administrator

Office of National Marine Sanctuaries
John Armor, Director



**NATIONAL[®]
MARINE
SANCTUARIES**

Cover photos (left to right, from top): coral cover at Tortugas Ecological Reserve; recreational fishing; sand flats in the backcountry; American Shoal lighthouse; shipwreck of the City of Washington; recreational boating

Cover photo credits (left to right, from top): Greg McFall/NOAA; Matt McIntosh/NOAA; Shawn Verne; Shawn Verne; David Ruck/NOAA; Gena Parsons/NOAA

Suggested citation: National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries. 2024. Florida Keys National Marine Sanctuary: Restoration Blueprint Final Environmental Impact Statement: Volume I. Silver Spring, MD.



About This Document

Abstract

The National Oceanic and Atmospheric Administration's (NOAA) Office of National Marine Sanctuaries (ONMS) proposes to expand the Florida Keys National Marine Sanctuary (FKNMS) boundary, update sanctuary-wide regulations, modify and establish new marine zones, update marine zone-specific regulations, and revise the sanctuary's non-regulatory management plan. The purpose of this proposal is to meet the purposes and policies of the National Marine Sanctuaries Act (NMSA; 16 U.S.C. § 1434(a)(4)), to implement specific actions identified in the 2007 FKNMS management plan, and to act upon several recommendations of the FKNMS Sanctuary Advisory Council. These recommendations are based primarily on the 2011 FKNMS condition report. The need for this proposal is based on widespread, acute, chronic, and emerging threats to marine resources in the Florida Keys. The existing regulations, marine zones, and management plan activities designed and implemented by FKNMS in the mid-1990s are no longer sufficient to ensure long-term resource protection and ecosystem function integrity into the future considering those threats.

NOAA prepared this final environmental impact statement (EIS) in accordance with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. §§ 4321 et seq.) as implemented by the Council on Environmental Quality's regulations (40 C.F.R. Parts 1500-1508), and NOAA Administrative Order (NAO) 216-6A and Companion Manual, which describe NOAA policies, requirements, and procedures for implementing NEPA. This final EIS also fulfills the mandate of NMSA 16 U.S.C. § 1434(a)(4), which requires that "terms of designation may be modified only by the same procedures by which the original designation is made." This document also serves as a resource assessment that details the present and future uses of the area of the national marine sanctuary. No significant adverse impacts are expected under any action alternative. Long-term beneficial impacts are anticipated if the proposed action is implemented.

Lead agency: National Oceanic and Atmospheric Administration

Cooperating agency: U.S. Fish and Wildlife Service

For further information on the project, see the [project website](#).

For further information contact: Beth Dieveney, policy advisor, Florida Keys National Marine Sanctuary, at (305) 797-6818 or beth.dieveney@noaa.gov



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of National Marine Sanctuaries
1305 East-West Highway
Silver Spring, Maryland 20910

Dear Reader:

In accordance with the National Environmental Policy Act (NEPA), we enclose for your review the National Oceanic and Atmospheric Administration (NOAA) Office of National Marine Sanctuaries (ONMS) final environmental impact statement (EIS) and final management plan for the Florida Keys National Marine Sanctuary Restoration Blueprint.

NOAA prepared this document to assess the environmental impacts of expanding the Florida Keys National Marine Sanctuary under the National Marine Sanctuaries Act (NMSA) in Monroe and Miami-Dade counties, Florida. The NMSA requires that an EIS be prepared for designation or expansion of a national marine sanctuary regardless of the significance of the impacts of the proposed action. The management plan contains the non-regulatory management actions for the sanctuary. NOAA will publish a final rulemaking to establish the modified boundaries, regulations, and terms of designation for the sanctuary. Under the NMSA, after the publication of the final rule the action becomes effective after 45 days of Congressional session. During this time, Congress and the Governor of Florida will review NOAA's final Restoration Blueprint documents. NOAA will also develop the Record of Decision and publish the notice of effective date for the action in the Federal Register after the review period is complete.

Although NOAA is not required to respond to comments received as a result of issuance of the final EIS, any comments received will be reviewed and considered for their impact on issuance of a Record of Decision. Please send comments to the Sanctuary Official identified below by January 13, 2025. NOAA will make the Record of Decision publicly available following final agency action.

Sanctuary official: Beth Dieveney, Policy Advisor
Office of National Marine Sanctuaries
33 East Quay Road
Key West, FL 33040

Sincerely,



John Armor
Director

Table of Contents

About This Document	i
Table of Contents	iii
Acknowledgements	v
Glossary of Acronyms	v
Executive Summary	vii
Background, Purpose, and Need	vii
Public Engagement to Date	viii
Summary of Proposed Action and Alternatives	x
Comparison of Impacts Across Alternatives	xvii
Chapter 1: Introduction and Background	1
1.1 Summary of the Proposed Action	1
1.2 Statutory Authorities	4
1.3 The Office of National Marine Sanctuaries	6
1.4 Florida Keys National Marine Sanctuary	6
1.5 The National Wildlife Refuge System	10
1.6 Florida Keys National Wildlife Refuge Complex	11
1.7 Project Location: Southern Florida, Florida Keys, and Pulley Ridge	12
1.8 Public Involvement	14
1.9 Summary of Changes from Draft EIS to Final EIS	16
1.10 Organization of Environmental Impact Statement	17
Chapter 2: Purpose and Need for Action	19
2.1 Proposed Action	19
2.2 Purpose of Action	19
2.3 Need for Action	20
2.4 Scope of Environmental Impact Statement	21
2.5 Cooperating Agency	22
2.6 Compliance with Other Requirements	22
Chapter 3: Description of Alternatives	25
Summary of Alternatives and Development of NOAA’s Final Preferred Alternative	26
Summary of Proposed Modifications to the Five Management Components Within Each Alternative	30
3.1 Component 1 – Modifications to the Sanctuary Boundary by Alternative	32
3.2 Component 2 – Modifications to Sanctuary-wide Regulations by Alternative	36
3.3 Component 3 – Proposed Modifications to Marine Zone Boundaries by Alternative	58
3.4 Component 4 – Proposed Modifications to Marine Zone Regulations by Alternative	75
3.5 Component 5 – Summary of the FKNMS Management Plan Development	84
3.6 Marine Zone Maps for the Final Preferred Alternative	85
3.7 Alternatives Considered and Eliminated	90
Chapter 4: Affected Environment	97
4.1 Introduction	97
4.2 Biological Resources	102
4.3 Physical Resources	142
4.4 Pulley Ridge Unit	152

4.5 Historical and Cultural Resources	157
4.6 Socioeconomic Resources and Human Uses	161
Chapter 5: Environmental Consequences	181
5.1 Introduction	181
5.2 Impacts Common to All Alternatives	184
5.3 Impacts Specific to Alternative 1: No Action (Status Quo)	207
5.4 Impacts Specific to Alternative 2	210
5.5 Impacts Specific to Alternative 3	242
5.6 Impacts Specific to Alternative 4	248
5.7 Impacts Specific to the 2022 NOPR and Final Preferred Alternatives	258
5.8 Comparison of Impacts Across Alternatives	275
5.9 Cumulative Impacts	280
Chapter 6: Conclusions	284
6.1 Summary of Final Preferred Alternative	284
6.2 Unavoidable Adverse Impacts	285
6.3 Relationship of Short-term Uses and Long-term Productivity	285
6.4 Irreversible and Irretrievable Commitments of Resources	286
References	287



Acknowledgements

This document was prepared by several staff members of NOAA's Florida Keys National Marine Sanctuary including Sarah Fangman, Karen Bohnsack, Andy Bruckner, Beth Dieveney, Matthew Lawrence, and Stephen Werndli. It was further prepared and reviewed by several Office of National Marine Sanctuaries (ONMS) headquarters staff including Caroline Brown, Matt Brookhart, Wilamena Harback, Jessica Kondel, Dayna McLaughlin, Danielle Schwarzmman, and Sarah Stein; by several National Ocean Service staff including Jay Nunenkamp; and by Jonelle Dilley of NOAA's Office of the General Counsel. Environmental data were compiled and analyzed by Christine Addison, Dan Dorfman, Chris Jeffrey, and Shay Viehman of NOAA's National Centers for Coastal Ocean Science (NCCOS). Maps of the expansion boundary alternatives and marine zones were created by Amy Frietag of NCCOS and Tony Reyer of ONMS. The interactive mapping tool was created by Mimi D'Iorio of ONMS. Additional scientific data were provided by NOAA's National Marine Fisheries Service and Florida's Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute. The proposal for updates to Florida Keys National Marine Sanctuary was initiated and developed over several years by Florida Keys National Marine Sanctuary staff and directed by the Florida Keys National Marine Sanctuary Advisory Council. This dedicated group consists of commercial and recreational fishermen, divers, maritime archaeologists, scientists, tourism, and conservation interests.

Glossary of Acronyms

ACHP – Advisory Council on Historic Preservation

ATBA – area to be avoided

Backcountry Management Plan – 1992 Management Agreement for Submerged Lands within the Boundaries of the Key West and Great White Heron National Wildlife Refuges

CA – conservation area

CCP – comprehensive conservation plan

CEQ – Council on Environmental Quality

CERP – Comprehensive Everglades Restoration Plan

C.F.R. – Code of Federal Regulations

CO₂ – carbon dioxide

CREMP – Coral Reef Evaluation and Monitoring Program

DEP – Florida Department of Environmental Protection

DHR – Florida Department of State Division of Historical Resources

EFH – Essential Fish Habitat

EIS – environmental impact statement

EMA – existing management area

EPA – U.S. Environmental Protection Agency

ER – ecological reserve

ESA – Endangered Species Act



FKNMS – Florida Keys National Marine Sanctuary
FKNMSPA – Florida Keys National Marine Sanctuary and Protection Act
FWC – Florida Fish and Wildlife Conservation Commission
FWRI – FWC Fish and Wildlife Research Institute
GMFMC – Gulf of Mexico Fishery Management Council
HAPC – habitat area of particular concern
IMO – International Maritime Organization
MA – Management Area
MMPA – Marine Mammal Protection Act
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NCCOS – NOAA’s National Centers for Coastal Ocean Science
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act of 1966
NMFS – NOAA’s National Marine Fisheries Service
NMSA – National Marine Sanctuaries Act
NOAA – National Oceanic and Atmospheric Administration
NOPR – Notice of Proposed Rulemaking
ONMS – NOAA’s Office of National Marine Sanctuaries
PWC – personal watercraft
RA – Restoration Area
Refuge Complex – USFWS Florida Keys National Wildlife Refuge Complex
Refuge Improvement Act – National Wildlife Refuge System Administration Act of 1966
SAFMC – South Atlantic Fishery Management Council
SCP – Sanctuary Community Profile
SCTLD – story coral tissue loss disease
SHPO – Florida State Historic Preservation Office; *also refers to* state historic preservation officer
SPA – sanctuary preservation area
SUA – special use research only areas
USACE – U.S. Army Corps of Engineers
USCG – U.S. Coast Guard
USFWS – U.S. Fish and Wildlife Service
WMA – wildlife management area
WQPP – Water Quality Protection Program

Executive Summary

Background, Purpose, and Need

NOAA prepared this final environmental impact statement (EIS) in accordance with the National Environmental Policy Act (NEPA), as amended (42 USC 4321 *et seq.*); NOAA Administrative Order 216-6A, which describes NOAA requirements, policies, and procedures for implementing NEPA; and the National Marine Sanctuaries Act (NMSA, 16 USC 1431 *et seq.*). This EIS applies the Council for Environmental Quality's (CEQ) 1978 NEPA regulations because review of this proposed action began on April 19, 2012, which preceded the effective date of July 1, 2024 for CEQ's Phase 2 NEPA regulations, 89 FR 35442 (May 1, 2024).

More specifically, following the principles and processes set forth in the National Marine Sanctuaries Act (NMSA, 16 U.S.C. §§ 1431 *et seq.*), NOAA developed this final EIS to evaluate the impacts to the human and ecological environment from a variety of management measures that would further the existing sanctuary management in a comprehensive effort to protect the ecosystem and maintain the vibrant quality of life and economies of the Florida Keys. This final EIS includes the alternatives included in the 2019 draft EIS, an alternative presented in the 2022 notice of proposed rulemaking (NPR), and the Final Preferred Alternative. This proposed action was developed to help counteract the decline in resource condition in the Florida Keys through a series of regulatory and management measures designed to reduce threats and, where appropriate, restore coral reefs, seagrasses, and other important habitats. The proposed action is informed by public and agency comment, the best available ecological and user data, and the policy and purposes of the NMSA and the Florida Keys National Marine Sanctuary and Protection Act (FKNMSPA).

On November 16, 1990, Congress designated Florida Keys National Marine Sanctuary (FKNMS). The sanctuary encompasses 3,800 square miles. It spans a shallow water interface between the Gulf of Mexico and the Atlantic Ocean, and is adjacent to most of the relatively shallow estuarine waters of South Florida, including those of Florida Bay and Biscayne Bay. FKNMS surrounds more than 1,700 islands, which constitute most of the limestone island archipelago of the Florida Keys. This archipelago extends from the Florida peninsula south and west over 220 miles (354 km), terminating at the islands of Dry Tortugas National Park. The oceanic boundary of FKNMS is the 300-foot isobath (~100-meter depth). FKNMS shares trusteeship of marine resources with the state of Florida, as 60% of the sanctuary falls within state waters.

FKNMS protects open ocean, offshore reef tract and nearshore patch reefs, seagrass meadows, hardbottom regions, and fringing mangroves. FKNMS waters and habitats support high species diversity due to the presence of both tropical and subtropical species, including the largest documented contiguous seagrass community in the Northern Hemisphere and extensive coral reef habitat. The sanctuary is also home to maritime heritage resources that encompass a broad historical period. The Florida Keys are part of the much larger South Florida regional ecosystem, which possesses a wealth of natural resources while also facing major ecological challenges and restoration opportunities.

Public Engagement to Date



Public input was provided at scoping meetings throughout the Florida Keys, Miami, and Fort Myers in 2012. Photo: NOAA

This final EIS is one of the last phases in a multi-year process to comprehensively review and update the sanctuary boundaries, regulations, marine zones, and management plan.

Phase I of this process included a formal Notice of Intent to Prepare an Environmental Impact Statement and public comment scoping period.

On April 19, 2012, NOAA and the U.S. Department of the Interior's U.S. Fish and Wildlife Service (USFWS) published a notice of intent in the Federal Register. The notice informed the public of the proposed action, announced five scoping meetings, and solicited public comment. Several hundred people participated in these meetings and provided input on specific issues to be analyzed or addressed as part of the marine zoning and regulatory review.

In addition to public scoping meetings, NOAA and USFWS accepted written comments from April 19, 2012, to June 29, 2012. Comments were provided in emails, letters, faxes, and electronic submission on regulations.gov. A specific section on the FKNMS website serves as a central location for information on the proposed action. During the comment period, the agencies received over 500 comments. The website provides a [summary document](#) of all scoping comments and a link to access all of the scoping comments [received](#).

This formal scoping period transitioned into Phase II, a more in-depth Sanctuary Advisory Council and community working group input process. The Sanctuary Advisory Council played a

significant leadership role throughout this review and the alternatives development process. The advisory council and three community working groups met over a period of 22 months—January 2012 through October 2014—to review scientific and human use data and information, hear further public comment, and develop advice and recommendations for the sanctuary superintendent, as well as the Florida Keys National Wildlife Refuge Complex manager, to consider when developing alternatives related to marine zones within the sanctuary. A fourth community working group met for a two-day workshop in July 2015 to address artificial habitats, an advisory council priority issue not previously discussed by the initial three community working groups. More than 70 meetings were held (January 2013 through October 2014) throughout the Florida Keys for the advisory council and community working groups to develop recommendations for the sanctuary superintendent and refuge manager. More information and summary documents of the advisory council and working groups are [available](#).

Note that due to broad public interest and the comprehensive nature of the review of FKNMS regulations and management plan, NOAA separated the draft EIS and rulemaking processes to allow increased opportunity for public and agency input to inform the Final Preferred Alternative presented in this final EIS.

Phase III culminated in the release of a draft EIS for a 5-month public comment period from August 2019 to January 2020. NOAA hosted six public hearings and two Sanctuary Advisory Council meetings devoted to hearing oral public comment. NOAA received 1,213 distinct comments during the public comment period, and several letter campaigns and petitions, each with multiple signatories for a total of well over 35,000 comments.

Phase IV began after considering public comment on the draft EIS, when NOAA published a NOPR. This notice began a 100-day public comment period (July 22–October 26, 2022) during which NOAA hosted four public comment meetings. FKNMS staff also held one Sanctuary Advisory Council meeting focused on public comment and a Sanctuary Advisory Council meeting focused on receiving advisory council comments and recommendations. NOAA received 426 distinct comments (letters and oral testimony) and several letter campaigns and petitions, each with multiple signatories for a total of approximately 45,000 comments on the NOPR and updated draft management plan during the July 2022 through October 2022 public review period.

Phase V, which is this final EIS, presents a Final Preferred Alternative that is informed by public and agency comment throughout each of the previous phases. After a minimum of 30 days following publication of this EIS, NOAA intends to release a final rule and Record of Decision, which would announce NOAA’s final selection of an alternative.

Comments received throughout this process are available at [regulations.gov](https://www.regulations.gov) for Docket NOAA-NOS-2019-0094. Responses to public comments received on the 2019 draft EIS and the 2022 NOPR are provided in Appendix C.

In addition to gathering public input throughout this process, NOAA worked closely with and sought input from numerous pertinent resource agencies and researchers on the development of the final EIS. In addition, informal briefings with other NOAA offices, the Gulf of Mexico Fishery Management Council (GMFMC), the South Atlantic Fishery Management Council

(SAFMC), and state of Florida partner agencies have been ongoing since initiation of the public scoping for this final EIS.

Summary of Proposed Action and Alternatives

This final EIS includes the four alternatives analyzed in the 2019 draft EIS, the alternative presented in the 2022 NOPR, and a Final Preferred Alternative. The 2022 NOPR alternative and Final Preferred Alternative include a combination of components of the other action alternatives. Under all action alternatives, NOAA would adopt the final management plan, which incorporates minor changes based on public comments received in 2019 and 2022. Alternatives 2, 3, and the Final Preferred Alternative propose the same boundary changes and the same sanctuary-wide regulatory changes. See Table E.1.

Each alternative describes NOAA's proposals for changes to five specific components of FKNMS management:

1. the sanctuary boundary;
2. sanctuary-wide regulations;
3. marine zone boundaries within the sanctuary;
4. marine zone regulations; and
5. changes to the sanctuary management plan.

A summary of the management plan and alternatives is included here.

Management Plan

The final management plan includes a vision and mission. It also includes goals and associated objectives and activities designed to facilitate understanding of sanctuary resource conditions and values that are applied to target management actions, reduce impacts to resources, and enhance stewardship and collaboration. The greatest change between the draft management plan and the final management plan includes the identification of a suite of six management priorities: management effectiveness/adaptive management, water quality, restoration, visitor use management, enforcement, and stewardship and engagement.

Direct, long-term benefits to living marine and marine-dependent resources are the primary outcomes sought through the updated management plan activities. The management plan goals related to better understanding sanctuary resources (Goal 1), maintaining and improving sanctuary resources (Goal 2), and maintaining or increasing efforts to reduce threats to sanctuary resources (Goal 3) include the majority of activities intended to benefit sanctuary habitats and wildlife resources. Updating the management plan would allow for a more coordinated and priority-driven effort and, as a result, would support more effective management and conservation-based outcomes.

Alternative 1: No Action (Status Quo)

The No Action Alternative, Alternative 1, would maintain the existing sanctuary boundary, sanctuary-wide regulations, marine zones and associated regulations, and management plan. NOAA would make no changes in the way the sanctuary would be managed. The sanctuary

would continue to be managed within the current boundary, marine zones, regulations, and management plan.

Alternative 2

Alternative 2 proposes to reduce stressors and impacts to sanctuary and national wildlife refuge resources. This alternative differs from the No Action Alternative in that NOAA would expand the boundary, update and add new sanctuary-wide regulations, modify existing marine zones, add new marine zones with regulations to increase protections, and update the management plan. Specifically, Alternative 2 would expand the boundary to 4,541 square miles to include the area to be avoided and encompass the area in the Tortugas region between the existing sanctuary boundary and the Tortugas South Ecological Reserve. Alternative 2 would modify three existing sanctuary-wide regulations and propose three new regulations. Alternative 2 would add 31 Wildlife Management Areas (WMA), six Sanctuary Preservation Areas (SPA), and two areas as Conservation Areas (CA) for a total of eight CAs. In all action alternatives, CA zone type would replace Special Use Areas (SUA) and Ecological Reserves (ER) zone types.

Alternative 3 (NOAA's Draft EIS Preferred Alternative)

Alternative 3 was NOAA's preferred alternative presented in the 2019 draft EIS. NOAA designed Alternative 3 to create a balance between resource protection and sustainable use, with a greater emphasis on resource protection than in Alternative 2. Specifically, Alternative 3 would expand the boundary to 4,541 square miles to include the area to be avoided and encompass the area in the Tortugas region between the existing sanctuary boundary and the Tortugas South Ecological Reserve. Alternative 3 would propose to modify the same three sanctuary-wide regulations as in Alternative 2 and propose one new regulation that is not included in Alternative 2. This alternative would add 32 WMAs, seven SPAs, and two CAs to the existing sanctuary.

Alternative 4

Alternative 4 is primarily designed to protect large contiguous habitats and includes the most protective regulations within individual marine zones. Specifically, Alternative 4 would expand the boundary to include a distinct unit at Pulley Ridge for a total of 4,800 square miles and would add 31 WMAs, three SPAs, and seven CAs.

Alternative 4 includes the same proposed sanctuary-wide regulation changes as proposed for alternatives 2 and 3. In addition, Alternative 4 would update two additional existing regulations: one designed to provide additional protection to all shorelines in the sanctuary, and one to provide FKNMS with additional permitting authority over live rock aquaculture activities to manage potential impacts to sanctuary resources.

Alternative 4 strives to meet a balance between protection of targeted site-specific locations where resource damage is evident, while also providing protection of the largest area of contiguous habitats compared to the other alternatives. The marine-zone-specific regulations and access restrictions would be more protective in Alternative 4 than in any of the other proposed alternatives.

2022 NOPR Alternative

The 2022 NOPR Alternative consists of updated regulations developed based on public and agency comment on the four alternatives presented in the 2019 draft EIS, which was published in the Federal Register. The 2022 NOPR Alternative combined individual aspects of each of the four alternatives presented in the 2019 draft EIS. Specifically, the 2022 NOPR Alternative would expand the boundary to 4,800 square miles to include the area to be avoided, encompass the area in the Tortugas region between the existing sanctuary boundary and the Tortugas South Ecological Reserve, and include a distinct unit at Pulley Ridge (same as Alternative 4). The 2022 NOPR Alternative would modify three existing sanctuary-wide regulations and propose three new regulations (same as Alternative 2). This alternative would add 19 WMAs, two new SPAs, and 11 restoration areas to the existing sanctuary. This alternative would also eliminate existing marine zones including two WMAs, two SPAs, and one SUA.

Final Preferred Alternative

The Final Preferred Alternative makes minor modifications to the 2022 NOPR based on public and agency comments received on the 2022 NOPR and the draft EIS (see Table 3.1 for details). Like the 2022 NOPR Alternative, the final alternative combined individual aspects of each of the four alternatives presented in the 2019 draft EIS. Given that this is NOAA's Final Preferred Alternative, more detail is provided.

Sanctuary Boundary

The Final Preferred Alternative would expand the sanctuary boundary to 4,539 square miles to include the area to be avoided (ATBA) and encompass the area in the Tortugas region between the existing sanctuary boundary and the Tortugas South Ecological Reserve. The ATBA includes four existing areas—some portion of which fall within the current sanctuary boundary and some that extend beyond the existing sanctuary boundary—where operating a tank vessel or a vessel greater than 50 meters in registered length is prohibited. The Final Preferred Alternative does not include a distinct unit at Pulley Ridge. Concurrent with considering boundary expansion to include Pulley Ridge, as noted in the 2022 NOPR, the United States proposed the International Maritime Organization (IMO) designate a No Anchoring Area in the southern portion of Pulley Ridge, which was approved and implemented starting June 1, 2023 (IMO SN.1/Circ.342).¹ Given that this area of Pulley Ridge is managed as a Habitat Area of Particular Concern with associated fishing regulations under the Magnuson-Stevens Fisheries Conservation and Management Act, through this IMO designation, the Final Preferred Alternative reflects the fact that the resource protection goals sought through adding Pulley Ridge to the sanctuary have been achieved.

Sanctuary-wide Regulations

The Final Preferred Alternative includes the same proposed sanctuary-wide regulation changes as Alternative 2, including an updated emergency regulation, an updated historical resources permit category, an updated discharge regulation, and a new proposed regulation to address the

¹See also: <https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/NCSR-9th-session.aspx>

threat posed by grounded, deserted, and derelict vessels. See below for a summary of the regulations. For more details, see Chapter 3.

The Final Preferred Alternative further clarifies the proposed updates presented in Alternative 2, including changing the title to “Temporary Regulation for Emergency and Adaptive Management,” explicitly identifies three categories of activities where this regulation could be applied, and sets out the procedure by which a temporary regulation would be promulgated.

Updating the historical resources permitting process to align with those of the Florida Department of State Division of Historical Resources (DHR) would improve the quality and reporting of historical research projects undertaken in the sanctuary, further aiding NOAA with its conservation mandates and advancing interpretation of sanctuary historical resources for the public. This proposed update considers the sensitive, nonrenewable character of historical resources and the shared stewardship responsibilities vested in NOAA and DHR. This is the same as Alternative 2.

Updating the discharge regulation to explicitly prohibit discharge by cruise ships, which are currently exempt from the discharge prohibitions, would improve localized water quality. Specifically, the Final Preferred Alternative would prohibit discharges of any material or other matter from a cruise ship, except cooling water. The Final Preferred Alternative slightly modifies Alternative 2, which proposed instead to specify certain discharges that would be allowed by cruise ships (e.g., “clean wash water”). After considering public comment on the draft EIS, NOAA found it is extremely difficult to define “clean wash water” based on changing industry standards and the fact that such terms could be interpreted differently among stakeholders, potentially creating compliance and enforcement challenges.

NOAA also updates the exemptions for vessels other than cruise ships by simplifying and clarifying terminology. Specifically, NOAA proposes to remove the exception for “exhaust gas” and “water generated by routine vessel operations,” instead exempting cooling water, deck washdown and runoff, and graywater as allowable discharges and deposits from vessels other than cruise ships. NOAA would also clarify that oily wastes from bilge pumping are not exempted. NOAA continues to intend that the terms “cooling water,” “deck washdown and runoff,” “graywater,” and “oily wastes from bilge pumping” have the same meaning as these terms hold under Section 312 of the Clean Water Act.

NOAA would revise regulations to address the threat of deserted and derelict vessels. These new prohibitions and requirements would help reduce or avoid harm to FKNMS resources from derelict vessels as a result of direct impacts from a vessel settling on or colliding with the seabed and damaging important habitats, or potential leakage of hazardous or harmful matter from a vessel. NOAA would be better positioned to enforce removal of deserted vessels or vessels at risk of becoming derelict to prevent potential groundings, collisions, or discharge of harmful materials that could harm FKNMS resources. This is the same as Alternative 2.

Finally, the Final Preferred Alternative also proposed several technical or language updates to the sanctuary-wide regulations intended to provide additional clarity. These changes are outlined in Appendix D. None of these changes would result in impacts to the human environment.

Marine Zones and Associated Regulations

The Final Preferred Alternative includes proposed modified and new marine zones to provide additional targeted, site-specific protection where resource damage is evident. Specific marine zone regulations and access restrictions proposed in the Final Preferred Alternative provide a strategy that is more protective of resources than that proposed in Alternative 2 but less restrictive than those proposed in Alternative 4, which is the most resource-protective alternative proposed. The Final Preferred Alternative is the middle path between resource protection and user access. In addition, in light of the increasing stressors sanctuary resources are experiencing, the Final Preferred Alternative considers action that would support and facilitate resilience and recovery of habitats and species throughout the sanctuary and within or moving through the individual marine zones.

The Final Preferred Alternative includes WMAs, SPAs, CAs (which would replace the existing ER and SUA zone names), management areas (which would replace the current Existing Management Area (EMA) zone name), and a new zone type called restoration areas. The Final Preferred Alternative includes 44 WMAs, 17 SPAs, 15 Restoration Areas (RA), 6 CAs, and 2 MAs, and 2 national wildlife refuges where sanctuary regulations apply for a total of 86 marine zones.

The Final Preferred Alternative modifies existing marine zones that are intended to protect a range of habitat types that support the full range of needs throughout a species' life cycle. The proposed marine zone regulations in the Final Preferred Alternative would reduce overuse of sanctuary resources and limit habitat degradation from prop scarring, anchor damage, and impacts to wildlife species such as flushing nesting and roosting birds. Under the Final Preferred Alternative, WMAs would be specific to the resource protection goals for each WMA and include idle speed/no-wake, no-motor, no-anchor, and no entry. SPA regulations would be updated such that regulations would be consistent within every SPA. Additional no-anchor regulations would be implemented in all SPAs as safeguards against potential vessel grounding events and provide additional habitat protection. Regulations for conservation areas, the most protective zone type, would maintain the existing transit only regulation (this is no change from Alternative 1 [No Action Alternative] regulations applied in ecological reserves and special use areas).

The Final Preferred Alternative includes a new zone type—restoration areas—to specifically facilitate ecosystem restoration, which would provide benefits to both resources within these areas and to advancing research and understanding of restoration techniques. These restoration area (RA) zones include four habitat RAs, where active restoration is underway, and 11 nursery RAs. For the habitat RAs, SPA regulations would be applied to protect these sites from anchor damage and potential impacts from fishing gear, while also allowing the public to access and learn about coral restoration efforts. The nursery RAs are all existing sanctuary permitted coral nursery sites, where corals are being propagated. Transit only regulations would apply in these areas to provide the greatest level of protection for these coral reef nursery sites. These proposed Restoration Area zones would provide direct beneficial impacts to the areas of active habitat restoration and coral nursery sites. Four of these proposed nursery restoration areas were included in Alternative 3 as SPAs.



Management Plan

A final management plan is included in the Final Preferred Alternative , which is slightly modified from the version included in the draft EIS. The most notable change is the identification of six management priorities. A brief summary is included above. For the full updated management plan see Appendix A of Volume II of this final EIS.

Table E-1. Summary of five management components within each alternative (areas are approximate)

Components	Alternative 1 (no action)	Alternative 2	Alternative 3 (draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Sanctuary boundary (Section 3.1)	Alt. 1 (no action) 3,800 sq. miles	Existing boundary ATBA Tortugas Region 4,539 sq. miles	Existing boundary ATBA Tortugas Region 4,539 sq. miles	Existing boundary ATBA Tortugas Region Pulley Ridge 4,800 sq. miles	Same as Alternative 4	Same as Alternatives 2 and 3 (draft EIS preferred)
Sanctuary-wide regulations (Section 3.2)	Alt. 1 (no action)	Update 3 existing; Propose 4 new	Update 4 existing; Propose 4 new	Update 5 existing; Propose 4 new	Update 3 existing; Propose 3 new	Same as NOPR Alternative
Marine zone boundaries ¹ (Section 3.3)	Alt. 1 (no action) 57 total zones 1033 sq. miles	96 total zones 1131 sq. miles	98 total zones 1144 sq. miles	97 total zones 1168 sq. miles	87 zones 1080 sq. miles	86 zones 1081 sq. miles
Additional marine zone regulations (Section 3.4)	Alt. 1 (no action)	Eliminate 2 exceptions; Update 2 existing regulations; Marine zones: Apply more protective regulations than Alternative 1	Eliminate 2 exceptions; Update 2 existing regulations; Marine zones: Apply more protective regulations than Alternative 2 (e.g., greater number of no entry areas)	Eliminate 2 exceptions; Update 2 existing regulations; Marine zones: Apply larger zones and more protective regulations than Alternative 3 (e.g., greater number of transit only areas)	Eliminate 2 exceptions; Update 2 existing regulations; Marine zones are similar to Alternative 2 for areas included in zones and Alternative 3 for regulations applied.	Eliminate 2 exceptions; Update 2 existing regulations; Marine zones are modified slightly from the NOPR Alternative to be more targeted and provide greater access.
Management plan (Section 3.5 and Appendix A)	Alt. 1 (no action)	New proposed management plan	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2 with edits to include priorities and other minor edits	Same as NOPR Alternative with minor edits

1. The total marine zone counts and areas include Great White Heron and Key West National Wildlife Refuges existing management areas.

Comparison of Impacts Across Alternatives

There are environmental tradeoffs among the alternatives and within resource areas or topics, making it difficult to summarize the net effect of the alternatives. Overall, all of the action alternatives would result in beneficial impacts in one or more environmental resource areas, and none of the action alternatives would result in a significant adverse impact.

NOAA has identified Alternative 4 as the most environmentally protective because it would protect the greatest total area; therefore, Alternative 4 is the environmentally preferred alternative.

Comparison of Proposed Sanctuary Boundary Alternatives

Table E-2. Boundary expansions in FKNMS by alternative (square miles)

Alternatives	Total area	Expansion area	ATBA expansion	Tortugas expansion	Pulley Ridge ¹
1 – no action	3,800	0	0	0	0
2	4,539	739	468	271	0
3 – 2019 draft EIS preferred	4,539	739	468	271	0
4	4,800	998	468	271	259
2022 NOPR	4,800	998	468	271	259
Final preferred	4,539	739	468	271	0

1. Pulley Ridge comprises two habitat areas of particular concern (HAPCs). Pulley Ridge South and Pulley Ridge South Portion A, both areas protect corals.

Comparison of Proposed Marine Zone Alternatives

Table E-3. Number and size of marine zones by type of zone and regulatory alternative

Alternatives	Sanctuary boundary (sq. miles)	Total zoned (sq. miles) ¹	Number of WMAs ²	Number of SPAs ³	Number of ER/ SUA/ CA ^{4,5,6}	Number of RAs	Number of EMA/ MA ⁷	Total marine zones
1 – no action	3,800	1,033	28	18	7	0	4	57
2	4,539	1,131	59	24	9	0	4	96
3 – 2019 draft EIS preferred	4,539	1,144	60	25	9	0	4	98
4	4,800	1,168	58	21	14	0	4	98
2022 NOPR	4,800	1,080	47	17	6	13	4	85

Alternatives	Sanctuary boundary (sq. miles)	Total zoned (sq. miles) ¹	Number of WMAs ²	Number of SPAs ³	Number of ER/ SUA/ CA ^{4,5,6}	Number of RAs	Number of EMA/ MA ⁷	Total marine zones
Final preferred	4,539	1,081	44	17	6	15	4	86

1. Includes area included in national wildlife refuges
2. Wildlife management areas
3. Sanctuary preservation areas, no-take areas
4. Ecological reserves, no-take areas
5. Special use areas, set aside for restoration or research only
6. Ecological reserves and special use areas changed to conservation areas in alternatives 2, 3, 4, NOPR, and Final Preferred Alternative
7. Existing management areas and management areas, includes national wildlife refuges

The socioeconomic benefits across the action alternatives are expected to be positive due to an increase in non-consumptive recreational activities. These include an increase in the number of person-days engaged in non-consumptive recreation activities, increased spending in direct expenditures (e.g., with tour companies), increased spending within Monroe County, and increased income within Monroe County (e.g., jobs). A person-day is one person's time spent engaged in a given activity for a day, or the equivalent, used as a measure of how much work or labor is required or consumed to perform some task.

The table below shows net impacts from measurable changes to market outcomes, assuming there is no substitution or replacement of lost activity in each industry described. This summary table does not include non-market impacts or changes to non-monetized benefits and costs, such as conservation and restoration values. Further, this table presents the maximum potential loss due to closure of fishing areas and does not account for the likelihood that fishers will fish outside of newly established protected areas or shift activities, minimizing losses. The decreased number of jobs is a reflection of the maximum potential loss in the fishing industries and does not provide an estimate for job growth in other sectors that may benefit from increased protections like science, research, education, and non-consumptive recreation.

Table E-4. Comparison of adverse socioeconomic impacts across the action alternatives. The No Action Alternative was not included because there would be no changes to economic indices under the No Action Alternative.

Adverse Impacts¹	Alternative 2	Alternative 3	Alternative 4	2022 NOPR/Final Preferred Alternative
Lost fishing revenue	\$17,000	\$17,000	\$2,038,000	\$1,025,000
Lost number of person-days	\$379,000	\$379,000	\$35,040,000	\$6,170,000
Decreased spending within Monroe County (sales/output)	\$96,000	\$96,000	\$10,812,000	\$5,079,000
Decreased income within Monroe County (jobs)	\$29,000	\$29,000	\$3,138,000	\$1,464,000
Decreased number of jobs	42.1	42.1	80.8	37.3

1. All of the adverse impacts are due to losses to recreational and commercial fishermen.

Chapter 1: Introduction and Background

1.1 Summary of the Proposed Action

This final environmental impact statement (EIS) includes a proposed action with various components that would help counteract the decline in resource condition in the Florida Keys through a series of regulatory and management measures designed to reduce threats and, where appropriate, restore coral reefs, seagrasses, and other important habitats. Following the principles and processes set forth in the National Marine Sanctuaries Act (NMSA) (16 U.S.C. §§ 1431 *et seq.*), this final EIS evaluates the impacts to the human and ecological environment under a variety of management measures that would further the existing management in a comprehensive effort to protect the ecosystem and to maintain the vibrant quality of life and economies of the Florida Keys.

As the lead agency for this federal action, the National Oceanic and Atmospheric Administration (NOAA) would expand the boundary of the sanctuary, update sanctuary-wide regulations, update the individual marine zones and their associated regulations, and revise the sanctuary management plan. In preparing this final EIS, NOAA worked closely with the U.S. Fish and Wildlife Service (USFWS), a partnering agency that manages the USFWS Florida Keys National Wildlife Refuge Complex (Refuge Complex) areas that overlap portions of Florida Keys National Marine Sanctuary (FKNMS). This action and associated alternatives are described in more detail in Chapter 3.

1.1.1 Historical context for the proposed action

Designated in 1990, FKNMS was the ninth national marine sanctuary to be established in a system that currently comprises 17 national marine sanctuaries and two marine national monuments. Currently, as one of the largest marine protected areas in the United States, the sanctuary protects approximately 3,800 square miles of coastal and ocean waters from the estuarine waters of South Florida along the Florida Keys archipelago, encompassing more than 1,700 islands, out to Dry Tortugas National Park.

The mission of the sanctuary, as presented in the final management plan (see Appendix A) is to serve as a living laboratory for scientific research, enhancing our understanding of the environment and improving management decisions for optimal resource conservation while allowing for sustainable public use and enjoyment. The public is engaged and involved with a desire to protect and restore the sanctuary's resources for current and future generations. Through continued science-based management, FKNMS endeavors to sustain high-quality environmental and socioeconomic resources for current and future generations. The Florida Keys support more than 77,000 residents and approximately 5.5 million visitors, who collectively contribute to the \$4.7 billion economy (Key West Chamber of Commerce, 2018) relying on the existence and maintenance of a healthy marine environment. The ecosystems of FKNMS provide habitats for more than 6,000 species of fishes, invertebrates, and plants in addition to uniquely expansive and diverse seagrass and coral reef communities. These resources are under increasing threat from high levels of use, coral disease, and climate change.

The Florida Keys have a long history of natural resource protection beginning in 1908 with the creation of Key West National Wildlife Refuge, followed by the 1938 establishment of Great White Heron National Wildlife Refuge. These refuges were established to protect colonial nesting and migratory birds including the great white heron and other wildlife from the impacts of plume hunting to support the millinery trade. In 1975, all of the islands within Key West National Wildlife Refuge with the exception of Ballast Key were designated as part of the National Wilderness Preservation System, which limits human use and influence in order to preserve the quality, character, and integrity of these protected wilderness lands. The first undersea marine park, John Pennekamp Coral Reef State Park, was established in 1960 followed by Key Largo National Marine Sanctuary in 1975 and Looe Key National Marine Sanctuary in 1981.

Following several large vessel groundings impacting offshore coral reefs, the identification of potential oil and gas exploration and drilling in Florida's coastal waters, environmental damage to Florida Bay and seagrasses, and public interest in protecting the Florida Keys resources, FKNMS was designated by Congress in 1990 through the Florida Keys National Marine Sanctuary and Protection Act (FKNMSPA). The act also established the Water Quality Protection Program (WQPP) that provides recommendations to the sanctuary, the Florida Department of Environmental Protection (DEP), and the U.S. Environmental Protection Agency (EPA) on how to maintain and restore water quality of the Florida Keys. The FKNMS boundary is contiguous with three national parks, and within the sanctuary boundary are four national wildlife refuges, six state parks, and three state aquatic preserves (see Figure 1.1.) all with their own agency authorities and jurisdiction.

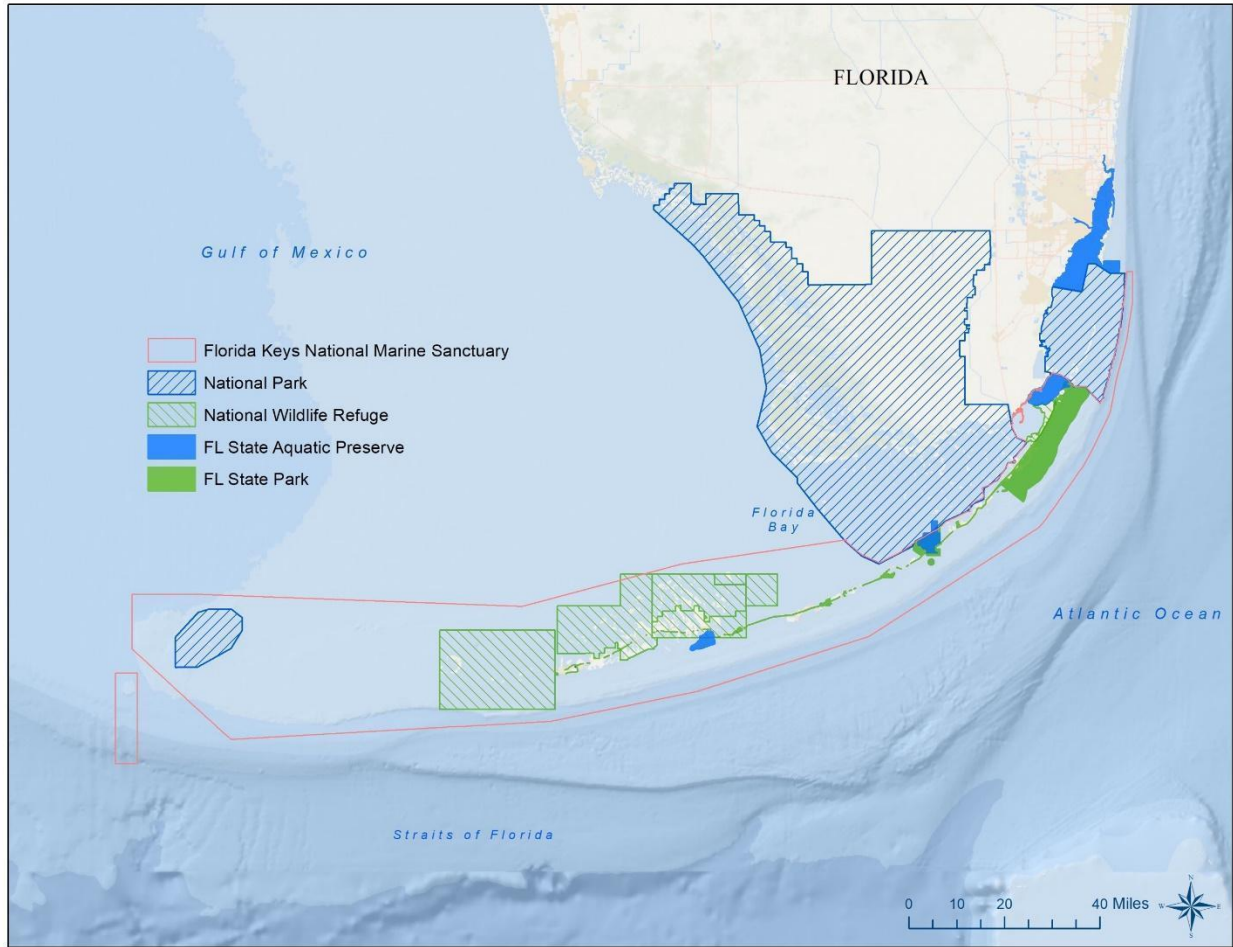


Figure 1.1. Florida Keys management jurisdictions: The FKNMS boundary is contiguous with three national parks, and within the sanctuary boundary are four national wildlife refuges, six state parks, and three state aquatic preserves. Image: NOAA

Since establishing FKNMS, NOAA has taken several actions to protect and manage the marine resources within the Florida Keys. NOAA's current management of the sanctuary is based on its 1997 final EIS and a 2007 revised management plan. The 1997 EIS and management plan implemented sanctuary-wide regulations and established the nation's first comprehensive network of marine zones in FKNMS after years of planning, design, and public input. The FKNMS marine zones have differing levels of use and protection for each area and are designed to protect and preserve sensitive parts of the ecosystem while allowing activities that are compatible with resource protection. Since implementation of regulations and marine zones in 1997, NOAA updated FKNMS marine zone regulations to include the Tortugas Ecological Reserve (ER) in 2001, added a No Discharge Zone regulation within federal waters in 2010 (Florida state waters were designated as No Discharge in 2002), and updated non-regulatory management plan activities in a 2007 revised management plan. The NMSA requires NOAA's Office of National Marine Sanctuaries (ONMS) to periodically review and update all sanctuary management plans.

In addition to this FKNMS management action, other NOAA offices have taken actions designed to protect marine resources in the Florida/Caribbean region. NOAA's National Marine Fisheries

Service (NMFS), for example, listed two coral species in 2005 and an additional five species in 2012 under the Endangered Species Act (ESA); designated critical habitat under the ESA for several coral and sea turtle species; designated Essential Fish Habitat (EFH) for several fish species; and implemented multiple other fishery management actions recommended by the Gulf of Mexico Fishery Management Council (GMFMC), South Atlantic Fishery Management Council (SAFMC), and the Atlantic Highly Migratory Species Management Division of NMFS. Furthermore, NMFS implemented a GMFMC recommendation to establish the Pulley Ridge Habitat Area of Particular Concern (HAPC) in 2005, which was updated in 2020, and where fishing with all bottom tending gear (except bottom longline gear in Portion A) and anchoring by fishing vessels is prohibited. This HAPC is designed to protect significant mesophotic reefs from impacts of bottom tending fishing gear.

The USFWS management of the Refuge Complex is guided by two comprehensive conservation plans (CCP), one covering the three refuges in the Lower Keys and the other for Crocodile Lake National Wildlife Refuge. The 2006 and 2009 CCPs outline management strategies and corresponding resource needs over a 15-year period to protect, enhance, and restore the natural diversity and integrity of the ecological landscapes of the Florida Keys Refuges, and provide unique opportunities for research and wildlife-dependent recreational uses in cooperation with partners when those uses are found compatible and in accordance with USFWS policy and the National Wildlife Refuge System Administration Act of 1966, as amended at 16 U.S.C. §§ 668dd *et seq.* (Refuge Improvement Act). An overriding consideration reflected in both CCPs is that fish and wildlife conservation has first priority in refuge management. All public use of refuges must be compatible with the purposes for which each refuge was established.

The 1992 Management Agreement for Submerged Lands within the Boundaries of the Key West and Great White Heron National Wildlife Refuges (also known as the “Backcountry Management Plan”) is a cooperative agreement between the state of Florida Board of Trustees of the Internal Improvement Trust Fund and the USFWS. This agreement authorizes the USFWS to manage state submerged lands within the boundaries of the Key West National Wildlife Refuge and Great White Heron National Wildlife Refuge for public purposes set forth in the plan. The state of Florida Board of Trustees of the Internal Improvement Trust Fund may authorize management of these lands by virtue of Chapter 253.03 of Florida Statutes and the USFWS may enter into such an agreement by virtue of the Refuge Improvement Act.

This same act enables the USFWS to cooperate with NOAA and the state of Florida on planning and implementation of resource management and enforcement actions where jurisdictions overlap in FKNMS.

1.2 Statutory Authorities

1.2.1 National Marine Sanctuaries Act

The NMSA of 1972, as amended (16 U.S.C. §§ 1431 *et seq.*) authorizes the Secretary of Commerce to designate areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities as national marine sanctuaries. Among the purposes and policies of the NMSA are mandates to:

- Identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System (16 U.S.C. § 1431(b)(1));
- Provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner which complements existing regulatory authorities (16 U.S.C. § 1431 (b)(2));
- Maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes (16 U.S.C. § 1431 (b)(3)); and
- Develop and implement coordinated plans for the protection and management of these areas with appropriate federal agencies, state and local governments, Native American tribes and organizations, international organizations, and other public and private interests concerned with the continuing health and resilience of these marine areas (16 U.S.C. § 1431 (b)(7)).

1.2.2 Florida Keys National Marine Sanctuary and Protection Act

The 1990 FKNMSPA (Pub. L. 101-605) established the sanctuary, outlines the policy and purpose of the sanctuary, and provides direction for sanctuary management. FKNMS was established to protect and preserve living and other resources of the Florida Keys marine environment, educate and interpret information about sanctuary resources for the public, and manage human uses of the sanctuary consistent with the FKNMSPA. The FKNMSPA mandated the development of a comprehensive management plan and implementing regulations. Components of the management plan development relevant to this action include:

- Facilitate all public and private uses of the sanctuary consistent with the primary objective of sanctuary resource protection;
- Consider temporal and geographical zoning to ensure protection of sanctuary resources;
- Incorporate regulations necessary to enforce the elements of the comprehensive water quality protection program;
- Identify needs for research and establish a long-term ecological monitoring program;
- Identify alternative sources of funding needed to fully implement the management plan's provisions;
- Ensure coordination and cooperation between sanctuary managers and other federal, state, and local authorities with jurisdiction within or adjacent to the sanctuary; and
- Promote education among users of the sanctuary about coral reef conservation and navigational safety.

FKNMS regulations are codified at 15 C.F.R. part 922, subpart P. The proposed action to expand the sanctuary boundary, modify and create new marine zones, and update and/or establish regulations for the management of the expanded sanctuary and individual marine zones is consistent with, and would further the purposes and policies of, both the NMSA and the FKNMSPA.

1.3 The Office of National Marine Sanctuaries

ONMS is within NOAA's National Ocean Service and serves as the trustee for a system of marine protected areas, encompassing more than 620,000 square miles of ocean and Great Lakes waters from the state of Washington to the Florida Keys and from Lake Huron to American Samoa (Figure 1.2). ONMS manages the national marine sanctuaries pursuant to the NMSA (see Section 1.2.1 and the [ONMS legislation webpage](#)). NOAA's National Marine Sanctuary System regulations implement the NMSA and are codified at 15 C.F.R. part 922. ONMS also cooperatively manages two marine national monuments with the USFWS and other federal and state authorities as codified at 50 C.F.R. part 404.



Figure 1.2. National Marine Sanctuary System map. Image: NOAA, adapted from National Geographic Maps

These national marine sanctuaries and marine national monuments include both nearshore and offshore marine areas. Their designation provides protection for sensitive marine ecosystems, such as coral reefs and kelp forests; deepwater habitats and geologic features such as canyons and seamounts; migration corridors and other habitats used by ecologically and economically important or protected marine species; and historically significant maritime archaeological sites including shipwrecks and other artifacts. In addition, these areas serve as valuable educational, recreational, scientific, and economic resources. Sites of the National Marine Sanctuary System range in size from less than one square mile in Monitor National Marine Sanctuary offshore North Carolina, to 582,578 square miles of ocean in Papahānaumokuākea Marine National Monument, located in the Northwestern Hawaiian Islands.

1.4 Florida Keys National Marine Sanctuary

On November 16, 1990, Congress designated FKNMS, which encompasses 3,800 square miles. The sanctuary spans a shallow water interface between the Gulf of Mexico and the Atlantic

Ocean and is adjacent to most of the relatively shallow estuarine waters of South Florida, including those of Florida Bay and Biscayne Bay. FKNMS surrounds more than 1,700 islands, which constitute most of the limestone island archipelago of the Florida Keys. This archipelago extends from the Florida peninsula south and west over 220 miles (354 km), terminating at the islands of Dry Tortugas National Park. The oceanic boundary of FKNMS is the 300-foot isobath (~100-meter depth). FKNMS shares trusteeship of marine resources with the state of Florida, as 60% of the sanctuary falls under state jurisdiction. FKNMS protects open-ocean, off-shore reef tract and near-shore patch reefs, seagrass meadows, hard bottom regions, and fringing mangroves. FKNMS waters and habitats support high species diversity due to the presence of both tropical and subtropical species, including the largest documented contiguous seagrass community in the northern hemisphere and extensive coral reef habitat. The sanctuary is also home to maritime heritage resources that encompass a broad historical period.

The FKNMS management plan guides actions needed to protect the rich marine ecosystems of ocean and coastal waters of the Florida Keys while continuing to allow compatible, sustainable human uses. The existing regulations and management plan address key issues including ecosystem protection, water quality, maritime heritage, research and monitoring, and education and outreach. Some of these regulations and actions include efforts to:

- Establish a marine zoning scheme that includes five distinct zone types, including
 - **Wildlife management areas** (WMAs) that protect shallow water habitats and dependent wildlife,
 - **Sanctuary preservation areas** (SPAs) that separate conflicting uses,
 - **Special use areas** (SUAs) to support specific targeted activities such as research and restoration,
 - **Ecological reserves** (ERs) to protect large contiguous habitats, and
 - **Existing management areas** (EMAs) to continue to manage areas that were established prior to 1997 by their own protections and restrictions in addition to regulations that are applicable sanctuary-wide;
- Prohibit discharge or deposit of matter into the sanctuary, including establishing all sanctuary waters as a No Discharge Zone (established through a 2010 regulation);
- Prohibit movement of, removal of, injury to, or possession of sanctuary historical resources;
- Establish regulations related to operating vessels in relation to sanctuary resources, markers, and human safety, among others;
- Prohibit removal of, injury to, or possession of coral or live rock;
- Develop a mooring buoy program to protect natural resources, mark marine zones, and facilitate multiple uses within sanctuary waters;
- Support education, outreach, and volunteer activities to facilitate better understanding of sanctuary resources and regulations and promote a stewardship ethic; and
- Facilitate enforcement of sanctuary regulations through a joint enforcement agreement with the state of Florida.

The sanctuary superintendent receives management advice and recommendations from a FKNMS Sanctuary Advisory Council, a volunteer, community-based advisory group representative of community constituents that meets regularly throughout the Florida Keys.

FKNMS maintains administrative offices in Key Largo and Key West and the Eco-Discovery Visitor Center in Key West. FKNMS also relies on an extensive network of volunteers and partners to assist in resource protection and outreach to the public.

1.4.1 Collaborative research and monitoring program highlights

Knowledge of marine resources including their extent and status is an essential component of effective management. Research and monitoring activities have been underway in the Florida Keys since the mid-1960s. However, since the designation of FKNMS, research and monitoring activities conducted by federal, state, and local agencies and academic and non-governmental organization partners have become much more coordinated and comprehensive. A few highlights follow.

As part of the WQPP, long-term monitoring programs for water quality, seagrass, and coral reefs have been in place since 1995. These programs have informed recommendations made and special studies implemented by the WQPP and serve as a means to assess the impacts of actions taken by the sanctuary and others on water quality, seagrass, and coral reef resources.

Understanding the population dynamics of reef fish, including how natural and human-made stressors are changing reef fish populations and communities, is important for assessing the condition of the coral reef ecosystem. Reef fish surveys have been conducted in the Florida Keys since the late 1970s. This effort has since been formally coordinated as the Reef Fish Visual Census monitoring program and includes well over 800 monitoring sites in the Florida Keys. Data collected from this program show population trends over time, habitat use by fish, and a comparison of fish populations inside and outside of the marine zones of the sanctuary (see below for specific study details).

Long-term research has been conducted to understand the physical and chemical dynamics of the Florida Keys including currents, meteorological events, ocean warming, and acidification. The SEAKEYS (Sustained Ecological Research Related to Management of the Florida Keys Seascape) program, which operated from 1989 to 2012, collected data on water quality, physical oceanography, and benthic communities using fixed buoys and observation stations along the length of the reef tract. Fixed observation sites continue to collect essential data to help understand the changes due to ocean warming and ocean acidification.

Although this section only provides a cursory summary of some of the research and monitoring activities, it shows the value and breadth of interest in understanding and preserving the marine, coastal, and terrestrial resources of the Florida Keys. The complete body of knowledge has been used to inform management decisions, is the backbone of the 2011 FKNMS condition report, and was used throughout this management plan review process to inform advisory council recommendations and agency preferred and alternative actions. More detail on these priority activities is provided in the final management plan (Appendix A to this final EIS).

1.4.2 Marine zone implementation highlights

In 1997, the sanctuary implemented a comprehensive system of marine zones consisting of five main types: SPAs, ERs, WMAs, SUAs, and EMAs.

Mooring buoy placement

Mooring buoys are an important management tool in FKNMS, providing boaters the ability to moor their vessels safely and avoid damaging coral reefs and other important ecosystems. Mooring buoys were first installed in 1981. FKNMS now maintains about 500 mooring buoys as part of an overall network of almost 800 buoys, which also includes 121 boundary buoys that mark marine zones, 160 WMA boundary buoys, shoreline marker buoys, and information buoys. Installation, inspection, and maintenance of this network of buoys requires six full-time staff, two 39-foot vessels, and specialized underwater hydraulic equipment.

Ecological Reserves

The Western Sambo and Tortugas ERs have been studied by scientists to determine how protection has affected marine life in the reserve and in nearby areas. Protection of shallow reefs, deep reefs, mangrove forests, seagrass beds, sandy bottom, hard bottom, and other habitats supports the diversity of marine life associated with the Florida Keys coral reef ecosystem and represents an ecosystem-based approach to resource management. Each reserve is relatively large and includes an array of habitat types that support a diverse assemblage of marine organisms and protect species during different life cycle stages.

Western Sambo Ecological Reserve study results

Western Sambo ER is a nine square nautical mile reserve in the Lower Keys that begins near shore and reaches out to the 60-foot bathymetric contour line and includes nearshore shallow water habitats, inshore patch reefs, mid-channel reefs, offshore patch reefs, and the shallow bank reef. In one of many studies assessing reserve performance, scientists studied lobster populations within and in nearby areas to the reserve before and after reserve protection in 1997. Five years after reserve establishment, study results showed that the proportion of large adult spiny lobsters inside the reserve became greater. After 10 years of reserve protection, legal-sized lobsters were significantly more abundant within the reserve when compared with the corresponding fished site and the smaller Eastern Sambo SUA, which is a no take area. In time, larger sized adult lobsters were detected in nearby fished areas (where large lobsters were not common before).

Tortugas Ecological Reserve marine zone study results

The Tortugas ER, established in 2001 and divided into Tortugas North and Tortugas South, protects sandy bottom, seagrass beds, hard bottom, and coral reef habitats. The Tortugas ER contains reef fish spawning grounds and the deepest coral reefs in the sanctuary, and is considered a source of larvae for multiple species that live within Florida Keys marine habitats. Larvae are carried to the Florida Keys by the Florida Current.

Studies show that after 10 years of reserve protection, black grouper exhibited marked increases in population numbers and size when compared to black groupers in two nearby areas—Dry Tortugas National Park and Tortugas Bank—where fishing is allowed. Prior to reserve implementation in 2001, very few black groupers in the area grew larger than the minimum legal size for harvesting. By 2008, the reserve had the greatest number of larger grouper when compared to the two other areas. However, increases were also seen in the black grouper inside

Dry Tortugas National Park and on Tortugas Bank, an observation attributed to spill-over from the reserve of larger black grouper.

Tortugas Ecological Reserve protects a multi-fish spawning site

Reserve protection helped restore the important reef fish spawning grounds at Riley's Hump in the Tortugas South ER. After nine years of reserve protection, scientists witnessed the gathering of thousands of spawning mutton snapper at Riley's Hump for the first time in years. This gathering of spawning fish, known as a "fish spawning aggregation," at Riley's Hump (inside Tortugas South) had all but disappeared prior to reserve establishment. Typically, such aggregations form at the same place at approximately the same times each year. Acoustic tracking of mutton snapper during spawning season showed that mutton snapper were moving from shallower reefs in the Dry Tortugas National Park's Research Natural Area (a fully protected reserve) to Tortugas South where Riley's Hump is located. During this journey, mutton snapper travel outside of reserve protection.

Surveys of fish spawning aggregations in the Florida Keys conducted by the Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute (FWRI) scientists show that aggregations form in deeper waters on the outlier reef near the Florida (Gulfstream) current. Most fish spawning aggregation sites or suspected sites in the FKNMS are not afforded reserve or other kind of zone protection.

1.5 The National Wildlife Refuge System

The National Wildlife Refuge System, managed by USFWS, is the world's premier system of public lands and waters set aside to conserve America's fish, wildlife, and plants. The refuge system manages more than 850 million acres of land and water, 565 national wildlife refuges, 38 wetland management districts, and management responsibility for five marine national monuments. USFWS manages 28 national wildlife refuges in Florida that comprise approximately 964,992 land and water acres. The mission of the refuge system, as defined by the Refuge Improvement Act of 1997, is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." The Refuge Improvement Act establishes wildlife conservation as the primary mission of the refuge system.

National wildlife refuges provide important habitats for native plants and many species of mammals, birds, fish, amphibians, reptiles, insects, and other invertebrates. They also play a vital role in the recovery of threatened and endangered species.

1.5.1 Refuge Improvement Act

The statutory authority for USFWS to update the Management Agreement for Submerged Lands within Boundaries of the Key West and Great White Heron National Wildlife Refuges (Backcountry Management Plan) is derived from the Refuge Improvement Act, 16 U.S.C. §§ 668dd-668ee. Section 4(a)(3) of the Refuge Improvement Act states: "With respect to the System, it is the policy of the United States that each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established."

Section 4(a)(4) states: “In administering the System, the Secretary shall monitor the status and trends of fish, wildlife, and plants in each refuge.” The Refuge Improvement Act provides USFWS the authority to establish policies, regulations, and guidelines governing habitat management planning within the system of national wildlife refuges (Service Manual 620 FW 1). Administration of national wildlife refuges is guided by the mission and goals of the refuge system, congressional legislation, executive orders, and international treaties. Policies for management options for refuges are further refined by policy and guidelines established by the Secretary of the Interior and by the director of USFWS.

The Florida Keys Refuge Complex consists of Key West National Wildlife Refuge, Great White Heron National Wildlife Refuge, National Key Deer Refuge, and Crocodile Lake National Wildlife Refuge, established in 1908, 1938, 1957, and 1980, respectively, under various authorities. The enabling legislation, which established and authorized the individual refuges, articulate various purposes. For more details see Section 1.6.

1.6 Florida Keys National Wildlife Refuge Complex

The USFWS’s Florida Keys National Wildlife Refuge Complex (Refuge Complex) manages four national wildlife refuges, including Crocodile Lake National Wildlife Refuge, National Key Deer Refuge, Great White Heron National Wildlife Refuge, and Key West National Wildlife Refuge. Each refuge has specific enabling legislation and purpose as designated by executive orders and subsequent federal statutes passed during the establishment of each refuge.

Management of the Refuge Complex is guided by two comprehensive conservation plans (CCP) and several management plans derived from these CCPs that include objectives such as habitat, fire management, and visitor services. These documents guide staff in addressing National Wildlife Refuge System trust resource stewardship including actions such as to maintain and, where appropriate, restore the biological integrity, diversity, and environmental health of these resources. The Lower Keys refuges also have a Backcountry Management Plan, which is a vehicle for a cooperative agreement between USFWS and the state of Florida for the management of state-owned sovereign submerged lands within the boundaries of Key West National Wildlife Refuge and Great White Heron National Wildlife Refuge.

Contained within the boundaries of the Lower Florida Keys national wildlife refuges is over 4,700 acres of designated wilderness comprising 28 keys and mangrove islands. These wilderness areas, established through the Wilderness Act, are managed such that the wilderness character of the area is preserved. The islands and surrounding waters of the Great White Heron and Key West national wildlife refuges are colloquially called “the backcountry.”

The Refuge Complex completed a Backcountry Management Plan in 1992² that responded to an increase in recreational and commercial use of refuge islands and surrounding state-owned waters in the Florida Keys. An increase in wildlife-human interactions involving disruption of roosting, foraging, and nesting of bird species led to several key management actions. Some of these actions:

² USFWS and the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida extended the terms of the backcountry management plan until November 16, 2027.

- Prohibit the use of personal watercraft (PWC), airboats, water skiing, and aircraft landing within specified areas of the Refuge Complex;
- Establish idle speed, no motor, and no access buffer zones in select areas for the protection of wildlife;
- Increase public education for backcountry boaters through press releases, public service announcements, brochures, informational maps, and educational panels at boat ramps;
- Enhance enforcement of current regulations that require a permit for commercial use of refuge islands;
- Increase enforcement with personnel to ensure compliance with the terms of this plan and existing rules covering camping, vegetation clearing, littering, and illegal structures; and
- Close mangrove islands where public use opportunities are virtually nonexistent and inherently incompatible with wildlife.

There is extensive overlap between FKNMS and the Refuge Complex. Therefore, with the establishment of FKNMS, the refuges were designated by NOAA as EMAs under the sanctuary's marine zoning plan. Additionally, NOAA adopted the specific place-based restrictions identified in the USFWS (1992) Backcountry Management Plan and designated those zones as WMAs. USFWS co-manages 20 of the sanctuary's 27 WMAs. This joint management approach supplements existing refuge and state authorities with sanctuary regulations and facilitates the comprehensive protection of natural resources.

For the purposes of this final EIS, the portions of the Refuge Complex under consideration include the marine portions of Crocodile Lake National Wildlife Refuge, which includes a single associated sanctuary WMA, and the marine portions of Great White Heron and Key West national wildlife refuges in the Lower Keys, which include 20 sanctuary WMAs. The Lower Keys National Wildlife Refuges, specifically those portions of state-owned sovereign submerged lands lying below mean high water within Great White Heron and Key West national wildlife refuges, are managed through a cooperative agreement between the USFWS and the state of Florida and associated Backcountry Management Plan.

1.7 Project Location: Southern Florida, Florida Keys, and Pulley Ridge

The Florida Keys are part of the much larger South Florida regional ecosystem, which possesses a wealth of natural resources while also facing major ecological challenges and restoration opportunities. The South Florida ecosystem supports unique and diverse habitats, including seagrass beds of Florida Bay, mangrove swamps, the Everglades sawgrass prairies, the Florida Keys tropical hardwood hammocks, mangroves, and coral reefs. The South Florida ecosystem has also been extensively altered through development of drainage canals completed to facilitate coastal development, agriculture, and flood control. These canals have significantly altered the distribution, timing, and quality of freshwater flow within the South Florida watershed, resulting in degraded marine habitats and other environmental changes that continue to impact the estuaries of Florida Bay and the environment of the Florida Keys.

The sanctuary contains components of five distinct physiographic regions: Florida Bay, the Southwest Continental Shelf, the Florida Reef Tract, the Florida Keys, and the Straits of Florida. The regions are environmentally and geologically unique, and together form the framework for the sanctuary's diverse terrestrial and aquatic habitats. Pulley Ridge is included as a sixth physiographic region as it is included in the proposed action and alternatives (See Figure 1.3 and Chapter 4 for more details).

The Florida Keys ecosystem is part of two large marine ecosystems, the Gulf of Mexico and the Southeast Continental Shelf, and is also ecologically connected to the Caribbean Sea. These large marine ecosystems are linked by the Loop Current, an area of warm water that travels up from the Caribbean, past the Yucatan Peninsula, and into the Gulf of Mexico. The current is also known as the Florida Current as it flows through the Florida Strait, into the Gulf Stream, and heads north up the eastern coast of the United States. The Loop Current, its eddies, and boundary currents affect biological communities in the Gulf as pathways for the distribution of fish larvae and juveniles, as well as pollutants. Because of these connections, international coordination is an important component of management of the Florida Keys ecosystem.

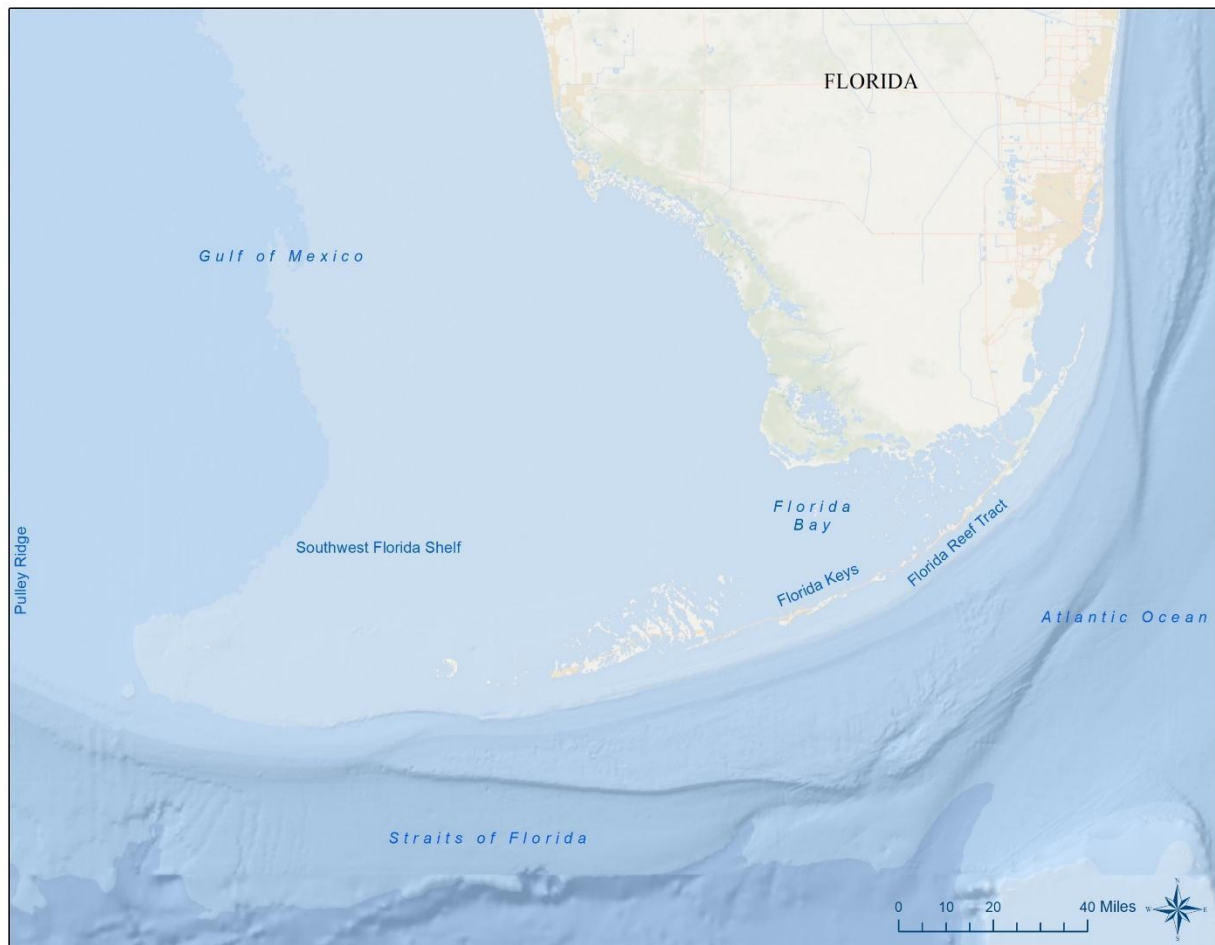


Figure 1.3. Project location: South Florida regional ecosystem includes interconnected natural resources and physical features. Image: NOAA

1.8 Public Involvement

According to Council on Environmental Quality (CEQ) regulations (40 C.F.R. § 1506.6(a)), federal agencies are required to “make diligent efforts to involve the public in preparing and implementing their NEPA [National Environmental Policy Act] procedures.” The following section outlines public involvement in the sanctuary marine zoning and regulatory review process.

1.8.1 Scoping

One aspect of public involvement is the scoping process (40 C.F.R. § 1506.6(b)). The scoping process begins with a notice of intent to prepare an EIS, which announces public scoping meetings and invites the public to comment on the proposed actions for 30 days.

On April 19, 2012, NOAA and the U.S. Department of Interior’s USFWS published a notice of intent in the Federal Register, which notified the public of the proposed action, announced five scoping meetings, and solicited public comment. ONMS and USFWS held public scoping meetings in Marathon on June 19, 2012; Key Largo on June 20, 2012; Key West on June 21, 2012; Miami on June 26, 2012; and Fort Myers on June 27, 2012. Several hundred people participated in these meetings and provided input on specific issues to be analyzed or addressed as part of the marine zoning and regulatory review (Figure 1.4).



Figure 1.4. Public input was provided at scoping meetings throughout the Florida Keys, Miami, and Fort Myers in 2012. Photo: NOAA

In addition to public scoping meetings, ONMS and USFWS accepted written comments from April 19, 2012, to June 29, 2012. Comments were provided in emails, letters, faxes, and electronic submission through regulations.gov. A specific section on the [FKNMS website](http://FKNMS.gov) serves

as a central location of project information while the review is underway and the final EIS is being developed. During the comment period, the agencies received over 500 comments. The website provides a [summary document](#) of all scoping comments and a [link to access](#) all of the scoping comments received on the project.

As part of formal scoping, the Sanctuary Advisory Council played a significant leadership role throughout this review and the alternatives development process. The advisory council and three community working groups met over a period of 22 months—January 2012 through October 2014—to review scientific and human use data and information, hear further public comment, and develop advice and recommendations for the sanctuary superintendent as well as the Refuge Complex manager to consider when developing alternatives related to marine zones within the sanctuary. A fourth community working group met for a two-day workshop in July 2015 to address artificial habitats, an advisory council priority issue not previously discussed by the initial three community working groups. Over 70 meetings were held throughout the Florida Keys for the advisory council and community working groups throughout this process. This [webpage](#) provides more information and summary documents of the advisory council and working groups.

ONMS reviewed all of the scoping comments and Sanctuary Advisory Council input and considered such comments when developing the content and scope of the draft EIS.

In addition to gathering public input during formal scoping, NOAA worked closely with and sought input from numerous pertinent resource agencies and researchers on the development of the draft EIS. In addition, informal briefings with the GMFMC and the SAFMC have been ongoing since initiation of the public scoping for the draft EIS.

1.8.2 Public review of the draft environmental impact statement

In accordance with the National Environmental Policy Act (NEPA, 42 U.S.C. §§ 4321 *et seq.*) and the NMSA (16 U.S.C. § 1434), NOAA prepared and released a draft EIS and updated draft management plan on August 20, 2019 through the Federal Register (84 Fed. Reg. 45728 [Sept. 3, 2019]) and online at the [Restoration Blueprint webpage](#).

NOAA accepted public comments on the draft EIS from August 2019 to January 2020 through [regulations.gov](#) for Docket NOAA-NOS-2019-0094 by mail, and in person during six public hearings and two Sanctuary Advisory Council meetings in Key West, FL; Marathon FL; Key Largo/Islamorada, FL; Coral Gables, FL; and Ft. Myers, FL. NOAA received a total of over 35,000 comments during the public comment period for the draft EIS. Some submissions from the public contained multiple comments; other submissions represented letter campaigns with repeated comments, or petitions that each had multiple signatories. NOAA reviewed all of these submissions and identified 1,213 distinct comments on the proposed action. The types of organizations that commented include the following: state and federal agencies, local municipalities, homeowners' associations, fishing organizations, diving organizations, non-governmental organizations, trade organizations, scientists, permit holders, and school groups.

1.8.3 Public review of the notice of proposed rulemaking

Due to broad public interest and the comprehensive nature of the review of FKNMS regulations and management plan, NOAA separated the draft EIS and rulemaking processes to allow increased opportunity for public and agency input to inform the Final Preferred Alternative and final rule. NOAA released the Notice of Proposed Rulemaking (NPR) in July 2022 (87 Fed. Reg. 42800 [July 18, 2022]). NOAA accepted public comments for a 100-day period and hosted four public comment meetings. FKNMS staff held one Sanctuary Advisory Council meeting focused on public comment and a Sanctuary Advisory Council meeting focused on receiving advisory council comments and recommendations. At each stage of the process NOAA has received comments from state and federal agency partners.

NOAA received over 45,000 comments during the public comment period for the NPR. Some submissions from the public contained multiple comments; other submissions represented letter campaigns with repeated comments, or petitions that each had multiple signatories. NOAA reviewed all of these submissions and identified 426 distinct comments on the NPR and updated draft management plan during the July 2022 through October 2022 public review period.

In total, across both these public review periods (2019 draft EIS and 2022 NPR), NOAA hosted thirteen public meetings and received written comments from members of the public submitted at regulations.gov, written comments from the Sanctuary Advisory Council, and oral and written comments provided during in-person and virtual public meetings. All comments received, in full format, are archived and available for viewing at regulations.gov (docket #NOAA-NOS-2019-0094). All substantive issues raised in the comments on both the draft EIS and 2022 NPR are summarized and addressed in Appendix C: Response to Comments.

Input provided throughout all of the public comment opportunities generally asserted that sanctuary resources are experiencing increased impacts from local, regional, and global threats (such as climate change), as well as from increased numbers of overall users. Public comments primarily focused on the need to improve sanctuary resource conditions and to monitor and address impacts from climate change and changes to water quality, to continue and expand living and non-living resource protection, and to advance efforts to restore habitats and ecosystem function. Comments included a mixture of support and opposition to the specific proposed regulatory updates. The greatest difference of opinion expressed in public comments related to proposals to modify existing or establish new marine zones that limited access.

1.9 Summary of Changes from Draft EIS to Final EIS

In preparing this final EIS, NOAA evaluated and considered all public and agency comments received on the 2019 draft EIS and 2022 NPR, which informed the development of NOAA's Final Preferred Alternative, which is described in detail in Chapter 3 of this final EIS. In the 2019 draft EIS, NOAA identified Alternative 3 as the preferred alternative. Informed by public comment and interagency coordination on the draft EIS, NOAA developed a 2022 NPR, which is included in this final EIS as the 2022 NPR Alternative. The 2022 NPR Alternative combined individual aspects of each of the four alternatives presented in the 2019 draft EIS (alternatives 1, 2, 3, and 4).

Subsequently, following analysis of the comments and further input received on the NOPR, NOAA developed the Final Preferred Alternative. The Final Preferred Alternative provides additional management and protection of sanctuary resources and aims to create a balance between resource protection and sustainable use. Given the increasing stressors on sanctuary resources, the Final Preferred Alternative considered action that would support and facilitate resilience and recovery of habitats and species throughout the sanctuary and within or moving through the individual marine zones. The Final Preferred Alternative encompasses 4,539 square miles and includes a total of 86 marine zones: 44 WMAs, 17 SPAs, 15 Restoration Areas (RAs), six Conservation Areas (CAs), two Management Areas (MAs), and two national wildlife refuges where sanctuary regulations apply. The following is a summary of the Final Preferred Alternative relative to the draft EIS and 2022 NOPR Alternatives for each sanctuary component:

- **Sanctuary boundary:** Same as Alternative 3 (draft EIS preferred)
- **Sanctuary-wide regulations:** Same as 2022 NOPR Alternative
- **Marine zone boundaries:** Variable by zone type and specific zone
- **Additional marine zone regulations:** Eliminate two exceptions; update two existing; zones are similar to Alternative 2 in level of additional protection
- **Sanctuary Management plan:** Same as 2022 NOPR Alternative with minor edits

1.10 Organization of Environmental Impact Statement

Chapter 1 (Introduction and background) is a background discussion of the statutory authorities, ONMS, and National Wildlife Refuge System; a summary of existing FKNMS and refuge management; and an overview of the public involvement process for the proposed action.

Chapter 2 (Purpose of and need for action) provides the purpose of and need for the proposed action, a summary of the scope of the final EIS, and an overview of the other regulatory requirements and consultations that NOAA will be conducting as part of this environmental review.

Chapter 3 (Description of alternatives) describes the alternatives development process, the No Action Alternative, the three alternatives considered in detail, and alternatives considered but eliminated from detailed evaluation. For the four alternatives considered in detail, Chapter 3 describes the components of each alternative including the sanctuary boundary, sanctuary-wide regulations, marine zone boundaries, marine zone regulations, and management plan activity proposals.

Chapter 4 (Affected environment) describes the existing conditions in FKNMS to provide a baseline for assessing environmental impacts that may occur under each alternative. Baseline information includes a description of the physical and biological environment, historical resources, and human uses, including socioeconomic resources and environmental justice.

Chapter 5 (Environmental consequences) includes an evaluation of potential impacts on the physical and biological environment, historical resources, and human uses, including an in-depth consideration of socioeconomic impacts that may occur as a result of implementing each alternative. NOAA evaluated the direct, indirect, short-term, long-term, and cumulative impacts and then compared the relative impacts among the four alternatives.

Chapter 6 (Conclusions) states the preferred alternative, describes any resource commitments and unavoidable adverse environmental impacts, evaluates the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity, and assesses whether the proposed action would result in the irreversible and irretrievable commitment of resources.

References are provided for the final EIS.

Appendices to this final EIS are provided as Volume II.

Chapter 2: Purpose and Need for Action

2.1 Proposed Action

NOAA proposes to: (1) expand the boundary of FKNMS, (2) update sanctuary-wide regulations, (3) modify existing and create new marine zones, (4) update associated marine zone-specific regulations, and (5) revise the sanctuary management plan. NOAA has considered state and federal authorities in proposing new regulations to ensure protection and management of sanctuary resources. Proposed new regulations are intended to complement existing authorities.

The foundation of the proposed action and alternatives outlined in Chapter 3 are the suite of Sanctuary Advisory Council recommendations, which are based on the goals, principles, and objectives outlined in the 2012 FKNMS Advisory Council Regulatory and Zoning Alternatives Development Workplan (see [FKNMS ecosystem restoration webpage](#)).

2.2 Purpose of Action

The purpose of the proposed action is threefold:

(1) To meet the purposes and policies of the NMSA (16 U.S.C. § 1431(b)), in particular:

- to identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System;
- to provide comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner which complements existing regulatory authorities;
- to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes;
- to facilitate to the extent compatible with the primary objective of resource protection, all public and private use of the resources of the marine areas not prohibited pursuant to other authorities; and
- to develop and implement coordinated plans for the protection and management of these areas with appropriate federal agencies, state and local governments, Native American tribes and organizations, international organizations, and other public and private interests concerned with the continuing health and resilience of these marine areas.

This action will also meet mandates outlined in the FKNMSPA, which directs the sanctuary to protect and preserve living and other resources of the Florida Keys marine environment, educate and interpret information about sanctuary resources for the public, and manage human uses of the sanctuary consistent with the FKNMSPA.

(2) To implement specific actions identified in the 2007 FKNMS management plan, specifically *Strategy R.2: Regulatory review and development*. Additional guidance and recommendations

specific to sanctuary marine zones were provided by the Sanctuary Advisory Council after they hosted a marine zoning workshop in 2008 to review the location, arrangement, size, effectiveness, and potential unintended consequences of the sanctuary marine zones; and

(3) To act upon several recommendations of the FKNMS Sanctuary Advisory Council. These recommendations are based primarily on the Florida Keys National Marine Sanctuary Condition Report 2011, which provided a synthesis of research and monitoring data collected over time on status and trends of sanctuary resources. Based on these findings, the Sanctuary Advisory Council developed goals, objectives, and a draft work plan to inform and guide the 2012 management plan review process and address existing and emerging threats to sanctuary resources. Specifically, this proposed action seeks to address the following Sanctuary Advisory Council recommendations:

- (1) expand the sanctuary boundary to provide additional protections for nationally significant benthic habitats and mesophotic reef systems with biological, ecological, and/or structural links to the existing sanctuary.
- (2) provide additional site-specific protections for important benthic habitats and associated wildlife while, as appropriate, allowing compatible human uses and providing opportunities for research and recovery of resources from observed impacts.

This final EIS describes the various adjacent and connected ecosystems proposed for incorporation into FKNMS, the resources considered for strengthened or additional protection through site specific marine zones, the alternative scenarios for achieving this goal, and NOAA's Final Preferred Alternative.

2.3 Need for Action

The need for the proposed action is to address widespread, acute, chronic, and emerging threats to marine resources and federal trust resources in the Florida Keys. The existing marine zones and management plan activities designed and implemented by FKNMS in the mid-1990s are no longer sufficient to ensure long-term resource protection and ecosystem function into the future considering those threats. This assessment is based primarily on the [2011 FKNMS condition report](#), which concluded that resources in the Florida Keys appear to be in fair to fair/poor condition, are generally either stable or in decline, and that emerging threats to sanctuary resources include invasive species, climate change, increasing coastal and visitor populations, and recreational use of the sanctuary.

Since release of the 2011 FKNMS condition report, sanctuary resources have been impacted by Hurricane Irma, a coral disease outbreak, a seagrass die-off, and most recently the summer 2023 marine heat wave, among other threats (see Chapter 4 for details).

The quality of the marine environment and marine resource health of the Florida Keys are inextricable. The Florida Keys support more than 82,874 residents and more than 5 million visitors annually, and tourism value to the Florida Keys economy was estimated at \$2.4 billion in 2018, supporting 43% of jobs and employment in Monroe County. The economy is inextricably tied to marine-related activities, including commercial and recreational fishing,

boating, diving, wildlife viewing, and other various tourist-related activities. To maintain the status quo of the declining marine environment puts the economy and jobs at risk.

FKNMS is currently operating under a 2007 revised management plan and regulations largely developed as part of the original management plan process in 1997, with minor modifications to the regulations in 2001 and 2010. An updated management plan and associated regulations are needed because much has occurred since 1997: resources within the sanctuary face increased threat from local, regional, and global impacts; a wide range of scientific data and information has become available; and visitor numbers, use patterns, types, and recreational interests have also changed. Each of these changes has major implications for FKNMS.

Consequently, the sanctuary's 1997 regulations and marine zones and 2007 management plan need to be updated to reflect current strategies for management decisions regarding natural and cultural resource protection and providing recreational access and public use opportunities.

During scoping for the draft EIS, the public supported the need for increased emphasis on a more ecosystem-based management approach to better protect the region's marine resources. To that end, there was support for sanctuary expansion and updated marine zones—actions that are consistent with the purposes and policies of the NMSA and the FKNMSPA. More specifically, the need for this proposed action is to extend national marine sanctuary protections to areas that have significant marine resources with demonstrated connectivity to existing sanctuary resources and to apply management strategies that target changing conditions, use patterns, and emerging threats to resources. The proposed action is informed by recent scientific findings showing degraded habitat in the sanctuary and how those resources can exhibit improvements with application of long-term management and conservation strategies, which include marine zoning.

At the same time, there is a need for continued research, exploration, restoration, and education related to these significant ocean resources. This work would be critical for assessing changes occurring in the environment, fostering a stewardship ethic, and for developing a better understanding of the ecosystem services sanctuary resources provide for communities throughout the Florida Keys.

2.4 Scope of Environmental Impact Statement

NEPA requires that federal agencies document a detailed assessment of the environmental impacts of their proposed actions that could significantly affect the environment and include the public in the decision-making process. The proposed action and action alternatives have been specifically developed to facilitate improved management and protection of identified priority resources within FKNMS and the Refuge Complex. The proposed action and action alternatives were designed with consideration of significant public and stakeholder input over a long period of time. The proposed action is intended to protect resources and generally reduce impacts of human activities on the environment. This final EIS evaluates the potential adverse and beneficial environmental effects of the proposed regulatory actions consistent with NEPA and the White House CEQ regulations implementing NEPA.

Section 304(a)(4) of the NMSA requires that “terms of designation may be modified only by the same procedures by which the original designation is made.” When FKNMS was designated under the NMSA and FKNMSPA, an EIS was prepared. Under the NMSA, alterations to the terms of designation require the sanctuary go through the same procedures as site designation, including an EIS, regardless of the significance of the impacts of the proposed alteration (16 U.S.C. § 1434(a)(4)).

2.5 Cooperating Agency

NEPA lays the groundwork for coordination between the lead agency preparing an EIS and other federal agencies that may have special expertise on an environmental issue or that have jurisdiction by law. These other agencies, referred to as “cooperating agencies,” are responsible for assisting the lead agency through early participation in the NEPA process, including scoping. The cooperating agencies provide technical input to the environmental analysis and provide staff support, as needed, to the lead agency.

For this proposed action, USFWS has technical expertise regarding the ecological resources within its wildlife refuges as well as statutory and regulatory authority over wildlife refuges that exist within FKNMS. The notice of intent to Prepare an EIS was issued jointly by NOAA and USFWS, on behalf of the wildlife refuges. USFWS agreed to be a cooperating agency for purposes of preparing the Restoration Blueprint draft EIS in a letter dated July 7, 2016. Since that time, USFWS has provided technical assistance and worked cooperatively with NOAA on the development and review of the 2022 NOPR Alternative and the Final Preferred Alternative presented in this final EIS. USFWS has continued to collaborate and support NOAA’s efforts on the Restoration Blueprint.

2.6 Compliance with Other Requirements

In addition to NEPA, NOAA is required to comply with several related environmental statutes applicable to the proposed action, including those described below. Compliance with these statutes and other legal requirements is discussed in greater detail in Appendix E.

2.6.1 Endangered Species Act

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §§ 1531 *et seq.*), provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. Section 7(a)(2) of the ESA states that each federal agency shall, in consultation with the Secretary of Interior and/or Commerce, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat.

In addition, ESA Section 10(a)(1)(A) authorizes NMFS and USFWS to issue permits for scientific purposes or to enhance the propagation or survival of listed species. The permitted activity must not operate to the disadvantage of the species and must be consistent with the purposes and policy set forth in section 2 of the Act. Section 10(a)(1)(A) permits are also required:

- when a reasonable and prudent alternative calls for scientific research that will result in take of the species (this includes scientific research carried out by the services);
- when the agency, applicant, or contractor plans to carry out additional research not required by an incidental take statement that would involve direct take (if this is part of the action and direct take is contemplated, a permit is not needed); and
- for species surveys associated with biological assessments (usually developed during informal consultation) that result in take, including harassment.

Section 4.2.3 of this EIS describes the species listed or proposed to be listed under the ESA that are most likely to occur within the action area, including all areas affected directly or indirectly by the proposed action and not merely the immediate area involved in the action. 50 C.F.R. § 402.02. Section 5.2.2 describes the potential impacts to listed species and critical habitats. Additional information regarding ONMS' informal ESA section 7 consultation with NMFS and USFWS is provided in Appendix E and H to this final EIS.

2.6.2 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA, 16 U.S.C. §§ 1361 *et seq.*) protects and conserves marine mammal species by placing a moratorium on harassing, hunting, capturing, or killing any marine mammal or attempting any of these. If a project proponent determines that an action could incidentally harass (“take”) marine mammals, the proponent must consult with either the USFWS or NMFS to determine if a permit to take a marine mammal is required. A redefinition of “take” of an MMPA-protected species occurred under the FY 2004 Defense Authorization Act (House Bill 1588), where an animal is “taken” if it is harassed, and where harassment is defined as “(i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered” (Section 315(f) Pub. L. 107–314; 16 U.S.C. § 703 note).

Section 4.2.3 of this EIS describes the species covered under the MMPA that may occur within the action area. NOAA/ONMS determined that potential impacts to marine mammals did not rise to a level that requires NOAA to apply for a take authorization under MMPA.

2.6.3 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §§ 1801 *et seq.*) fosters long-term biological and economic sustainability of the nation’s marine fisheries in U.S. federal waters out to 200 nautical miles from shore. Key objectives of the MSA are to prevent overfishing, rebuild overfished stocks, increase long-term economic and social benefits, and ensure a safe and sustainable supply of seafood. The EFH provisions of the MSA require NMFS to provide recommendations to federal and state agencies for conserving and enhancing EFH for any actions that may adversely impact EFH. EFH is defined (50 C.F.R. § 600.10) as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Federal agencies must consult with NMFS and assess the effects of their actions on EFH.

Section 4.2.3 of this EIS describes EFH designated under the MSA that may occur within FKNMS. Section 5.2.2 describes the potential impacts to designated EFH. Additional information regarding ONMS' EFH consultation with NMFS is provided in Appendix E to this final EIS.

2.6.4 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA, 16 U.S.C. §§ 1451 *et seq.*) was enacted in 1972 to encourage coastal states, Great Lake states, and U.S. territories and commonwealths (collectively referred to as “coastal states” or “states”) to preserve, protect, develop, and where possible, to restore or enhance the resources of the nation’s coastal zone. Section 307 of the CZMA is known as the “federal consistency” provision. The federal consistency provision requires federal actions (inside or outside a state’s coastal zone) that affect any land or water use or natural resource of a state’s coastal zone, to be consistent with the enforceable policies of the state coastal management program. The term “effect on any coastal use or resource” means any reasonably foreseeable effect on any coastal use or resource resulting from the activity, including direct and indirect (cumulative and secondary) effects. The federal consistency regulations can be found at 15 C.F.R. part 930.

In accordance with 15 C.F.R. part 930, subpart C, NOAA submitted a federal consistency determination to the Florida DEP on May 21, 2024. Additional information regarding NOAA’s CZMA consultation is provided in Appendix E.

2.6.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 (NHPA) (54 U.S.C. § 306108) requires federal agencies to take into account the effects of their undertakings on historic properties in accordance with regulations issued by the Advisory Council on Historic Preservation (ACHP) at 36 C.F.R. part 800. The regulations require that federal agencies consult with states, tribes, and other interested parties (consulting parties) when making their effect determinations.

NOAA initiated Section 106 consultation with the Florida State Historic Preservation Office (SHPO) at the time of public release of the draft EIS. Additional information regarding NOAA’s NHPA Section 106 consultation on the Restoration Blueprint process is provided in Appendix E. NOAA has also been coordinating with the SHPO and the ACHP to review and update FKNMS’s Section 106 programmatic agreement.

Chapter 3:

Description of Alternatives

This chapter includes a summary of the alternative development process, descriptions of the range of alternatives (including the Final Preferred Alternative) and descriptions of the individual components of each alternative (e.g., boundary, marine zones, etc.). Each alternative includes the following components: (1) changing the sanctuary boundary, (2) updating sanctuary-wide regulations, (3) modifying existing marine zones and creating new ones, (4) updating marine zone-specific regulations, and (5) updating the sanctuary management plan (see Tables 3.1–3.8 for summaries of the alternatives and their components). An impact analysis of the alternatives is included in Chapter 5. NOAA considered federal and state authorities in proposing new regulations and how these regulations complement existing authorities. NOAA is also proposing minor or technical revisions and updates to regulatory definitions, terms, and provisions (Appendix D).

NOAA prepared this final EIS in accordance with NEPA, as amended (42 U.S.C. §§ 4321 *et seq.*); NOAA Administrative Order 216-6A, which describes NOAA requirements, policies, and procedures for implementing NEPA; and the NMSA (16 U.S.C. §§ 1431 *et seq.*). This EIS applies CEQ's 1978 NEPA regulations because review of this proposed action began on April 19, 2012, which preceded the effective date of July 1, 2024 for CEQ's Phase 2 NEPA regulations, 89 FR 35442 (May 1, 2024).

NOAA's starting point for the development of the range of alternatives was the 2012 Florida Keys National Marine Sanctuary Advisory Council Regulatory and Zoning Alternatives Development Workplan (for the full administrative record of advisory council discussion and action see the FKNMS Advisory Council workplan and working groups [webpage](#)). The development of the alternatives was further informed by input from the public during the public scoping period, sanctuary advisory and community working group recommendations, and public comment following publication of the 2019 draft EIS and 2022 NOPR. NOAA also consulted with agency partners from the State of Florida, USFWS, U.S. Department of the Navy, and EPA, among others. Finally, NOAA also received input from the research community and from agency personnel.

As described in Chapter 2, the alternatives described below are a result of the need for increased protection of the Florida Keys marine ecosystems, including protection of sanctuary and refuge resources dependent upon the marine environment. In determining the scope of alternatives to be considered, NOAA evaluated possible boundary, regulatory, marine zone, and management plan changes that would be consistent with achieving increased resource protection while also allowing for compatible use.

In addition to the purpose and need outlined in Chapter 2, NOAA used the following screening criteria to determine and evaluate a range of reasonable alternatives:

- Alternatives must be feasible, enforceable, and aim to facilitate compliance with regulations;

- Alternatives must be consistent with the purposes and policies of the NMSA and FKNMSPA; and, where the alternatives overlap with the Refuge Complex, should be consistent with the National Wildlife Refuge System Improvement Act Department of Interior/USFWS regulations and policy, and the National Wildlife Refuge System;
- Alternatives should support and be aligned with the USFWS Lower Keys Refuges CCPs;
- Alternatives must be consistent with and achieve the overall purpose and need of the proposed actions as described in Chapter 2 of this final EIS;
- Alternatives must address resource management issues, generate beneficial environmental effects through implementation of management actions, and address uses or other activities that have an adverse effect on sanctuary resources;
- Alternatives should allow for the incorporation and consideration of recent or best available data and scientific knowledge;
- Alternatives should maximize environmental benefits, while avoiding unnecessary adverse socioeconomic impacts;
- Alternatives should remove obsolete requirements and improve the clarity of existing sanctuary regulations;
- Alternatives should, where appropriate, increase consistency of state and federal regulations, including with other relevant national marine sanctuary sites;
- Alternatives should be consistent with and aim to achieve the Sanctuary Advisory Council goals, objectives, and principles outlined in their 2012 Florida Keys National Marine Sanctuary Advisory Council Regulatory and Zoning Alternatives Development Workplan.

Alternatives initially considered that did not meet these screening criteria are listed in Section 3.7.

Summary of Alternatives and Development of NOAA's Final Preferred Alternative

This chapter describes the range of alternatives evaluated for this action. NOAA evaluated an initial range of alternatives in a 2019 draft EIS and include Alternative 1 (no action); Alternative 2 (slightly more environmentally protective); Alternative 3 (preferred alternative, with many components identical to Alternative 2 or progressively more environmentally protective); and Alternative 4 (many components identical to Alternative 2 or 3 or progressively more environmentally protective). Public and agency comment on the four alternatives presented in the 2019 draft EIS informed the development of a 2022 NOPR, which is described here as the 2022 NOPR Alternative. The 2022 NOPR Alternative combined individual aspects of each of the four alternatives presented in the 2019 draft EIS. Comments on the NOPR Alternative, in addition to updated data and expert input, informed a Final Preferred Alternative. The Final Preferred Alternative is informed by public and agency comments received on the NOPR Proposed Alternative. NOAA's Final Preferred Alternative is described in detail below.

Each alternative describes NOAA's proposals for changes to five specific components of FKNMS management: (1) the sanctuary boundary; (2) sanctuary-wide regulations; (3) marine zone boundaries within the sanctuary; (4) marine zone regulations; and (5) the sanctuary

management plan. The document is organized in this way to provide the reader information to compare the four overall alternatives as well as proposed changes to the specific management components within each alternative. NOAA will consider and compare the environmental consequences (discussed in Chapter 5) for each alternative. Table 3.1 provides a summary of the alternatives and their components presented in this chapter.

Alternative 1: No action (status quo)

The No Action Alternative would maintain the existing sanctuary boundary, sanctuary-wide regulations, marine zones and associated regulations, and management plan activities. Specifically, Alternative 1 encompasses 3,800 square miles, and includes 28 WMAs, 19 SPAs, four SUAs, two ERs, and four EMAs for a total of 57 marine zones.

Sanctuary boundary. In the No Action Alternative, the sanctuary boundary would not change and would continue to encompass 3,800 square miles.

Sanctuary-wide regulations. There would be no changes to existing sanctuary regulations at 15 C.F.R. part 922, subpart P.

Marine zones and associated regulations. There would be no changes to the 57 existing marine zones and their associated regulations.

Management plan. There would be no changes to the 2007 revised management plan.

Alternative 2

Alternative 2 proposes to reduce stressors and impacts to sanctuary and refuge resources. As compared to the No Action Alternative, Alternative 2 proposes a boundary expansion, updated and new sanctuary-wide regulations, modifications to existing marine zones, new marine zones, increased application of regulations in those marine zones, and an updated management plan.

Sanctuary boundary. Alternative 2 proposes to expand the sanctuary boundary to include the area to be avoided (ATBA) and to encompass the area in the Tortugas region between the existing sanctuary boundary and the Tortugas South ER. The sanctuary boundary in Alternative 2 encompasses 4,539 square miles.

Sanctuary-wide regulations. Alternative 2 includes updates to three existing sanctuary-wide regulations and proposes four new sanctuary-wide regulations. In general, these proposed updated and new regulations provide NOAA additional authority to protect sanctuary resources, rapidly respond to impacts to sanctuary resources and, in some cases, create consistency with other sanctuary and state regulations.

Marine zones and associated regulations. The marine zones proposed in Alternative 2 are specifically designed to minimize conflicting and heavy concentrations of use. This alternative maintains many of the marine zones in the No Action Alternative and adds marine zones to provide additional, site-specific protection where resource damage is evident. In these new zones, it implements the least restrictive regulations to meet the resource protection goals set by the advisory council and the FKNMSPA. Alternative 2 includes a total of 96 marine zones, 39 more than Alternative 1 (status quo).

Management plan. Alternative 2 includes an updated management plan with a vision, mission, goals, and associated objectives and activities designed to facilitate understanding of sanctuary resource condition and value that is applied to targeted management action, reduction of impacts to resources, and enhanced stewardship and collaboration.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is specifically designed to create a balance between resource protection and sustainable use with an even greater emphasis on resource protection than Alternative 2.

Sanctuary boundary. Alternative 3 includes the same proposed boundary changes as Alternative 2. The sanctuary boundary in Alternative 3 encompasses 4,539 square miles.

Sanctuary-wide regulations. Alternative 3 includes the same proposed sanctuary-wide regulation changes as Alternative 2. Alternative 3 also includes a non-regulatory update (which is also discussed in the final management plan in Appendix A) to provide additional coordination of live rock aquaculture activities.

Marine zones and associated regulations. Like Alternative 2, this alternative would maintain many of the existing marine zones in the No Action Alternative and also adds marine zones to provide additional, site-specific protection where resource damage is evident. However, Alternative 3 proposes to implement more protective regulations than would be implemented in Alternative 2. Specific marine zone regulations and access restrictions proposed in Alternative 3 allow a more resource protective strategy than those proposed in Alternative 2 and are less restrictive than those proposed in Alternative 4. Alternative 3 includes a total of 98 marine zones.

Management plan. Alternative 3 includes the same proposed updated management plan as Alternative 2.

Alternative 4

Alternative 4 is primarily designed to protect large contiguous habitats and applies the most protective regulations within individual marine zones.

Sanctuary boundary. Alternative 4 includes the same proposed boundary changes included in alternatives 2 and 3, and includes a distinct unit at Pulley Ridge, an area of nationally significant mesophotic coral reefs with demonstrated connectivity to the Florida Keys. The sanctuary boundary in Alternative 4 encompasses 4,800 square miles.

Sanctuary-wide regulations. Alternative 4 includes the same proposed sanctuary-wide regulation changes as Alternative 2 and includes updates to two existing regulations: one to provide additional protection to all shorelines in the sanctuary, and the other to provide FKNMS with additional permitting authority over live rock aquaculture activities to manage potential impacts to sanctuary resources.

Marine zones and associated regulations. Alternative 4 strives to meet a balance between protecting site-specific locations where resource damage is evident, while also protecting the largest area of contiguous habitats compared to the other proposed alternatives. To do this,

FKNMS proposes to combine some marine zones and include larger zones in each of the five geographic regions (Upper Keys, Middle Keys, Lower Keys, Marquesas, and Tortugas). This approach aims to more fully meet Goal 2 of the Advisory Council Regulatory and Zoning Alternatives Development Workplan: *Protect large, contiguous, diverse, and interconnected habitats that provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic protection of marine life and protect and preserve all habitats and species.* The marine zone-specific regulations and access restrictions would be more protective in Alternative 4 than in any of the other proposed alternatives. Some of the zones in this alternative, including the Long Key/Tennessee Reef and Tortugas Spawning Corridor ERs, were discussed by the advisory council working groups but not included as part of their final recommendations to the advisory council. Alternative 4 includes a total of 98 marine zones.

Management plan. Alternative 4 includes the same proposed updated management plan as Alternative 2.

NOPR Alternative (presented in the 2022 NOPR)

Sanctuary boundary. The sanctuary boundary of the 2022 NOPR Alternative is the same as the Alternative 4 boundary.

Sanctuary-wide regulations. The 2022 NOPR Alternative includes updates to three existing sanctuary-wide regulations. The update to the historical resource permits is the same as Alternative 2. The updates to the exceptions for discharge and the emergency regulation are modified from Alternative 2. This alternative also includes three proposed new sanctuary-wide regulations for additional authority to manage and address impacts from fish/marine life feeding, large vessel use of mooring buoys, and derelict vessels, which have only slight modifications from Alternative 2. The 2022 NOPR Alternative also includes a non-regulatory update (which is discussed in Appendix A: Management plan: Florida Keys National Marine Sanctuary) to provide additional coordination of live rock aquaculture activities, which is the same as Alternative 2. Finally, this alternative does not include 2 sanctuary-wide regulations evaluated in the 2019 draft EIS including (1) modifying the existing idle speed no wake along residential shorelines, and (2) prohibiting overnight use of mooring buoys.

Marine zones and associated regulations. The 2022 NOPR Alternative combines individual aspects of each of the four alternatives presented in the draft EIS. This NOPR Alternative is primarily aimed at creating a balance between additional protection of sanctuary resources and allowing the greatest level of use given those resource protection goals. Marine zone sizes and regulations in this alternative also specifically consider user understanding of the marine zones and associated regulations to facilitate compliance with those regulations, and provide greater clarity for potential enforcement action, if needed.

Management plan. The 2022 NOPR Alternative modifies the management plan included in the 2019 draft EIS by (1) adding a suite of six priority management themes to guide FKNMS management actions, resource allocation decisions, and partnership development, and (2) including appendices to highlight partners and collaborators, outline the factors informing prioritizing and implementation, and describe military activities that would be subject to NOAA regulations but are otherwise exempt from FKNMS prohibitions.

Final Preferred Alternative

The Final Preferred Alternative provides additional management and protection of sanctuary resources and aims to create a balance between resource protection and sustainable use. Compared to the other alternatives presented here, the Final Preferred Alternative is the middle path between promoting resource protection and user access. In addition, in light of the increasing stressors sanctuary resources are experiencing, the Final Preferred Alternative includes action that would support and facilitate resilience and recovery of habitats and species throughout the sanctuary and within or moving through the individual marine zones. The Final Preferred Alternative encompasses 4,539 square miles, and includes 44 WMAs, 17 SPAs, 15 RAs, six CAs, two MAs, and two National Wildlife Refuges where sanctuary regulations apply for a total of 86 marine zones.

Sanctuary boundary. The Final Preferred Alternative is the same as that proposed in alternatives 2 and 3. The Final Preferred Alternative expands the sanctuary boundary to include the ATBA and to encompass the area in the Tortugas region between the existing sanctuary boundary and the Tortugas South ER. The Final Preferred Alternative sanctuary boundary encompasses 4,539 square miles.

Sanctuary-wide regulations. The Final Preferred Alternative is similar to the 2022 NOPR Alternative with minor changes that are described in detail below.

Marine zones and associated regulations. The Final Preferred Alternative further refined the 2022 NOPR Alternative based on public and agency comment and updated environmental and user data. The Final Preferred Alternative includes 44 WMAs, 17 SPAs, 15 RAs, six CAs, two MAs, and two National Wildlife Refuges where sanctuary regulations apply for a total of 86 marine zones.

Management plan. The Final Preferred Alternative includes minor changes from the 2022 NOPR Alternative, which primarily include greater specificity for activities related to water quality, restoration, artificial habitat, and acknowledging key stakeholders and partners. In addition, the draft management plan in the 2022 NOPR Alternative included “Appendix III: List of Exempted Military Activities”, which is included as Appendix F in this final EIS. The Final Preferred Alternative management plan is included in Appendix A. A summary of the development of the final management plan is included in section 3.5.

Summary of Proposed Modifications to the Five Management Components Within Each Alternative

As indicated above, each of NOAA’s alternatives describes proposed modifications to five specific components of FKNMS management (the sanctuary boundary, sanctuary-wide regulations, marine zone boundaries, marine zone regulations, and the management plan). Proposed modifications to each of these components are summarized below and in Table 3.1.

Table 3.1. Summary of five management components within each alternative (areas are approximate)

Components	Alternative 1 (no action)	Alternative 2	Alternative 3 (draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Sanctuary boundary (Section 3.1)	Alt. 1 (no action) 3,800 sq miles	Existing boundary ATBA Tortugas Region 4,539 sq miles	Existing boundary ATBA Tortugas Region 4,539 sq miles	Existing boundary ATBA Tortugas Region Pulley Ridge 4,800 sq miles	Same as Alternative 4	Same as Alternatives 2 and 3 (draft EIS preferred)
Sanctuary-wide regulations (Section 3.2)	Alt. 1 (no action)	Update 3 existing Propose 4 new	Update 4 existing Propose 4 new	Update 5 existing Propose 4 new	Update 3 existing Propose 3 new	Same as NOPR Alternative
Marine zone boundaries ¹ (Section 3.3)	Alt. 1 (no action) 57 total zones 1033 sq miles	96 total zones 1131 sq miles	98 total zones 1144 sq miles	97 total zones 1168 sq miles	87 zones 1080 sq miles	86 zones 1081 sq miles
Additional marine zone regulations (Section 3.4)	Alt. 1 (no action)	Eliminate 2 exceptions Update 2 existing regulations. Marine zones: Apply more protective regulations than Alternative 1	Eliminate 2 exceptions Update 2 existing regulations. Marine zones: Apply more protective regulations than Alternative 2 (e.g., greater number of no entry areas)	Eliminate 2 exceptions Update 2 existing regulations. Marine zones: Apply larger zones and more protective regulations than Alternative 3 (e.g., greater number of transit only areas)	Eliminate 2 exceptions Update 2 existing regulations. Marine zones are similar to Alternative 2 for areas included in zones and Alternative 3 for regulations applied.	Eliminate 2 exceptions. Update 2 existing regulations. Marine zones are modified slightly from the NOPR Alternative to be more targeted and provide greater access.
Management plan (Section 3.5 and Appendix A)	Alt. 1 (no action)	New proposed management plan	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2 with edits to include priorities and other minor edits	Same as NOPR Alternative with minor edits

1. Marine zone numbers and area calculations include Great White Heron and Key West National Wildlife Refuges

3.1 Component 1 – Modifications to the Sanctuary Boundary by Alternative

See Section 3.6 (or Appendix B) for maps of each sanctuary boundary alternative.

3.1.1 Alternative 1: No action (status quo)

For the No Action Alternative, the sanctuary boundary would continue to encompass 3,800 square miles (9,842 square km).

3.1.2 Alternative 2: Sanctuary expansion to encompass the ATBA and the Tortugas region

In Alternative 2, the sanctuary boundary would encompass a total area of 4,539 square miles (11,756 square km), which is an expansion of the sanctuary boundary by 741 square miles (1,919 square km). Alternative 2 includes expansion of the sanctuary boundary to encompass 468 square miles (1,212 square km) of the ATBA that is currently outside the existing sanctuary boundary. Alternative 2 includes expansion of the sanctuary boundary to encompass 271 square miles (702 square km) of the Tortugas region.

Alternative 2 includes expansion of the sanctuary boundary to encompass 468 square miles (1,212 square km) of the ATBA that is currently outside the existing sanctuary boundary. The sanctuary boundary would be expanded in two locations to align with the regulatory ATBA boundary: (a) the area north of the existing sanctuary boundary and west of Biscayne National Park and (b) the area south of the existing sanctuary boundary.

The ATBA was originally proposed by the United States Coast Guard (USCG) (*see* 55 Fed. Reg. 19418 [May 9, 1990]) and was codified through the FKNMSPA in 1990 (Pub. L. 101-605). The ATBA was added to FKNMS regulations in 1997 (62 Fed. Reg. 32161 [June 12, 1997]) and was slightly modified in 2001 (66 Fed. Reg. 34533 [June 29, 2001]). These regulations establish four ATBAs where operating a tank vessel or a vessel greater than 50 meters in registered length is prohibited. The ATBA boundary expansion proposes aligning the geographic boundary of the sanctuary with the existing ATBA boundaries. This proposed boundary expansion would clarify NOAA's area of responsibility and enhance compliance and enforcement.

Alternative 2 includes expansion of the sanctuary boundary to encompass 271 square miles (702 square km) of the Tortugas region. The expansion of sanctuary designation to adjacent and ecologically connected habitat in the Tortugas is evaluated for a number of reasons. In the Tortugas region, features and resources adjacent to the existing boundary would benefit from additional sanctuary-wide and targeted zone-specific protections. These include the important habitats and ecological features of Tortugas Bank that provide habitat for a host of species and support fish spawning aggregation activity. In addition, extending the sanctuary boundary to encompass the area between the existing boundary and Tortugas South ER would provide additional protections to this biologically significant area.

The expansion in the Tortugas Region aligns with the existing particularly sensitive sea area (PSSA), encompasses the Tortugas South ER, and extends to the west of the Tortugas South ER

by one mile. The PSSA was established by the International Maritime Organization (IMO) in 2002. PSSAs are used to protect areas for special ecological, socioeconomic, or scientific reasons and that are vulnerable to damage by international maritime activities. This expansion provides additional protections for important ecological resources and the ecological connectivity in the region, particularly between Tortugas North and South ERs and Tortugas Bank. Existing sanctuary-wide regulations and proposed updated or new sanctuary-wide regulations as outlined in Section 3.2 would apply in this expanded area.

3.1.3 Alternative 3: Sanctuary expansion to encompass the ATBA and the Tortugas region (2019 draft EIS preferred)

For the sanctuary boundary alternatives, Alternative 3 is the same as Alternative 2. In Alternative 3, the sanctuary boundary would encompass a total area of 4,539 square miles (11,756 square km).

3.1.4 Alternative 4: Sanctuary expansion to encompass the ATBA, the Tortugas region, and Pulley Ridge

Alternative 4 includes the boundary expansion as proposed and described in Alternatives 2 and 3 and proposes to add a distinct unit at Pulley Ridge. Alternative 4 would expand the sanctuary boundary by 1,000 square miles (2,590 square km), resulting in a boundary that encompasses a total area of 4,800 square miles (12,432 square km). The expansion area would comprise 468 square miles (1,212 square km) of ATBA area, 271 square miles (702 square km) of the Tortugas region area, and 257.5 square miles (667 square km) at Pulley Ridge.

Pulley Ridge is a nationally significant mesophotic reef ecosystem with demonstrated biological connectivity with the Florida Keys (Sponaugle & Cowen, 2019). Potential sanctuary expansion to include a distinct unit at Pulley Ridge would provide additional and broader protections not currently afforded by existing management in the region. The proposed expansion would overlap with the existing GMFMC HAPC (south portion and south portion A), which limits use of bottom tending gear and prohibits anchoring by fishing vessels. In the proposed Pulley Ridge boundary expansion, existing sanctuary-wide regulations and proposed updated or new sanctuary-wide regulations as outlined in Section 3.2 would apply. In addition, a no anchoring regulation for all vessels is proposed in the Pulley Ridge expansion area. Since the 2019 draft EIS, this area has been designated as an International Maritime No Anchoring Area.

As noted, this expanded area is a GMFMC HAPC with associated regulations. Sanctuary expansion would not alter that designation or existing regulations.

3.1.5 2022 NOPR Alternative

The sanctuary boundary for the 2022 NOPR Alternative is the same as Alternative 4 described in Section 3.1.4 above.

3.1.6 Final Preferred Alternative

In the Final Preferred Alternative, the sanctuary boundary is the same as Alternative 2 described in 3.1.2 above.

The Final Preferred Alternative does not include boundary expansion to include a distinct unit at Pulley Ridge as was proposed in Alternative 4 and the 2022 NOPR Alternative. Since the 2019 draft EIS, as noted in the proposed rule, the United States proposed the IMO designate a No Anchoring Area in the southern portion of Pulley Ridge, which was approved and implemented starting June 1, 2023 (IMO SN.1/Circ.342).³ Because the management goal to protect these habitats from anchor damage from all vessels has been achieved, and there are additional protections in place through GMFMC HAPC regulations of fishing and anchoring by fishing vessels, this alternative reflects that the original goals for sanctuary expansion to include Pulley Ridge have been met. Therefore, this area is not included in the proposed sanctuary boundary in the Final Preferred Alternative.

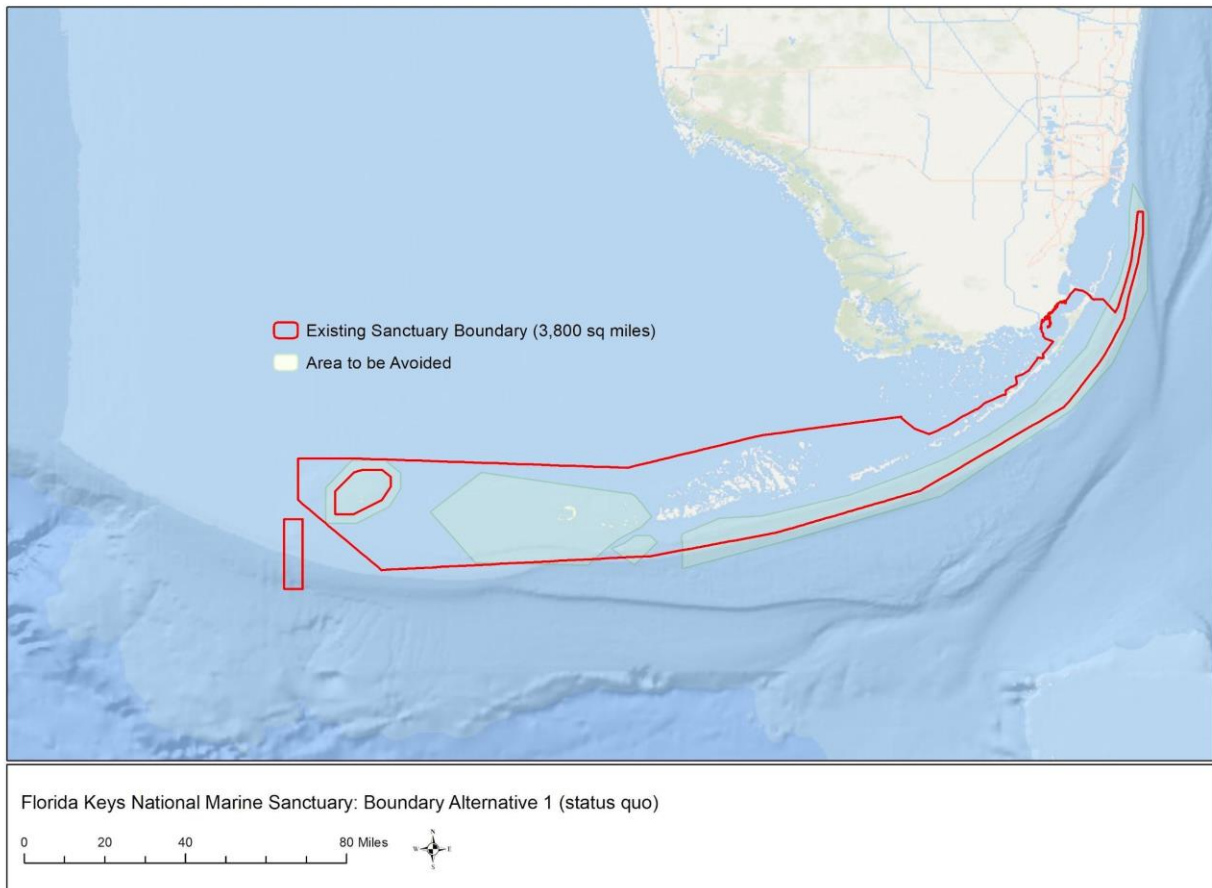


Figure 3.1a. Sanctuary boundary: Map of Alternative 1 (status quo) boundary (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

³ See also <https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/NCSR-9th-session.aspx>

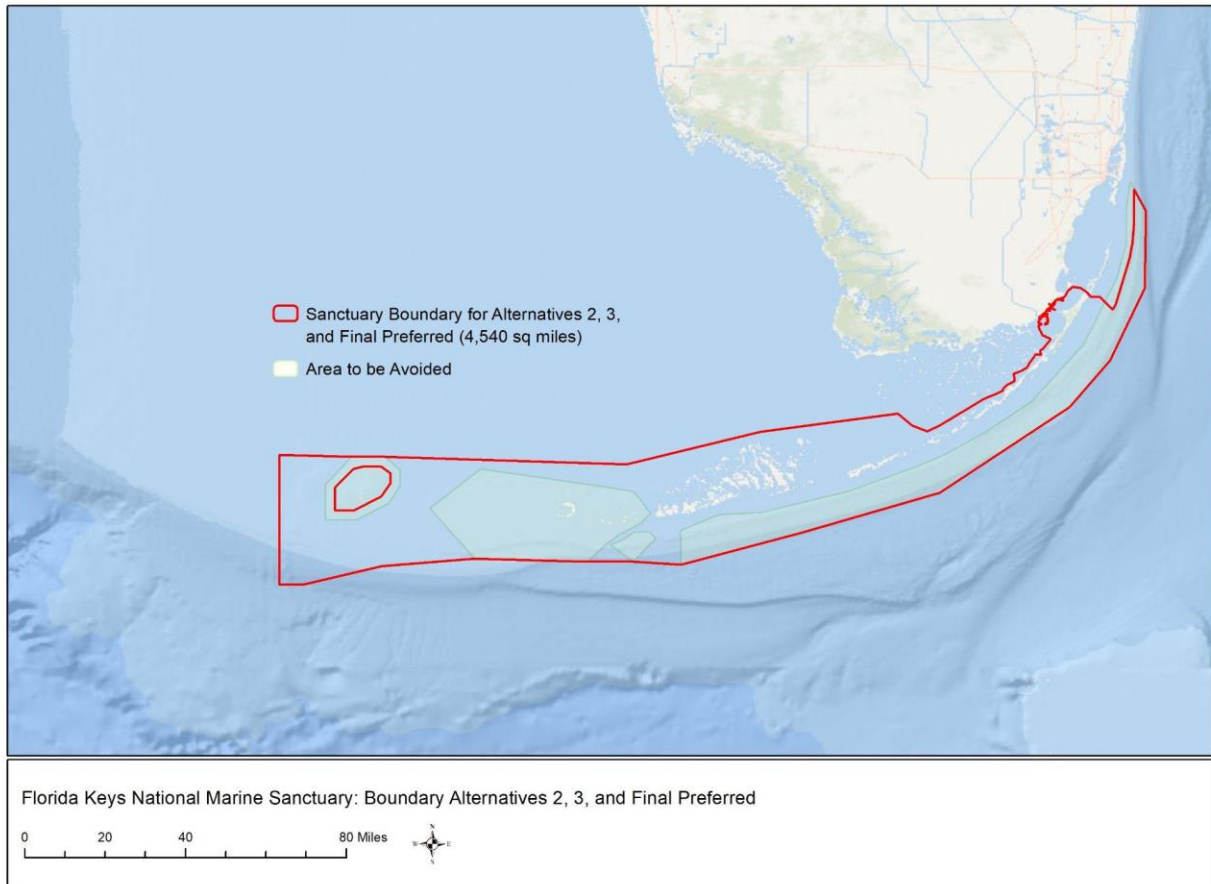


Figure 3.1b. Sanctuary boundary: Map of Alternatives 2, 3, and the Final Preferred Alternative boundary (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

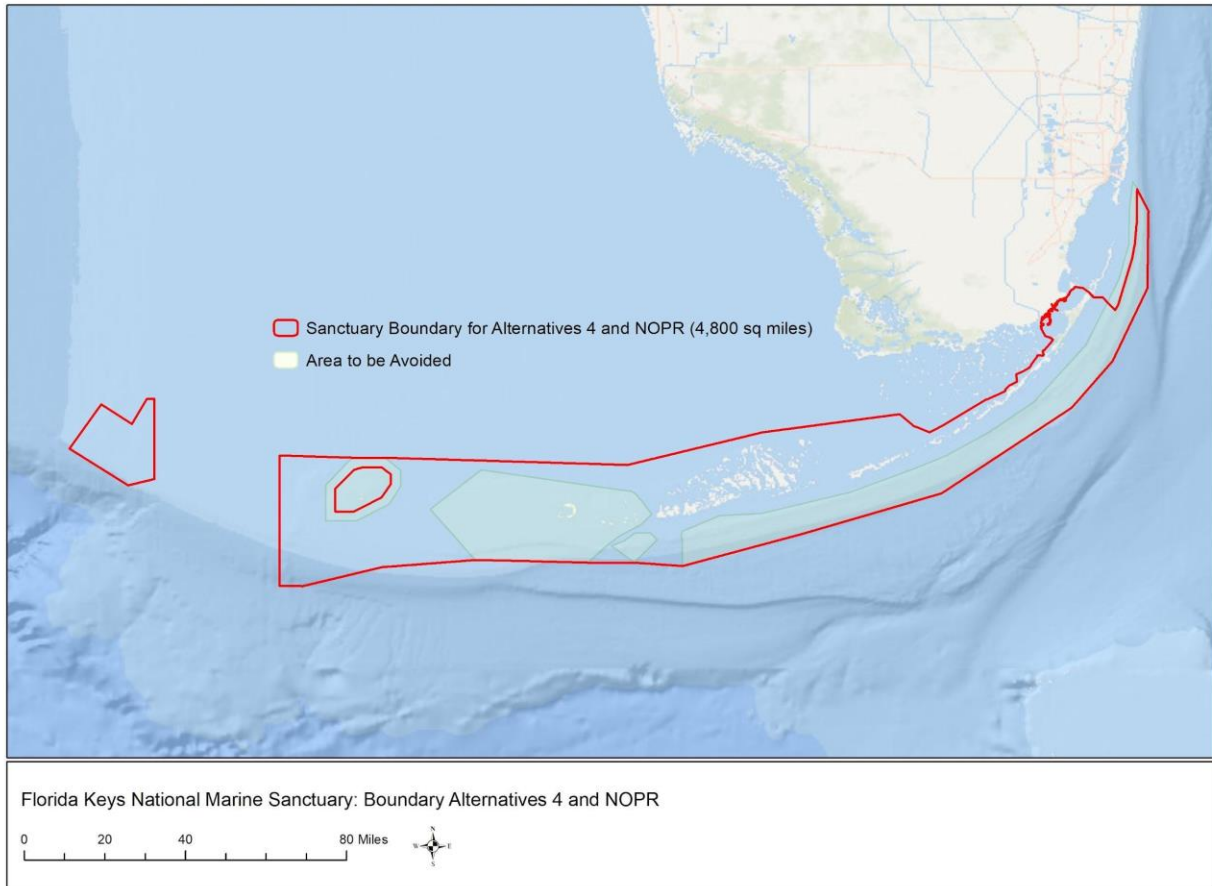


Figure 3.1c. Sanctuary boundary: Map of Alternative 4 and the 2022 NOPR Alternative boundary (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

3.2 Component 2 – Modifications to Sanctuary-wide Regulations by Alternative

Sanctuary-wide regulations are those that apply throughout the entire sanctuary, including within the sanctuary marine zones (see sections 3.3 and 3.4 for more details regarding additional marine zone-specific regulations). The proposed modified and/or new sanctuary-wide regulations address issues related to access, the emergency regulation authority, the discharge regulation and associated exemptions, derelict vessels, and fish feeding. In addition, many of the proposed regulations would also have specific terms and definitions associated with them as described below.

NOAA is also proposing minor or technical revisions and updates to regulatory definitions, terms, and provisions (Appendix D). For the complete text of existing sanctuary-wide regulations see 15 C.F.R. § 922.163 Prohibited activities—Sanctuary-wide. The proposed changes described would be implemented for all of the alternatives considered in this final EIS, except for the No Action Alternative. The minor or technical revisions and updates that FKNMS is proposing to update would not result in direct, indirect, or cumulative impacts on any sanctuary resources in the existing sanctuary or proposed expansion area. Therefore, these proposed regulatory changes are not discussed in Chapter 5, Environmental consequences.

3.2.1 Live rock prohibition (proposed update)

Alternative 1: No action (status quo)

Alternative 1 would retain the existing FKNMS regulations, which currently prohibit removal of, injury to, or possession of coral or live rock, or harvesting, or attempting to harvest, any live rock from the sanctuary (15 C.F.R. § 922.163(a)(2)). There is an exception to this prohibition for live rock aquaculture activities permitted under the MSA regulations at 50 C.F.R. part 622 or permits/licenses issued by the Florida Department of Agriculture and Consumer Services for live rock aquaculture activities in state waters of the sanctuary.

Alternative 2

Alternative 2 would retain the existing regulation as described above in Alternative 1: No action.

Alternative 3 (2019 draft EIS preferred)

NOAA would not change the existing live rock prohibition under Alternative 3. However, NOAA recognizes that greater FKNMS oversight of these activities is needed and, as such, under Alternative 3, NOAA would

develop a memorandum of agreement / understanding with the state of Florida and National Marine Fisheries Service for management and permitting of live rock aquaculture activities in the sanctuary.

While this would be a programmatic management plan activity (as opposed to a regulatory change), it is included here to provide the reader the full list of proposed alternatives related to live rock aquaculture. For more details of this management plan activity, see Appendix A.

Alternative 4

Under Alternative 4, NOAA would update the live rock prohibition by modifying the existing exception for permitted live rock aquaculture activities. The revised regulation would

require sanctuary authorization for existing and any future live rock aquaculture activities inside the boundary of the sanctuary.

With this proposed update, NOAA would require anyone with an existing or future live rock aquaculture lease from the state of Florida or permit from NMFS to also hold a FKNMS authorization. Sanctuary authorizations issued to the existing and potential future permit holders could include additional conditions designed to protect sanctuary resources to the greatest extent possible while still allowing compatible aquaculture activities to occur.

In addition, the proposed update would better enable FKNMS to address activities that might otherwise be inconsistent with FKNMS goals and objectives, complicate enforcement, and/or lead to illegal poaching of corals. FKNMS would craft specific terms and conditions designed to further protect sanctuary resources to the greatest extent possible while allowing compatible aquaculture activities to occur.

2022 NOPR Alternative

The 2022 NOPR Alternative for live rock aquaculture is the same as Alternative 3.

Final Preferred Alternative

The Final Preferred Alternative for live rock aquaculture is the same as Alternative 3.

3.2.2 Discharge regulation exception (proposed update)

Sanctuary discharge prohibitions are necessary to protect sanctuary resources and the condition of those resources from the effects of pollutants associated with discharges.

Alternative 1: No action (status quo)

Existing FKNMS regulations currently prohibit discharging or depositing materials or other matter within the boundary of the sanctuary (15 C.F.R. § 922.163(a)(4)). Exceptions include discharging or depositing: (1) fish, fish parts, chumming materials, or bait during traditional fishing activities; (2) water generated by routine vessel operations (e.g., graywater as defined in section 312 of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act), excluding oily wastes from bilge pumping; and (3) vessel cooling water or engine exhaust. In certain protected zones, including ERs, SPAs, and SUAs, NOAA only allows discharges from engine exhaust and cooling water. In 2010, NOAA amended FKNMS regulations to eliminate the former exception for discharges of biodegradable effluent incidental to vessel use and generated by marine sanitation devices approved under the Clean Water Act.

Alternative 2

Under Alternative 2, NOAA would update the existing exceptions for discharge from vessels to prohibit discharge of certain materials from cruise ships while inside the sanctuary boundary. The revised regulation would

prohibit discharge of any material or other matter from a cruise ship except clean vessel engine cooling water, clean vessel generator cooling water, vessel engine or generator exhaust gas, clean bilge water, or clean anchor wash water.

This proposed update would increase protection of water quality and sanctuary resources from pollutants present in cruise ship discharges, such as graywater, scrubber wash water, and other discharges that occur during vessel operations. This proposed update would be effective throughout the entire sanctuary, in both state and federal waters. This update would make FKNMS regulations consistent with those of other sanctuary sites.

Finally, in conjunction with this prohibition, the ONMS definition for “cruise ship” found at National Marine Sanctuary System-wide regulations at 15 C.F.R. § 922.11 will apply. In the draft EIS, NOAA had proposed to update the definition for “cruise ship” as part of this proposed action. Since publication of the 2019 draft EIS, NOAA has promulgated the same definition (see below), under the ONMS-wide regulations (88 Fed. Reg. 958 [Jan. 6, 2023]) at 15 C.F.R. 922.11. This definition now applies to all national marine sanctuaries including FKNMS, negating the need to define “cruise ship” in FKNMS regulations at 15 C.F.R. § 922 subpart P.

Cruise ship means a vessel for hire with 250 or more passenger berths.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for discharge regulations.

Alternative 4

Alternative 4 is the same as Alternative 2 for discharge regulations.

2022 NOPR Alternative

The 2022 NOPR Alternative simplifies Alternative 2. Under the 2022 NOPR Alternative, NOAA would

prohibit discharge of any material or other matter from a cruise ship except cooling water.

NOAA determined that Alternative 2, which proposed instead to specify certain discharges that would be allowed by cruise ships (e.g., “clean wash water”) would be extremely difficult to define based on changing industry standards. The use of such terms could be interpreted differently among stakeholders, which could create compliance and enforcement challenges. Cruise ships are among the largest vessels traversing the sanctuary and the source of a considerable volume of graywater discharges generated by carrying passengers (e.g., showers, laundry, sinks, kitchens). Scientific literature discusses the adverse effects of various cruise ship discharges on the marine environment, including brine from desalination equipment, ballast water, and spa/pool water, among others. It is feasible for cruise ships to successfully avoid discharging or depositing in sanctuary waters because cruise ship operations in sanctuary waters are limited to entering and leaving the port of Key West. In addition, certain routine maintenance activities may occur while a cruise ship is in port within the sanctuary, including deck washdown which may affect water quality. These routine maintenance activities could occur outside of the sanctuary in other less environmentally sensitive ports.

Further, NOAA has reason to believe there may be new and emerging technologies and activities on cruise ships that may result in discharges into ocean waters, such as the increased use of exhaust gas scrubber systems. While recent technology such as engine exhaust gas scrubbers may help reduce air emissions from large vessel engines that use high sulfur fuels, including cruise ships, this results in the pollution being discharged in waste water from the EGCS open loop system. While the wash water is treated before discharge, the discharge still contains metals, polycyclic aromatic hydrocarbons, and higher pH. The long-term accumulation of metals and hydrocarbons in estuaries or harbors is greater, and of more concern to scientists, than the long-term discharge of these contaminants in the open ocean (Teuchies et al., 2020). Cruise ships currently switch to low sulfur fuels when entering harbors and ports where EGCS discharges are prohibited.

ONMS definition for “cruise ship” found in National Marine Sanctuary System-wide regulations at 15 C.F.R. § 922.11 will apply.

In addition, the 2022 NOPR Alternative would simplify and clarify terminology of the existing FKNMS discharge regulation by removing the exception for “exhaust gas” and “water generated by routine vessel operations.”

Final Preferred Alternative

The Final Preferred Alternative is the same as the 2022 NOPR Alternative for discharge regulations.

3.2.3 Shoreline slow speed regulation (proposed update)

Alternative 1: No action (status quo)

Existing sanctuary-wide regulations include regulations (15 C.F.R. § 922.163(a)(5)(iii)(D)) that prohibit operating a vessel at a speed greater than 4 knots or in a manner which creates a wake within 100 yards of residential shorelines. These regulations do not apply within officially marked navigation channels.

Alternative 2

Alternative 2 would retain the existing regulation as described above in Alternative 1: No action.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 would retain the existing regulation as described above in Alternative 1: No action.

Alternative 4

To address impacts to shallow water habitats and dependent wildlife, primarily including nesting, roosting, and foraging bird species, NOAA would update the sanctuary-wide regulation regarding idle speed/no wake within 100 yards of residential shorelines so that it would require “slow speed” and apply to all shorelines within the sanctuary.

The proposed updated sanctuary-wide regulation would prohibit the following:

Operating a vessel on plane or in a manner that creates an extensive wake within 100 yards of all shorelines.

This proposed regulation would maintain the existing exception and would not apply in officially marked navigation channels.

In conjunction with this proposed prohibition, a new definition for “slow speed” would be added to the regulations to clarify the specific applicability of this prohibition, as follows:

Slow speed means that a vessel must be fully off plane and completely settled into the water. The vessel must then proceed at a speed which is reasonable and prudent under the prevailing circumstances so as to avoid the creation of an excessive wake or other hazardous condition which endangers or is likely to endanger other vessels or other persons using the waterway. Due to the different speeds at which vessels of different sizes and configurations may travel while in compliance with this definition, there is no specific numerical speed assigned to slow speed. Vessels that would not meet this slow speed regulation include vessels:

(a) Operating on plane;

*(b) In the process of coming off-plane and settling into the water or coming up onto plane;
or*

(c) Operating at a speed that creates an excessive wake or other hazardous condition which unreasonably or unnecessarily endangers other vessels or other persons using the waterway, or is likely to do so.

This definition is informed by and consistent with state of Florida definitions at 68C-22.002 Florida Administrative Code.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 1: No action for shoreline slow speeds.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 1: No action for shoreline slow speeds.

3.2.4 Temporary Regulation for Emergency and Adaptive Management (proposed update)

Emergency regulations allow the sanctuary to respond to emergencies and unforeseen impacts to sanctuary resources to prevent or minimize the destruction of, loss of, or injury to a sanctuary resource or quality.

Alternative 1: No action (*status quo*)

The existing FKNMS emergency regulation outlined at 15 C.F.R. § 922.165 allows a temporary regulation to be in effect for up to 60 days, with one 60-day extension. Additional extended action requires notice and comment rulemaking under the Administrative Procedures Act.

In addition to the emergency regulation authority, NOAA has the authority to modify the number or location of access restrictions within marine portions of WMAs (15 C.F.R. § 922.164(c)(4)), to temporarily restrict access to portions of SPAs or ERs (15 C.F.R. § 922.164(d)(2)), and to modify the number, location, or designations applicable to SUAs (15 C.F.R. § 922.164(e)(4)). These regulations provide for flexible and adaptive management response to unforeseen impacts to sanctuary resources to prevent or minimize the disturbance, destruction, loss of, or injury to a sanctuary resource or quality. Examples of resource management issues that may require rapid response and intervention include coral bleaching, disease, weather impacts, invasive species, or specific impacts from intense or concentrated human activities.

FKNMS has implemented emergency regulations on four separate occasions. In 1997, the emergency regulation was used to prohibit anchoring of vessels 50 meters or greater in an area of Tortugas Bank, which was shown to have caused significant injury to living coral resources in that area. This temporary prohibition later went through notice and comment rulemaking, including consultation with and approval by the governor of Florida, to become a final rule in August 1998.

In 2002, an area of approximately 0.58 acres was identified as an area to avoid for a period of 45 days (May 15 to June 28), which was then extended for an additional 49 days (June 28 to August 15), due to the presence of heavy construction equipment and to ensure timely and safe restoration activities at the M/V *Wellwood* grounding site. The additional closure days were needed due to poor weather impacting the sanctuary's ability to complete restoration activities in the first time period. In 2003, two areas totaling 425 acres were closed for a period of 60 days (June 26 to August 25) to prevent additional injury to living coral in an area impacted by a rapidly spreading coral disease outbreak.

Most recently, in response to extreme ocean temperatures, NOAA used its emergency authority to create a temporary SUA to protect endangered corals that have been relocated to a nursery in deeper water locations with conditions more conducive to coral survival. This emergency regulation was effective September 6, 2023 through November 6, 2023 ([88 Fed. Reg. 60887 \[Sept. 6, 2023\]](#)) and was extended for an additional 60-days until January 5, 2024. ([88 Fed. Reg. 75229 \[Nov. 2, 2023\]](#)).

Similarly, USFWS has authority to close or restrict access to areas within the Florida Keys National Wildlife Refuge Complex to protect federal trust resources, specifically those areas above the mean high water line where USFWS has exclusive jurisdiction. The Backcountry Management Plan and associated cooperative agreement between the state of Florida and USFWS governs mutually agreed upon regulations within the backcountry state-owned sovereign submerged lands within Key West National Wildlife Refuge and Great White Heron National Wildlife Refuge.

Alternative 2

Sanctuary-wide emergency regulation

Under Alternative 2, NOAA would update the existing emergency regulation (15 C.F.R. § 922.165) to strengthen the sanctuary's ability to more rapidly and flexibly respond to threats impacting sanctuary resources. The proposed regulation would allow

a temporary regulation to be in effect for up to six months (180 days), with one six-month (additional 186-day) extension.

This proposed update would not change the requirement for public notice and comment rulemaking under the Administrative Procedures Act for any actions that extend beyond these timelines. This proposed update is intended to provide NOAA sufficient time to conduct the necessary review and public notice if a rulemaking process is deemed necessary.

Sanctuary marine zone emergency regulations

In addition to the above proposed update to the emergency regulation, NOAA proposes to eliminate the marine zone-specific emergency regulations.

The sanctuary-wide emergency regulation update would provide the management and response flexibility that the existing marine zone-specific regulations allow and would also result in more consistent application, implementation, and public notice requirements. The following marine zone-specific regulations would be eliminated:

WMAs (15 C.F.R. § 922.164(c)(4)),

SPAs or ERs (15 C.F.R. § 922.164(d)(2)), and

SUAs (15 C.F.R. § 922.164(e)(4)).

Proposed updates to the emergency regulation and elimination of the marine zone-specific regulations would be consistent with and are intended to meet the advisory council workplan Item 5: permit procedures and adaptive management. This update to existing regulations would be in direct response to the advisory council's request that the sanctuary: (1) identify potential

resource threats needing rapid management responses not available in the existing regulatory framework, (2) develop, modify, or insert regulatory language to better respond to management challenges or resource protection issues, (3) develop a research and monitoring component to feed adaptive management measures, and (4) allow greater flexibility in modifying zones to address changing resource management needs.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for emergency regulations.

Alternative 4

Alternative 4 is the same as Alternative 2 for emergency regulations.

2022 NOPR Alternative

The 2022 NOPR Alternative is similar to Alternative 2 related to the time extension for which a temporary regulation for emergency and adaptive management could be in place. However, the 2022 NOPR Alternative modifies Alternative 2 with additional details for execution of this regulation.

The proposed additions included in the 2022 NOPR Alternative identify three categories of activities where this Temporary Regulation for Emergency and Adaptive Management would be applied:

- 1) *prevent or minimize destruction of, loss of, or injury to sanctuary resources from any human-made or natural circumstances, including a concentration of human use, change in migratory or habitat use patterns, vessel impacts, natural disaster or similar emergency, disease, or bleaching;*
- 2) *initiate restoration, recovery, or other activities where a delay would undermine the success of the activity; or*
- 3) *initiate research where an unforeseen event produces an opportunity for scientific research that may be lost if it is not initiated immediately.*

Finally, the 2022 NOPR Alternative sets out the procedure by which a temporary regulation would be promulgated. This includes the requirement that the agency provide a justification for the time sensitivity of the action to comply with the Administrative Procedure Act (5 U.S.C. § 553(b)(B)). This procedure also (1) addresses notice and comment requirements, and (2) requires state approval for any temporary regulations proposed in state waters.

Final Preferred Alternative

The Final Preferred Alternative makes one technical change to the 2022 NOPR Alternative. The 2022 NOPR Alternative noted that the Director *shall* receive public comments on the necessity for, and extent of, the temporary regulation for a period of 15 days after the effective date of notification. This final alternative changes the word *shall* to *may*. Where the agency determines that time is available without jeopardizing the effectiveness of the action, NOAA will follow notice and comment procedures before taking action, even for temporary actions. Additionally, the sanctuary may choose to collect public comment for 15 days after issuing an emergency, temporary rule, when in the sanctuary's discretion it determines that post-decision comment

would be worthwhile, such as to inform potential modifications to the emergency or temporary response action and/or its duration.

3.2.5 Historical resources permit categories (proposed update)

Alternative 1: No action (status quo)

The current permit categories for activities involving historical resources include survey/inventory of historical resources, research/recovery of historical resources, and deaccession/transfer of historical resources. Since implementation of the initial 1996 FKNMS management plan, 62 unique historical resource projects have been granted a survey/inventory or research/recovery of historical resources permit. No deaccession/transfer permits have been applied for or issued. Existing historical resources permit requirements are available at 15 C.F.R. § 922.166(b), (c), and (d).

Alternative 2

Based on more than 30 years of historical resource management, issuance of dozens of historical resource permits, and evaluation of the efforts of the permittees towards meeting NOAA's stewardship goals, NOAA has determined that the historical resources permitting process needs revision to improve resource protection and more closely align NOAA permitting regulations with those of the Florida Department of State Division of Historical Resources (DHR) and the Federal Archaeological Program. In consideration of the sensitive non-renewable character of historical resources and the shared stewardship responsibilities of NOAA and Florida DHR, NOAA would modify the historical resources permit categories as follows:

Eliminate the survey/inventory, research/recovery, and deaccession/transfer of historical resources permit categories and replace them with a single archaeological research permit category that is consistent with the standards and procedures implemented by Chapter 1A-32, Florida Administrative Code, for Archaeological Research on State Lands in Florida.

With approximately 50% of the sanctuary lying within state waters (this percentage assumes the overall sanctuary boundary as proposed in Alternative 2), NOAA seeks to reconcile its standards for archaeological research permits by adopting those used by DHR. NOAA believes aligning its permit processes with that of DHR would improve the quality and reporting of historical resource research projects undertaken in the sanctuary, further aiding NOAA with its conservation mandates and advancing interpretation of sanctuary historical resources to the public.

In conjunction with this proposed prohibition, a new definition for “archaeological research” would be added to the regulations to clarify the specific applicability of this prohibition, as follows:

Archaeological research means scientific study of the physical remains of human activity and its surrounding environmental context utilizing research questions to inform society's understanding of the past.

This definition is informed by and consistent with the state's 1A-32 archaeological research permit standards and with the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation.

In conjunction with this proposed change, the Office of National Marine Sanctuaries Instructions for Submitting Applications for National Marine Sanctuary Permits and Authorizations, Appendix I Archaeological Research Permits would be updated.

In addition, an updated draft programmatic agreement with DHR and the ACHP to help NOAA fulfill its responsibilities under Section 106 of NHPA (54 U.S.C. § 306108) was included for reference and comment in the [2019 draft EIS Appendix C](#). This draft programmatic agreement outlined the process the parties would follow to meet their legal obligations under Section 106 of the NHPA, and to manage historical resources within the sanctuary. The signatory parties to the agreement would include NOAA's FKNMS, ACHP, and the Florida SHPO.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for historical resource permit categories.

Alternative 4

Alternative 4 is the same as Alternative 2 for historical resource permit categories.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 2 with the exception that the 2022 NOPR Alternative does not include an explicit definition for “archaeological research.” Instead, the permitting regulations provide more details of the requirements of archaeological research applicants including qualifications and a commitment to develop and follow explicit statements of work for research conducted in the sanctuary.

Final Preferred Alternative

The Final Preferred Alternative is the same as the 2022 NOPR Alternative for sanctuary historical resources permitting.

3.2.6 Fish, shark, and marine species feeding regulation (proposed new)

Marine life feeding is a common practice in the Florida Keys and is conducted at various locations including from shore, from boats, and by divers and snorkelers. Fish feeding is generally conducted in order to attract fish. This practice has resulted in human safety issues and has been shown to alter fish behavior (Milazzo, 2006; Albuquerque et al., 2014; Cruz de Paula et al., 2018).

Alternative 1: No action (status quo)

Existing FKNMS regulations for discharges within the sanctuary boundary do not explicitly or adequately address activities associated with feeding fish, sharks, or other marine life species from vessels or by divers. Existing FKNMS discharge regulations include an exception for discharging fish, fish parts, chumming materials, or bait used incidental to and only while

conducting a traditional fishing activity (15 C.F.R. § 922.163(a)(4)). Existing Florida rule at 68B-5.005 Florida Administrative Code prohibits: (1) divers from engaging in the practice of fish feeding, and (2) anyone from operating any vessel for hire for the purpose of carrying passengers to any site in the saltwaters of the state to engage in fish feeding or to allow such passengers to observe fish feeding. This state regulation does not currently extend into the federal waters of the sanctuary.

Alternative 2

NOAA is proposing a new regulation to explicitly address fish feeding and its threat to sanctuary resources. This new proposed regulation would clarify prohibitions specific to the practice of feeding fish, shark or other marine species.

To address the potential impact that the feeding of fish, sharks, or other marine species poses for human safety, the environment, and changes in behavior of such species, NOAA would update its regulations to

prohibit the feeding of fish, sharks, or other marine species from any vessel and/or while diving.

The proposed regulation would not affect the existing exemption which allows discharge of fish, fish parts, chumming materials, or bait used incidental to and only while conducting a traditional fishing activity in the sanctuary.

In conjunction with this proposed prohibition, the following definitions would be added to the regulations to clarify the specific applicability of this regulation.

Feeding means offering, giving, or attempting to give any food or other substance to fish, sharks, or other marine species, except for the purpose of harvesting such marine species during traditional fishing as defined in FKNMS regulations.

Diving means an activity during which a person who is wholly or partially submerged in the water and is equipped with a face mask, face mask and snorkel, or underwater breathing apparatus. (Note: this definition is consistent with Florida law at 68B-5.005 Florida Administrative Code).

For this proposed prohibition, the ONMS definition for “fish” and “vessel” found at National Marine Sanctuary System-wide regulations at 15 C.F.R. § 922.11 will apply:

Fish means finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds, as defined in the Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. § 1802(12)).

Vessel means a watercraft of any description capable of being used as a means of transportation in or on the waters of a sanctuary. The term includes but is not limited to, motorized and non-motorized watercraft, personal watercraft, airboats, and float planes while maneuvering on the water. For purposes of this part, the terms “vessel,” “watercraft,” and “boat” have the same meaning.

And finally, a revised definition of “traditional fishing” that provides additional clarity and specificity for what is intended would apply:

Traditional fishing means those commercial or recreational fishing activities that were customarily conducted within the sanctuary prior to its designation as identified in the environmental impact statement and management plan (EIS/MP) for this sanctuary, as managed by the appropriate federal (NMFS in coordination with SAFMC, GMFMC) and state (FWC) agencies. Traditional fishing does not include use of novel or new gear types to catch species that were fished by other means as identified in the EIS/MP; does not include use of gear types (modified or not) identified in the EIS/MP to catch species those gear types were not originally intended to catch; or does not include use of gear or harvest of species outside of the seasons/time of year identified in the EIS/MP.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for fish feeding regulations.

Alternative 4

Alternative 4 is the same as Alternative 2 for fish feeding regulations.

2022 NOPR Alternative

The 2022 NOPR Alternative modifies Alternative 2 to include the intent of “attracting.” This updated regulation would

prohibit the feeding and attracting of fish, including sharks, or other marine species, from any vessel or while diving.

The 2022 NOPR Alternative would include the same terminology and definitions for “diving” as proposed in Alternative 2.

The 2022 NOPR Alternative would further modify the definitions for “feeding” and “traditional fishing” as follows

Feeding means offering, giving, or attempting to give any food or other substance to fish, including sharks, or other marine species, except for the purpose of harvesting marine species during traditional fishing

Traditional fishing means those commercial or recreational fishing activities that were customarily conducted within the sanctuary prior to its designation as identified in the 1996 Environmental Impact Statement and Management Plan for this sanctuary (Volume II, pages 84–92). The 1996 EIS and Management Plan is incorporated by reference into this section with the approval of the Director of the Office of the Federal Register in accordance with 5 U.S.C. § 552(a) and 1 C.F.R. part 51.

The purpose of the 2022 NOPR Alternative definition of traditional fishing was to capture the scope of fishing activities that were taking place at the time “traditional fishing” was defined and codified in the 1997 regulations. Importantly, the 2022 NOPR Alternative definition points the reader to the 1996 environmental impact statement and management plan where the fishing

activities taking place in the sanctuary at that time, and therefore considered “traditional,” are described.

And finally, a new definition for “attracting” would be included and is defined in National Marine Sanctuary System-wide regulations at 15 C.F.R. § 922.11.

Attract or Attracting means the conduct of any activity that lures or may lure any animal by using food, bait, chum, dyes, decoys (e.g., surfboards or body boards used as decoys), acoustics or any other means, except the mere presence of human beings (e.g., swimmers, divers, boaters, kayakers, surfers).

Final Preferred Alternative

The Final Preferred Alternative for the regulation specific to feeding or attracting fish, shark, and marine species and associated definitions for “attract or attracting” and “feeding” are the same as the 2022 NOPR Alternative. The associated definitions for “diving,” “fish,” and “vessel” are the same as Alternative 2.

The Final Preferred Alternative modifies the definition for “traditional fishing” that would include fishing activities taking place as of the effective date of the final rule associated with this final EIS. Appendix G of this final EIS provides additional description of the fishing activities managed by the FWC in state waters and in the Exclusive Economic Zone for species over which FWC has extended its management authority, and by NMFS in the Exclusive Economic Zone that are intended to be considered traditional fishing. The updated definition is:

*Traditional fishing means those commercial or recreational fishing activities that are customarily conducted within the sanctuary as of the effective date of the final 2025 sanctuary regulations.*⁴

3.2.7 Vessel groundings and derelict and deserted vessels regulation (proposed new)

Derelict and deserted vessels are an ongoing and persistent threat to the marine environment of the Florida Keys.

Alternative 1: No action (status quo)

Currently, removal of grounded derelict or deserted vessels and the harmful matter aboard such vessels (e.g., motor oil, fishing gear that could cause entanglement) is not specifically required unless a discharge has occurred, the vessel or harmful matter has altered the seabed, or the vessel or harmful matter resulted in the destruction, loss, or injury to a sanctuary resource. Existing FKNMS regulations do not include a requirement to provide notice of a grounded vessel to the sanctuary.

⁴ NOAA intends to include the effective date of the final 2025 sanctuary regulations for FKNMS in the regulatory text of the definition “traditional fishing” in 15 C.F.R. § 922.162.

Alternative 2

To address concerns regarding the potential threats to the marine environment from derelict or deserted vessels and to require vessel owners to take care of deserted vessels before they become grounded and cause damage, NOAA would:

prohibit anchoring, mooring, or occupying a vessel at risk of becoming derelict, or deserting a vessel aground, at anchor, or adrift in the sanctuary.

This proposed new regulation would be consistent with other national marine sanctuary regulations (see 15 C.F.R. §§ 922.81 and 922.131) and Section 823.11 Florida Statutes. When implementing this proposed regulation, NOAA would take into consideration the criteria outlined in Section 327.4107 Florida Statutes: “Vessels at risk of becoming derelict on waters of [the] state.”

In conjunction with this proposed prohibition, new definitions for “at risk” and “deserting” would be added to the regulations to clarify the specific applicability of this prohibition.

Consistent with definitions applicable in other national marine sanctuaries:

Deserting means leaving a vessel aground or adrift without notification to the director of the vessel going aground or becoming adrift within 24 hours of its discovery and developing and presenting to the director a preliminary salvage plan within 72 hours of such notification, after expressing or otherwise manifesting intention not to undertake or to cease salvage efforts, or when the owner/operator cannot after reasonable efforts by the director be reached within 24 hours of the vessel’s condition being reported to authorities; or leaving a vessel at anchor when its condition creates potential for a grounding, discharge, or deposit and the owner/operator fails to secure the vessel in a timely manner.

The 24-hour and 72-hour timeframes for responding to vessel grounding incidents are consistent with Section 403.93345 Florida Statutes, “Florida Coral Reef Protection Act.”

Once a vessel is grounded there is a high risk of discharge of harmful matter into the marine environment. Currently, removal of harmful substances (e.g., motor oil, gear that could cause entanglement) is not specifically required unless a discharge has occurred. Therefore, NOAA is proposing to

prohibit leaving harmful matter aboard a grounded or deserted vessel in the sanctuary.

In conjunction with this proposed prohibition, in the draft EIS, NOAA had proposed to include a definition for “harmful matter” as part of this proposed action. Since publication of the 2019 draft EIS, NOAA has promulgated the same definition (see below), under the ONMS-wide regulations (88 Fed. Reg. 958 [Jan. 6, 2023]) at 15 C.F.R. § 922.11. This definition now applies to all national marine sanctuaries including FKNMS, negating the need to define “harmful matter” in FKNMS regulations at 15 C.F.R. § 922 subpart P.

Harmful matter means any substance or combination of substances that, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a present or potential threat to FKNMS resources or qualities. Such substances or a combination of substances may include, but is not limited to, fishing nets, fishing line,

hooks, fuel, oil, and hazardous substances as defined by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 42 U.S.C. § 9601) at 40 C.F.R. § 302.4.

These new regulatory provisions would help reduce or avoid harm to FKNMS resources from derelict vessels as a result of direct impacts from the settling or colliding of a vessel on habitats and potential leakage of harmful matter from a vessel. NOAA would have the authority to enforce removal of deserted vessels to prevent potential groundings, collisions, or discharge of harmful materials that could harm FKNMS resources. Under existing authorities, vessel owners can be held liable for groundings and associated fuel spills that violate seabed disturbance or discharge regulations. The main purpose of the proposed regulations is to facilitate response activities and make enforcement easier.

Once a vessel is grounded, removal and salvage of the vessel is necessary. There are no guidelines or regulations specific to towing and salvage operations in sanctuary waters. Therefore, NOAA would work with the towing and salvage industry to develop a suite of guidelines and best practices and apply the existing sanctuary general permit category to certain towing and salvage operations. See the management plan in Appendix A for more details.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for the regulation of derelict and deserted vessels.

Alternative 4

Alternative 4 is the same as Alternative 2 for the regulation of derelict and deserted vessels.

2022 NOPR Alternative

The 2022 NOPR Alternative is similar to the 2019 draft EIS Alternative 2, but no longer includes a definition for “harmful matter” because this term was defined, using the same definition proposed Alternative 2, in the ONMS-wide regulations (88 Fed. Reg. 958 [Jan. 6, 2023]) at 15 C.F.R. § 922.11, which were promulgated after NOAA published the draft EIS. NOAA also considers a definition of vessels “at-risk of becoming derelict” that matched Section 823.11 of Florida Statutes.

Final Preferred Alternative

The Final Preferred Alternative is similar to the 2022 NOPR Alternative with slight modifications to the definitions and prohibitions to more clearly harmonize the sanctuary regulations with the state of Florida’s derelict vessel regulations at Section 823.11 Florida Statutes and Section 403.93345 Florida Statutes, “Florida Coral Reef Protection Act.” The changes include adding a new definition of “derelict” that matches the Florida Statutes definition, and more clearly explaining the timelines for notice and removal in the prohibition pertaining to such vessels under 922.163 rather than within the various definitions.

NOAA would prohibit:

Anchoring, mooring, deserting, operating, or occupying a derelict vessel or a vessel at risk of becoming derelict, or deserting a vessel aground or adrift in the sanctuary. Deserted vessels, derelict vessels, or vessels at risk of becoming derelict, must be removed within 72

hours of when the vessel owner or operator receives telephonic notice, in-person notice recorded on an agency approved body camera, or written notice which may be provided by facsimile, electronic mail, or other electronic means, stating removal is necessary from the Director or any authorized officer or the Director makes reasonable attempts to provide notice using any of these means, unless the Director agrees that extenuating circumstances, such as weather or marine hazards, would prevent safe removal, or if removal is consistent with a removal plan approved by the Director. The owner and/or operator must remove or cause the removal of the vessel in a manner that avoids injury to sanctuary resources and shall consult with the Director in accomplishing this task. The Director may require the preparation of and approval of a removal plan.

Deserting would be defined as:

Leaving a vessel unoccupied that is adrift, aground, derelict, or at risk of becoming derelict unless: (1) within 24 hours of leaving such a vessel, the Director has been notified or it has been more than 24 hours since the Director made a reasonable attempt to notify a vessel owner/operator of an unoccupied vessel adrift, aground, derelict, or at risk of becoming derelict, and the vessel owner/operator has not responded; and (2) removing or causing to be removed a vessel has been removed within 72 hours in accordance with 15 CFR 922.163(a)(5)(i) or (viii).

3.2.8 Large vessel mooring buoy regulation (proposed new)

Mooring buoys serve as an important management tool in FKNMS, providing boaters the ability to moor their vessel safely and avoid damaging coral reefs and other important ecosystems. However, mooring buoy use by large vessels has been shown to damage the mooring buoy anchoring hardware and in some cases the substrate to which the hardware is secured.

Alternative 1: No action (status quo)

Existing FKNMS regulations do not include regulations specific to vessel size and mooring buoy requirements. Current restrictions of marker and mooring buoys include a prohibition on damaging or removing markers, including mooring buoys (15 C.F.R. § 922.163(a)(8)).

Alternative 2

NOAA is proposing a new regulation that would prevent mooring buoy damage by requiring vessels of a certain length to use mooring buoys of a specific size:

Require vessels over 65' length overall to use large vessel designated FKNMS mooring buoys. Require vessels under 65' length overall to use small designated FKNMS mooring buoys.

This proposed regulation would also apply to vessels rafting up to one another on a single mooring buoy if their combined length is or would be equal to or greater than 65' length overall. In conjunction with this prohibition, NOAA would designate specific "large vessel only" (65' length overall) mooring buoys in areas frequented by large vessels, which would facilitate compliance with this proposed new regulation and ensure mooring buoy availability for both small and large vessels. Vessels less than 65' length overall would not be permitted to use the

mooring buoys designated for large vessels. NOAA would work with various user groups to ensure that an adequate number of small and large vessel mooring buoys would be available and placed at appropriate locations.

In conjunction with this proposed prohibition, a new definition for “large vessel” would be added to the regulations to clarify the specific applicability of this prohibition.

Large vessel means a vessel greater than 65’ length overall, or the combined lengths of more than one vessel if, when tied together, the vessels are or would be greater than 65’ length overall.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for large vessel mooring buoy regulation.

Alternative 4

Alternative 4 is the same as Alternative 2 for large vessel mooring buoy regulation.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 2 for large vessel mooring buoy regulation.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 2 but includes an upper size limit for vessel use of sanctuary mooring buoys. This revised proposed regulation would

Require vessels over 65’ length overall to use large vessel designated FKNMS mooring buoys. Require vessels under 65’ length overall to use small designated FKNMS mooring buoys. Prohibit tying a vessel greater than 100’ length overall, or tying more than one vessel if the combined lengths would exceed 100’ length overall, to a mooring buoy.

The definition for *large vessel* is the same as Alternative 2.

However, specific to this regulation, NOAA would delay the effective date for the large vessel mooring buoy requirement for two years beyond the effective date of the final regulation. The purpose of this delay is to provide NOAA with adequate time to finalize a mooring buoy plan, including numbers and locations of mooring buoys, to secure materials, and to install new mooring buoys. Until this provision is effective, large vessels may continue to use regular mooring buoys.

3.2.9 Overnight use of mooring buoys regulation (proposed new)

As noted above, mooring buoys serve as an important management tool in FKNMS providing boaters the ability to moor their vessels safely and avoid damaging coral reefs and other important ecosystems. Mooring buoys are currently provided as a free service to the many boaters that visit the Florida Keys every year and are available on a first come, first serve basis. There has been a recent increase in overnight use of FKNMS mooring buoys by individuals using commercial and/or private services that provide overnight lodging rentals. Longer duration and overnight use of mooring buoys has the potential for individuals to unfairly monopolize and

monetize a government resource in the sanctuary. Mooring buoys are intended to increase accessibility while reducing impact to critical and sensitive natural resources. Longer term and overnight use of mooring buoys can also provide access and opportunity for an individual to illegally take natural resources (e.g., fish, invertebrates) from marine zones (where many mooring buoys are located) with less potential oversight from other boaters and enforcement officers.

Alternative 1: No action (status quo)

Existing FKNMS regulations do not include regulations specific to overnight use of mooring buoys.

Alternative 2

To facilitate equitable access to the mooring buoys and ensure compliance with sanctuary rules while at mooring buoys, NOAA is proposing a new regulation that would prohibit overnight use of FKNMS's mooring buoy systems:

Prohibit overnight use of any designated FKNMS mooring buoys.

An exception to this regulation would apply to vessels seeking safe harbor and to vessels permitted to use mooring buoys in Tortugas North ER.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for regulation of the overnight use of mooring buoys.

Alternative 4

Alternative 4 is the same as Alternative 2 for regulation of the overnight use of mooring buoys.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 1: No action for regulation of the overnight use of mooring buoys.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 1: No action for regulation of the overnight use of mooring buoys.

Table 3.2. Sanctuary-wide regulations: Summary of alternatives

Regulation Title	Alternative 1 (No action: status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
3.2.1 Live rock aquaculture	No Action: Current regulation, 15 C.F.R. § 922.163(a)(2)(ii): Prohibits harvesting, or attempting to harvest, any live rock from the sanctuary, or possessing (regardless of where taken from) any live rock within the sanctuary, except as authorized by a permit for the possession or harvest from aquaculture operations in the Exclusive Economic Zone, issued by the NMFS pursuant to applicable regulations under the appropriate Fishery Management Plan, or as authorized by the applicable state authority of competent jurisdiction within the sanctuary for live rock cultured on state submerged lands leased from the state of Florida, pursuant to applicable state law.	Same as Alternative 1	Retain existing regulation, and develop a memorandum of agreement/understanding with the state of Florida and NMFS for management and permitting of live rock aquaculture activities in the sanctuary. This is a management plan activity; see Section 3.5 for details.	Require sanctuary authorization for existing and any future live rock aquaculture activities.	Same as Alternative 3: no change to regulation; but includes a management action (2019 draft EIS preferred)	Same as Alternative 3 (2019 draft EIS preferred)

Regulation Title	Alternative 1 (No action: status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
3.2.2 Discharge regulation exception update	No action: Current regulation, 15 C.F.R. § 922.163(a)(4): Prohibits. (i) Discharging or depositing, from within the boundaries of the sanctuary, any material or other matter, except (B) water generated by routine vessel operations (e.g., deck wash down and graywater as defined in section 312 of the Federal Water Pollution Control Act), excluding oily wastes from bilge pumping.	Prohibit discharge of any material or other matter from a cruise ship except clean vessel engine cooling water, clean vessel generator cooling water, vessel engine or generator exhaust gas, clean bilge water, or clean anchor wash water.	Same as Alternative 2	Same as Alternative 2	Modified Alternative 2: Prohibit discharging or depositing any material or other matter from a cruise ship, except cooling water, within the boundary of the sanctuary	Same as NOPR Alternative
3.2.3 Shoreline slow speed zone	No action: Current regulation, 15 C.F.R. § 922.163(a)(5): Prohibits (iii) Except in officially marked channels, operating a vessel at a speed greater than 4 knots or in a manner which creates a wake: (D) within 100 yards of residential shorelines.	Same as Alternative 1	Same as Alternative 1	Extend this prohibition to apply to all shorelines within the sanctuary and modify the restriction to slow speed.	Same as Alternative 1	Same as Alternative 1
3.2.4 Emergency regulation	No action: Current regulation, 15 C.F.R. § 922.165: A temporary regulation to be in effect for up to 60 days, with one 60-day extension.	A temporary regulation to be in effect for up to six months (180 days), with one six-month (additional 186-day) extension. Eliminate zone specific emergency regulations.	Same as Alternative 2	Same as Alternative 2	Similar to Alternative 2 with additional details Including specific categories for application and sets out process for implementation	Same as NOPR Alternative

Regulation Title	Alternative 1 (No action: status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
3.2.5 Historical resources	No action: The current permit categories for activities involving historical resources include survey/inventory of historical resources, research/recovery of historical resources, and deaccession/transfer of historical resources.	Eliminate the survey/inventory, research/recovery, and deaccession/transfer of historical resources permit categories and replace them with a single archaeological research permit category that is consistent with the standards and procedures implemented by Chapter 1A-32, Florida Administrative Code, for Archaeological Research on State Lands in Florida.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.2.6 Fish feeding	No action: Currently not explicitly regulated unless such action results in discharge, or destruction, loss, or injury to a sanctuary resource.	Prohibit the feeding of fish, sharks, or other marine species from any vessel and/or while diving.	Same as Alternative 2	Same as Alternative 2	Prohibit attracting or feeding fish, including sharks, or other marine species from any vessel and/or while diving.	Same as NOPR Alternative

Regulation Title	Alternative 1 (No action: status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
3.2.7 Vessel grounding, deserted vessels, and abandoning gear	No action: Currently not explicitly regulated unless such action results in discharge, alteration to the seabed, or destruction, loss, or injury to a sanctuary resource.	Prohibit anchoring, mooring, or occupying a vessel at risk of becoming derelict, or deserting a vessel aground, at anchor, or adrift in the sanctuary.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2 and includes a definition of derelict
		Prohibit leaving harmful matter aboard a grounded or deserted vessel in the sanctuary.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.2.8 Large vessel mooring buoy	No action: Currently not regulated.	Require vessels over 65' length overall to use large vessel designated FKNMS mooring buoys. Require vessels under 65' length overall to use small designated FKNMS mooring buoys.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Similar to Alternative 2 and includes an upper size limit of 100' length overall
3.2.9 Overnight use of mooring buoys	No action: Currently not regulated.	Prohibit overnight use of FKNMS mooring buoys, except for safe harbor.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1

3.3 Component 3 – Proposed Modifications to Marine Zone Boundaries by Alternative

NOAA is evaluating alternatives that revise existing and establish new marine zone designations for many reasons. Since the original sanctuary management plan, regulations, and marine zone designation in 1997, much has changed in relation to specific habitats and marine species that could benefit from modified or enhanced marine zone designation. Marine zone designation could: provide additional conservation protections for significant and sensitive habitats, including seven federally listed coral species protected under the ESA; facilitate important research opportunities to advance the science of coral reef ecosystem restoration and recovery; and protect large contiguous habitats that serve as natural spawning and nursery sites and permanent residence areas for many marine species. There is also a need to minimize and mitigate threats to habitats and species as a result of heavy, concentrated, and conflicting uses. Targeted marine zone designation could allow sustainable use while also separating conflicting uses and managing high intensity and concentrated use activities. Additionally, there is a need to simplify and, where possible, make the marine zone regulations and access restrictions consistent within each zone type and with state of Florida regulations and practice.

The marine zone alternatives are presented slightly differently than other alternative components in this chapter. Each alternative includes all zone types so the alternative description below is presented as a package of complementary marine zones (e.g., WMAs, SPAs, etc.) for each alternative, rather than presenting each zone type and its alternatives individually (e.g., all WMAs alternatives together). For a description of the purpose of each zone type, see 3.3.1.

Alternative 1 is the No Action Alternative and represents no change in the current FKNMS marine zones.

Alternative 2 provides additional targeted protection to resources not sufficiently protected by the existing marine zones and/or areas with degraded or impacted resources to facilitate recovery. Alternative 2 places greater emphasis on allowing sustainable public use and is specifically designed to minimize conflicting and heavy concentrations of use in the proposed marine zones while still allowing a relatively high level of overall use.

Alternative 3 places greater emphasis on resource protection in sensitive areas and applies greater access restrictions in those areas. This alternative proposes to establish limited use areas to further promote sustainable use and test the effectiveness of limited use areas in the sanctuary. Alternative 3 is NOAA's preferred alternative.

Alternative 4 provides the greatest level of protection for targeted site-specific locations where resource damage is evident while also protecting the largest area of contiguous habitats compared to the other three alternatives. Under Alternative 4, some marine zones would be combined and new larger zones would be included in each of the five geographic regions (Upper Keys, Middle Keys, Lower Keys, Marquesas, and Tortugas). This approach aims to more fully meet Goal 2 of the Advisory Council Regulatory and Zoning Alternatives Development Workplan to *protect large, contiguous, diverse, and interconnected habitats that provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic*

protection of marine life and protect and preserve all habitats and species. This alternative includes the greatest conservation protection measures and most restrictive public access recommendations in comparison to the other three alternatives.

The NOPR Alternative combined individual aspects of each of the four alternatives presented in the draft EIS primarily aimed at creating a balance between additional protection of sanctuary resources and allowing the greatest level of use given those resource protection goals. Marine zone sizes and regulations in this alternative also specifically considered user understanding, compliance, and enforcement.

The Final Preferred Alternative further refined the 2022 NOPR Alternative based on public and agency comment, updated environmental and user data, and expert input. In addition, in light of the increasing stressors sanctuary resources are experiencing, the Final Preferred Alternative considered action that would support and facilitate resilience and recovery of habitats and species throughout the sanctuary and within or moving through the individual marine zones.

Summary tables for each marine zone alternative are included at the end of this section.

See Section 3.6: Boundary and marine zone maps for individual marine zone maps for the Final Preferred Alternative. See Appendix B for regional maps for the 2019 draft EIS and 2022 NOPR Alternatives.

Existing marine zone types – Background (Alternative 1, status quo)

Currently, FKNMS has five distinct marine zone types, each with a specific resource management goal as outlined below:

- 1) WMAs: protect shallow water habitats and wildlife that are dependent on those and other nearshore habitats;
- 2) SPAs: protect significant patch and fore-reef coral reef areas, limit consumptive activities, and separate users engaged in conflicting activities;
- 3) ERs: protect larger contiguous habitats, which include a wide range of habitats including shallow water seagrass, hardbottom, and coral reefs that support life cycle needs of marine wildlife (e.g., spawning sites, nursery habitat, etc.); and
- 4) SUAs: an umbrella category of marine zones that can be applied for specific management goals including:
 - Recovery area;
 - Restoration area;
 - Research-only area; and
 - Facilitated-use area.

Currently, the only SUA zone type in FKNMS is the research-only area. All of these research-only areas are located in coral reef areas and were established to limit use and allow scientists to differentiate between impacts caused by use and those caused by changing environmental conditions.

Note that for all but the No Action Alternative, the existing SUA and ER zone types are proposed to be combined into one zone type called “conservation area” (CA).

- 5) EMA: management areas that existed at the time of FKNMS designation and include Key Largo National Marine Sanctuary (Key Largo EMA), Looe Key National Marine Sanctuary (Looe Key EMA), and the national wildlife refuges, each with associated regulations at 15 C.F.R. § 922.164(b).

In addition to protecting habitats and ecosystems, each marine zone has associated regulations designed to meet the stated purpose of the marine zone type and specific resource protection goals at each location (see 15 C.F.R. § 922.164).

3.3.1 Marine zones within Alternative 1 (status quo)

Wildlife management areas (Alternative 1, no action)

In the No Action Alternative, there are 28 existing WMAs, 20 of which are within the boundary and jurisdiction of the Refuge Complex. NOAA is including the Tortugas Bank No Anchor Zone area in this zone type category as the regulations are similar to other WMAs.

For a full list of existing WMAs and associated marine zone-specific regulations, see 15 C.F.R. § 922.164(c) and Appendix III to subpart P of part 922.

Sanctuary preservation areas (Alternative 1, no action)

In the No Action Alternative, there are 19 existing SPAs. Although Western Sambo ER is categorized as an ER, NOAA is including it in this zone type category as the regulations are similar to other SPAs.

For a full list of existing SPAs and associated regulations, see 15 C.F.R. § 922.164(d) and Appendix V to subpart P of part 922.

Ecological reserves (Alternative 1, no action)

In the No Action Alternative, there are two existing ERs, Tortugas North and South, which are both transit only. However, Tortugas North has a specific regulation that allows access with a Tortugas North access permit. While Western Sambo is categorized as an ER, regulations within this zone are similar to a SPA and NOAA is not including it in this zone type category. ERs are intended to protect large contiguous habitats including those habitats necessary to support the full life cycle of a range of species.

For a full list of existing ERs and associated site-specific regulations, see 15 C.F.R. § 922.164(d) and Appendix IV to subpart P of part 922.

Special use areas (Alternative 1, no action)

In the No Action Alternative, current FKNMS regulations allow for four types of SUAs: recovery area, restoration area, research-only area, and facilitated-use area. However, only one type of SUA—research-only area—is currently used. There are four existing SUA research-only areas, all of which are in coral reef habitat and are transit-only with certain activities allowed by permit.

For a full list of existing SUAs and their associated site-specific regulations, see 15 C.F.R. § 922.164(e) and Appendix VI to subpart P of part 922.

Existing management areas (Alternative 1, no action)

In the No Action Alternative, there are four areas referred to as EMAs. EMAs are those areas that existed when FKNMS was designated in 1990. These include Key Largo EMA, Looe Key EMA, and the Florida Keys National Wildlife Complex Refuges.

Note that for all but the No Action Alternative, the existing EMA zone type name would no longer be used (i.e., Looe Key and Key Largo would be referred to as management areas (MAs) and the national wildlife refuges would simply be referred to as national wildlife refuges rather than an EMA).

For a full list of existing EMAs and associated site-specific regulations, see 15 C.F.R. § 922.164(b) and Appendix II to subpart P of part 922.

3.3.2 Modifications to marine zones within Alternative 2

Marine zones included in Alternative 2 would provide additional targeted protections to areas with demonstrated natural resource impacts (e.g., vessel propeller scarring) and with sensitive habitats and wildlife. Compared to Alternatives 3 and 4, this alternative places greater emphasis on allowing public use. Alternative 2 is specifically designed to reduce conflicting and heavy concentrations of use while still allowing a relatively high level of overall use. This alternative would maintain many of the marine zones in the No Action Alternative and would add 39 new marine zones to provide additional, site-specific protection where resource damage is evident. In addition, compared to the other action alternatives, these new zones would have the least restrictive regulations needed to meet the resource protection goals set by the advisory council and the FKNMSPA.

Specifically, Alternative 2 would add 31 WMAs, six SPAs, and two CAs compared to the No Action Alternative. The CA is a new proposed zone type that would include what are now the existing ERs and SUAs. Alternative 2 maintains Key Largo and Looe Key as MAs.

Wildlife management areas (Alternative 2)

A total of 59 WMAs are proposed (31 new areas compared to the No Action Alternative). The modified or proposed new WMAs would provide additional, site-specific protection where resource damage is evident and the least restrictive regulations would be applied to meet the resource protection goals set by the advisory council and the FKNMSPA. Regulations for WMAs are and would continue to be specific to sanctuary resource needs and therefore vary by zone. Proposed regulations would include vessel restrictions on access, anchoring, and speed, and are designed to protect seagrass, hardbottom, and other critical shallow water habitats and associated wildlife including fish, birds, and turtles.

Sanctuary preservation areas (Alternative 2)

A total of 25 SPAs are proposed (six new areas compared to the No Action Alternative). Differences in regulations from the No Action Alternative include the addition of idle speed/no wake and no anchor, a three-year phase-out for the issuance of permits for bait fishing (see

3.4.4), and elimination of catch and release by trolling in the four SPAs where it is currently allowed (see 3.4.3) (i.e., Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key SPAs).

Conservation areas (Alternative 2)

(In Alternative 1: No action these are included as ERs and SUAs)

The CA is a proposed new zone type. The existing SUA and ER zone names would no longer be used. The proposed regulation for CAs is transit-only (without a valid sanctuary permit). This represents no change from the existing regulation applied in ERs and SUAs.

A total of eight CAs are proposed (two new areas compared to the No Action Alternative, which includes two ERs and four SUAs). New habitat types, specifically hardbottom, bank, and seagrass, would be included in Alternative 2.

Management areas (Alternative 2)

(In Alternative 1: No action these zones are referred to as EMAs)

Alternative 2 proposes removing the term “existing management area” and referring to these marine zones by their name (e.g., Looe Key MA, Key Largo MA). There would be no change to the spatial area of Key Largo MA. The Looe Key MA would be decreased to include only the western portion of the existing zoned area. Differences in regulations from the No Action Alternative include a proposed no anchor regulation in both Key Largo and Looe Key MAs.

Key West National Wildlife Refuge and Great White Heron National Wildlife Refuge would no longer be referred to as EMAs but would simply be zoned as national wildlife refuges with overlapping and complementary jurisdiction to the sanctuary. In the national wildlife refuges, all regulations in the No Action Alternative would be maintained, with the exception of a small area in Key West National Wildlife Refuge where operation of PWC would be permitted. This proposed regulation change would not affect the refuge boundary (see Section 3.4.1 and Figure 3.2).

3.3.3 Modifications to marine zones within Alternative 3 (2019 draft EIS preferred alternative)

Alternative 3 places greater emphasis on resource protection over allowing a high level of use. Alternative 3 proposes to maintain many of the marine zones in the No Action Alternative and would also add marine zones (41 more than Alternative 1, and two more than Alternative 2) to provide additional, targeted site-specific protection where resource damage is evident. This alternative includes increased conservation protection measures and more restrictive access recommendations than the No Action Alternative and Alternative 2. ONMS used the information discussed through the working group process and additional input from other NOAA offices, other agencies, and the research community to develop components of this alternative.

Specifically, Alternative 3 would add 32 WMAs (one more than Alternative 2), seven SPAs (one more than Alternative 2), and two CAs (the same as Alternative 2) compared to the No Action Alternative.

Wildlife management areas (Alternative 3, 2019 draft EIS preferred)

A total of 60 WMAs are proposed (32 additional from the No Action Alternative and one more than Alternative 2). In Alternative 3, more protective access restrictions would be applied (e.g., no entry) in many of the proposed modified or new WMAs to meet the resource protection goals set by the advisory council and the FKNMSPA, and to meet the policies and purposes of the national wildlife refuges. Regulations for WMAs would still vary by zone and would include vessel restrictions on access, anchoring, and speed to protect seagrass, hardbottom, and other critical shallow water habitats and associated wildlife including fish, birds, and turtles.

Sanctuary preservation areas (Alternative 3, 2019 draft EIS preferred)

A total of 26 SPAs are proposed (seven additional compared to the No Action Alternative and one more than Alternative 2). Differences in regulations from Alternative 2 include three SPAs (Carysfort, Sombrero, and Sand Key) that would be limited use areas, accessible by Blue Star Dive Operators only (see Section 3.4.5). All other proposed regulations included in Alternative 2 would apply.

Conservation areas (Alternative 3, 2019 draft EIS preferred)

(In Alternative 1: No action these are included as ERs and SUAs.)

A total of eight CAs are proposed (two additional compared to the No Action Alternative, which includes two ERs and four SUAs). There are no differences between Alternative 2 and Alternative 3 for CAs.

Management areas (Alternative 3, 2019 draft EIS preferred)

(In Alternative 1: No action these zones are referred to as EMAs.)

Alternative 3 would maintain all the proposed actions as outlined in Alternative 2 for Key Largo and Looe Key MAs.

In the national wildlife refuges, Alternative 3 would maintain the exception of a small area in Key West National Wildlife Refuge where operation of PWC would be permitted (see Section 3.4.1 and Figure 3.2 for details).

3.3.4 Marine zones within Alternative 4

Alternative 4 is primarily designed to protect large contiguous habitats. This alternative strives to meet a balance between protecting site-specific locations where resource damage is evident while also protecting the largest area of contiguous habitats compared to the other alternatives proposed. To do this, some marine zones are proposed to be combined and larger zones are included in each of the five geographic regions (Upper Keys, Middle Keys, Lower Keys, Marquesas, and Tortugas). This approach aims to more fully meet Goal 2 of the Advisory Council Regulatory and Zoning Alternatives Development Workplan: *Protect large, contiguous, diverse, and interconnected habitats that provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic protection of marine life and protect and preserve all habitats and species*. The marine zone-specific regulations and access restrictions would be more restrictive in Alternative 4 than in any of the other proposed alternatives. This

alternative includes the greatest conservation protection measures and most restrictive access recommendations over all the other three alternatives.

Specifically, Alternative 4 would add 31 WMAs (no change from Alternative 2), three SPAs (three less than are included in both Alternatives 2 and 3), and seven CAs (five more than is included in Alternatives 2 and 3) compared to the No Action Alternative.

Wildlife management areas (Alternative 4)

A total of 59 WMAs are proposed (31 additional from the No Action Alternative, the same as Alternative 2, and one less than Alternative 3). Alternative 4 would include similar access restrictions to those included in Alternative 3. However, in some areas, rather than a 100-yard contour zone around an island, the zone would be squared off for easier marking, enforcement, and compliance.

In addition to specific WMA zone alternatives, Alternative 4 includes an update to an existing sanctuary-wide regulation. The existing operation of vessels regulation at 15 C.F.R. § 922.163(a)(5)(iii)(D), which prohibits operating a vessel at a speed greater than four knots or in a manner which creates a wake within 100 yards of residential shorelines, would be modified to require “slow speed” and apply to all shorelines within the sanctuary (for more details see Section 3.2.3).

Sanctuary preservation areas (Alternative 4)

A total of 22 SPAs are proposed (three additional compared to the No Action Alternative, three less than Alternative 2, and four less than Alternative 3). All proposed regulations included in Alternative 2 would apply and the limited use SPA proposal in Alternative 3 would also apply, with the exception of Carysfort SPA. In Alternative 4, Carysfort SPA is proposed to be expanded to extend from the shoreline to the deep reef in an effort to meet the advisory council principle for this management plan review process, that: *Each habitat type should be represented in a non-extractive marine zone in each of the biogeographically distinct subregions of Florida Keys National Marine Sanctuary to achieve replication. The sub regions identified were the Tortugas; Marquesas; and Lower, Middle, and Upper Keys.*

Conservation areas (Alternative 4)

(In Alternative 1: No action these are included as ERs and SUAs)

A total of 13 CAs are proposed (seven additional CAs compared to the No Action Alternative and five additional CAs compared to Alternatives 2 and 3). Alternative 4 includes the largest number of this zone type in an effort to meet the advisory council principle for this management plan review process, that: *Each habitat type should be represented in a non-extractive marine zone in each of the biogeographically distinct subregions of Florida Keys National Marine Sanctuary to achieve replication. The sub regions identified were the Tortugas; Marquesas; and Lower, Middle, and Upper Keys.*

Several of the zones in this alternative were discussed by the advisory council working groups but not included as part of their final recommendations to the advisory council, in particular the Long Key/Tennessee Reef, Western Dry Rocks, and Tortugas Spawning Corridor CAs.

Management areas (Alternative 4)

(In Alternative 1: No Action these zones are referred to as EMAs)

Alternative 4 would maintain all the proposed actions as outlined in Alternative 2 for Key Largo and Looe Key MAs and Key West National Wildlife Refuge where operation of PWC would be permitted (see Section 3.4.1 and Figure 3.2 for details).

3.3.5 Marine Zones within the 2022 NOPR Alternative

The 2022 NOPR Alternative combined individual aspects of each of the four alternatives presented in the 2019 draft EIS. This alternative is primarily aimed at creating a balance between additional protection of sanctuary resources and allowing the greatest level of user access within marine zones given the resource protection goals and additional considerations such as user understanding, compliance, and enforcement. The 2022 NOPR Alternative includes five marine zone types: WMAs, SPAs, restoration areas (RAs), CAs, and MAs. The RA zone type is a proposed new zone type not included in any of the 2019 draft EIS Alternatives. However, several of the areas included as RAs were proposed as SPAs in the 2019 draft EIS alternatives.

Wildlife management areas (2022 NOPR Alternative)

A total of 47 WMAs are proposed, of which 23 are proposed new zones. Two existing zones are proposed to be eliminated. The 2022 NOPR Alternative is a blend of all the 2019 draft EIS alternatives. The sizes, shapes, and regulations applied in this alternative aim to allow the greatest level of user access compatible with the specific resource protection goals. However, if data and expert input indicated the need for more protective access restrictions ONMS favored protection over access. Regulations for WMAs would still vary by zone and would include vessel restrictions on access, anchoring, and speed to protect seagrass, hardbottom, and other critical shallow water habitats and associated wildlife including fish, birds, and turtles.

Sanctuary preservation areas (2022 NOPR Alternative)

A total of 17 SPAs are proposed in the 2022 NOPR Alternative. The 2022 NOPR Alternative expands two existing SPAs (Carysfort Reef and Alligator Reef) to capture deep reef habitat, connects the existing Key Largo Dry Rocks and Grecian Rocks SPAs, slightly expands Sombrero Key SPA, eliminates the existing French Reef and Rock Key SPAs, creates two new SPAs at Turtle Rocks and Turtle Shoal, and makes no spatial changes to the eleven existing SPAs: The Elbow, Molasses Reef, Conch Reef, Davis Reef, Hen and Chickens, Cheeca Rocks, Coffins Patch, Newfound Harbor Key, Looe Key, Eastern Dry Rocks, and Sand Key SPAs.

This alternative most closely aligns with the 2019 draft EIS Alternative 2. Differences include a smaller and more targeted area proposed for combining Key Largo Dry Rocks and Grecian Rocks SPAs, the proposed elimination of two existing SPAs (French Reef and Rock Key), three zones that were included as SPAs in Alternative 2 are included as RAs in the 2022 NOPR Alternative, and two areas included in Alternative 2 as proposed new SPAs (Snapper Ledge and Delta Shoal) are not included in the 2022 NOPR Alternative.

SPA regulations included in the 2022 NOPR Alternative are the same as those proposed in the 2019 draft EIS Alternative 2 with the exception of idle speed no wake, which is not included in

this alternative. The 2022 NOPR Alternative would eliminate the current exception for catch and release fishing in four existing SPAs where it is currently applied (Conch Reef, Alligator Reef, Sombrero Key, and Sand Key) and eliminate the practice of issuing bait fishing permits (see Section 3.4 Component 4—Proposed modifications to marine zone regulations by alternative). In addition, NOAA proposes to prohibit anchoring in all SPAs and to include a new definition for “anchoring.”

Anchoring means securing a vessel to the seabed by any means.

All other existing SPA regulations would remain, including prohibitions on discharging any matter except cooling water and fishing by any means or harvesting any marine life.

Restoration Areas (2022 NOPR Alternative)

A new zone type, RA, is proposed in the 2022 NOPR Alternative. This zone type would be further delineated by Nursery RA and Habitat RA. Nursery RAs would encompass existing permitted nursery areas and be regulated similar to CAs to provide the highest level of protection to sensitive corals and other organisms while they are being propagated. These regulations would prohibit fishing, anchoring, and discharges and would require that vessels remain in transit through the area. Habitat RAs would protect sites where active transplanting and restoration activities are ongoing. These areas would be managed with the same regulations that apply to SPAs to provide for access and educational opportunities while prohibiting fishing, anchoring, and discharges.

In addition to creating this new zone type, NOAA would define “restoration area” as follows

Restoration Area means an area of the sanctuary that supports species or habitat recovery, including protection for short- and long-term propagation nurseries (referred to as Nursery Restoration Areas) and active restoration sites (Habitat Restoration Areas), within which activities are subject to conditions, restrictions, and prohibitions to achieve these objectives.

NOAA proposes to establish nine new Nursery RAs, all of which are existing sanctuary-permitted coral reef nursery sites. These proposed zones are very small (individual zones are approximately 70 acres (0.1 square miles) and are designed to protect the underwater nursery structures and associated corals growing on them with a 200-yard buffer.

NOAA proposes to establish four new Habitat RAs, all of which are existing sanctuary-permitted coral reef outplanting sites.

Three of the proposed Nursery RAs (Pickles Reef, Marathon, and Sand Keys) were included in the 2019 draft EIS as individual SPA zones in Alternatives 2 and 3. These were included in the 2019 draft EIS as representative coral nursery sites in the Upper, Middle, and Lower Keys. Otherwise, all are proposed new zones in the 2022 NOPR Alternative.

Conservation Areas (2022 NOPR Alternative)

A total of six CAs, all of which are existing sanctuary marine zones, are proposed in the 2022 NOPR Alternative. Proposed changes include slightly expanding the spatial area of three existing zones (Tennessee Reef, Western Sambo, and Tortugas South), and eliminating one zone

(the existing Looe Key SUA). With the exception of the zone name change to CA, NOAA proposes no changes to the existing Conch Reef SUA, Eastern Sambo SUA, or Tortugas North ER. With the exception of Western Sambo, CAs would be transit only, which is intended to provide the greatest level of protection to these contiguous habitats and areas set aside to support scientific research. Western Sambo would allow access for snorkeling and diving and no-anchor restrictions would be included for the southern portion in the area of most prominent coral reef development.

Management Areas (2022 NOPR Alternative)

The 2022 NOPR Alternative is the same as the 2019 draft EIS Alternative 1: No Action with the exception of the zone type change from EMA to MA for Key Largo and Looe Key. Key West National Wildlife Refuge and Great White Heron National Wildlife Refuge would no longer be referred to as EMAs but would simply be zoned as national wildlife refuges with overlapping and complementary jurisdiction to the sanctuary.

3.3.6 Marine Zones within the Final Preferred Alternative

The Final Preferred Alternative further refined the 2022 NOPR Alternative based on public and agency comment and updated environmental and user data. In addition, in light of the increasing stressors sanctuary resources are experiencing, the Final Preferred Alternative considered action that would support and facilitate resilience and recovery of habitats and species within or moving through the marine zones.

Wildlife management areas (Final Preferred Alternative)

A total of 44 WMAs are proposed, of which 20 are proposed new zones. This alternative includes three fewer total zones, all of which were proposed as new zones in other alternatives. The Final Preferred Alternative further refines the 2022 NOPR Alternative, and like the 2022 NOPR Alternative favors resource protection over access where data and environmental conditions indicate the need.

Sanctuary preservation areas (Final Preferred Alternative)

The Final Preferred Alternative is the same as the 2022 NOPR Alternative with minor spatial changes to two proposed zones (Turtle Rocks and Sombrero Key) and a two year delay for implementation of the no anchor regulation. A total of 17 SPAs are proposed.

Turtle Rocks is modified slightly from 2.3 square miles in the 2022 NOPR Alternative to 2.5 square miles in the Final Preferred Alternative in order to align this SPA with the existing John Pennekamp Coral Reef State Park marine zone. Sombrero Key is modified from 0.52 square miles in the 2022 NOPR Alternative to 0.33 square miles in the Final Preferred Alternative. This change is made to focus SPA protection on the area with the greatest amount of coral and to exclude areas of primarily sandy bottom.

Specific to the no anchor regulation in all SPAs, NOAA would delay the effective date for the prohibition on anchoring in SPAs for two years beyond the effective date of the final regulation. The purpose of this delay is to provide NOAA with adequate time to finalize a mooring buoy

plan, including numbers and locations of mooring buoys, to secure materials, and to install new mooring buoys.

Restoration Areas (Final Preferred Alternative)

A total of 15 RAs are proposed, two more than in the 2022 NOPR Alternative. This includes four habitat RAs (the same as the 2022 NOPR Alternative) and 11 nursery RAs (two more than were included in the 2022 NOPR Alternative). The same proposed regulations would apply as proposed in the 2022 NOPR Alternative with the exception that the no anchor regulation for habitat restoration areas would be delayed by two years. The purpose of this delay is to provide NOAA with adequate time to finalize a mooring buoy plan, including numbers and locations of mooring buoys, to secure materials, and to install new mooring buoys.

These two areas were established and permitted as coral nursery sites after the 2022 NOPR Alternative was released for public comment. NOAA received comments requesting that these two nursery sites be included as Nursery RAs in the Final Preferred Alternative. Both sites are in the Upper Keys region and are in federal waters of the sanctuary. Key Largo Nursery RA is approximately 0.07 square miles (46.8 acres) and Islamorada Nursery RA is approximately 0.07 square miles (47.2 acres).

Conservation Areas (Final Preferred Alternative)

The Final Preferred Alternative is the same as the 2022 NOPR Alternative with the exception that, in Western Sambo Conservation Area, the no-anchor restrictions for the southern portion in the area of most prominent coral reef development would be delayed by two years beyond the effective date of the final regulation. The purpose of this delay is to provide NOAA with adequate time to finalize a mooring buoy plan, including numbers and locations of mooring buoys, to secure materials, and to install new mooring buoys.

Management Areas (Final Preferred Alternative)

Like the 2022 NOPR Alternative, the Final Preferred Alternative is the same as Alternative 1: No Action with the exception of the zone type change (which is a technical change included in Alternative 2) from EMA to MA (Key Largo and Looe Key) and Key West National Wildlife Refuge and Great White Heron National Wildlife Refuge would no longer be referred to as EMAs, but would simply be zoned as national wildlife refuges with overlapping and complementary jurisdiction to the sanctuary.

3.3.7 Summary of marine zone boundary alternatives

Table 3.3. Marine zones: Summary of wildlife management areas across alternatives

Wildlife management area alternatives	Alternative 1 (status quo) ¹	Alternative 2 ¹	Alternative 3 (2019 draft EIS preferred) ¹	Alternative 4 ^{1, 2}	NOPR Alternative ^{1, 2}	Final Preferred Alternative ¹
Total zones	28	59	60	58	47	44
Total within state waters	28	58	59	57	43	44
Total area (sq miles) ³	37.55	69.39	72.37	325.12	322.60	64.87
Regulations applied	• Idle speed/no wake • No motor • No anchor • No access buffer zone • Closed	• Idle speed/no wake • No motor • No anchor • Trolling only • No entry	Same as Alternative 2	• Idle speed/no wake • No motor • No anchor • No entry	Same as Alternative 4 and transit only April 1 through July 31	Same as Alternative 4 and transit only April 1 through July 31

1. Includes Tortugas Bank no anchor zone (32.23 square miles).

2. Includes Pulley Ridge no anchor zone.

3. Includes a zone even if only a small portion falls within state waters (e.g., Tortugas South).

Table 3.4. Marine zones: Summary of sanctuary preservation areas across alternatives

Sanctuary preservation area alternatives	Alternative 1 (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Total zones	18	24	25	21	17	17
Total within state waters	6	11	12	8	7	7
Total area (sq miles)	6.4	55.85	65.42	29.08	12.14	12.14

Sanctuary preservation area alternatives	Alternative 1 (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Regulations applied	- Existing SPA regulations - Baitfishing permits - Catch and release trolling allowed in 4 SPAs	- Existing SPA regulations and: - Eliminate baitfish permits - Eliminate catch and release trolling - Idle speed/no wake - No anchor	Same as Alternative 2 and three restricted access SPAs	Same as Alternative 3	- Existing SPA regulations and: - Eliminate baitfish permits - Eliminate catch and release trolling - No anchor	Same as NOPR Alternative

For more information on proposed updated and/or new regulations related to baitfishing permits, catch and release fishing by trolling, and the proposal for three restricted access SPAs, see Section 3.4.

Table 3.5. Marine zones: Summary of conservation areas across alternatives

Note that “conservation area” is a new zone type that would replace the existing ecological reserve and special use area zone types that are in Alternative 1.

Ecological reserves/special use areas/conservation areas alternatives	Alternative 1 (status quo) ¹	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Total zones	7	9	9	14	6	6
Total within state waters ²	5	7	7	13	4	4
Total area (sq miles)	193.85	215.78	203.21	282.59	213.11	213.11
Regulations applied	Transit only Except Western Sambo which has SPA regulations applied	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1 and no anchor in the offshore portion of Western Sambo	Same as NOPR Alternative

1. Includes the existing ecological reserves and special use areas.

2. Includes a zone even if only a small portion falls within state waters (e.g., Tortugas South).

For more information on proposed updated regulations related to Tortugas ER North access permits, see Section 3.4.

Table 3.6. Marine zones: Summary of management areas and national wildlife refuge across alternatives

Management areas (including national wildlife refuges) ¹ alternatives	Alternative 1 (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Total zones	4	4	4	4	4	4

Management areas (including national wildlife refuges)¹ alternatives	Alternative 1 (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Total within state waters	2	2	2	2	2	2
Total area: Looe Key and Key Largo (sq miles)	153.68	153.68	153.68	153.68	153.68	153.68
Regulations applied to Key Largo and Looe Key	Prohibited activities: • Removing, taking, spearing, or otherwise damaging any coral, marine invertebrate, plant, soil, rock, or other material • Taking tropical fish • Certain fishing gear types • Spearfishing	• Existing regulations applied and • No anchoring	Same as Alternative 2	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1
Total area: Key West and Great White Heron National Wildlife Refuge	656.21	656.21	656.21	656.21	656.21	656.21

Management areas (including national wildlife refuges)¹ alternatives	Alternative 1 (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Regulations applied to National Wildlife Refuge portions:	Prohibition for operating a PWC, airboat, or water skiing	Prohibition for operating airboat, water skiing and a small area of relief for PWC operation around the "G13" marker	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

For more information on proposed updated regulations related to operation of personal watercraft in Key West National Wildlife Refuge, see Section 3.4.

Table 3.7. Marine zones: Summary of restoration areas across all alternatives

Restoration Areas	Alternative 1 (status quo)	Alternative 2	Alternative 3 (draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Total Zones	0	0 ¹	0 ¹	0 ¹	13 4 Habitat RA 9 Nursery RA	15 4 Habitat RA 11 Nursery RA
Total within state waters	0	0	0	0	4 2 Habitat RA 2 Nursery RA	4 2 Habitat RA 2 Nursery RA
Total area: Habitat RAs (sq miles)	0	0	0	0	0.53	0.53

Restoration Areas	Alternative 1 (status quo)	Alternative 2	Alternative 3 (draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
Regulations applied Habitat RAs	NA	NA	NA	NA	- Existing SPA regulations and - No anchor	Same as NOPR Alternative
Total area: Nursery RAs (sq miles)	0	0	0	0	0.91	1.17
Regulations applied Nursery RAs	NA	NA	NA	NA	Conservation Area regulations: Transit only without applicable permit	Same as NOPR Alternative

1. The 2019 draft EIS Alternatives included three of these zones as SPAs. The 2022 NOPR and Final Preferred Alternatives changes the zone name and includes additional area in the RA zone type. Existing SPA and CA regulations are applied.

3.4 Component 4 – Proposed Modifications to Marine Zone Regulations by Alternative

In addition to regulations that apply throughout the sanctuary (see Section 3.2), there are proposed new and modified regulations that would apply to additional activities within a small number of marine zones. Table 3.7 summarizes alternatives for regulations that would apply in specific marine zones, and the full descriptions for each alternative are explained below.

For more general access regulations (e.g., idle speed/no wake, no motor, etc.) applicable to specific marine zones see the summary tables in Section 3.3 and Section 3.6. For a full list of existing marine zones and existing regulations, see 15 C.F.R. § 922.164 and 15 C.F.R. part 922, subpart P, appendix II to VI.

3.4.1 Motorized personal watercraft regulation (proposed update)

Note, this proposed regulatory update applies in the Key West National Wildlife Refuge EMA.

Alternative 1: No action (status quo)

Existing FKNMS regulations detailed at 15 C.F.R. § 922.164(b)(2) prohibit operating a PWC, operating an airboat, or water skiing within the marine portions of the Great White Heron and Key West national wildlife refuge MAs (except within Township 66 South, Range 29 East, Sections 5, 11, 12, and 14; Township 66 South, Range 28 East, Section 2; and Township 67 South, Range 26 East, Sections 16 and 20, all Tallahassee Meridian).

Alternative 2

NOAA, after coordinating with USFWS, proposes to modify regulations for motorized PWC operation to minimize marine wildlife disturbance, minimize user conflicts between motorized personal watercraft operators and other recreationists, and maintain opportunities for motorized PWC use within FKNMS. Current regulations restrict motorized PWC use from a portion of the sanctuary and Great White Heron and Key West national wildlife refuges and manage motorized PWC use through existing regulations for vessel operation in general.

To reduce user conflict while still ensuring resource protection NOAA is proposing to modify the existing prohibition against operating a PWC in the marine portions of Key West National Wildlife Refuge. The proposed regulation will

create a "notch" in Key West National Wildlife Refuge to allow passage of personal watercraft around marker "G13" but on the inside of marker "G WR5" (See Figure 3.2).

This proposed modification would not change the boundary of Key West National Wildlife Refuge, only the area where this restriction would apply. NOAA considered several other options related to operation of motorized PWC but ultimately eliminated them from further review. See Section 3.7 for more information.



Figure 3.2. Proposed area where PWC operation could occur in Key West National Wildlife Refuge.
Image: NOAA

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for the regulation of motorized PWC.

Alternative 4

Alternative 4 is the same as Alternative 2 for the regulation of motorized PWC.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 2 for the regulation of motorized PWC.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 2 for the regulation of motorized PWC.

3.4.2 Tortugas North Ecological Reserve access permits regulation (proposed update)

Note, this proposed regulatory update applies in the Tortugas North ER.

Alternative 1: No action (status quo)

Existing FKNMS regulations at 15 C.F.R. § 922.167 require permits to access the Tortugas North ER for any activity other than for passage without interruption through the reserve, for law enforcement purposes, or for purposes of monitoring. The current permit process as detailed at 15 C.F.R. § 922.167 requires permit applicants to request a Tortugas North ER access permit at least 72 hours, but no longer than one month, before the desired effective date of the permit. Current regulations also include a two-week maximum permit duration. In addition to the lead time for requesting a permit, FKNMS regulations at 15 C.F.R. § 922.164 (d)(viii) require access permit holders to notify FKNMS staff at Dry Tortugas National Park before entering and upon leaving the reserve.

Alternative 2

Tortugas North ER remains an important sanctuary marine zone for continued protection, management, and controlled access through issuance of access permits. From 2012 through 2015, FKNMS issued a total of 143 Tortugas North ER access permits with an average of 36 per year. The average time permit holders spent in the ER during that period was seven days and activities conducted while in the ER generally included diving and snorkeling with one or two research missions per year.

Based on 30 years of management and issuance of access permits, NOAA is proposing minor modifications to the regulations for Tortugas North ER access permits. While still requiring access permits, updated regulations would

remove the current timing limitation requiring Tortugas North Ecological Reserve access permits be requested no longer than one month before the permit effective date and remove the requirement to notify FKNMS before entering and upon leaving the reserve.

FKNMS believes the requirement to request a permit no greater than a month in advance is not necessary based on the level and type of activity in the Tortugas North ER. Applicants would still be required to request an access permit at least 72 hours in advance to allow FKNMS staff time to review and process the request. Access permits would still be required for access to the Tortugas North ER and the maximum duration of each permit would remain two weeks. These permits serve a valuable purpose in tracking activity and informing enforcement personnel of the vessels approved for operation within the ER. The provision to notify FKNMS staff before entering and upon leaving the reserve is not deemed necessary given the limited amount of use within the reserve. When making the proposed modifications, the contact information for requesting such access permits would be updated.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for Tortugas North ER access permits.

Alternative 4

Alternative 4 is the same as Alternative 2 for Tortugas North ER access permits.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 2 for Tortugas North ER access permits.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 2 for Tortugas North ER access permits.

3.4.3 Catch and release fishing by trolling in four SPAs regulatory exception (proposed update)

Note: this proposed regulatory update applies in SPAs.

Alternative 1: No action (status quo)

Existing FKNMS regulations at 15 C.F.R. § 922.164(d)(1)(iii) prohibit fishing by any means within SPAs, except for catch and release fishing by trolling in the Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key SPAs.

Alternative 2

To address concerns regarding potential threats to sanctuary resources, human safety, and conflict of use, NOAA proposes to modify existing SPA regulations to:

remove the exception for catch and release fishing by trolling in the Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key sanctuary preservation areas.

This existing exception is no longer consistent with the goals and objectives of sanctuary management. This proposed update would serve to fulfill the original intent of the SPA zone type to separate conflicting uses and protect benthic habitats. Through this review process, concerns were raised by advisory council working groups and public comment regarding human safety aspects of allowing any level of conflicting use to occur within SPAs. Updating this regulation would also meet agency direction to simplify and, where possible, make the regulations applicable to activities and access for specific marine zones consistent within each zone type. With this proposed modification, catch and release fishing by trolling would be prohibited in all SPAs and such prohibitions would apply in any new proposed SPA (see Section 3.6).

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for the regulation of catch and release fishing by trolling in SPAs.

Alternative 4

Alternative 4 is the same as Alternative 2 for the regulation of catch and release fishing by trolling in SPAs.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 2 for the regulation of catch and release fishing by trolling in SPAs.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 2 for the regulation of catch and release fishing by trolling in SPAs.

3.4.4 Baitfish permits (proposed update)

Note: this proposed regulatory update applies in SPAs.

Alternative 1: No action (status quo)

FKNMS regulations currently prohibit fishing within SPAs, with exceptions for catch and release fishing in four SPAs noted above (see 15 C.F.R. § 922.164(d)). However, FKNMS has been issuing permits for limited bait fishing in SPAs since the initial 1997 EIS and management plan. Since that time, permits have been issued as follows: Castnet permits are issued for and valid in all SPAs and are issued by calendar year. Hair hook permits, which are valid in only Davis, Conch, and Alligator SPAs, are issued for October 15 through April 15 and fishing is allowed only from 5:00 a.m. until 10:00 a.m. daily.

Alternative 2

NOAA is proposing to modify baitfish permitting to:

Eliminate, over a three-year period, the practice of issuing permits that allow capture of baitfish from within the sanctuary preservation areas.

The collection of baitfish in SPAs is no longer consistent with the goals and objectives of sanctuary management. This proposed update would serve to fulfill the original intent of the SPA zone type to separate conflicting uses.

The practice of issuing baitfish permits would be eliminated over a three-year period following the effective date of final regulations. During this time, only individuals who have historically held baitfish permits would be eligible to receive any further permits. Baitfish permit data from 2019 would be used to determine those eligible for permits in the three-year phase out period. In conjunction with this proposed change, the *Office of National Marine Sanctuaries Instructions for Submitting Applications for National Marine Sanctuary Permits and Authorizations, Appendix D Florida Keys National Marine Sanctuary Baitfishing Permits* would be eliminated.

Alternative 3 (2019 draft EIS preferred)

Alternative 3 is the same as Alternative 2 for baitfish permitting.

Alternative 4

Alternative 4 is the same as Alternative 2 for baitfish permitting.

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 2 for baitfish permitting.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 2 for baitfish permitting.

3.4.5 Limited use access restrictions for specific SPAs (proposed new)

Note: this proposed regulatory update applies in select SPAs.

Alternative 1: No action (status quo)

Existing FKNMS regulations do not include specific marine zones that restrict the number of users that can access an area or marine zone at any one time.

Status quo for this action also applies in Alternative 2. No additional information is provided for this alternative as they are the same as Alternative 1: No action, where the sanctuary does not restrict the overall level of use in any marine zone.

Alternative 2

Alternative 2 maintains the existing management approach as described above in Alternative 1: No action.

Alternative 3 (2019 draft EIS preferred)

NOAA is proposing to limit the levels of use within a select number of SPAs. The areas proposed would be Carysfort, Sombrero, and Sand Key SPAs. These sites include areas within each of the central regions of the Florida Keys: Upper Keys, Middle Keys, and Lower Keys.

This proposal is based on increasing levels of overall use and in some areas, increasing concentrated uses that could impact both the condition of sanctuary resources and the user experience. To address these concerns, NOAA proposes to restrict the overall numbers of users that can access these areas at any one time. In Alternative 3, NOAA proposes to:

restrict user access in Carysfort, Sombrero, and Sand Key sanctuary preservation areas to Blue Star⁵ dive/snorkel operators.

In conjunction with this proposed regulation, NOAA would use data from the 2017 FWC Aerial Overflight User Survey, other data sources, and input from the public and user groups to determine if the proposed SPAs are the best sites to test this management approach. NOAA would consider innovative approaches to managing concentrated uses in the sanctuary including limiting access to Blue Star dive/snorkel operators only. (See Appendix A Goal 3, Objective 3.1, Activity 3.1.1 for proposed management plan activities related to this action.)

Alternative 4

Alternative 4 includes the same proposed new regulation creating limited-use SPAs as described in Alternative 3; however, this would only apply in Sombrero and Sand Key SPAs. In Alternative

⁵ Blue Star is a program established by the sanctuary recognizing tour operators who are committed to promoting responsible and sustainable diving, snorkeling, and fishing practices to reduce the impact of these activities on ecosystems in the Florida Keys. Blue Star operators take the extra step to educate their clients to be better environmental stewards and to interact responsibly with natural resources in the Florida Keys. Visit <https://sanctuaries.noaa.gov/bluestar> for more information.

4, FKNMS is proposing to expand the Carysfort SPA from the shoreline to the deep reef (see Section 3.6).

2022 NOPR Alternative

The 2022 NOPR Alternative is the same as Alternative 1: No Action for access restrictions in SPAs.

Final Preferred Alternative

The Final Preferred Alternative is the same as Alternative 1: No Action for access restrictions in SPAs.

Table 3.8. Additional marine zone regulations: Summary of alternatives

Notes: The marine zone where each regulation would apply is in bold.

Sub-action	Alternative 1: No action (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
3.4.1 Motorized PWC	No action: Operating a PWC, operating an airboat, or water skiing are prohibited within the marine portions of the Great White Heron and Key West national wildlife refuge management areas . 15 C.F.R. § 922.164(b)(2)	Create a "notch" in Key West National Wildlife Refuge to allow passage of PWC around marker "G13" but on the inside of marker "G WR5"	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.4.2 Tortugas North ER access permits	No action: For access to Tortugas ER North , access permits must be requested at least 72 hours but no longer than one month before the date the permit is desired to be effective. 15 C.F.R. § 922.167(b)(1) and The following activities are prohibited within the ERs: entering or leaving the Tortugas North area with a valid access permit issued pursuant to § 922.167 without notifying FKNMS staff at the Dry Tortugas National Park office by telephone or radio no less than 30 minutes and no more than 6 hours before entering and upon leaving the Tortugas ER. 15 C.F.R. § 922.164(d)(1)(viii)	Remove the current requirement for requesting access permits to Tortugas ER North no longer than one month before the date of the permit. Remove the requirement to notify FKNMS before entering and upon leaving Tortugas ER North .	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

Sub-action	Alternative 1: No action (status quo)	Alternative 2	Alternative 3 (2019 draft EIS preferred)	Alternative 4	NOPR Alternative	Final Preferred Alternative
3.4.3 Catch and release fishing by trolling in four SPAs	No action: Allow exception for catch and release fishing by trolling in the Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key SPAs . 15 C.F.R. § 922.164(d)(1)(iii)	Remove the exception for catch and release fishing by trolling in the Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key SPAs .	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.4.4 Bait fishing permits	No action: Castnet permits are issued for and valid in all SPAs where fishing is prohibited (with exceptions noted above for catch and release in certain zones) and are issued by calendar year. Hair hook permits are valid in only Davis, Conch, and Alligator SPAs , where fishing is prohibited (with exceptions noted above), are issued for October 15 through April 15, and only allow fishing from 5:00 a.m. until 10:00 a.m. daily.	Eliminate, over a three-year period, the practice of issuing permits that allow capture of baitfish from within the SPAs.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
3.4.5 Restricted access in select SPAs	No action: Current regulations do not include specific marine zones that regulate or restrict the number of users that can access an area or marine zone at any one time.	Same as Alternative 1	Restrict user access in Carysfort, Sombrero, and Sand Key SPAs	Restrict user access in Sombrero and Sand Key SPAs	Same as Alternative 1	Same as Alternative 1

3.5 Component 5 – Summary of the FKNMS Management Plan Development

Since its designation in 1990, FKNMS has worked to address impacts from human influences on sanctuary resources. Sanctuary management plans have articulated the non-regulatory actions needed to advance sanctuary management. The first sanctuary management plan was developed in 1996, followed by a review and release of the 2007 [FKNMS Revised Management Plan](https://floridakeys.noaa.gov/mgmtplans/2007.html).⁶ The Restoration Blueprint has included management plan alternatives that are designed to improve the abundance and health of sanctuary resources and the condition of associated habitats through updated and adaptive management efforts, regulatory compliance, community involvement, and stewardship.

The 2019 draft EIS included a first draft of an updated management plan⁷ that was the same across all alternatives except Alternative 1 (status quo). Comments on that version informed a second draft,⁸ which was released with the 2022 NOPR.

This final FKNMS management plan incorporates comments received throughout the Restoration Blueprint process and replaces the 2007 FKNMS Revised Management Plan. The final 2024 management plan focuses on understanding and improving the condition of sanctuary resources through reducing threats and addressing emerging issues. Management activities focus on targeted research, updated and adaptive management efforts, regulatory compliance, community involvement, and stewardship.

Input on the 2019 and 2022 versions of the draft management plans generally asserted that sanctuary resources are experiencing increased impacts from local, regional, and global threats (such as climate change), as well as from increased numbers of overall users. Public comments primarily focused on the need to improve sanctuary resource conditions and to monitor and address impacts from climate change and changes to water quality, to continue and expand living and non-living resource protection, and to advance efforts to restore habitats and ecosystem function. Public comments also called for increased issue- and audience-specific education and outreach efforts; enhanced enforcement capacity; greater support for mooring buoys; monitoring and evaluating effectiveness of management actions; increased capacity to administer sanctuary programs; and more responsive and adaptive management to address emerging threats and the increasing number of people in the sanctuary. Informed by these public comments, ONMS updated the draft management plan in 2022 to identify a suite of priority management themes to guide FKNMS management actions, resource allocation decisions, and partnership development.

See Appendix A for the 2024 FKNMS management plan.

⁶ <https://floridakeys.noaa.gov/mgmtplans/2007.html>

⁷ <https://floridakeys.noaa.gov/blueprint/documents.html> (see Chapter 3 Section 3.5)

⁸ <https://floridakeys.noaa.gov/blueprint/phase-IV.html>

3.6 Marine Zone Maps for the Final Preferred Alternative

This section includes regional maps for the Final Preferred Alternative. To see maps of the individual marine zones included in the Final Preferred Alternative and regional maps for the 2019 draft EIS and 2022 NOPR Alternatives see Appendix B.

Upper Keys Region

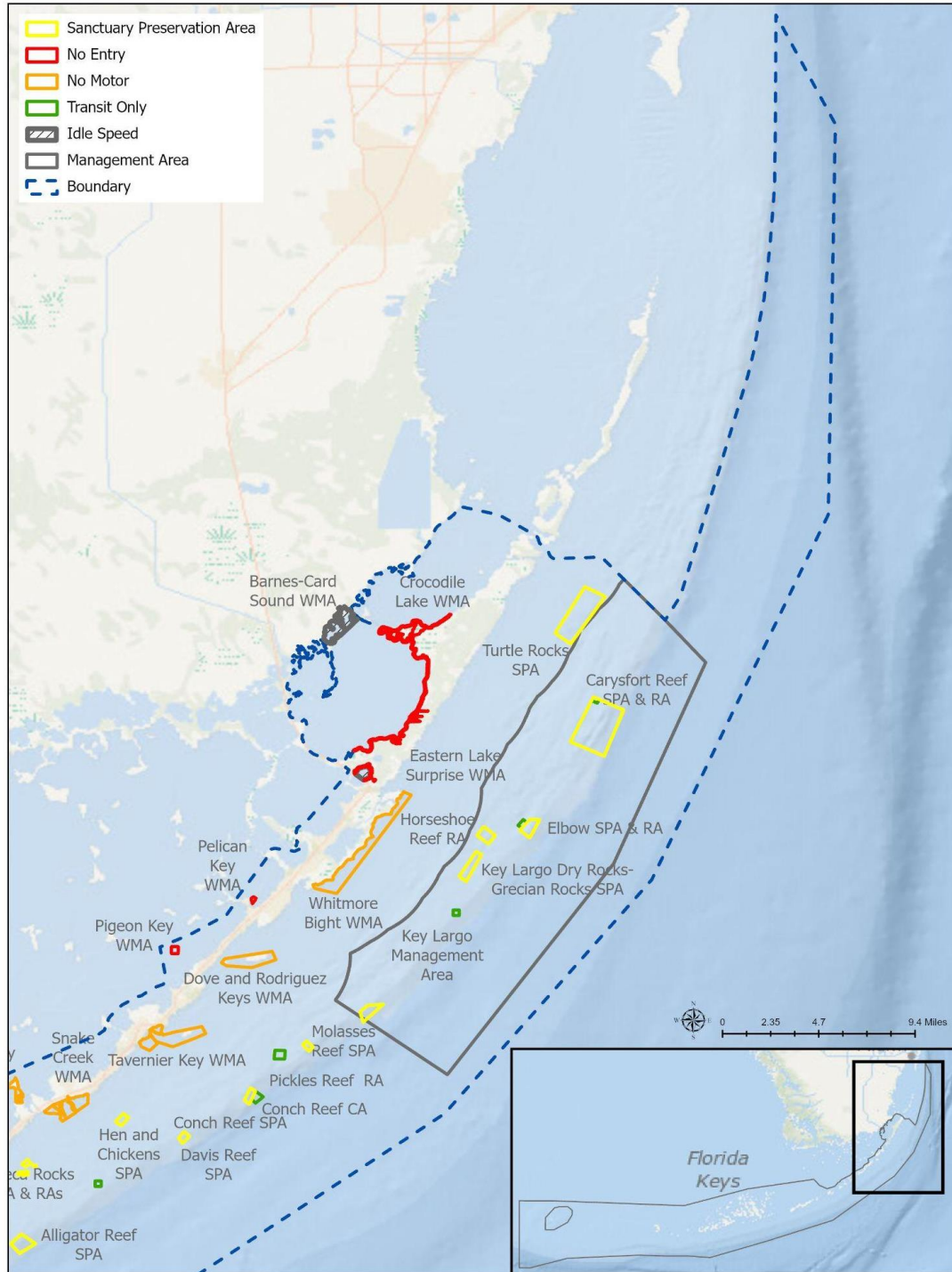


Figure 3.3. Final Preferred Alternative: Upper Keys Region and marine zones (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

Middle Keys Region

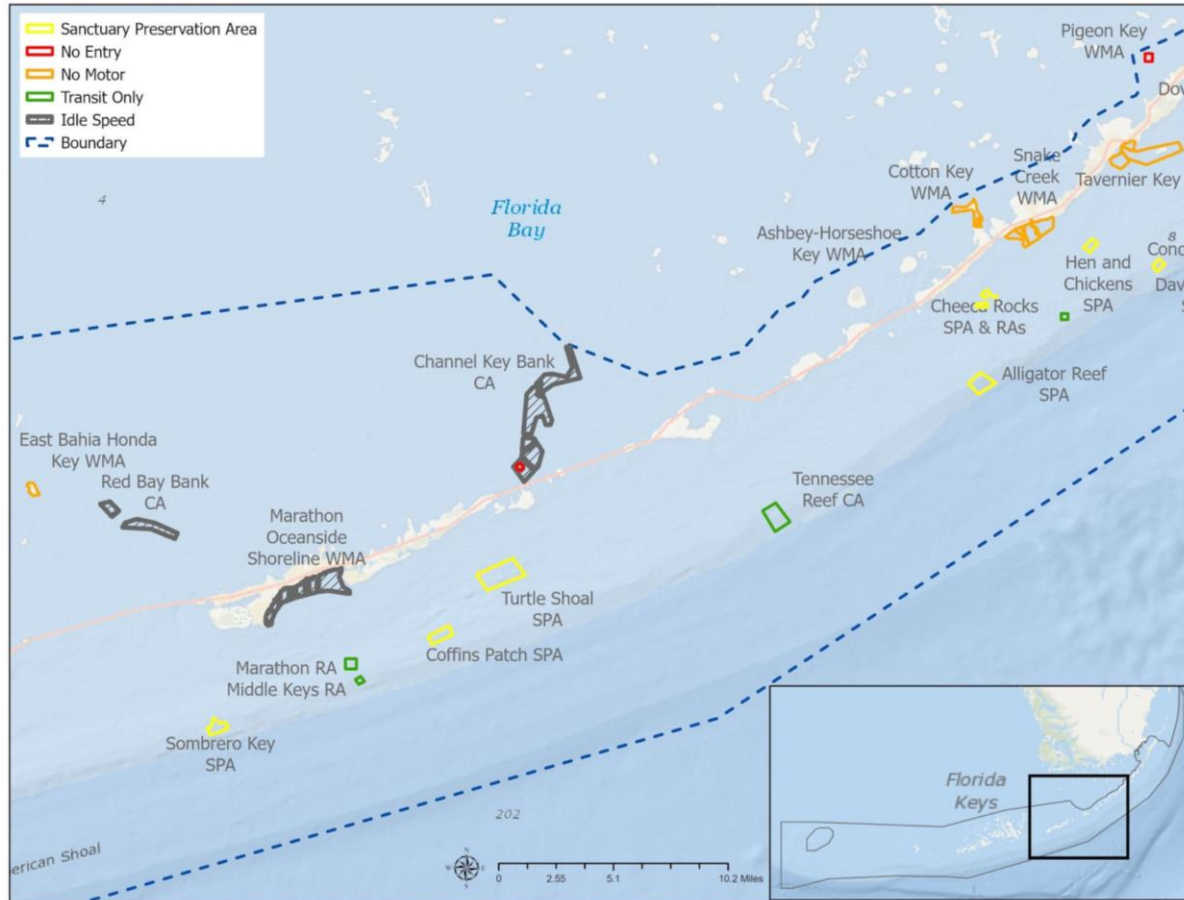


Figure 3.4. Final Preferred Alternative: Middle Keys Region and marine zones (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

Lower Keys Region

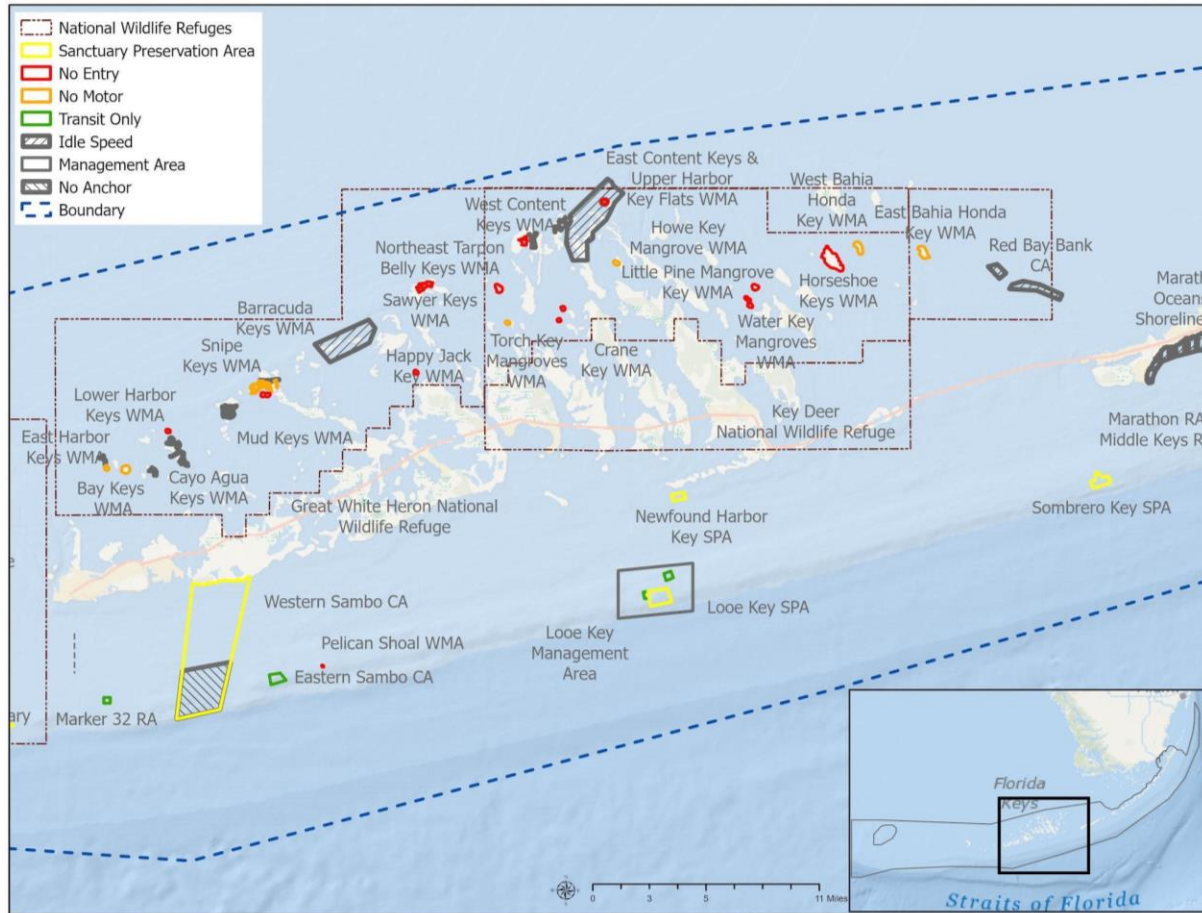


Figure 3.5. Final Preferred Alternative: Lower Keys Region and marine zones (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

Marquesas Region

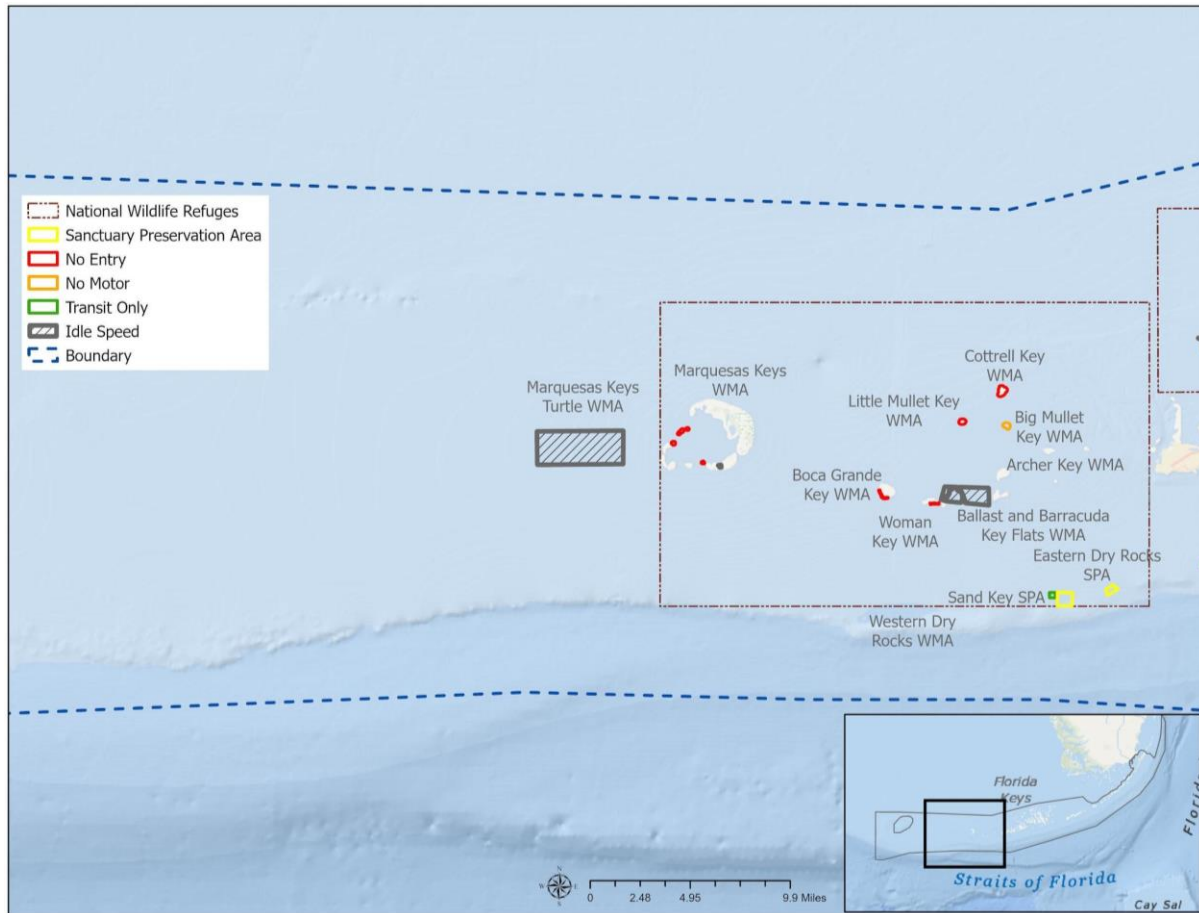


Figure 3.6. Final Preferred Alternative: Marquesas Region and marine zones (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

Tortugas Region

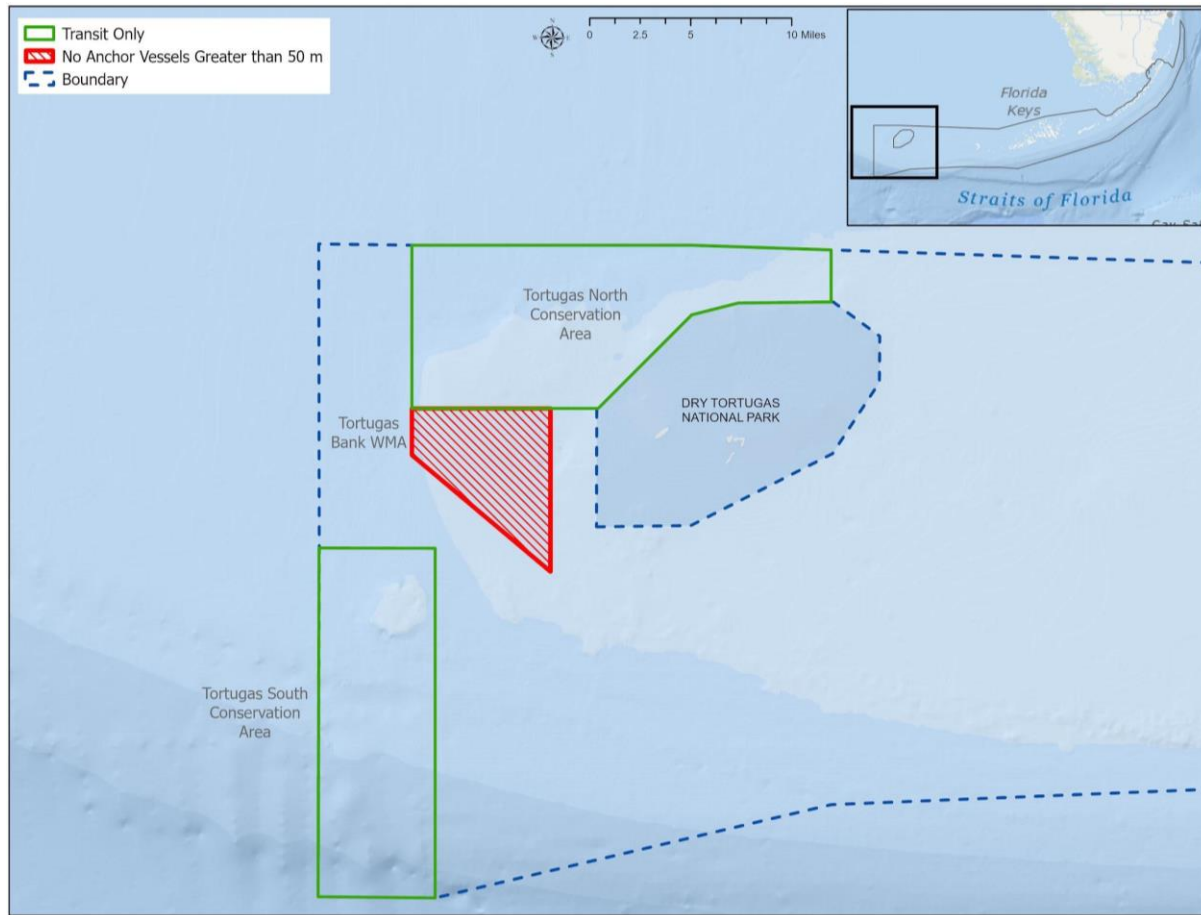


Figure 3.7. Final Preferred Alternative: Tortugas Region and marine zones (see Section 3.6 and Appendix B for more detailed maps). Image: NOAA

3.7 Alternatives Considered and Eliminated

Numerous boundary, marine zone, and regulatory alternatives were suggested during the scoping process and a range of potentially reasonable alternatives were considered. Alternatives considered but eliminated are described below. These alternatives were proposed by the public, Sanctuary Advisory Council members, established working groups, and/or agency staff. These alternatives were eliminated from consideration at this time for various reasons, including lack of relevance to the purpose and need, inability to address the particular issue within the scope of existing authority, or the need for more analysis beyond the scope of this management plan review process (see introduction to this chapter for the specific screening criteria NOAA used to consider and analyze alternatives for this EIS). For these reasons, the below boundary, marine zone, and regulatory alternatives were carefully considered but eliminated from further consideration as the agency focused on alternatives that best achieve the purpose and need of the proposed action and goals, principles, and objectives outlined by the Sanctuary Advisory Council in their 2012 Florida Keys National Marine Sanctuary Advisory Council Regulatory and Zoning Alternatives Development Workplan.

3.7.1 Boundary

Study area boundary expansion in Florida Bay and Gulf of Mexico

At the December 2012 Sanctuary Advisory Council meeting, the council established the “study area,” which is the area that could be considered for potential boundary, regulatory, and marine zone updates through this review. The advisory council recommended including an area of Florida Bay between the existing sanctuary boundary and Everglades National Park extending to Cape Sable, and a larger area of the Gulf of Mexico north of the existing sanctuary boundary (see Figure 3.3).

The Florida Bay and Gulf of Mexico portions of the study area were considered and eliminated from further review for several reasons, primarily that alternatives should maximize environmental benefits while avoiding unnecessary adverse socioeconomic impacts and should allow for the incorporation and consideration of recent or best available data and scientific knowledge. Information about the status and trends of habitats and species in this area is less well known than those in the existing and proposed sanctuary expansion boundary area. Therefore, it was not clear that through boundary expansion the environmental benefits of protection would avoid unnecessary and adverse socioeconomic impacts to existing users. Specific to the Gulf of Mexico study area, at the time of this management plan review, it was determined that sanctuary boundary expansion to this area was beyond the scope of the goals, principles, and objectives of the advisory council and the purpose and need of this EIS. In addition, at this time NOAA determined that expansion to include these areas would place an unnecessary additional administrative and management burden on NOAA, which could impact management of the existing sanctuary and proposed boundary expansion area. NOAA determined that boundary expansion in the Florida Bay and Gulf of Mexico portions of the study area would not be evaluated as part of this EIS.

Boundary expansion to include the Ten Thousand Islands

NOAA received a request to consider boundary expansion to include the Ten Thousand Islands chain of mangrove islands between Marco Island and Lostmans River. Inclusion of this additional area in the sanctuary was considered and eliminated from further review for several reasons, primarily that alternatives must be feasible, enforceable, and aim to facilitate compliance. The Ten Thousand Islands are a distinct area at a distance of approximately 63 miles from the existing sanctuary boundary. In addition, this area is managed by the Department of Interior by the Everglades National Park and the Ten Thousand Islands National Wildlife Refuge. At the time of this management plan review, it was determined that additional sanctuary management would be duplicative of these other management regimes and would place an unnecessary additional administrative and management burden on NOAA, which could impact management of the existing sanctuary and proposed boundary expansion area. NOAA determined that boundary expansion in the Ten Thousand Islands area would not be evaluated as part of this EIS.

3.7.2 Sanctuary-wide regulations

User fees

The Sanctuary Advisory Council discussed the concept of implementing user fees for access to the sanctuary. A user fee working group was established to examine how user fees would be implemented in the sanctuary, identify potential sources of funds and an estimate of funds that could be generated, determine how funds generated would be allocated and for what purpose/project, and consider how a user fee program could be enforced. The coral reef ecosystem restoration working group and shallow water wildlife and habitat protection working group also considered the need for innovative funding opportunities to fund coral and seagrass restoration activities.

NOAA considered development of a user fee program but ultimately eliminated it from further review for several reasons, primarily that alternatives must be feasible, enforceable, and aim to facilitate compliance. At this time, with current technology and the large number of access points (U.S. Highway 1, individual homes, boat ramps, marinas, etc.) to the sanctuary, it is not feasible to control access to manage and ensure compliance with collection of user fees. Many challenges to implementing, managing and enforcing a user fee program were identified, including administrative challenges: who would collect the user fees; where and how would the user fees be collected; how would such a program be administered and managed; and how would enforcement be implemented related to collection of user fees and controlling access to the sanctuary. While user fees are successfully implemented at adjacent public lands (national and state parks), at this time NOAA determined that the challenges were greater than the potential benefit gained from a user fee program, and therefore would not be evaluated as part of this EIS.

Mandatory boater education

The Sanctuary Advisory Council discussed the need for enhanced boater education at several meetings in advance of and throughout this review process. The shallow water wildlife and habitat working group also explored options to enhance boater education, ultimately recommending a volunteer boater education program modeled after the Eco-Mariner program implemented in Everglades National Park. With recent changes in the Everglades National Park management plan to include an online mandatory boater education requirement, the advisory council requested that mandatory boater education be considered in FKNMS.

NOAA considered a mandatory boater education requirement but ultimately eliminated it from further review for a variety of reasons. As discussed previously, the sanctuary, unlike Everglades National Park, has a high number of access points (individual homes, boat ramps, marinas, etc.) and does not require permits for access, making it more challenging to ensure user compliance with and enforcement of a mandatory boater education requirement. In addition, alternatives should, where appropriate, increase consistency of regulations with state regulations. The state of Florida has existing laws that require anyone who was born on or after January 1, 1988, to successfully complete an approved boating safety course and obtain a boating safety identification card (Florida Statutes section 327.395). For these reasons, NOAA determined that, at this time, mandatory boater education would not be evaluated as part of this EIS.

However, NOAA acknowledges that enhanced boater education is needed and is committed to working with other agency partners, the state, and the advisory council to develop and implement a more robust boater education program within the sanctuary (see Appendix A for more details). In April 2019, FKNMS developed and launched a voluntary online boater education course in partnership with Indiana University's Eppley Institute for Parks and Public Lands. This effort was funded through a FKNMS WQPP special studies grant administered by the EPA. FKNMS plans to evaluate implementation of this voluntary boater education course, including numbers of users taking the course, knowledge of users before and after taking the course, and shifts in behavior that may result in decreasing vessel impacts. FKNMS would use this information to consider the need and implement options for a mandatory boater education requirement.

Fish feeding from shore-based operations

The Sanctuary Advisory Council requested that NOAA clarify the existing discharge prohibition to address fish feeding from land-based activities, divers, vessels for hire, and in general, except during fishing (see Advisory Council Resolution Addressing Permit Procedure and Adaptive Management for Analysis in a draft EIS, October 21, 2014). NOAA considered this request and has proposed a fish feeding regulation that addresses fish, shark, and other marine species feeding from divers and vessels for hire that strengthens an existing state regulation (see Section 3.2 for more details). NOAA considered prohibiting fish feeding from land-based activities but ultimately eliminated it from further review for a variety of reasons, primarily that alternatives should aim to facilitate compliance and maximize environmental benefits while avoiding unnecessary adverse socioeconomic impacts. Due to the large number of shore-based fish feeding venues, most small-scale, coin operated operations with a handful of larger-scale operations at points throughout the sanctuary, it would be difficult to control this activity to manage and ensure compliance. In addition, NOAA determined that fish feeding from land-based activities is not a current enforcement priority. NOAA determined that, at this time, these challenges were greater than the potential benefit gained from prohibiting fish feeding from land-based activities, and therefore would not be evaluated as part of this EIS.

Sanctuary-wide anchoring prohibition

NOAA considered including a sanctuary-wide anchoring prohibition to target a direct and local impact known to affect sanctuary resources and address concerns regarding the threats to the marine environment from anchor impacts and damage. Anchoring has been documented to cause reduced fish density and richness; coral cover, size, density, and species richness; and reef structural complexity (Flynn, 2015). Through managing local impacts, FKNMS aims to increase resilience of the ecosystem to better withstand regional and global impacts that NOAA cannot or does not have the authority to regulate or manage. In addition, decreased incidence of anchor damage may facilitate recovery of sanctuary resources.

However, NOAA ultimately eliminated it from further review for a variety of reasons, primarily that alternatives should aim to facilitate compliance and maximize environmental benefits while avoiding unnecessary adverse socioeconomic impacts. While any anchoring prohibition would have identified specific habitat types where anchoring would be restricted, NOAA identified many challenges to implementing, managing, and enforcing such a prohibition including

sanctuary operations, resource availability, and navigation impacts among others. In addition, such a regulation would likely require placement of a large number of new mooring buoys, which is likely to have minimal adverse impact on the benthic habitats where mooring buoy hardware would be placed. NOAA determined that these challenges were greater than the potential benefit gained from a sanctuary-wide anchor prohibition, and therefore would not be evaluated as part of this EIS.

Through this EIS, NOAA is proposing additional no anchor regulations in all SPAs and the proposed new RA marine zones. If determined necessary, NOAA will evaluate the environmental benefits and impacts of no anchor regulations to determine if there is value in expanding no anchor regulations to additional areas of the sanctuary.

Live rock aquaculture prohibition

NOAA considered updating the live rock prohibition by removing the exemption for permitted live rock aquaculture activities in FKNMS and eliminating existing operations over time. NOAA would have required that existing aquaculture activities permitted by the state of Florida and NMFS cease within five years of the effective date of final regulations and that all aquaculture materials be removed from state and federally permitted sites within the sanctuary. Removing the exemption for permitted live rock aquaculture activities from FKNMS regulations and phasing out existing sites could provide NOAA with greater ability to address activities that complicate enforcement and/or lead to illegal poaching of wild corals and wild live rock. It could also result in direct and indirect benefit to sanctuary resources, particularly habitats and wildlife in the vicinity of live rock aquaculture areas.

However, NOAA ultimately eliminated it from further review for a variety of reasons, primarily that alternatives should maximize environmental benefits while avoiding unnecessary adverse socioeconomic impacts. While socioeconomic data on landings in the live rock aquaculture fishery are known, the extent to which business operations that currently have active permits depend on live rock aquaculture for all or part of their livelihood is not fully known. The level of activity at permitted sites is also not known, so it is unclear whether an outright prohibition on live rock aquaculture at this time would better protect sanctuary resources than the alternatives being put forward. However, NOAA plans to gather additional information about live rock aquaculture operations in the sanctuary, including examining the extent to which such activities may complicate enforcement of illegal poaching of wild live rock and wild corals. NOAA will also evaluate existing operations to determine if modifications to the fishery resulting from this environmental review process are sufficient to protect sanctuary resources. NOAA would use this information to consider whether removing the exemption for permitted live rock aquaculture activities in FKNMS is warranted in the future.

3.7.3 Marine zones and associated regulations

The Sanctuary Advisory Council established three community working groups to review and provide options for updating the sanctuary marine zoning scheme. Several marine zone recommendations were considered but eliminated from further analysis.

“Area to be avoided” changes in Tortugas Region

The ecosystem protection: ecological reserves, preservation areas, and wildlife protection working group considered potential expansion of the existing ATBA in the Tortugas Region of the sanctuary. The ATBA was designated through the FKNMSPA in 1990, approved by the IMO in 1991, and codified in sanctuary regulations in 1997 at 15 C.F.R. § 922.164(a). Changes to the ATBA in the Tortugas Region were considered and eliminated from further review for several reasons, primarily that alternatives should maximize environmental benefits while avoiding unnecessary adverse socioeconomic impacts. Designation of the ATBA in the Tortugas Region was determined based on the potential for environmental impact by large vessels. Modification of the ATBA in the Tortugas Region would not provide significant additional environmental benefits without avoiding unnecessary and adverse socioeconomic impacts. In addition, any change to the ATBA would require coordination across several agencies and internationally with the IMO. NOAA determined that modification of the ATBA in the Tortugas Region would not be evaluated as part of this EIS.

Temporal marine zones in the backcountry region

The shallow water wildlife and habitat protection working group considered applying a temporal zoning option for many of the marine zones considered for the national wildlife refuges and areas managed through the USFWS Backcountry Management Plan. The temporal zoning option included no access and no entry buffer areas extending 100-yards around islands when species of concern are present, such as nesting, roosting, or foraging bird species, nesting or foraging turtles, and other sensitive wildlife. While temporal zoning may provide more targeted, species-specific, and time-limited management, temporal marine zones were ultimately eliminated from further review for several reasons, primarily that alternatives must be feasible and enforceable and aim to facilitate compliance. NOAA and USFWS determined that temporal marine zones were not feasible due, in part, to the need for continual placement and removal of marker buoys at each zone for each temporal zoning period; the administrative burden to coordinate marker buoy permitting and placement among the various agencies with authority over aids to navigation (e.g., Monroe County, FWC, USCG, Army Corps of Engineers (USACE), etc.); and the resource implications for funding and staff to manage such a program. NOAA and USFWS determined that temporal marine zones would not facilitate compliance and were not fully enforceable due to the ongoing need to update and notify the public regarding updates to marine zone temporal closure regulations. In addition, NOAA and USFWS considered how temporal zone alternatives address resource management issues, generate beneficial environmental effects, and address uses or other activities that have an adverse effect on sanctuary resources. In doing so, NOAA and USFWS determined that if an area was of value for a particular species during a portion of their life cycle, then protecting that area year-round would be necessary to ensure the long-term and continued use of that area by species of concern. NOAA and USFWS determined that temporal marine zones would not be evaluated as part of this EIS at this time.

Tarpon migration zone

The shallow water wildlife and habitat protection working group considered several marine areas for zoning to protect tarpon during their migration in the Florida Keys. Two areas

discussed by the working group, Seaplane Basin and Tarpon Wildlife Migration Lane, were considered but eliminated from further review for several reasons, primarily that alternatives should aim to facilitate compliance and must be consistent with the purposes and policies of the NMSA and FKNMSPA. The areas identified for potential closure are large, multi-use, and, due to the large size and year-round multi-use of the area proposed, would present compliance and enforcement challenges. In addition, it is not clear that the closure of these areas would meet the stated purpose in the FKNMSPA to protect the resources of the sanctuary while not restricting activities that do not cause an adverse effect to sanctuary resources. At this time, NOAA determined that these two marine zones would not be evaluated as part of this EIS.

Motorized personal watercraft

Several motorized PWC alternatives were considered based on public comment and direction from the 2007 FKNMS revised management plan. The following three alternatives were considered but eliminated from further review:

1. *Prohibit PWC throughout the sanctuary.*
2. *Ban the operation of all vessels in less than two feet of water in the sanctuary.*
3. *Establish a 400-yard, point-to-point travel corridor from shorelines to designated high-speed rental-riding areas.*

These alternatives were considered but eliminated from further review for several reasons. In general, alternatives should maximize environmental benefits while avoiding unnecessary adverse socioeconomic impacts and be consistent with the purposes and policies of the NMSA and FKNMSPA. Prohibiting the use of PWC throughout the sanctuary and banning operation of all vessels in less than two feet of water would be difficult to enforce and would likely have potential for adverse socioeconomic impacts due to the high numbers of vessels including PWC that are used in sanctuary waters. NOAA determined that these three motorized PWC options would not be evaluated as part of this EIS. However, to address some of the potential impacts from vessel and PWC use in shallow and other nearshore waters, NOAA is proposing to update the existing sanctuary-wide idle speed/no wake within 100 yards of residential shorelines to be slow speed and apply to all shorelines (see Section 3.2.3 for details).

Chapter 4: Affected Environment

4.1 Introduction

This chapter provides detailed information on the biological, physical, historical, and economic resources affected by the proposed action and alternatives presented in Chapter 3. This chapter includes a site description and an overview of the baseline resource conditions within the study area of the proposed action (i.e., the potentially affected area for a particular resource).

This chapter is organized by sections on each resource area or type of use that may be impacted by the proposed action or alternatives, as follows:

- Biological resources
- Physical resources
- Pulley Ridge Unit and associated resources
- Cultural and historical resources
- Socioeconomic resources, human uses, and environmental justice

Each section includes a discussion of the general conditions of the resource or use within the study area. The study area varies by topic, but is generally inclusive of the existing sanctuary and national wildlife refuges boundaries, the ATBA, Florida Bay, and Pulley Ridge (Figure 4.1). Appendix E gives an overview of federal regulations and federal and local jurisdictions and agreements that apply to the study area.

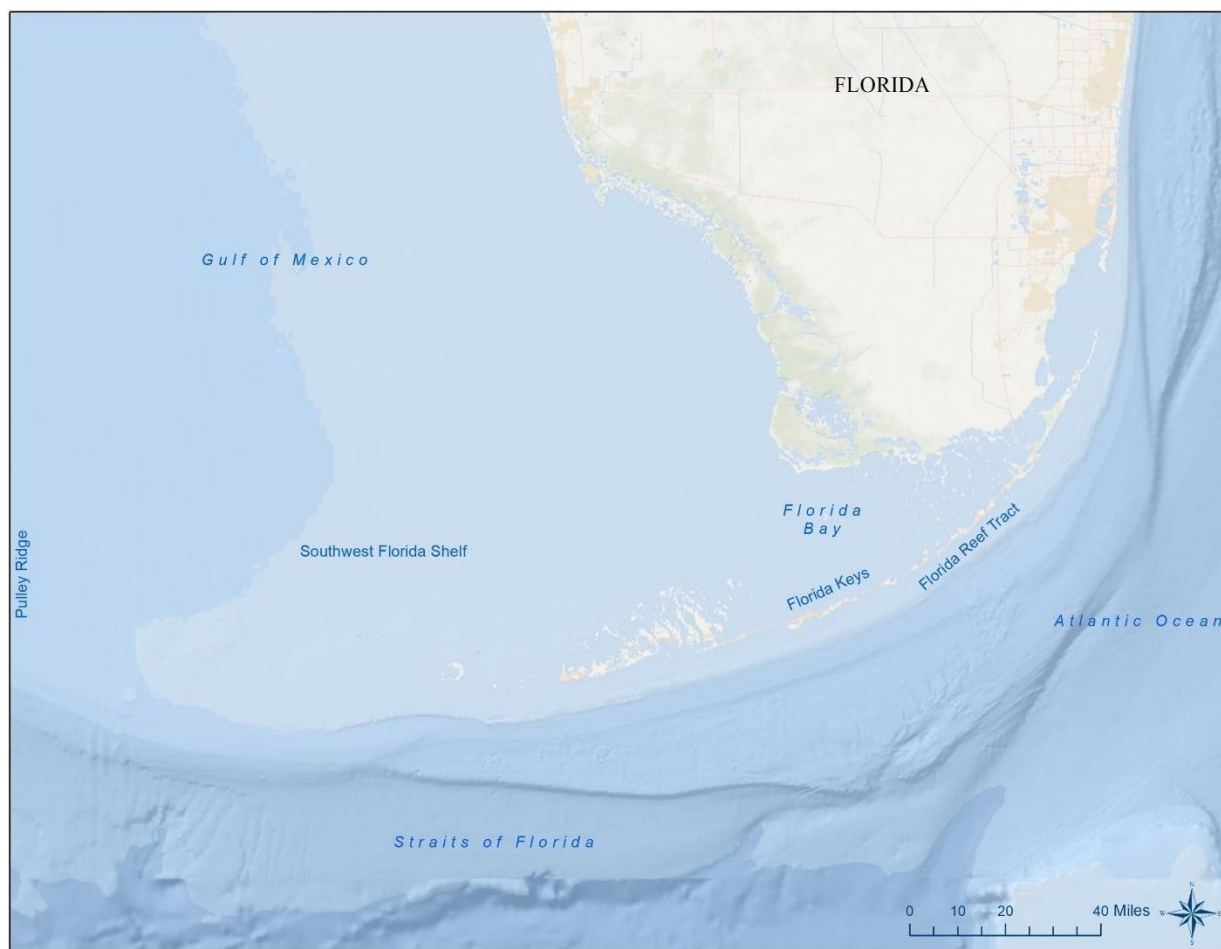


Figure 4.1. Florida Keys National Marine Sanctuary study area. The South Florida regional ecosystem includes interconnected natural resources and physical features. Image: NOAA

Since the proposed action includes a series of separate alternatives and regulatory actions that may not equally affect all areas of the sanctuary or refuges, the focus of the affected environment description is on the resources or uses that may be affected by changes in the sanctuary boundaries, sanctuary-wide regulations, marine zone boundaries, or marine zone regulations. As a result, some sections, such as hydrology under physical resources, provide only a general discussion of the resource conditions, while others, such as the biological resources section, provide a more specific discussion of the resources. The nature of existing conditions in the affected area waters is interpreted from available literature and summarized in the resource sections.

Only the background environmental and socioeconomic conditions relevant to the proposed action or alternatives are presented. Resource areas that have been determined to have no potential for impacts by the proposed action or alternatives are not discussed in this final EIS. These include land use, utilities, and visual resources.

4.1.1 Study area

The study area contains components of six distinct physiographic regions: Florida Bay, the Southwest Continental Shelf, the Florida Reef Tract (portion to the south and west of Virginia

Key), the Florida Keys, the Straits of Florida, and Pulley Ridge. The regions are environmentally and geologically unique, and together form the framework for the sanctuary's diverse terrestrial and aquatic habitats.

Florida Bay

Roughly triangular in shape, Florida Bay is a large shallow subtropical estuary located at the base of the Florida peninsula and is bordered by the Everglades to the north, the Florida Keys to the east and south, and the Gulf of Mexico to the west. The bay covers approximately 849 square miles (2,200 square km) and consists of a series of shallow carbonate mud banks that lie atop a karstic limestone bedrock that slopes from the Florida mainland to the southwest. The extensive network of mudbanks separates Florida Bay into a system of shallow basins, each with its own physical and chemical characteristics and unique habitats (Fourqurean & Robblee, 1999). The subtidal coastal environment forms a patchwork of seagrass meadows, sand and mud soft bottom communities, and sponge-dominated hard bottom. Low-lying islands typically form on banks where mangrove colonization can result in sedimentation above the mean high tide (Enos, 1977). Seagrass communities cover 95% of the bottom of Florida Bay, including extensive areas of the bay's banks and basins (Zieman et al., 1989). The habitats of Florida Bay are noted for their productivity, biological diversity, and roles as nursery habitats for many organisms (Butler et al., 1995).

Large seasonal and spatial variations in temperature, salinity, and turbidity are common due to the bay's shallow depth and the effect of the mudbanks at reducing water circulation and tidal energy (Wanless & Tagett, 1989). Coral reefs and other habitats within the Florida Keys are connected to the Florida Bay and Southwest Florida shelf by channels and passages in the Lower and Middle Keys. Outflow events occur sporadically and seasonally, typically on time scales of days to weeks, and can include water masses that are hypersaline, unusually hot or cold, rich in nutrients and sediments, or contain harmful organisms, and they represent a potential threat to the health of the Florida Reef Tract (Porter et al., 1999). In the Upper Keys, the nearly continuous barrier formed by the Florida Keys island chain separates the bay from the Straits of Florida and the Atlantic Ocean and shields the Florida Reef Tract on the ocean side from the environmentally variable bay waters.

Southwest Florida Shelf

The southwest Florida Shelf is a wide, shallow shelf aligned northwest-southeast and bounded by Gulf of Mexico waters to the west and the Straits of Florida near the Florida Keys and the Dry Tortugas to the south. The marine environment is highly variable and includes estuarine, coastal, and oceanic habitats that vary depending on the cross shelf location, substrate type, light availability, depth, ocean currents and waves, and a host of other factors. One of the most common benthic habitats on the shelf are seagrass beds. These include meadows of small, fast-growing paddle grass (*Halophila decipiens*) in the deeper waters where sunlight is limited and the more ubiquitous Turtle grass (*Thalassia testudinum*), which is the dominant seagrass in shallow areas. Closer to shore where light is less limited and conditions are relatively stable, manatee grass (*Syringodium filiforme*) forms tall, dense beds.

Live bottom habitats, including shallow hard bottom and offshore hard bottom habitats, are found throughout the shelf and they support vulnerable life stages of economically and

ecologically valuable fish as well as sea turtles and key motile invertebrates. This habitat is characterized by assemblages of macroalgae and sessile invertebrates living on rocky formations, including hardbottom with stony corals (Scleractinia), gorgonians (Alcyonacea), macroalgae, sponges (Porifera) and other invertebrates, with large loggerhead sponges (*Spheciospongia vesparium*) and vase sponges (*Ircinia campana*) creating the dominant vertical structure. Pen shells (Pinnidae), calico scallops (*Argopecten gibbus*), fighting conchs (*Strombus pugilis*), and other mollusks are found in the shallow shelf areas, and barrel sponges (*Xestospongia muta*) are found in deeper depths. Pink shrimp (*Farfantepenaeus duorarum*), stone crab (*Menippe mercenaria*), red drum (*Sciaenops ocellatus*), and other commercially valuable species spend part of their life cycle on the shelf and depend on shelf habitats (Nuttall & Fletcher, 2013).

Florida Keys Reef Tract

The Florida Keys Reef Tract consists of a bank-barrier reef system and associated patch reefs that have developed on the continental shelf between the islands of the Florida Keys and the deeper waters of the Straits of Florida. It is the only emergent coral reef system found off the continental US and it comprises the largest coral reef system of its type in the world (Keller et al., 2003). The bank-barrier reef system is a narrow, linear, discontinuous arc-shaped band of living coral located at the seaward edge of the shelf and extending approximately 81 miles (130 km) from Fowey Rocks off Miami to Tortugas Bank west of Key West. This bank-barrier reef system is the third largest in the world, and with peak growth approximately 7,000 years ago (Toth et al., 2018). The bank reef system has developed in a high energy environment at the edge of the shelf approximately four miles (6.4 m) offshore, and it provides a key barrier that absorbs wave energy from storms and storm surges.

Patch reefs occur in more protected offshore locations, primarily seaward of Hawks Channel, although nearshore patch reefs occur off several islands in the Lower Keys. Most patch reefs form aggregates along an inner ridge, with aggregate patch reefs interspersed among sand and rubble areas, isolated patch reefs, and seagrass beds. Approximately 6,000 patch reefs lie along the Florida Keys Reef Tract, with over 80% between northern Elliott Key and North Key Largo. Patch reefs occur in water between six and 30 feet (2–9 m) deep in the low-energy environment nearshore of the outer bank reef system. Patch reefs tend to have high structural relief and are primarily constructed of large frame-building boulder corals. In the Upper Keys most patch reefs are located 2–4 miles offshore, and they tend to be dome-shaped, circular to oval in outline, and 100–2300 feet (30–700 m) in diameter. In the Lower Keys, 2251 patch reefs were visible using satellite imagery (Peters et al., 2008). These were distributed across four cross shelf bands, with most forming aggregate and dome-type reefs located in mid-shallow and offshore locations. Well-developed coral reef ecosystems are found in the Upper and Lower Keys, while they are much more poorly developed in the Middle Keys, primarily due to environmental conditions. The numerous channels connecting the Middle Keys increases their exposure to waters from the Florida Bay and Gulf of Mexico which are much more variable in temperature, salinity, nutrients, and toxins. In the northern Keys, reef growth is generally best overall, mainly due to the protection from Florida Bay offered by the long island of Key Largo as well as the closer proximity of the Florida Current (Ginsburg & Shinn, 1964; Voss, 1988; Shinn

et al., 1989). (See the biological resources section of this chapter for more detail on the reef environment.)

Florida Keys

The Florida Keys extend southwest from the southeastern part of the Florida peninsula over 220 miles (354 km) terminating at the islands of the Dry Tortugas. The Florida Keys can be divided into five areas based on morphology, lithology, and location: the Upper, Middle, and Lower Keys, the Marquesas, and the Dry Tortugas.

The Upper Keys are oriented northeast to southwest and extend from Virginia Key to Lower Matecumbe Key. The islands in the Upper Keys are long, narrow, and low-lying, with an average elevation of three to six feet (1–2 m) and a maximum elevation of 20 feet (6 m) at Windley Key (Minerals Management Service, 1990). Only a few narrow channels connect Florida Bay to the Atlantic Ocean.

The Middle Keys extend from Lower Matecumbe Key to the Seven Mile Bridge. The Middle Keys are similar in size, elevation, and orientation to the Upper Keys; however, numerous wide channels separate each island.

The Lower Keys are aligned northwest to southeast and extend from Little Duck Key to Key West. The Lower Keys are broad, flat, are separated by long narrow channels, and turn perpendicular to the Middle and Upper Keys.

The Marquesas and Dry Tortugas regions are found to the west of the Lower Keys and are more recently formed isolated clusters of carbonate sand shoals on the southern edge of the southwest continental shelf. Their continuing formation is dependent on sediment transported to the area and the growth of surrounding reef-building coral reefs (Multer, 1977; Minerals Management Service, 1990).

Straits of Florida

The Straits of Florida make up a large block-faulted basin paralleling the Florida Keys and the Florida Keys Reef Tract. The basin is an open-ocean, deepwater environment that slopes gradually for several kilometers to a depth of 984 feet (300 m) before dropping off sharply to an average depth of 2,624 feet (800 m). One of the Straits' most significant features is the Pourtales Terrace, a well-defined plateau (124 miles [200 km] long by 19 miles [30 km] wide and 656 to 1,312 feet [200–400 m] deep) that borders the Lower Keys (Multer, 1977; Mineral Management Service, 1990). The morphology of the Straits is controlled by the Florida Current, which links the Gulf of Mexico Loop Current with the Gulf Stream. The warm, clear, low-nutrient waters of the Florida Current create the warm, stable conditions that make coral reef development possible at this more northerly latitude. The Florida Current and its eddies bring larvae spawned elsewhere in the Caribbean Basin and Dry Tortugas to the Florida Keys Reef Tract (Lee & Williams, 1999).

Pulley Ridge

Pulley Ridge is a carbonate ridge that is 197 to 295 feet (60–90 m) deep. It extends nearly 186 miles (300 km) along the southwestern Florida Shelf in the northern Gulf of Mexico approximately 41 miles (66 km) west of the Dry Tortugas and includes unique geomorphology

and associated habitats. The southern portion of Pulley Ridge, at depths of 200 to 262 feet (60–80 m), supports the deepest known photosynthetic coral reef off the continental United States. The dominant communities in these reefs, also called mesophotic reefs due to their depth and reduced access to light for photosynthesis, are coralline algae and scleractinian corals. Mesophotic reefs create hard-bottom habitat that supports a diverse community of plants and animals, many of which are unique and include coral, sponge, and algal species. Regional currents drive important physical connectivity between the coral reefs of Pulley Ridge, the Dry Tortugas, and the Florida Keys. (See Section 4.4 for more detail on the mesophotic reef environment and associated resources at Pulley Ridge.)

4.2 Biological Resources

This section presents information on a variety of habitat types and associated biological communities, a summary of marine flora, and a discussion of specific wildlife resources including fishes, marine mammals, birds, invertebrates, and reptiles. This section also includes information on specific species that are protected by federal and/or state law.

The study area for biological resources includes the existing FKNMS, Florida Keys National Wildlife Refuges, and the areas in the Tortugas and Pulley Ridge that are included in potential boundary expansion alternatives.

Biological resources in the study area are described in many publications, and additional information is available from a variety of sources. Regular benthic monitoring provided valuable quantitative information beginning in 1994 about the overall condition of coral reefs, including trends in coral, macroalgae, and sponge cover and prevalence of bleaching and disease. The main, reef-wide programs that are currently being implemented include the Coral Reef Evaluation and Monitoring Program (CREMP) led by scientists with the FWC-FWRI, the Disturbance Response Monitoring Program, which is part of the Florida Coral Reef Resilience Program (FCRRP) coordinated by FWC, and the National Coral Reef Monitoring Program coordinated by NOAA's Coral Reef Conservation Program. Additional targeted monitoring of permanent stations as well as stratified random surveys of fish, motile invertebrates, and benthic communities, including both restored and wild corals, is being implemented at the seven Mission: Iconic Reefs locations. Historical data are also available from the Sanctuary Coral Reef Ecosystem Monitoring (SCREAM) program, but these surveys are no longer being conducted.

NOAA and USFWS staff gathered this information for existing and future management efforts, to monitor conservation objectives, and as part of ongoing resource assessment and research. For a more detailed discussion on biological resources within FKNMS, please refer to the following documents: Tortugas Integrated Assessment (Jeffrey et al., eds 2012) and Florida Keys National Marine Sanctuary Condition Report (NOAA, 2011), as well as Tropical Connections (Kruczynski & Fletcher, 2012), USFWS Lower Florida Keys CCP (2009), and USFWS Crocodile Lake National Wildlife Refuge CCP (2006). Detailed summaries of the regional coral reef monitoring programs provide additional data on status and trends of coral, benthic and fishery resources, including:

National Coral Reef Monitoring Program biological monitoring summary Florida: 2020–2021 (NOAA, 2022).

Coral Reef Condition: A status report for Florida’s Coral Reef. 2020 release. 2014–2018 data. NOAA Coral Reef Conservation Program.

Appendix H of this final EIS contains comprehensive lists of species known to occur in the study area that are protected under state and/or federal law, including species listed as threatened or endangered.

4.2.1 Habitats

The study area contains a diversity of habitats, including coral reefs, unconsolidated soft bottom habitats (e.g., sand and mudflats), rubble fields, colonized hard bottom habitats, submerged aquatic vegetation (e.g., seagrass and algae), mangrove⁹, beach/dune, coastal berms, and beach ridge hammocks. The following discussion focuses on habitats in and adjacent to the study area.

4.2.1.1 Coral reef

The Florida Reef Tract is the most extensive living coral reef ecosystem in North American waters. It extends from the Dry Tortugas in the west to St. Lucie inlet off the southeast coast of peninsular Florida. Coral reefs are created by reef-building (stony) corals, calcareous marine algae, and other marine invertebrates that produce skeletons or structures made of calcium carbonate (CaCO₃, or limestone). The skeletons of corals and other marine life become cemented together by calcareous algae to form a rigid, wave-resistant living structure elevated off the seafloor.

Within the tissue of most shallow-water reef-building corals live small, microscopic algae called zooxanthellae. These algae produce energy and oxygen as byproducts of photosynthesis which they share with the coral and in return the coral provides the algae with shelter, food, and CO₂ produced during the process of respiration and calcification. Zooxanthellae also aid in the deposition of their skeleton by removing the CO₂ during photosynthesis.

Coral reefs are generally restricted to the tropics and subtropics, where waters are warm (64–88 F), clear, low in nutrients such as nitrogen and phosphorus, and have stable salinity (32–36 ppt). The Florida Keys Reef Tract is one example in which the warm waters of the Florida Current and Gulf Stream expand the range of corals north of the tropics.

Coral reefs create important habitats for various organisms including both sessile and mobile invertebrates, as well as highly diverse ecologically and economically important reef-associated fish. In turn, many of these animals provide food for predators that often visit reefs, such as sharks, pelagic fish, and dolphins (Cetacea). In total, 64 species of stony corals, 55 soft corals, and hundreds of other invertebrates such as sponges (Porifera), anemones (Actiniaria), crustaceans (Arthropoda), molluscs (Mollusca), and echinoderms (Echinodermata) have been described from the Florida Keys (Levy et al., 1996). Coral reefs provide many ecosystem benefits to humans, supporting fisheries, tourism, and recreation. They also provide vital coastal

⁹ FWC integrates maps from partners to maintain a Florida’s Unified Coral Reef, see: <https://myfwc.com/research/gis/fisheries/unified-reef-map/>

shoreline services by protecting the coastline from wave action, storm surges, and even tsunamis (Cochard et al., 2008; Storlozzi et al., 2019).

Bank barrier reefs

The reef tract within FKNMS extends from the northern boundary of the sanctuary to west of the Marquesas Keys and is also found at the Dry Tortugas. The reef tract consists of an offshore bank-barrier reef system, intermediate reefs, deep reefs, outlier reefs, offshore patch reefs, mid-channel patch reefs, and an inner reef system. The bank-barrier reef system is similar to barrier reefs found in the Caribbean, but it exhibits lower relief than a true barrier reef and the characteristic deep-water lagoon that separates a barrier reef from land is absent.

The bank-barrier reef system varies in morphology and species composition with large regional differences in the structural complexity of individual bank reefs. Bank-barrier reefs include both high-relief communities with a well-developed spur and groove formations, reefs that lack distinctive spur and groove characteristics, and older drowned spur and groove reef systems that are not actively growing and have a very low profile (0.5–1.5 m relief) (FMRI, 2000). Relic reefs with less than 3–4 feet of vertical reef are characteristic of the Middle Keys and a portion of the Lower Keys, where adjacent islands are smaller and tidal channels connecting to the Florida Bay are larger. The only exception is Sombrero Reef, which is a high-relief reef system in the Middle Keys.

The distinct habitats or zones found on these reefs are structured by reef age, position on the shelf, underlying topography, water depth, degree of light penetration, and wave energy (Jaap, 1984). Habitat types may include a sheltered back reef, rubble zone, exposed reef crest, shallow and deep spur-and-groove, fore reef slope/terrace, and deep reef (Jaap, 1984).

The most characteristic feature of the high-relief outer reefs are the high-profile slopes, ledges, and spurs of living and fossilized corals, separated by sand channels. These form a series of coral fingers that extend perpendicular (seaward) to the reef system and are referred to as spur-and-groove formations. These features extend up to 1–2 km off the main reef and occur at depths of 1–30 feet (Keller et al., 2003). The development of the spur and groove formation varies across the reef tract, with some reef systems (e.g., French Reef) having poorly developed shallow spur-and-groove zones and a well-developed deep spur-and-groove that developed on the antecedent reef platform. This habitat supports a diverse community of sea fans and branching gorgonians (octocorals), colonial sea anemones, sponges, and stony corals. Historically, it supported dense thickets of elkhorn coral on the shallow tops of the spurs, boulder corals on the sides of the spurs, and large stands of staghorn coral at the bases of the spur and in back reef habitats.

The reef crest is a very shallow zone that separates the spur and groove formations from the back reef. This zone is inhabited by species that can tolerate extreme conditions of low tides or breaking waves, such as mustard hill coral, encrusting brain corals, and fire coral.

Most bank barrier reefs support a fore reef zone that gradually slopes seaward from the base of the spurs. In some cases, this is relatively low relief and may be very wide, while other reefs support large buttresses constructed primarily by large *Orbicella* colonies that provide substantial structure and relief.

Seaward of the shallow bank reefs are deeper intermediate reef communities. This habitat begins at about 30 feet depth and extends out to 60–70 feet depth very gradually. The reef is composed of low-profile “drowned” coral spurs and fossilized coral covered with fine sediment. Prior to the mid 1970s, much of this habitat was occupied by staghorn coral (Wheaton, 1981). At about 65–70 feet depth, the slope of the reef increases and extends to 90–100 feet or deeper. The slope is more gradual off Key Largo, steeper in the Lower Keys, and almost vertical at several reefs between Sombrero (Middle Keys) and American Shoals (Lower Keys). Much of the deep reef is barren fossilized coral covered in fine sediment. While coral cover tends to decline in deeper water, boulder and brain corals become plate-like in response to reduced light levels, and many of the more fragile foliaceous and plating corals, finger corals, and other less common species (e.g., pillar coral, cactus coral) are found here.

In several locations the margin of the deep reef habitat terminates in sand/mud. This soft bottom habitat extends seaward about 0.5–1.5 km, until it reaches outlier reefs, which extend parallel to the shallow reef system from American Shoals to Sand Key off Key West (Wheaton, 1981). Deep reefs are also found off Carysfort, The Elbow, and French Reef, but these primarily consist of large 1–2 m tall mounds interspersed with sand channels.

Representative hard coral species found on bank-barrier reef systems include elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicornis*), mountainous star coral (*Orbicella faveolata*), and lobate star coral (*O. annularis*), brain corals (*Pseudodiploria strigosa*, *Diploria labyrinthiformis*, *Pseudodiploria clivosa*, and *Colpophyllia natans*), mustard hill coral (*Porites astreoides*), finger coral (*Porites porites*), starlet coral (*Siderastrea siderea*), and lettuce corals (*Agaricia agaricites*).

Patch reefs

Over 2,200 patch reefs are found between the offshore reef system and the shoreline, occurring predominantly in the mid-channel within Hawk Channel and in inshore locations. Most patch reefs are found in the Upper Keys between Key Largo and Elliot Key, followed by the Lower Keys; the fewest are found in the Middle Keys. Patch reefs are also found off the Marquesas and Dry Tortugas and a smaller number are found offshore in the Gulf of Mexico between Content Keys and Bay Keys. Many of these patch reefs consist of small, scattered, circular, elliptical, or dome-shaped reefs, surrounded by sand halo, seagrass beds, or shallow hardbottom in nearshore environments, but they also form a linear aggregation in offshore locations.

Patch reefs are found in two distinct zones, one seaward of Hawk Channel running parallel to the bank-barrier reef system and a second landward of Hawk Channel, on the hardbottom margin of the seaward side of the island chain. Many of the mid-channel patch reefs are in an area usually hidden by the turbid waters of Hawk Channel, the deeper body of water that separates the Florida Keys islands from the main outer reef tract. Mid-channel reefs rise up to 15 feet (4.6 m) from the bottom and provide an important refuge for fish and invertebrates during different stages of their life cycles.

The offshore patch reef habitat is a transitional zone between the mid-channel and inshore habitats and the outer bank-barrier reef. Offshore patch reefs are primarily located along the seaward edge of Hawk Channel, parallel to the outer reef tract. They consist of diverse high-

relief habitats with tall gorgonians (octocorals), abundant massive stony corals, and a diverse assemblage of sponges.

Patch reefs exhibit extreme variability in coral diversity, abundance, and demography which is partially controlled by their cross-shelf distribution, size, structure, and developmental stage (Jaap, 1984). Most patch reefs generally do include elkhorn coral, but historically they supported staghorn coral. The patch reefs are constructed primarily of very large frame-building boulder corals such as star coral (*Orbicella* spp. and *Montastraea cavernosa*), starlet coral (*Siderastrea siderea*), and brain corals (*Colpophyllia*, *Pseudodiploria*, and *Diploria* spp.). Living coral cover on outer reefs today ranges from about 1–5%, while many of the patch reefs still have very high coral cover (5–30%) along with a wide diversity of invertebrates, reef fish, and macroalgae (Ruzicka et al., 2013). Associated flora and fauna vary greatly between shallow water and deep-water patch reefs (Florida Natural Areas Inventory, 2010).

Bleaching and disease

As climate change continues to intensify, negative consequences associated with changes in sea water temperatures are predicted to be most pronounced on larval fish, crustaceans, mollusks, echinoderms, corals, and other calcifying organisms, but these impacts are likely to extend to the entire marine food web and the valuable ecosystem services provided by the Florida Keys marine ecosystems. Reef-building corals in particular are sensitive to sudden and prolonged changes in sea water temperatures, including elevated summer temperatures and colder than normal winter temperatures. These temperature fluctuations have caused localized and regional scale coral bleaching events and have also increased susceptibility to disease, morbidity, and mortality.

Large-scale coral bleaching was first recorded in the lower Florida Keys in 1979 along the outer reef tract, primarily in shallow fore-reef habitats (Jaap, 1979). Bleaching has progressively become more widespread and severe, affecting reefs throughout Florida and the wider Caribbean in 1982–1983, 1987 and 1990, globally during the mass coral bleaching events in 1997–1998, and during 2005 (Manzello, 2015). The most severe cold water event since the 1970s impacted nearshore and mid-shelf reefs in the winter of 2010, primarily affecting corals in the Middle and Lower Keys. The second global bleaching event and the first ever to affect reefs around the world for multiple years caused severe bleaching in FKNMS during 2014 and again in 2015 (Gingter et al., 2018; Manzello et al., 2018; Smith et al., 2019). Since 2018, minor bleaching has been observed annually, with the most severe heatwave ever recorded and extreme bleaching between June–October 2023. These bleaching events have contributed to a decline in living coral cover on reefs throughout the Florida Keys.

Temperature data from NOAA's Coastal Marine Automated Network station at Molasses Reef in FKNMS provided a more than 30-year continuous record of seawater temperatures on the outer reef, until 2019. The oldest known *in situ* temperature record of any coral reef in the Florida Keys is from Hens and Chickens Reef in the Florida Keys, which showed significant warming from 1975 to 2014 (Manzello, 2015). Near real-time temperature data from both surface water and the bottom are also now available for 10 sites, including SoFar buoys deployed at the seven Mission: Iconic Reefs, Florida International University data buoys at Sand Key, Molasses Reef, and Sombrero Reef and DEP data buoys at Newfound Harbor. Seafloor temperatures in the

summers of 2014 and 2015 and the winter of 2013–14 were the warmest on record until the unusual marine heatwave in 2023. During the summer of 2023 seawater temperatures in multiple locations in the Florida Keys exceeded all previously recorded data with temperatures on the seafloor in several reef environments of ‘93–‘94 F (NOAA, 2023). A global analysis of bleaching has shown that coral bleaching has increased in frequency and intensity over the last decade. However, the onset bleaching has occurred at significantly higher sea surface temperatures than in the previous decade, suggesting that surviving corals may have a higher threshold of bleaching resistance (Sully et al., 2022). While this suggests some corals may acclimate to higher temperatures, the highest probability of coral bleaching occurs at tropical mid-latitude sites like the Florida Keys, despite similar thermal stress levels at equatorial sites (Sully et al., 2022). Coral diseases were first described in the Caribbean in the 1970s (Antonius, 1973), and have since been recognized as a major driving force behind the decline of reef-building corals throughout Florida and globally. The wider Caribbean has been described as a hotspot for coral diseases and the occurrence of disease outbreaks or epizootics have become increasingly common (Morais et al., 2022). In addition to localized, often seasonal outbreaks, corals that are exposed to abnormal temperatures that subsequently bleach appear to be more vulnerable to disease, and often, outbreaks of diseases have emerged as the corals began to recover from bleaching following the decline in temperatures (Miller et al., 2006). Heat stress during bleaching events likely lowers the resistance of corals to pathogens, possibly due to a breakdown of their immune system. In the Florida Keys, white band disease and white pox diseases caused extensive declines to elkhorn coral and staghorn coral populations during the 1980s and 1990s, and these corals have continued to decline from these and other diseases and concurrently experienced further reductions from bleaching events over the last decade. Several new diseases also emerged in the 1990s and 2000s, including diseases affecting long-lived boulder corals, foliaceous corals, gorgonians, and sponges (Woodley et al., 2016).

Presently, Florida’s Coral Reef is facing a highly contagious coral disease (stony coral tissue loss disease or SCTLD) that first emerged near Miami in 2014, reached the Upper Keys by December 2015, and slowly spread throughout the entire Florida Keys Reef Tract, reaching reefs off Tortugas in May 2021. SCTLD affects 302 species of stony coral, including five species listed as threatened under the ESA (Precht et al., 2016; Walton et al., 2018). SCTLD has contributed to the regional extinction of the pillar coral (*Dendrogyra cylindricus*) and continues to cause widespread declines to the most important massive frame building corals (Muller et al., 2020; Neely et al., 2021). While most diseases tend to increase in severity as the water warms, SCTLD is unusual in that the prevalence declines in late summer/fall as corals bleach and it tends to emerge again during winter. SCTLD is unprecedented in terms of the high numbers of species affected, rapid rates of tissue loss and mortality, and transmission rates, and it has resulted in a significant loss in coral species richness, coral cover, and coral structures (Gintert et al., 2018; Walton et al., 2018).

The mean coral cover on reefs in the Florida Keys is now 5.2% (CREMP 2022 data). Even before the emergence of SCTLD, there had been a transition from stony coral dominance to benthic communities dominated by octocorals, colonial anemones, and other non-reef-building species (Ruzicka et al., 2013). Coral reef ecosystems in the Florida Keys have developed very slowly over the last 10,000 years, increasing in height only about three millimeters per year during periods when climate was optimal for reef development, but growth rates became more marginal as

temperatures cooled and by 3000 years ago net accretion rates were only about 0.5 mm/yr (Toth et al., 2022). Due to declines in the dominant reef building corals (especially *Acropora palmata* and *Orbicella* spp.) following a series of increasing severe thermal stress events and repeated coral disease outbreaks, rates of reef growth have continued to decline and by 2019 only about 15% of the reefs exhibited positive net reef growth (Toth et al., 2022). Disease, temperature stress, physical impacts from boat groundings and anchors, and numerous other stressors have taken their toll on Florida's coral reef systems, affecting both the reef structure and thousands of species that use reefs as nursery, feeding, and refuge areas. Unless proactive steps are taken to reduce threats and restore damaged areas, coral communities critical to the survival of these ecosystems may take decades to fully recover, if they are ever able to.

Coral status

CREMP has conducted annual monitoring of the cover, diversity, and abundance of coral reef taxa in the sanctuary since 1996. These sites have shown a progressive decline in stony coral populations and concurrent increases in gorgonians (sea whips and sea fans), colonial anemones (Palythoa), and macroalgae. In 2022, mean benthic cover in the Florida Keys was 13.1% for octocorals, 16.0% for macroalgae, 5.2% for stony corals, 3.8% for sponges, and 2.1% for zoanthids. The high values in macroalgal cover in recent years provide cause for concern as macroalgae directly compete for space with corals and octocorals on the reef. The reductions in coral cover in the Florida Keys have been attributed to multiple stressors, including both warm- and cold-water coral bleaching events, disease outbreaks, harmful algal blooms, vessel impacts, and hurricanes. Deteriorating water quality and changes in environmental conditions have also hindered coral recovery in the aftermath of these major disturbances. Figure 4.2 shows CREMP data over time.

Federally protected coral species

There are six coral species within the Florida Keys that are listed as threatened under the ESA and one coral listed as endangered. NMFS listed two Acroporid coral species, elkhorn and staghorn, in 2006, and five additional species in 2014. In 2023, Pillar coral (*Dendrogyra cylindrus*) was uplisted from threatened to endangered. Species descriptions for federally protected species can be found in Section 4.2.3.

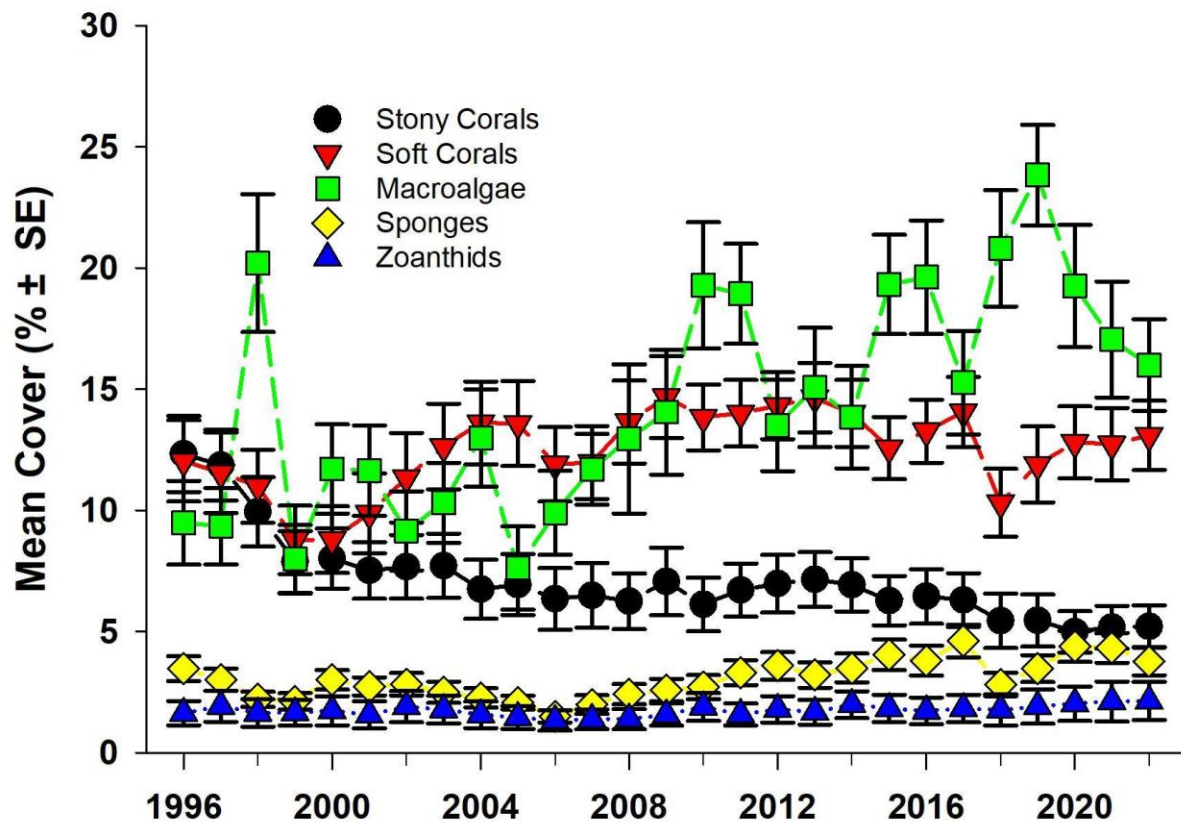


Figure 4.2. Trends in benthic cover for stony corals, soft corals, macroalgae, sponges, and zoanthids show changes over time (CREMP data 1996–2020). Source: FWC-FWRI

4.2.1.2 Consolidated substrate: Hardbottom

Shallow hardbottom communities are found throughout nearshore environments within the Florida Keys, on both the ocean and bay side, covering roughly 30% of the nearshore environment of the Florida Keys (Bertelsen et al., 2009). Hardbottom communities can form on exposed solid rock or on low-relief limestone substrates covered with a layer of sediment and sparse seagrass. Hardbottom communities support more than 60 species of sponges, along with sea fans and branching gorgonians, stony corals, and macroalgae (Butler et al., 2021). Many of the stony corals found here are unique and are typically rare in reef environments such as *Solenastrea* (smooth star coral) and *Manacina* (rose coral).

Typically, stony coral cover is low in hardbottom habitats, while sponges are the dominant invertebrates, occurring at densities of up to 47,000 sponges per hectare (Butler et al., 2021). Overall brown branching sponges (*Ircinia felix*; 1643/ha) and yellow rope sponges (*Aplysina fulva*; 1340 per ha) occur at the highest density. While some of the larger species, such as loggerhead sponges (*Spheciospongia vesparium*) make up only about 10% of the total sponge density, they can reach a size that exceeds 1 m in diameter and they make up about 60% of the biomass (Butler et al., 2021). These larger loggerhead sponges are especially important, as they provide shelter and habitat for fish and invertebrates and they play a key role in lobster

recruitment of Caribbean spiny lobster (*Panulirus argus*) (Bertelson et al., 2009) and habitat for stone crab (Butler et al., 1995). Some sponge species also shelter infaunal animals such as snapping shrimp, polychaetes, and brittle stars that inhabit the complex network of canals inside the sponge. In addition to the effect of these sponges at increasing the structural complexity of these habitats, sponges filter an immense amount of water, removing dissolved and particulate matter, altering water chemistry as a result of their symbiotic microorganisms, and reducing the potential for sedimentation. In areas of high sponge biomass, they have been shown to reduce chlorophyll-a, ammonium, and dissolved organic carbon, while increasing concentrations of nitrites, nitrates, and phosphates (Valentine & Butler, 2019).

Hardbottom habitats form the foundation for the development of other marine and estuarine natural communities, and they are critical nursery areas for many commercially important invertebrates and fishes. Over the past three decades, nearshore hardbottom communities have experienced substantial ecological changes. Much of the change was triggered by seagrass die-offs in the Florida Bay that precipitated expansive cyanobacterial blooms (Butler et al., 1995). Multiple cyanobacterial blooms in the 1990s and 2000s caused substantial mortality of sponges (>90% in some locations) and hindered natural recovery of these sponge communities (Stevely et al., 2011). Catastrophic mortality events affecting sponges and other invertebrates occurred in nearshore hard bottom habitats 1991, 2007, 2013, and 2016 and were associated with anomalous and persistent weather conditions including thermal stress and elevated salinity (Stevely et al., 2011; Butler et al., 2021).

4.2.1.3 Unconsolidated substrate: Beaches, sandflats, and mudflats

Unconsolidated substrates are found throughout the Florida Keys on both the Atlantic and Gulf side. The sediments that compose these habitats include coralgall, marl, mud, mud/sand, sand, or shell and they may originate from organic sources, such as decaying plant tissues (e.g., mud) or from calcium carbonate depositions of plants or animals (e.g., coralgall, marl, and shell substrates). While these areas may seem relatively barren, the densities of infaunal organisms in subtidal zones can be substantial, making these areas important feeding grounds for many bottom-feeding fish. Common infaunal organisms can include tube worms (Annelida), sand dollars and sea biscuits (Clypeasteroidea), mollusks, isopods, amphipods, burrowing shrimp (Thalassinidea), and an assortment of crabs. Submerged sandflats are also important settlement habitats for bonefish (Albulidae), snapper (Lutjanidae), grunts (Haemulidae), permit (*Trachinotus falcatus*), anchovies (Engraulidae), and other commercially important fishes (Snodgrass & Harden, 2009). The intertidal and supratidal zones are extremely important feeding grounds for many shorebirds and invertebrates (Florida Natural Areas Inventory, 2010).

Tidal flats

Tidal flats are dominated by soft sand or mud sediments and generally lack vegetation, and are submerged at high tide and exposed at low tide. They are most abundant near inlets, where tidal influence is strongest, but they generally are protected from wave action. These can include mudflats, which occur in the upper portion of the intertidal zone and in areas with low energy such as that found adjacent to mangroves. These tend to have higher organic content which may originate as a result of microbial activity or from dead and decaying plant material exported from mangroves and seagrass beds. Sandflats generally occur in areas with stronger currents

and moderate wave action and include the popular “sandbars” on both the Atlantic and Gulf sides. While biological diversity may be relatively low, these are highly productive ecosystems that support a high abundance of microorganism and benthic infauna. These organisms play a key role in recycling of organic matter as well as nutrients, and they are an important food source for finfish, motile invertebrates, and resident and migratory birds. Tidal flats provide essential foraging habitat for wading and shorebirds that hunt small fish, crustaceans, and marine invertebrates during low tide cycles. These birds include federally listed species such as piping plover (*Charadrius melodus*), as well as numerous imperiled and state-threatened wading bird species.

4.2.1.4 Seagrasses

The Florida Keys supports one of the world’s largest seagrass beds. Seagrass occurs throughout the soft-bottom, shallow-water areas of the sanctuary wherever water quality allows adequate light penetration to enable photosynthesis. Seagrass present within the study area include turtle grass (*Thalassia testudinum*), the dominant seagrass community; shoal grass (*Halodule wrightii*); and manatee grass (*Syringodium filiforme*), with three species of *Halophila* found in some deeper seagrass habitats. Other living components of this habitat include thin finger coral (*Porites divaricata*) and various species of fish, macroalgae, sponges, and other invertebrates. Seagrass communities have high economic value, with more than 70% of recreational and commercially important fish, molluscs, and crustaceans spending some portion of their life in seagrass beds. Data from the sanctuary’s WQPP seagrass monitoring indicates approximately 4,942 square miles (12,800 km²) of seagrass beds lie within and adjacent to the sanctuary.

Seagrass communities provide a range of ecosystem services, including stabilizing the bottom through their dense roots and rhizomes, and helping to maintain water clarity by trapping fine sediments and other particles in their leaves and root systems. Seagrass beds are integrally linked to reef environments, mangrove communities, and hardbottom habitats, both spatially and in terms of food webs (Valentine et al., 2008). Seagrass beds provide critical settlement and nursery habitat for juvenile life stages of many fishes and invertebrates, including crustaceans (e.g., lobster and shrimp), molluscs (e.g., queen conch), and echinoderms (e.g., sea urchins) as well as grunts, snapper, and other recreationally and commercially important marine life. Seagrass beds also provide foraging area for herbivores including turtles, West Indian manatees (*Trichechus manatus*), parrotfishes (Scaridae), and sea urchins (Echinoidea), and refuge from predation for numerous invertebrates and fishes (Rudnick et al., 2005; Acosta et al., 2007). Seagrass blades also support a community of attached invertebrates and algae (epiphytes) that provide food for numerous small animals living among the seagrass. In addition, a number of unique and threatened marine invertebrates reside in seagrass beds, including stony corals that rarely occur on the reef (*Manicina* rose coral, *Porites* finger corals, branching *Oculina*, and *Solenastrea* star coral), sponges, soft corals, anemones, sea stars (Asteroidea), sea urchins, and sea cucumbers (Holothuroidea). An array of terrestrial wildlife, including great white heron (*Ardea herodias occidentalis*), reddish egret (*Egretta rufescens*), tricolored heron (*Egretta tricolor*), white pelicans (*Pelecanus erythrorhynchos*), and other seabird species are dependent upon seagrass communities for their diet (Waycott et al., 2009). Contiguous seagrass with minimal propeller scarring is critical in the protection of foraging areas for great white heron.

Seagrass beds also provide long-term storage and sequestration of carbon, primarily in their soils.

Seagrass beds have declined in abundance and distribution and species composition has shifted in some nearshore areas due to water quality degradation and through the direct loss of habitat due to anthropogenic influences such as dredging, infilling, coastal development, and boating impacts (e.g., propeller scars and groundings), as well as physical disturbances by major hurricanes.

Federally protected species in seagrass areas

Federally listed animal species that depend upon seagrass habitat in South Florida include: American crocodile (*Crocodylus acutus*), green sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*), roseate tern (*Sterna dougallii dougallii*), wood stork (*Mycteria americana*), bald eagle (*Haliaeetus leucocephalus*), smalltooth sawfish (*Pristis pectinata*), West Indian manatee (*Trichechus manatus*), and others. See Section 4.2.3 for more information on listed species.

Seagrass habitat status

Seagrass habitat can be damaged by propeller scarring and prop wash blowout from powered vessels operating in shallow water, and from anchor damage. Disruptions can take many years to naturally recover without restoration assistance (Kenworthy, 2002). Propeller damage impacts fish and invertebrate species diversity (Uhrin & Holmquist, 2003), which negatively affects foraging habitat for imperiled wading bird species (Meyer & Kent, 2011).

A mapping project conducted in 1995 and replicated in 2015 documented visible scarring and grounding impacts in shallow seagrass habitats from the sanctuary's northern boundary north of Ocean Reef to the west of Key West in the Marquesas Keys. Within these habitats, there was a 285% increase in severely impacted acres between 1995 to 2015, increasing from 5,060 acres (20 km) to 19,462 acres (79 km) (Kruer, 2017).

Increased sea surface temperatures, reduced freshwater inputs and elevated salinity, and increased nutrients can contribute to episodic die-offs of seagrasses and shifts from seagrass dominance to macroalgae. A seagrass die-off occurred in Florida Bay in 1987, impacting 9,884 acres (40 km²) of seagrass (Hall et al., 2016). Florida Bay experienced another large-scale seagrass die-off in 2015 due to increased water temperatures, salinity, a stratified water column, and bottom water anoxia (lack of oxygen) (Hall et al., 2016).

The WQPP has conducted annual monitoring of seagrass extent and condition since 1995 at a total of 40 permanent monitoring sites (30 sites monitored since 1995, five additional sites in the Florida Bay in 2000, 10 nearshore sites added in 2012, and 17 sites established in the Dry Tortugas in 2011) (Krause et al., 2022). Trends show relative stability over a 25-year monitoring period, although there has been a complete loss of seagrass at some exposed back reef sites and there has been a loss of the climax species *Thalassia testudinum* in some areas with little or no recovery over decadal time scales (Krause et al., 2022). In areas that experienced decline, the species composition has shifted towards faster growing *Halodule* spp. and macroalgae in nutrient-rich nearshore sites. A shift towards faster-growing seagrass and algae (manatee grass

macroalgae and calcareous green algae is replacing turtle grass) is associated with areas of higher water column nutrients, especially nitrogen (Collado-Vides et al., 2007). In addition, the most stable benthic communities throughout the monitoring network have been seagrass beds dominated by dense meadows of *S. filiforme*, especially in the back country and north of the Middle and Lower Keys and off the west Florida shelf where concentrations of nitrogen and phosphorus are elevated and episodic upwelling of nutrients from the Gulf of Mexico occurs (Weisberg et al., 2016; Krause et al., 2022). The natural system has historically been nutrient-limited, which has allowed seagrasses to outcompete algae for nutrient resources. Such changes in seagrass composition can impact the seagrass-based food web. Additionally, 10% of the sites have been impacted by hurricanes that caused loss of cover and species changes. Repeated disturbance at a few of these sites has prevented recovery to their 1995 state.

4.2.1.5 Macroalgae

Algae are photosynthetic organisms that lack many of the structures found in plants (e.g., leaves, roots, vascular system, and other distinct cell and tissue types) but can coexist with aquatic plants and often dominate many benthic habitats throughout the sanctuary (NOAA, 2007). There are several different groups, often subdivided based on their color (e.g., red, brown, and green algae) and their growth form (e.g., crustose coralline algae, turf algae, and macroalgae). Due to their ability to grow in the marine environment and their size, fleshy macroalgae are commonly referred to as “seaweeds.” Like land-based “weeds,” seaweeds grow faster when they are fertilized and tend to grow rapidly when they are not grazed by sea urchins or fish.

To a major extent, macroalgae compete with corals, sponges, and other sessile invertebrates for living space on the seafloor, but it is important to note that macroalgae are a common and natural component of every coral reef system. Like seagrasses, they are a food source for a number of reef-dwelling animals, especially sea urchins and certain herbivorous reef fishes such as surgeonfishes (Acanthuridae) and parrotfishes. Typically, it is only when the ecological balance of a reef is upset (e.g., by widespread coral mortality from bleaching or disease, loss of herbivores, or input of high levels of nutrients) that it tends to become overgrown by the rapidly growing macroalgae (Maliao et al., 2008).

While too much macroalgae can be problematic for a reef or seagrass bed, certain types of algae are a key component of a healthy environment. They provide important habitat for many small creatures, act as the base of the food web for many coral reef species, are one of the main contributors to primary productivity, and they play a critical role in O₂ production and CO₂ uptake, playing an essential role in carbon sequestration (Raven, 2017). Some species, such as *Halimeda* spp., have branches that contain calcium carbonate, which become sand on the reef when the algae die. Crustose coralline algae is a type of red, calcified algae that forms a pink crust on the surface of the reef. This type of algae grows over rubble and broken coral, mollusk shells, and other skeletal materials, and essentially glues them together. It also provides an important substrate that promotes settlement of coral larvae (Szmant et al., 2006). Turf algae is a diverse assemblage of small, filamentous algae that forms a dense mat on hard substrates. Turf algae is an important food source for herbivorous parrotfishes and surgeonfishes, sea urchins, and crabs, and fills most of the space on the reef where corals are not already growing.

Many species of macroalgae are found in seagrass meadows, and these can be grouped into drift algae and rhizophytic or attached algae. Calcareous green algae tend to be the dominant algal group in seagrass beds followed by red algae, with both brown algae and calcareous red algae less common. Calcareous green algae tend to exhibit a seasonal peak in summer, while red algae is dominant in winter (Collado-Vides et al., 2013). Many species of turf and macroalgae attach to seagrass blades or the substrate, although several taxa, such as the red algae *Laurencia poiteau*, are important drift species. These drift species reproduce through vegetative fragmentation and are carried by water movement through a site, secondarily attaching to benthic macroalgae, sponges, and other organisms (Wick, 2002). *Laurencia* often forms seasonal blooms associated with high rates of fragmentation during warm water periods in summer followed by rapid growth during late summer and fall associated with rainfall events and input of land-based sources of nutrients into Florida Bay. The algae may be present in large clumps that have the potential to alter the productivity of seagrass and its biomass through shading. Large blooms of *Laurencia*, *Dictyota*, and *Anadyomene* species have been documented in parts of Biscayne Bay to the immediate north of the sanctuary, beginning in 2005 and peaking in 2012 (Collado-Vides, 2013). These blooms, associated with high loads of nutrients and fine sediments from urban and agricultural terrestrial sources, can smother seagrasses, reducing the benefits of those habitats and leading to hypoxic (low dissolved oxygen) to anoxic (no dissolved oxygen) conditions. In contrast, benthic algae play a key role in stabilizing sediments and adding organic matter utilized by the seagrasses. While these algae are affected by nutrients and salinity, as long as they do not outcompete and overgrow seagrasses, they are an important component of these habitats.

Macroalgae also can form important drift and floating pelagic communities. Two species of pelagic sargassum (*Sargassum* spp.) are the most conspicuous drift algae in the Atlantic, forming an extensive floating community seasonally that supports the offshore Sargasso Sea population. Now known as the Great Sargassum Belt, these mats have expanded since 2011, and now stretch about 8,850 km from the west coast of Africa, across the tropical Atlantic to Brazil, through the Caribbean, into the Gulf of Mexico and along the Atlantic side of the Florida Keys (Wang et al., 2019). The growth of these mats is linked to nutrient cycling from associated fishes as well as nutrient enrichment from river discharges and land-based run-off (Lapointe et al., 2014). The floating algae provides food, shelter, and breeding grounds for a number of fishes, sea turtles, marine birds, crustaceans, and it is an important nursery area for commercially important Mahi Mahi, amberjacks, and other fish. The bloom observed since 2011 appears to be the result of increasing nutrients from Mississippi river discharge and the Amazon River basin, coastal upwelling off Africa and possibly African Dust (Lapointe, 2019). While sargassum transport throughout the Caribbean and to the shores of the Keys has provided beneficial organic material to beach and dune habitats, the excessive Sargassum influx is having severe ecosystem and human health issues associated with the large quantities of decomposing organic material and anoxic conditions where it accumulates at seawalls and in canals.

Algae found in reef environments includes species that cement the reef together and form a crust on hard substrates (crustose coralline algae), erect calcified species such as *Halimeda*, fleshy macroalgae or seaweeds such as *Dictyota* spp., fine filamentous species that form turfs and often trap sediment when they become dense, and filamentous and mat-forming cyanobacteria. Algal communities form a key component of a healthy coral reef, providing food,

sequestering and recycling nutrients and carbon, sheltering small organisms, contributing calcite which helps stabilize the reef structure and cement together shells and skeletons, and may ultimately comprise a large portion of the sandy sediments. However, under altered conditions of high nutrients and/or reduced herbivory, certain taxa have become the dominant space occupiers, often at the expense of more important reef-building species. Historical coral reef algal communities were dominated by encrusting and turf-forming macroalgae, while more fleshy macroalgae have become more prevalent over the last three decades (Fong & Paul, 2011). This change is referred to as a “phase shift” where the rich, diverse algal/coral community has been transformed to an algal-dominated state composed of a monoculture or just a few species of fleshy macroalgae (McManus & Polsenberg, 2004; Fong & Paul, 2011; Lapointe et al., 2019). This phase shift from a coral community to an algal dominated community has been attributed to a gradual increase in stress due to losses of herbivory and/or increases in nutrient levels, although it has usually been triggered by a major disturbance such as a hurricane, mass coral bleaching, or disease outbreak.

Coral reef algae are highly diverse and include species that are found throughout the year as well as certain taxa that are seasonal. Two genera, a calcified green algae (*Halimeda opuntia*), and two species of fleshy brown algae (*Dictyota menstrualis* and *D. pulchella*) can make up 70% or more of the algal biomass on a reef (Herren et al., 2006) and cover 40% or more of the reef substrate (Kuffner et al., 2006). These taxa are at their lowest biomass in winter and they increase seasonally in summer as water temperatures and light levels increase (Lirman & Biber, 2000). *Dictyota* algae are highly successful competitors due to the secretion of allelochemicals that suppress the growth of other organisms while *Halimeda* incorporates calcium bicarbonate into their skeleton, adding a structural defense. As a result, these taxa are capable of monopolizing the substrate and forming dense mats that overgrow and cover living corals. Other taxa that have undergone significant blooms during summer and fall include the brown algae *Styopodium*, the red algae *Trichoglea*, and the green algae *Codium*. These algae cause coral mortality through shading, sediment accumulation, abrasion, and overgrowth, especially under eutrophic conditions or in areas with reduced herbivory. Several types of algae also release toxic substances that can prevent successful settlement and survival of new corals and they contain structural and chemical defenses to deter fish grazing. Some of the most problematic fleshy macroalgae include *Dictyota*, *Lobophora*, *Styopodium*, *Trichoglea*, *Dasycladus*, and various filamentous cyanobacteria, as these overgrow corals and other invertebrates and can monopolize large areas of the reef. Because many of these chemically-defended algae are not preferred foods of herbivorous sea urchins, parrotfishes, or surgeonfishes, their dominance can have negative impacts on reef condition.

4.2.1.6 Mangroves

Mangrove communities range from tall, coastal forest to low, dense scrub communities, with each variety providing different physical habitats, topology, niches, microclimates, and food sources for a diverse assemblage of animals. Elevation ranges from shallow submerged land to about four inches above sea level. The roots of these trees are usually either constantly submerged or inundated daily by the tides. The red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*) are considered to be the three true mangrove species found in the Florida Keys. Red mangrove trees

fringe much of the 1,700 islands and shoreline within the sanctuary and are a vital component of the Florida Keys ecosystem, while the black and white mangrove species are found further up-slope in coastal wetlands.

Mangroves provide important shoreline protection services by buffering the action of waves and storm surges associated with both frontal and tropical storms. They also assist in trapping and cycling various organic materials, chemical elements, and important nutrients throughout the interconnected reef-seagrass-mangrove system. This includes serving as a sink for carbon both in living plant material and in the layers of soil and peat that make up the mangrove substrate. Detritus from mangrove leaves is also a carbon source for the food web, supporting decomposers and consumers. In addition, mangrove roots provide attachment surfaces for various marine organisms, many of which filter water and, in turn, trap and cycle nutrients. These prop roots also provide structure used by commercially- and recreationally-important reef fishes and crustaceans.

Mangrove communities are among the most biologically productive ecosystems in the world (Lugo & Snedaker, 1974) and contribute to the overall health of the coastal zone. These forests are a vital component of the estuarine and marine environment, providing a major detrital base and essential nutrients to organic food chains; important habitat for arboreal, intertidal, and subtidal organisms; nursery areas for juvenile fish and crustaceans and other invertebrates; nesting sites; cover and foraging sites for migratory birds; and habitat for some reptiles and mammals, notably the federally endangered silver rice rat. Mangrove wetlands are excellent filters of runoff and provide a protective barrier that diminishes the intensity of storm surges on interior upland habitats. Mangroves provide protected nursery areas for young fish and crustaceans, shellfish, and other invertebrates (Drew & Eggleston, 2008). Many of these species are food for a multitude of fish species, including important commercial or recreational species such as snapper, jack, snook, tarpon, sheepshead, and red drum. Mangrove tree canopies serve as roosting areas and nesting areas, or rookeries, for coastal birds such as great white herons, reddish egrets, and brown pelicans (*Pelecanus occidentalis*), and oceanic birds such as magnificent frigatebirds.

Mangrove habitat status

Since the 1940s, when dredge and fill operations began in the Florida Keys, mangrove forests have suffered significant losses. Approximately 60% of shallow water mangroves in the Upper Keys were lost between 1965 and 1985 due to construction of marinas, airports, and seawalls; dredging of channels; and other commercial and residential construction. Mangrove forests in the Florida Keys have most recently been impacted by the high winds and storm surge from Hurricane Irma. At sites studied, impacts include a reduction in overall canopy cover; varied impacts to and recovery of the understory, including new seedling growth; and sedimentation of the understory, which in some cases led to smothering of roots and affected oxygen exchange (Radabaugh et al., 2019). While some recovery has occurred, mangrove forest recovery can take 10 to 15 years.

Rhizophora mangle (red mangrove) lines approximately 1,800 miles of shoreline in the sanctuary.

4.2.1.7 Beach, dune, berm, ridge hammock habitats

Beach berms are dynamic and fragile ecosystems that host a wide diversity of species across three main vegetation classifications within a 10-foot (3 m) elevation range above sea level. These ecosystems are created and maintained naturally through the accretion and erosion of sediment from storm and wind events, setting back succession of vegetation through disturbance, and recolonization of vegetation through deposition of seeds that are transported through oceanic currents. Beach berms support a suite of terrestrial invertebrates, neotropical migrant and resident passerine and raptor species, reptiles, and small mammals; breeding and nectaring plants for imperiled butterfly species; refuge for eastern diamondback rattlesnakes (*Crotalus adamanteus*) and the Florida Keys mole skink (*Plestiodon egregius egregius*); and nesting habitat for green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and hawksbill (*Eretmochelys imbricata*) sea turtles (USFWS, 2023).

Of all berm hammocks in Key West National Wildlife Refuge, elevation is highest (6.5–10 feet / 2–3 m) and size greatest on the northwest side of the Marquesas Keys. Within this hammock is the only viable population of yellowheart trees (*Zanthoxylum flavum*) in the United States. Coastal prairies and beach berms occur landward of the dune at an elevation of three to seven feet (0.9–2.1 m) and have moderate plant diversity on refuge islands in Key West National Wildlife Refuge. These habitats serve as the primary nectaring area for many terrestrial species including the Miami blue butterfly, whose only known population occurs within the Key West National Wildlife Refuge. Small patches of coastal prairie communities also occur among beach and dune systems in Key West National Wildlife Refuge.

Coastal berm and beach ridge hammocks are composed of narrow coastal berms that typically parallel a fringe of red mangrove (*Rhizophora mangle*), which is characterized by a ridge of storm-deposited debris that is subjected to an accumulation of flotsam. The substrate is coarse calcareous sand, which has accumulated to an elevation of one to two feet (0.3–0.6 m). A variety of plant associations develop on this ridge and include dense thickets of large shrubs, small trees, or sparse shrubby vegetation.

Beach ridge hardwood hammocks occur on high sand berms, within a few feet above sea level, created by storm surge and wind events. Although many of the plants found there are also found in tropical hardwood hammocks, this habitat is sufficiently different to warrant a separate classification (Folk et al., 1991). Trees in this habitat type grow on a sand or calcareous gravel substrate with low freshwater retention and are usually long, narrow linear features immediately adjacent to beaches. Beach ridge hammocks normally have relatively low plant diversity with a sparse understory, which may contain limber caper (*Capparis flexuosa*), Bahama nightshade (*Solanum bahamense*), and blackbead (*Pithecellobium guadalupense*). However, the latter may serve as the dominant species over a large area in some beach ridge hammocks. A nearly pure four-acre stand on Boca Grande Key provides an example.

Crocodile Lake National Wildlife Refuge maintains important tropical hardwood hammock habitat for the Key Largo woodrat (*Neotoma floridana smalli*), Key Largo cotton mouse (*Peromyscus gossypinus allapaticola*), and Schaus' swallowtail butterfly (*Heracles aristodemus ponceanus*). The refuge also maintains mangrove and beach berm habitats for nesting and wintering American crocodiles (*Crocodylus acutus*). Research has shown that

invasive predators such as feral cats (Winchester et al., 2009) and Burmese pythons (*Python molurus bivittatus*) (Alligood & Savage, 2011) are major threats to the woodrat and cotton mouse.

The coastal dune is found at an elevation of zero to four feet (1.2 m) and is adjacent to the intertidal zone. This area is primarily comprised of sandy soils and is sparsely vegetated with species such as bay cedar (*Suriana maritima*), sea oat (*Uniola paniculata*), and seashore dropseed (*Sporobolus virginicus*). Dunes are a fragile habitat easily damaged by humans, the extent of which depends on dune size and profile, quantity and type of flora, beach characteristics, and surrounding water depth (Liddle & Greig-Smith, 1975; McDonnell, 1981; Nickerson & Thibodeau, 1983). The beach-dune interface is an important ecological front that produces sustained levels of biological activity.

Beach and associated dunes are a prominent part of the Key West National Wildlife Refuge, occurring on Man, Woman, Marquesas (seven separate beaches), and Boca Grande keys, in Great White Heron National Wildlife Refuge on Mud, Marvin, Snipe, Sawyer, and West Content keys, and in National Key Deer Refuge on Lower Sugarloaf, Big Pine, and Ohio keys. Beach length varies from 15 to 8,530 feet (4.6–2600 m). All refuge beaches are narrow and coarse-grained, formed primarily of calcareous remains from various shallow water marine organisms. The beaches also afford important nesting, foraging, and loafing habitat for a variety of shorebirds, wading birds, and seabirds.

Protected species in beach, dune, berm, ridge hammock areas

The federally endangered Miami blue butterfly (*Cyclargus thomasi bethunebakeri*) and piping plover, federally threatened roseate tern, as well as the state threatened least tern (*Sternula antillarum*) and reddish egret are found in these habitats. No marine plants within the study area are currently listed as federal threatened or endangered species. Several terrestrial plants found within coastal rock barren and beach berm communities are listed as federally threatened or endangered species, including Cape Sable thoroughwort (endangered; *Eupatorium frustratum*), Garber's spurge (threatened; *Chamaesyce garberi*), and Blodgett's silverbush (threatened; *Argythamnia blodgettii*). About 25 populations of *E. frustratum* remain and are particularly susceptible to disturbance and habitat loss due to sea level rise. To see a list of listed species, including state species, see Appendix H.

4.2.2 Fish and wildlife resources

The Florida Keys archipelago serves as a biogeographic transition zone between the warm-temperate waters of the Gulf of Mexico and the adjacent tropical to subtropical waters of the Atlantic Ocean, resulting in a distribution of marine fauna and flora characterized by having both a warm-temperate and tropical Caribbean component (NOAA, 1997). Therefore, this region hosts a wide range of fish and wildlife resources, including several special-status species. The following section contains general descriptions of ecologically-important living marine resources. Appendix H includes lists of federal and state status species.

4.2.2.1 Fish and marine invertebrates

The Florida Keys region is home to a diversity of fishes that are essential for maintaining ecosystem functions within coral reefs and associated habitats and providing services critical for

humans including recreation (e.g., snorkeling, scuba diving, sport fishing), and commercial fishing. Fish depend on healthy coral reef, seagrass, mangrove, and other habitats throughout their lives and in turn they help maintain healthy, functioning ecosystems. Like their habitats, fishes are vulnerable to anthropogenic impacts via unsustainable levels of exploitation, climate change, habitat degradation, and variable water quality.

Historical long-term studies have identified between 389 and 440 total fish species in the Florida Keys (Longley & Hildebrand, 1941; Starck, 1968), although these numbers vary depending on cross shelf location, habitat and depth, and may represent a significant underestimate. Fishes inhabiting the Florida Keys have been described more recently in the sanctuary condition report (NOAA, 2011) and other scientific studies (Burke et al., 2011; Hepner, 2017; Starck et al., 2017; NOAA, 2018c), and these reports suggest earlier estimates may represent a significant underestimate. For instance, an updated fish inventory from Alligator Reef in the Upper Keys documents 618 species from 122 families (Starck et al., 2017). REEF Environmental Education Foundation diversity report for the Tropical Western Atlantic also reported a higher number of fish species for Florida (623 species) than any other region in the tropical western Atlantic (Holt et al., 2013). The fishes found within the Florida Keys are primarily reef species (420) while the remainder are normally restricted to inshore waters (69 species), others are epipelagic and demersal dwellers from depths of about 100 m (102 species) and 27 species were identified from trawl samples in depths of 300 m (Starck et al., 2017). In addition, many of the reef-associated species recruit into shallow, nearshore waters on the Atlantic and/or Gulf side of the Florida Keys, and utilize these shallow hard bottom, seagrass, mangrove, and sandy areas as spawning areas, nurseries, and juvenile habitat, moving to the reef as adults. Some species also migrate between habitats diurnally and ontogenetically. Overall, the most abundant species are reef-associated fishes and can be classified into feeding guilds including invertivores, omnivores (generalists), herbivores, benthic carnivores, piscivores, and planktivores (Burke et al., 2011).

To evaluate the status and trends of reef fishes, a rigorous, collaborative, region-wide field survey, the Florida Keys Reef Visual Census (RVC), has been used to monitor fish communities since 1998 (Smith et al., 2011), and since 2008 has been conducted every other year as part of the National Coral Reef Monitoring Program. Sampling involves a stratified random sampling design, with stations encompassing reef environments subdivided into different regions, cross shelf locations, habitats, and management zones (Viehman et al., 2023). The 2022 RVC data was the most comprehensive to date (648 fish sites in the Florida Keys and 118 additional sites in the Dry Tortugas), with surveys including both fishery target and non-target species ranging from small cryptic species to larger motile fishes. Wrasses, grunts, damselfish, yellowtail snapper, parrotfish, and surgeonfish are numerically dominant on reefs in the Florida Keys, occurring at densities of 100–1000 individuals per hectare, and the masked goby (*Coryphopterus personatus*), bicolor damselfish (*Stegastes partitus*), and bluehead wrasse (*Thalassoma bifasciatum*) dominate the reef fish community overall (Viehman et al., 2022). The numbers of fish species and density are related to habitat complexity, with many species such as yellowtail snapper, gray snapper, and black grouper preferring more complex habitats because they provide better refuge and foraging grounds (Bohnsack et al., 2009). An evaluation of reef fish data from 1999–2018 demonstrated that protected areas had higher fish biomass, and an increase over time compared to unprotected areas, although these differences decreased

for no take zones over time and differences between unprotected zones became less pronounced. High relief reef habitats had the greatest reef fish abundance, biomass, and species richness, but biomass in high relief linear and patch reef communities also declined since 2006–2008 (Medina et al., 2021). Among no-take zones, no effect of size of the protected area was observed for reef fish abundance, biomass, and diversity.

Snappers and groupers

The Snapper-Grouper complex includes ecologically important reef fishes that include snappers (family Lutjanidae), groupers (family Serranidae), amberjack, hogfish, jacks, porgy, rudderfish, sand perches, sea bass, tilefish, and triggerfish, most of which are harvested both commercially and recreationally throughout the Florida Keys. The sustainability of these species is of particular concern along the coast of South Florida because of their long-term overexploitation and slow recovery times following overharvesting. These species are generally long-lived, slow-growing, and late-maturing, making them particularly vulnerable to exploitation. They are also known to use many inshore and offshore habitats during their life cycle (Ault et al., 2005), moving between these habitats on a daily basis and during ontogenetic changes, with some species form spawning aggregations on the offshore bank-barrier reef system (discussed below; Schmidt et al., 1999). Currents disperse their eggs/larvae, with most moving and settling into nearshore habitats and nursery areas where they grow to juveniles and subsequently move back out to the reef as adults (e.g., Ault et al., 2012; Bryan et al., 2015).

The SAFMC and GMFMC have developed a variety of harvest regulations and protected areas that have been implemented by NMFS to prevent overfishing and rebuild overfished reef fish and snapper-grouper stocks. These species are subject to fisheries regulations by the SAFMC under the Snapper-Grouper Fishery Management Plan (FMP) for the Snapper-Grouper Fishery of the South Atlantic Region (FMP, 59 species) and by the GMFMC under the FMP for the Reef Fish Resources of the Gulf of Mexico (30 species). The 2021 Report to Congress on the Status of U.S. Fisheries indicated that in the South Atlantic, Southeast Florida hogfish (*Lachnolaimus maximus*), red snapper (*Lutjanus campechanus*), red porgy (*Pagrus pagrus*), snowy grouper (*Hyporthodus niveatus*), gag, and red grouper were overfished and red snapper, red porgy, snowy grouper, and gag were experiencing overfishing; speckled hind and Warsaw grouper were removed from the overfishing list and added to “now unknown” and tilefish were also removed. In the Gulf of Mexico, greater amberjack (*Seriola dumerili*) and gag were overfished and greater amberjack, Lane Snapper, and Gag were undergoing overfishing (NMFS, 2022). NMFS defines “overfished” as a population that has declined below sustainable harvest limits and “experiencing overfishing” as a population that is currently undergoing unsustainable harvest.

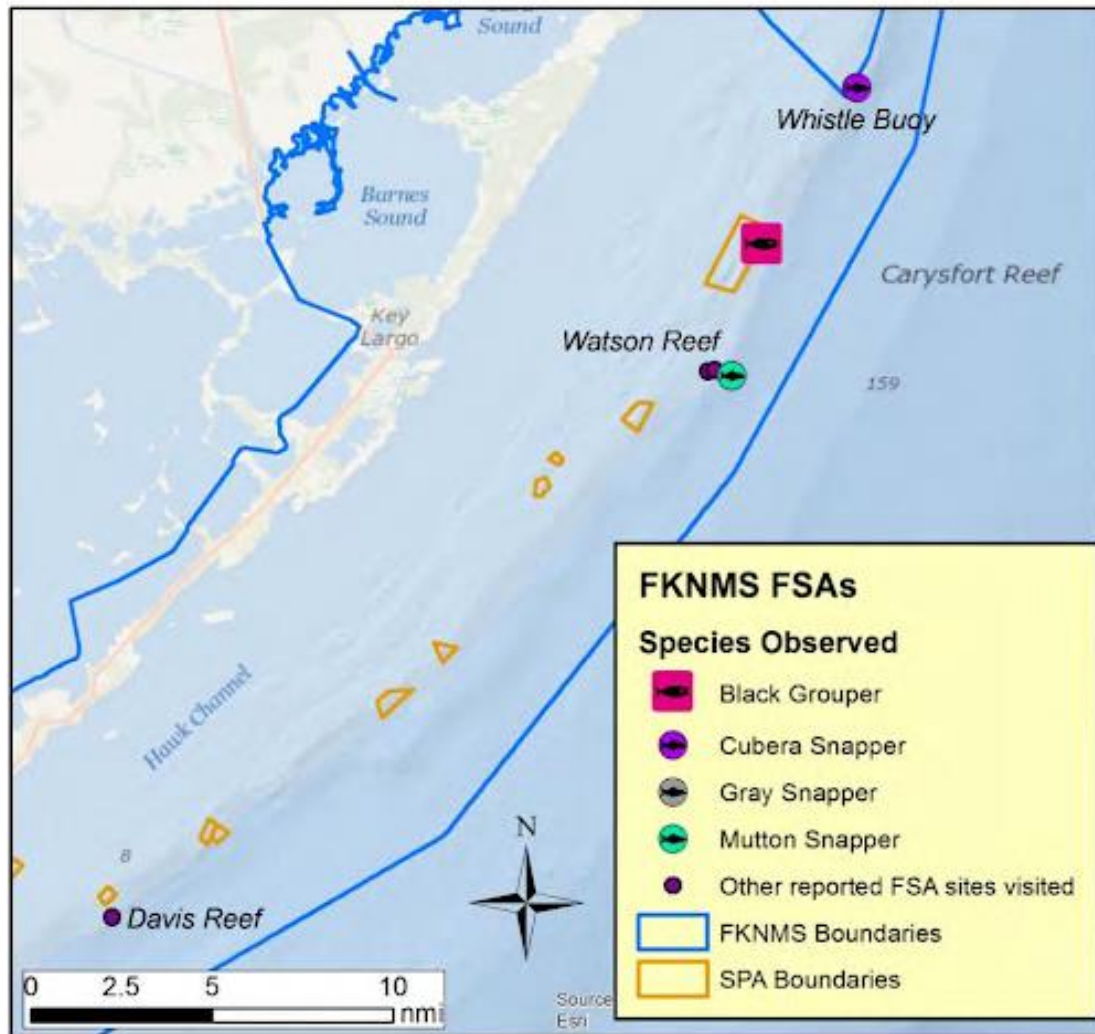
Several investigations have demonstrated the utility of fisheries harvest restrictions and protected areas for restoring reef fish and snapper-grouper populations. No-take marine zones, in aggregate, had a higher reef fish abundance, biomass, and diversity than unprotected areas, particularly between 1999–2010, but this declined in later years (Medina et al., 2021). Using the Florida Keys Reef Visual Census dataset for the Dry Tortugas region, one analysis showed a substantial increase in mutton snapper (*Lutjanus analis*) abundance and size along many reef habitats between 1999–2000 and 2012–2014 (Figure 4.3; FWC-FWRI, 2015). Additionally, densities of black grouper (*Mycteroperca bonaci*) and yellowtail snapper (*Ocyurus chrysurus*) were significantly higher in protected areas of the Dry Tortugas than in adjacent unprotected

zones during most years of Florida Keys Reef Visual Census sampling (FWRI, 2019). Protected areas within the Dry Tortugas also observed up to a 20% increase in abundance of harvestable size black grouper. Overall, recent research has demonstrated increases in size and abundance of harvested fishes within reserve areas in the Florida Keys (e.g., Ault et al., 2012; Ault et al., 2014).

Fish spawning aggregations

Many reef fishes form spawning aggregations, which occur when fish assemble in higher than usual densities to reproduce. Fish spawning aggregations typically occur at the same place and time each year within a species, but spawning behavior tends to be highly variable across species (SCRFA, 2013). Fish spawning aggregations benefit fish populations by increasing reproductive success, increasing population-scale genetic diversity, and providing protection from predators (Young et al., 2014; Farmer et al., 2017). However, fishes that use spawning aggregations are particularly vulnerable to overexploitation because of the predictability in which they occupy these habitats; therefore, protecting fish spawning aggregations is especially important for promoting sustainable fisheries resources (e.g., Nemeth, 2012; Ault et al., 2013). When a fish spawning aggregation becomes depleted, it can take decades to recover, showing the importance of protecting these existing resources and the environments where spawning aggregation behavior is known to occur.

In the Florida Keys, 14 reef-associated fishes are known to exhibit spawning aggregation behavior, including several species in the heavily exploited snapper-grouper complex (e.g., Rowell et al., 2015). In the Upper Florida Keys region, there has been visual evidence of fish spawning aggregations by cubera snapper (*Lutjanus cyanopterus*), black grouper, and mutton snapper within the sanctuary boundary but outside of the SPAs. Similarly, in the Lower Florida Keys, mutton snapper, gray snapper (*Lutjanus griseus*), yellowtail snapper, and other species have been observed by divers and fishing boats exhibiting spawning behavior at Western Dry Rocks, Mangrove Toppino, Eyeglass Bar, and Maryland Shoal (Figure 4.4; FWRI presentation, 2013).



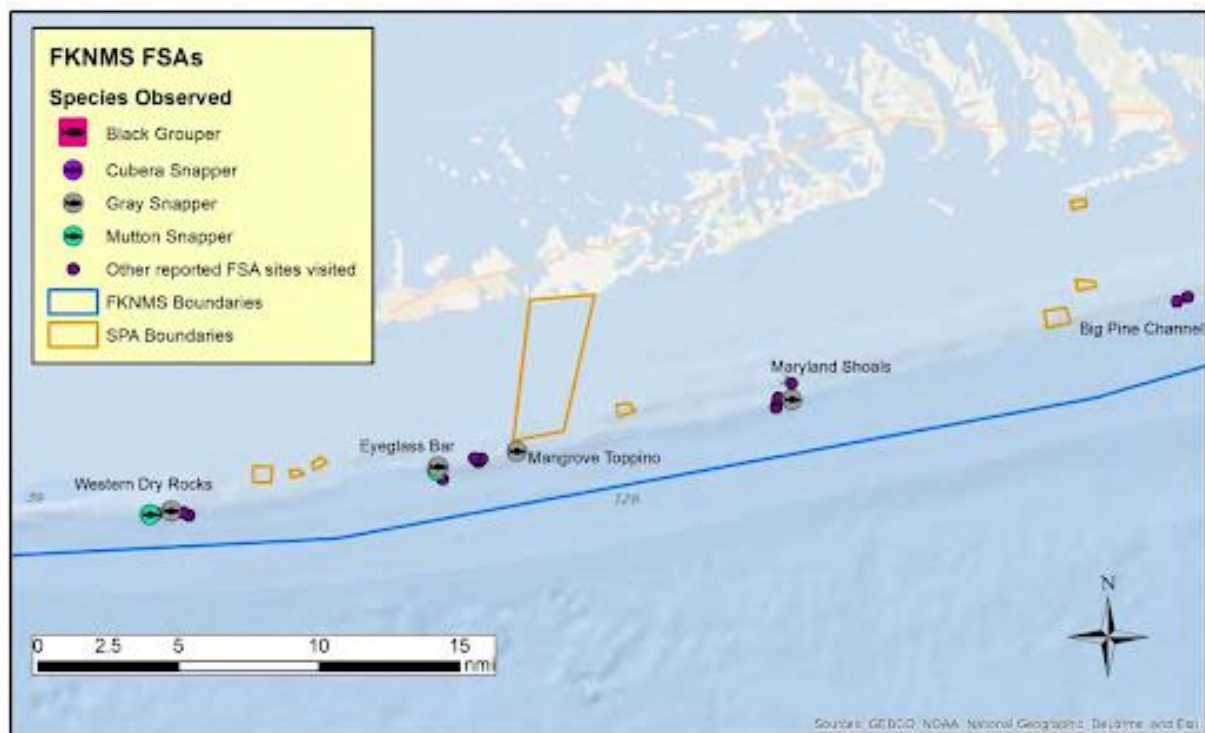


Figure 4.4. Fish spawning aggregation sites in the Florida Keys. Image: NOAA and FWC-FWRI

The Dry Tortugas region also provides important fish spawning aggregation habitat for mutton snapper, cubera snapper, and other fishes (Feeley et al., 2012; Bryan et al., 2015; FWRI presentation, 2019). In particular, multispecies spawning aggregations have been observed at Riley's Hump (Tortugas South ER), and there is evidence of a spawning corridor for mutton snapper between Riley's Hump and the Tortugas Research Natural Area (Figure 4.5; FWC-FWRI presentation, 2013). The geomorphology common in the Dry Tortugas and other areas throughout the Florida Keys is typical of other Caribbean fish spawning aggregation sites (Heyman & Kjerfve, 2008), suggesting that new proposed zones included in the marine zone alternatives (see Section 3.3) may include more areas where spawning aggregations occur or where historical evidence of them exists.

Pelagic fishes and sharks

Many species migrate and thus spend a portion of their time in the sanctuary. These species include, but are not limited to, the following pelagic species: Atlantic bigeye tuna (*Thunnus obesus*), North Atlantic albacore tuna (*Thunnus alalunga*), Atlantic yellowfin tuna (*Thunnus albacares*), Atlantic skipjack tuna (*Katsuwonus pelamis*), Western Atlantic bluefin tuna (*Thunnus thynnus*), Atlantic common thresher shark (*Alopias vulpinus*), Atlantic sharpnose shark (*Rhizoprionodon terraenovae*), Atlantic shortfin mako shark (*Isurus oxyrinchus*), oceanic whitetip shark (*Carcharhinus longimanus*), Atlantic blacktip shark (*Carcharhinus limbatus*), North Atlantic swordfish (*Xiphias gladius*), Atlantic mahimahi (*Coryphaena hippurus*), Atlantic wahoo (*Acanthocybium solandri*), cobia (*Rachycentron canadum*), and king mackerel (*Scomberomorus cavalla*).

Marine invertebrates

Invertebrates in the sanctuary are highly diverse and comprise a large portion of the marine fauna inhabiting all habitat types in the sanctuary. Resident phyla include, but are not limited to, Cnidaria (corals, sea anemones, jellyfish), Platyhelminthes (flatworms), Porifera (sponges), Annelida (segmented worms), Arthropoda (crustaceans), Ectoprocta (bryozoans), Mollusca (bivalves and snails), and Echinodermata (sea stars, sea urchins, and sea cucumbers). With the exception of a few “fishery” crustaceans (e.g., shrimp, lobster, stone crab), the ecological roles of many of these invertebrates are not well understood and continue to be studied (Levy et al., 1996). See sections 4.2.1 and 4.2.3 for more details on coral species.

Spiny lobster

The Caribbean spiny lobster (*Panulirus argus*) is widely distributed throughout the western Atlantic Ocean, ranging from North Carolina to Brazil, inclusive of the Caribbean and Central America. However, in the Gulf of Mexico and South Atlantic regions, the commercial fishery and most of the recreational fishery occurs off South Florida (GMFMC, 2017).

Caribbean spiny lobsters are found throughout the mangrove, shallow hardbottom, seagrass, and reef habitats of the Florida Keys. Postlarvae settle in nearshore, architecturally-complex substrates, especially hardbottom habitat covered by red macroalgae. Once juveniles reach 0.59–0.79 in (15–20 mm) carapace length, they emerge from the algae and take up refuge in crevices under sponges, octocorals, and corals, and also within dissolved limestone burrows and in seagrass blowouts. Larger juveniles migrate to patch reef and offshore reef systems, and both male and female lobsters travel from their shelters to foraging grounds on a daily basis. During the reproductive season, female lobsters undergo migrations to deeper waters and outlier reefs to release eggs (Cox & Hunt, 2005). Lobsters are an important component in the seagrass ecosystem, as they are food for many fish species.

Caribbean spiny lobster is one of the Florida Keys’ most economically important commercial fisheries, and while they are heavily exploited by both the commercial fishery and by recreational divers and snorkelers, their population currently appears to be stable (GMFMC, 2017). The lobster population in the Florida Keys benefits from larvae that originate elsewhere in the Caribbean and are transported to the hardbottom habitats of the Florida Keys by ocean currents. In the sanctuary, lobster fishery restrictions at the Western Sambo ER have led to an increase in mean size and frequency of occurrence of this species (Cox & Hunt, 2005) as well as retention of older individuals and more mature females, which has contributed to increased stability in the population (Matthews, 2016).

The spiny lobster fishery poses an environmental concern because it is estimated that thousands of traps are lost annually in the Florida Keys, leading to ghost fishing (Butler & Matthews, 2015). Ghost fishing lobster traps (those lost due to storms and boat propellers) have been shown to lead to mortality of approximately 643,000 lobster per year. Additionally, lobster trap debris including concrete, buoys, and rope can be washed up on shorelines and remain in the marine environment for decades. According to FWC surveys, approximately 70% of marine debris in the Florida Keys is composed of lobster traps and associated gear, which can damage benthic fragile coral and seagrass habitats (Uhrin et al., 2014).

Stone crab

The stone crab (*Menippe mercenaria*) supports a lucrative fishery in Florida, which has been overexploited since 1997 and is currently estimated to be overfished (Gandy et al., 2010). This species ranges from North Carolina to the Caribbean, including the eastern Gulf of Mexico, and is locally managed by the state of Florida. Uniquely, the stone crab fishery involves harvesting one of the claws and returning live individuals back into the water. Stone crabs are predatory, feeding primarily on small mollusks, polychaete worms, and other crustaceans in hardbottom reefs and seagrass habitats. Females reach maturity at approximately two years old, and they are known to spawn from June to October off continental areas and at lower frequencies from November to May in southern Florida (Gerhart & Bert, 2008). Stone crabs are pelagic during their larval and post-larval stages, approximately three to six weeks, before they settle on a benthic substrate as juveniles. Inhabiting nearshore environments during most of their lives, stone crabs are vulnerable to changes in water chemistry including acidification (Gravinese et al., 2018).

Shrimp species

The commercial shrimp fishery, composed of brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), pink shrimp (*Farfantepenaeus duorarum*), royal red shrimp (*Hymenopenaeus robustus*), and rock shrimp (*Sicyonia brevirostris*) (all of which are federally managed), is one of the most important fisheries in the Florida Keys. SAFMC and GMFMC measures to protect these stocks and their habitat have included closed areas in federal waters to protect spawning white shrimp, the requirement for bycatch reduction devices to minimize bycatch, and the prohibition on rock shrimp trawling in *Oculina* coral areas.

Brown shrimp, white shrimp, and pink shrimp are found in shallower state and federal waters while royal red and rock shrimp occur in deeper waters. Pink shrimp are historically common in estuaries and shallow marine waters surrounding southern Florida and in the deep waters (approximately 328 ft/100 m) southeast of the Florida Keys, and are the dominant species within the Dry Tortugas shrimping grounds and Florida Bay (Saloman, 1968). Adult pink shrimp congregate in deep water (>36 ft/11 m) off the Dry Tortugas to spawn. Larvae can take two routes to estuarine nursery areas where they spend most of their life cycle. One route is directly to the shallow-water estuaries of the Ten Thousand Islands, Whitewater Bay, and Florida Bay. Alternately, larvae are swept southwesterly into the Florida Current by way of the Loop Current and are carried northeasterly along the outer edge of the Florida Keys Reef Tract or east coast of Florida (Ingle et al., 1959). As the postlarval pink shrimp mature, they enter Florida Bay on incoming tides. Young shrimp spend from two to seven months in the bay's seagrass nursery grounds before moving into the Gulf off the Dry Tortugas (Schomer & Drew, 1982; Bielsa et al., 1983).

Shrimp with important ecological associations include cleaner shrimp and peppermint shrimp (genera *Periclimenes* or *Lysmata*), coral shrimp (genus *Stenopus*), and snapping shrimp (genus *Alpheus*). Snapping shrimp, in particular, exhibit a commensal association with certain sponges, and the snapping sound coming from the vicinity of the sponges attracts larval lobster (e.g., Butler et al., 2017). Additionally, snapping shrimp densities have been shown to be greater in protected habitats than in degraded habitats in Florida Bay.

Other hardbottom invertebrates

Sponges (Porifera) are important components of coral reef ecosystems, occurring on reefs, shallow hardbottom communities, seagrass beds, and mangrove prop roots. Some species form massive balls, tubes, and barrels, achieving sizes of up to three feet in height. Besides filtering large amounts of water, sponges in nearshore hardbottom habitat are critical shelter habitat for a myriad of obligate and opportunistic invertebrates and fish such as crabs, shrimps, and brittle stars (Ophiuroidea, McMurray et al., 2008). Some sponges, such as *Cliona* spp., are known as boring or excavating sponges that bore into and dissolve the reef framework, reef building corals, mollusks, and other organisms with a limestone skeleton, forming a key process in a reef's carbonate budget. This genus has been on the increase in recent years, likely due to climate change and eutrophication, which could result in continued damage to coral reefs in the Florida Keys (Keller & Donahue, 2006; Chiappone et al., 2007).

Sea urchins such as the long-spined sea urchin (*Diadema antillarum*), were historically one of the most important invertebrate grazers on coral reefs in the Florida Keys, helping control the abundance of algae. The massive die-off of *Diadema* that began in the Caribbean in 1983 caused cascading effects in coral reefs throughout the region. Prior to the die-off, these urchins created halos or barrens around the reef and controlled algal growth, serving a critical functional role in keeping hard surfaces clean to allow settlement and growth of coral larvae (Levitan, 1988). Other urchins, crabs, and herbivorous fishes such as parrotfish and surgeonfish have partially filled the important role in controlling algal dominance on coral reefs (Furman & Heck, 2008), but the proliferation of fleshy macroalgae since the die-off of urchins has contributed to the decline of coral cover within reef environments.

Marine life: Ornamental species

The state of Florida maintains the largest aquarium or ornamental fishery in the United States, which is distributed among a limited number of licenses (see Section 4.6 for more information). While marine life harvesters are required to use sustainable practices, capture and trade of these species can be difficult to monitor and enforce. The ecological function of harvested marine life fish fishery species includes bioturbators, filterers, scavengers, and predators, and this fishery is dominated by collection of grazers (Rhyne et al., 2009).

In a May 2019 report, Florida FWC evaluated time series data for 27 marine life taxa (e.g., *Ricordea* [false corals], ringed anemone, balloonfish) that showed a pattern of negative landings and catch per unit effort values combined with an ex-vessel price (i.e., the dockside value or average price for a given species) trend that was either stable or increasing, a combination that can indicate a potential sustainability issue. FWC stressed that interpreting the results of these trends as an indicator of an individual taxon's status should include other considerations. Marine life listed taxa consist of a diverse array of organisms whose ecology and life history vary greatly, and many are infrequently reported within the trip ticket database (Sharp & Sheridan, 2019).

Live rock aquaculture

Live rock is a valuable commodity, used primarily in home aquaria. Live rock consists of limestone reef framework (coral skeletons) and associated coralline algae, fleshy algae, and invertebrates. Removing live rock by chipping or breaking it from the reef framework harms or

destroys habitat for other key marine species, increases erosion, and reduces biodiversity (Bruckner, 2000). Recognizing the destructiveness of this practice, the state of Florida prohibited live rock harvest in waters of the state in 1992. The SAFMC and GMFMC followed suit by prohibiting live rock harvest in federal waters of the Atlantic Ocean and Gulf of Mexico in 1995 and 1996, respectively. The state and fishery management councils then developed lease and permit processes by which limestone rocks that were mined from quarries on land could be placed into state and federal waters off the coast of Florida to allow colonization by bacteria and other organisms. After several years, these rocks are harvested for use in aquaria as substrate upon which to build a reef display or to maintain aquaria water quality.

In Florida state waters, a submerged lands lease, managed by the Florida Department of Agriculture and Consumer Services, is required to conduct live rock aquaculture. In federal waters off the coast of Florida, a permit from NMFS is required for live rock aquaculture. With the exception of coral species listed under the ESA, all organisms that settle and grow on aquacultured live rock may be harvested and sold by the lease or permit holder.

Some threats associated with live rock aquaculture include reduction of hardbottom and sand habitat available for other species, potential spread of non-native species, and increased risk of spreading coral disease. The illegal harvest of wild live rock from Florida and elsewhere in the Caribbean and around the world, and use of permitted live rock aquaculture sites as a front for illegal wild live rock harvest, remains a serious threat to reef habitats and species. Multiple state and federal enforcement actions have been taken to address illegal live rock activities; such actions may be complicated when live rock aquaculture is permitted to occur.

4.2.2.2 Wildlife

Marine mammals: Cetaceans and sirenians

The Florida Keys and the sanctuary are within the seasonal geographic range of a variety of marine mammals. Thirteen species of whales, seven species of dolphins, and the West Indian manatee either reside in or travel through the sanctuary at some point in their lifetimes. (See Section 4.2.3 for more information on whales and manatees.)

While not endangered, bottlenose dolphin (*Tursiops truncatus*) are present in the sanctuary and are protected by the MMPA (16 U.S.C. §§ 1361 *et seq.*). Bottlenose dolphins occur in the area year-round. They tend to inhabit coastal and offshore areas and may feed in shallow areas throughout the Florida Keys with higher prevalence in the Lower Keys region.

Birds

The Florida Keys host more than 285 species of birds, many of which are seabird or shorebird species. Birds most frequently encountered in and around the waters of the sanctuary include terns, gulls, plovers, sandpipers, cormorants, pelicans, herons, egrets, osprey (*Pandion haliaetus*), and the magnificent frigatebird (*Fregata magnificens*). In recognition of the importance of bird species and associated habitat in the Florida Keys, the Florida Keys National Wildlife Refuges were designated and are managed, in part, for the diversity of migratory and resident bird species that use these habitats. For example, Great White Heron National Wildlife Refuge was established with the purpose of providing mangrove nesting and seagrass foraging habitat for the great white heron (*Ardea herodias occidentalis*) and other imperiled wading bird

species. The federally threatened roseate tern nests in Key West National Wildlife Refuge on exposed sandbars. Federally threatened piping plover and red knot (*Calidris canutus*) use the sandy beaches and tidal flats of the Key West, Great White Heron, and National Key Deer refuges as both stopover and wintering areas. Wood stork (*Mycteria americana*) also use the Lower Keys for foraging and roosting.

The red knot is an ESA-listed threatened species. State-listed species include the aforementioned species, as well as the least tern (*Sternula antillarum*), peregrine falcon (*Falco peregrinus*), snowy plover (*Charadrius nivosus*), roseate spoonbill (*Platalea ajaja*), reddish egret (*Egretta rufescens*), tricolored heron (*Egretta tricolor*), little blue heron (*Egretta caerulea*), and white-crowned pigeon (*Patagioenas leucocephala*).

The Florida Keys are also an important stopover point for other migratory raptors, neotropical and resident land birds and are listed as an Audubon Important Bird Area. Shorebirds and wading birds forage along tidal flats, seagrass beds, and sandy beaches that are often used by recreational boaters, kayakers, fishermen, snorkelers, and wildlife viewers. It is critical to the health of these species that select foraging, nesting, loafing, and staging areas are protected from human disturbance. (See Section 4.2.3 for more information on listed species and Appendix E for a full species list.)

Shorebirds, waterbirds, and marshbirds

Waterbirds serve as important indicators of ecological health in coastal marine habitats (Ogden et al., 2014). The Florida Keys contain extensive mangrove and shallow-water habitats that are important foraging and loafing sites for several species of imperiled wading birds and migratory shorebirds. The refuges harbor all species of Florida wading birds as either nesters or migrants. Known nesters include all Florida great white heron, great blue heron (*Ardea herodias wardi*), great egret, reddish egret, tricolored heron, little blue heron, green heron (*Butorides virescens*), and yellow-crowned night-heron (*Nyctanassa violacea*), as well as the white ibis (*Eudocimus albus*). The refuges are particularly important to nesting great white herons.

Other birds that have nested in the refuges include black neck stilt, Wilson's plover (*Charadrius wilsonia*), brown pelican, white ibis, magnificent frigatebird, least tern, roseate tern, and double-crested cormorant (*Phalacrocorax auritus*). Brown pelican nesting has declined markedly in Key West National Wildlife Refuge since 1987. The historical (1986–2005) nesting colony in the Marquesas Keys was abandoned in 2005, with no sign of nesting activity in 2006 through 2008. One rookery remains in Key West National Wildlife Refuge. Non-nesting, fish-eating birds include various tern and gull species. Descriptions of piping plover, roseate tern, and red knot can be found in Section 4.2.3.

Raptors (hawks and allies)

The Florida Keys are situated along a major migratory pathway for raptors. Sixteen migratory species have been observed in the refuges. Fall migration begins in late August with the passage of swallow-tailed kites (*Elanoides forficatus*) and ends in November with the passage of Swainson's hawks (*Buteo swainsoni*). Broad-winged hawks (*Buteo platypterus*), peregrine falcons, ospreys, sharp-shinned hawks (*Accipiter striatus*), and American kestrels (*Falco sparverius*) are the most abundant migratory raptors. More peregrine falcons pass over the Florida Keys than any other hawk observation sites in North America (Lott, 2006). While most

of the migratory raptors use the refuges as a resting and foraging stopover en route to wintering areas in South America and elsewhere, significant numbers of certain species overwinter, such as the broad-winged hawk and short-tailed hawk (*Buteo brachyurus*). Bald eagle nesting was monitored annually from 1985 to 2009 with four to six active nests sighted annually. Some islands were used for nesting for over 20 years and others for only a few years, with pairs moving elsewhere. Osprey and red-shouldered hawks (*Buteo lineatus*) also nest in the refuges.

Waterfowl

Waterfowl do not nest in the Florida Keys refuges. Apart from small numbers of overwintering red-breasted mergansers (*Mergus serrator*) and blue-winged teal (*Anas discors*) seen annually, other migratory waterfowl are rarely observed.

Landbirds

Resident and breeding neotropical migrants include Red-bellied woodpeckers (*Melanerpes carolinus*), red-winged blackbirds (*Agelaius phoeniceus*), gray kingbird (*Tyrannus dominicensis*), black-whiskered vireo (*Vireo altiloquus*), white-eyed vireo (*Vireo griseus*), white-crowned pigeon, and mangrove clapper rail (*Rallus longirostris*). The only warbler species known to breed in the Florida Keys Refuges are Cuban yellow (*Setophaga petechia gundlachi*) and prairie (*Setophaga discolor paludicola*) warblers. Both are common breeders in the backcountry islands. The mangrove cuckoo (*Coccyzus minor*) is listed as a species of concern on the 2014 State of the Birds Watch List, but data are lacking on its status and ecology in the Florida Keys.

Neotropical migratory birds *en transient* to or through the Florida Keys are species that breed in North America and winter in south Florida, Mexico, Central America, the Caribbean, and South America. These species are of keen interest to birdwatchers and conservationists because they migrate remarkable distances in all weather conditions, and they provide a diversity of viewing opportunities during the spring and fall migration, more than doubling the number of species seen in the Florida Keys compared to the nesting season. Many are experiencing range-wide declines due to the destruction and fragmentation of breeding and wintering habitat, poisoning by pesticides, collisions with towers and large buildings, and feral cat predation.

Reptiles

The Florida Keys and the sanctuary are within the seasonal geographic range of a variety of reptiles, including five of the seven living sea turtle species, one lizard (Florida Keys mole skink) as well as the American crocodile (*Crocodylus acutus*), and American alligator (*Alligator mississippiensis*).

Turtles

Five of the seven sea turtle species frequent the waters of the sanctuary, and some species, including the green (*Chelonia mydas*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*) sea turtles, nest within the Florida Keys. All marine turtles are either threatened or endangered and thus protected by the ESA in U.S. territorial waters (see Section 4.2.3 for more details). The highest densities of sea turtles in the Gulf of Mexico region are observed in waters surrounding the Florida Keys (McDaniel et al., 2000).

Nesting by sea turtles on beach berms occurs throughout the Florida Keys National Wildlife Refuges and several other beaches throughout the Florida Keys and Dry Tortugas. The beaches of Boca Grande, Woman Key, and the Marquesas are most heavily used by green and loggerhead sea turtles during the summer and autumn, although several islands within Great White Heron National Wildlife Refuges are also consistently used. Hawksbill sea turtles have historically been documented nesting within the Marquesas Keys during the winter months. The Quicksands area west of the Marquesas Keys, Mooney Harbor within Marquesas Keys, and the Lakes Passage have all been found to be important foraging grounds for green, loggerhead, and hawksbill sea turtles due to availability of continuous seagrass beds at a range of water depths that provide a principal food source (Inwater, 2008).

Crocodiles

The American crocodile (*Crocodylus acutus*) historically occurred throughout mangrove and estuarine areas of South Florida, including the Florida Keys, and is listed as federally threatened. Worldwide, American crocodiles are found throughout the Caribbean Sea and Central and South America along the Pacific and Atlantic coasts (Thorbjarnarson et al., 2010). Crocodiles forage opportunistically for fish, snakes, crabs, turtles, birds, and small mammals (Ogden, 1978). Crocodiles bask in the sun during the daytime in cooler months and spend warmer months in shaded areas or underground dens.

4.2.2.3 Non-native species

Non-native species are present in the marine, nearshore, and terrestrial environments of the Florida Keys. They can be an environmental threat to living resources and habitats in FKNMS and in areas included in the potential boundary expansion alternatives.

Introduced species in the marine environment can impact the ecosystem in significant ways. Their presence can alter community composition, reduce the abundance and diversity of native marine species (Olden et al., 2004), interfere with ecosystem function, alter habitats, disrupt commercial and recreational activities, and in some instances cause extinction of native plants and animals (Clavero & Garcia-Berthou, 2005). Introduced organisms can cause local extinction of native species either by preying on them directly or by outcompeting them for food or space. Once a breeding population is established, non-native species can be difficult, if not impossible, to eradicate. Invasions by non-native aquatic species are increasingly common worldwide in coastal habitats due to shipping traffic, world travel, and intentional or accidental releases by individuals.

Within the Florida Keys there are several efforts underway to monitor, eradicate, research, and conduct community outreach to address the issue of introduced species.

- REEF Early Detection/Rapid Response Program (Reef Environmental Education Foundation [REEF])
- REEF Exotic Species Sighting Program
- REEF Lionfish Invasion Program
- Mote Marine Laboratory SEAFAN: Southeast Florida Action Network
- FWC-FWRI targeted research on the extent, impact, and removal opportunities

The known fish, invertebrate, and reptile invasive species present in the Florida Keys include red lionfish (*Pterois volitans*), devil firefish (*Pterois miles*), peacock hind (*Cephalopholis argus*), sailfin tang (*Zebrasoma veliferum*), orange cup coral (*Tubastraea coccinea*), Asian tiger shrimp (*Penaeus monodon*), giant foam oyster (*Hyotissa hyotis*), gryphaeid oyster (*Hyotissa mcgintyi*), gastropod (*Cyclothyca pacei*), worm-snail (*Thylacodes vandyensis*), green mussel (*Perna viridis*), veined rapa whelk (*Rapana venosa*), green iguana (*Iguana iguana*), spiny-tailed iguana (*Ctenosaura* spp.), and Burmese (*Python molurus bivittatus*) and other invasive python species.

For more information on the invasive lionfish, orange cup coral, invasive mollusks, and plant species that can affect sanctuary resources and management see Schofield, 2009 and 2010; Ruttenberg et al., 2012; Green and Côté, 2009; Morris and Whitfield, 2009; Whitfield et al., 2007; Glynn et al., 2008; Cairns, 2000; Riul, 2013; Vermeij, 2006; Lages et al., 2010; Shearer, 2009; Mikkelsen and Bieler, 2007; and Bieler et al., 2017.

4.2.3 Protected species and habitats

4.2.3.1 Endangered Species Act

USFWS and NMFS jointly administer the ESA, as amended (16 U.S.C. §§ 1531 *et seq.*). USFWS generally manages the protection of and recovery effort for listed terrestrial and freshwater species, and NMFS manages the protection of and recovery effort for listed marine and anadromous species. USFWS also manages the protection of the manatee.

The ESA protects plant, fish, and wildlife species (and their habitats) that are listed as endangered and threatened. A species is defined as endangered if it is at risk of extinction throughout all or a significant part of its range. A threatened species is one that is likely to become endangered in the near future, and a species of special concern has received this classification based on either unfavorable regional factors or a decline in population (Owre, 1990). The ESA requires federal agencies to consult with USFWS and/or NMFS, as applicable, before initiating any action that may affect a listed species.

Action area

The action area for purposes of ESA analysis for effects of the proposed actions is the entire Florida Keys region in Monroe County, Florida, including the mainland shoreline of Card and Barnes Sounds in Miami-Dade County and the Pulley Ridge area.

The implementing regulations for Section 7(a)(2) of the ESA state, “action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50 C.F.R. § 402.02). The action area effectively bounds the analysis of ESA-protected species and habitats because only species that occur within the action area may be affected by the federal action.

For the purposes of the ESA analysis for the proposed expansion of FKNMS, ONMS defines the action area as:

- (1) the proposed boundaries of the expanded FKNMS; (Figures 3.1a, 3.1b, and 3.1c)

(2) shorelines, wetlands, and mangroves adjacent to FKNMS where noise from recreational and other activities would be audible to birds and wildlife; and

(3) the main routes vessels would travel to operate within the sanctuary and recreational boats would travel to visit diving, snorkeling, or other sites within FKNMS.

NOAA expects all direct and indirect effects of the proposed action to be contained within the action area as defined above. NOAA recognizes that while the action area is stationary, federally listed species can move in and out of the action area. For instance, a migratory bird species could occur in the action area seasonally as it forages or breeds at or near FKNMS. Thus, in its analysis, NOAA considered not only those species known to occur directly within the action area, but also those species that may passively or actively move into the action area for limited periods of time. NOAA then considered whether the life history of each species makes the species likely to move into the action area where it could then be affected by the proposed action.

Listed species that may occur within the action area

NOAA used the USFWS Environmental Conservation Online System (ECOS) Information for Planning and Conservation (IPaC) tool to search for federally listed endangered or threatened species that may be present in the action area. In informal consultation with USFWS, USFWS concurred with NOAA's determination that the proposed action may affect, but is not likely to adversely affect, 19 of these ESA-listed species and critical habitat for five species. NOAA determined the proposed action would have no effect on the remaining species and critical habitat identified by the IPaC tool (see Appendix E for more information and Appendix H for the full species list).

To compile the list of NMFS protected species, NOAA used the NMFS Southeast Regional Office Protected Resource Division's threatened and endangered species lists for Florida's Atlantic and Gulf coasts on September 8, 2023. These lists comprise 26 species, of which two (Atlantic sturgeon and shortnose sturgeon) are not believed to exist in the sanctuary. NMFS concurred with the list of species that may occur within the action area based on a technical assistance meeting between NMFS and ONMS.

The protected status of each species under USFWS and NMFS jurisdiction is summarized in Appendix H. Additionally, below are brief descriptions of the listed species most likely to occur within the Florida Keys action area.

Plants

No marine plants within the study area are currently listed as federal threatened or endangered species. Several terrestrial plants found within coastal rock barren and beach berm communities are listed as federal threatened or endangered species, including Cape Sable thoroughwort (endangered; *Eupatorium frustratum*), Garber's spurge (threatened; *Chamaesyce garberi*), and Blodgett's silverbush (threatened; *Argythamnia blodgettii*). About 25 populations of *E. frustratum* remain and are particularly susceptible to disturbance and habitat loss due to sea level rise. Because these plants do not occur within the action area, which is limited to marine waters for any direct disturbances, these species are not considered in further detail within this final EIS.

Animals

Marine invertebrates

There are seven coral species within the Florida Keys that are threatened under the ESA. The two Acroporid coral species (elkhorn and staghorn) were listed in 2006 and five additional species were listed in 2014. In addition, Pillar Coral is proposed to be uplisted to endangered (2023). The status of all coral species is further impacted due to SCTL and the 2023 marine heat wave.

Elkhorn and staghorn coral

Elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) corals were listed as threatened under the ESA on May 9, 2006 (NMFS, 2006). Elkhorn and staghorn corals were once the most abundant and important species on Atlantic/Caribbean coral reefs in terms of building reef structure. Both elkhorn and staghorn corals underwent precipitous declines in abundance throughout their ranges in the 1970s and 1980s, with losses of up to 95%. White band disease is the main factor for their near demise, with additional losses from disease, bleaching, hurricanes, and predation in the 1990s and 2000s. The significant reduction in the density of these species affects their role as a habitat forming coral and also may reduce the likelihood of natural recovery, as their ability to successfully reproduce is greatly diminished. Although disease was the primary cause of the initial decline, elevated seawater temperatures and ocean acidification associated with climate change are credible and potentially significant impediments to recovery of these species (NMFS, 2015).

Pillar coral (*Dendrogyra cylindrus*)

NMFS listed pillar coral as threatened under the ESA on September 10, 2014 and is currently being considered for uplisting to endangered. It has historically been found throughout the Caribbean and off the southeast coast of Florida but is generally uncommon. Recent reports indicate that it may be locally extinct off southeast Florida. It usually occurs as scattered, isolated colonies, although a few small aggregations historically occurred in the Florida Keys. Beginning in 2014, an extensive study was undertaken to identify locations with colonies; assess the size, abundance, and condition of these colonies; and determine their genetic makeup. Population assessments from February 2017 documented 78 remaining genotypes (represented by 257 live colonies), which represents a loss of 48% of genotypes and 64% of colonies from the baseline surveys in 2014. The low abundance and infrequent encounter rate make it difficult to determine population trends (NMFS, 2015).

Rough cactus coral (*Mycetophyllia ferox*)

NMFS listed rough cactus coral as threatened under the ESA on September 10, 2014. It occurs in southeast Florida and throughout the greater Caribbean. It is one of the least common coral species observed in monitoring studies. Low encounter rate and percent cover coupled with the tendency to survey *Mycetophyllia* spp. at the genus level make it difficult to discern population trends from monitoring data. Available data indicate *M. ferox* has experienced significant declines in Florida (NMFS, 2015).

Lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*)

NMFS listed the star corals in the *Orbicella* species complex as threatened under the ESA on September 10, 2014. The star corals historically dominated coral reefs throughout the Caribbean both by abundance and cover in areas outside of elkhorn coral habitats. They formed dense assemblages of large, centuries-old colonies interspersed with few small colonies (Bruckner, 2012). Bleaching and coral diseases have caused major declines of these over the last twenty years, and in many locations they are now rare. Fortunately, in some Florida Keys locations, especially in mid-channel and nearshore patch reefs, populations of these species have been stable or have suffered minimal losses.

Queen Conch (*Strombus gigas*)

The queen conch is a large marine mollusk found in warm waters of the Caribbean Sea and Gulf of Mexico. Recognizable by its large, spiral shell and vibrant pink coloration, the queen conch plays a crucial role in maintaining the health of coral reefs and seagrass beds through its grazing habitats, helping to control algae growth. However, the queen conch faces threats from overfishing and habitat destruction, leading to population decline. The queen conch was listed as threatened in March of 2024.

Terrestrial invertebrates

Miami blue butterfly (*Cyclargus thomasi bethunbakeri*)

The federally endangered Miami blue butterfly is a brightly colored subspecies of blue butterfly primarily found using beachside scrub in the lower Florida Keys. This population once spanned the southern Florida coast and the Florida Keys and is now constricted to six islands in Key West National Wildlife Refuge and one island in Great White Heron National Wildlife Refuge. USFWS listed the butterfly as an endangered species in 2012 (USFWS, 2012). Potential threats include habitat loss, degradation and fragmentation, group isolation, mortality, and invasive species. This subspecies is now vulnerable to extinction from large storms and hurricanes due to its small range. Mosquito control efforts using pesticides have been implicated in the decline of the subspecies; however, areas untreated by these pesticides have also experienced a dramatic decline (Zhong et al., 2009). This butterfly primarily uses beach ridge habitats on Marquesas and Boca Grande keys. Since the Miami blue has poor dispersal abilities (Emmel & Daniels, 2003), nectar sources must be near host plants, which can be found within the coastal prairie communities located on select islands. Peak abundance on the Marquesas Keys is generally during spring and fall, but is likely linked to precipitation events (Henry & Haddad, 2013).

Stock Island tree snail (*Orthalicus reses*)

Stock Island tree snails are found in hardwood hammocks in the Florida Keys. The snail historically occurred on Stock Island and Key West, where it was virtually eliminated. Habitat loss and a major decline in the original Stock Island population led snail collectors to move snails to other hammocks throughout the Florida Keys. The translocation of snails successfully prevented extinction of the species, but several of the few remaining populations are at risk due to continuing habitat loss to development. The National Key Deer Refuge contains one of the last established populations of this snail. Strategies for protecting hardwood hammocks will benefit the Stock Island tree snail.

Fishes

Nassau grouper (*Epinephelus striatus*)

The Nassau grouper is a shallow-water grouper species that has supported fisheries throughout the wider Caribbean, South Florida, Bermuda, and the Bahamas (Carter et al., 1994). On June 29, 2016, NMFS published a final rule (81 Fed. Reg. 42268 [June 29, 2016]) listing Nassau grouper as threatened under the ESA. Critical habitat was designated for the Nassau grouper in 2022 (NOAA Fisheries, 2022).

Smalltooth sawfish (*Pristis pectinata*)

Smalltooth sawfish belong to a group of fish called elasmobranchs, whose skeletons are made of cartilage, like sharks, skates, and rays. Most sawfish species take a long time to mature. This low reproductive potential, historical bycatch, and trophy fishing (for the saw [i.e., rostrum]) of sawfish has led to the endangered status of smalltooth sawfish. The smalltooth sawfish's historical range spanned from New York to Brazil. The U.S. distinct population is now only present in Florida and has been reported in both Atlantic and Gulf areas of the sanctuary. Critical habitat for this species was designated in 2009 (NOAA Fisheries, 2009).

Oceanic whitetip shark (*Carcharhinus longimanus*)

The oceanic whitetip shark was listed by NMFS as threatened under ESA during 2018. This species experienced declines in population size including an 88% decline in the Gulf of Mexico due to commercial fishing. Given their life history traits, particularly their late age of maturity and low reproductive output, oceanic whitetip sharks are inherently vulnerable to depletions, with low likelihood of recovery. Additional research is needed to better understand the population structure and abundance of the oceanic whitetip shark (NOAA Fisheries, 2023).

Giant manta ray (*Manta birostris*)

The giant manta ray was listed as threatened under the ESA by NMFS in 2018. It is the world's largest ray, with a wingspan of up to 29 feet (8.8 m). They are filter feeders and eat large quantities of zooplankton. Giant manta rays are slow-growing, migratory animals with small, highly fragmented populations that are sparsely distributed across the world. The main threat to the giant manta ray is commercial fishing, with the species both targeted and caught as bycatch in a number of global fisheries throughout its range. Manta rays are particularly valued for their gill rakers, which are traded internationally.

Florida Keys Mole Skink (*Plestiodon egregius*)

The Florida Keys mole skink is a proposed threatened ESA reptile species found exclusively in the Florida Keys. This small, elusive lizard burrows in loose soil or beneath debris. The Florida Keys mole skink is notable for its elongated body and distinctive iridescent sheen, with a background coloration that ranges from grey to brown (USFWS, 2023). The Florida Keys mole skink is able to shed its tail as a defense mechanism against predators.

Amphibians and reptiles

Green sea turtle (*Chelonia mydas*)

The Florida breeding population of green sea turtles is federally threatened. This large sea turtle inhabits marine coastal and oceanic waters and occurs in Florida year-round. There is evidence

that green sea turtles using the Florida Keys are genetically a separate population from the mainland Florida population (Shamblin et al., 2014). Nesting has been documented on several beaches in Key West National Wildlife Refuge: Boca Grande Key, Sawyer Key, and three beaches in the Marquesas Keys. Nest numbers have remained stable on Boca Grande and Sawyer Keys since 1990, despite progressive degradation of nesting habitat from wave action caused by storm events and boat traffic. Climate change effects, such as sea level rise and more frequent storms, could have a substantial impact on nesting habitat for sea turtles. Critical habitat for the green sea turtle is present within the proposed sanctuary boundary (USFWS, 2023).

Hawksbill sea turtle (*Eretmochelys imbricata*)

The hawksbill sea turtle is endangered throughout its range. This small-to-medium-sized sea turtle is found throughout Key West National Wildlife Refuge in hardbottom and reef habitats containing sponges. Nesting is rare and has only been documented once on Boca Grande Key and several times in the Marquesas Keys. On the latter island, nesting has been restricted to the fall and winter months. Genetic analyses of hawksbills in Key West National Wildlife Refuge indicated that the refuge serves as developmental habitat for juveniles originating from both the Mexican and Cuban nesting aggregations (Gorham et al., 2014). Critical habitat for the hawksbill sea turtle is present within the proposed sanctuary boundary (USFWS, 2023).

Kemp's ridley sea turtle (*Lepidochelys kempii*)

The Kemp's ridley sea turtle is endangered throughout its range. It is a small-to-medium-sized turtle with a nearly circular shell. Primarily a Gulf of Mexico species, it inhabits marine coastal waters with sand or mud bottoms. Juveniles frequent bays. Nesting occurs on Gulf beaches in south Texas and northern Mexico, although a few nests have been confirmed in Florida. Data are lacking on this species, but it likely occurs at least sporadically in the waters of the sanctuary and within the boundaries of the Lower Florida Keys National Wildlife Refuges (NOAA Fisheries, 2023).

Leatherback sea turtle (*Dermochelys coriacea*)

The leatherback sea turtle is endangered throughout its range. It is the largest sea turtle species found in the Florida Keys, weighing 600 to 1,100 lbs (272–499 kg) and inhabiting marine coastal and oceanic waters. They feed exclusively on jellyfish. Nesting activity was documented at Bahia Honda State Park in 2016. Critical habitat for the leatherback sea turtle is present within the proposed sanctuary boundary (USFWS, 2023).

Loggerhead sea turtle (*Caretta caretta*)

The loggerhead sea turtle is federally listed as threatened. Loggerhead sea turtles inhabit marine coastal and oceanic waters and are present in Florida year-round. Nesting occurs in Key West National Wildlife Refuge on Woman, Boca Grande, and the Marquesas keys; on Sawyer Key and West Content Keys in Great White Heron National Wildlife Refuge; and on Big Pine Key and Ohio Key in National Key Deer Refuge. A peak of 81 nests were found in Key West National Wildlife Refuge in 1995, but annual loggerhead nesting activity has ranged from 17 to 73 nests between 2006 and 2016 (Watts pers. comm., 2015–2018). Critical habitat for the loggerhead sea turtle is present within the proposed sanctuary boundary (USFWS, 2023).

American crocodile (*Crocodylus acutus*)

American crocodiles historically occurred throughout mangrove and estuarine areas of South Florida, including the Florida Keys. Worldwide, American crocodiles are found throughout the Caribbean Sea and Central and South America along the Pacific and Atlantic coasts (Thorbjarnarson et al., 2010). In the United States, the American crocodile is federally listed as a threatened species after being downlisted from endangered in 2007. Areas that contain breeding populations include Crocodile Lake National Wildlife Refuge, Turkey Point Power Plant cooling canals, and Everglades National Park. Increasingly, there is also evidence of nesting areas further south in the Florida Keys and an overall increase in population size over the last few decades (Cherkiss et al., 2011). The American crocodile is typically active from shortly before sunset to shortly after sunrise (Mazzotti, 1983; Mazzotti et al., 2003). Crocodiles forage opportunistically for fish, snakes, crabs, turtles, birds, and small mammals (Ogden, 1978). Crocodiles bask in the sun during the day in cooler months and spend warmer months in shaded areas or underground dens. Habitat fragmentation, sea level rise, and vehicle collisions are thought to be the greatest anthropogenic threat to American crocodiles. Critical habitat for the American crocodile is present within the proposed sanctuary boundary (USFWS, 2023).

Birds

Roseate tern (*Sterna dougallii*)

The North American subspecies of the roseate tern is a colonial nesting seabird found along the East Coast of North America. Populations breeding in Florida and the Caribbean are listed as threatened under the ESA. In South Florida, roseate terns typically nest on open sandy islands, dredge-spoils and rooftops, using open sand, broken coral, or rocky cliffs as nesting substrate. They typically select flat ledges for nesting and will lay their eggs directly on the ground beginning in May. These birds are susceptible to human disturbance during nesting and rearing of young, as well as to predation, storms, flooding, and tidal inundation. Climate change impacts, such as sea level rise and the erosion of sandy islands, may reduce the availability of suitable breeding habitat. Rooftop nesting occurs in areas where sandy nesting habitats are unavailable or heavily disturbed, leading to a suite of potential human disturbance and urban predation issues. Roseate terns forage over shallow coastal waters and offshore seas, feeding primarily on small, schooling fish such as herring (Clupeidae), young mackerel (Scombridae), and small squid (Teuthoidea) (Nisbet, 1981; Duffy, 1986; Kirkham & Nisbet, 1987). Roseates will hover over schools of fish at heights of up to 65 feet (20 m) (USFWS, 1989), and plunge-dive to catch the fish, sometimes completely submerging their bodies in the water.

Piping plover (*Charadrius melodus*)

This small, sandy-colored shorebird is primarily found along the sandy beaches of the Atlantic coastline. Piping plovers winter along the coast from North Carolina to Florida, as well as in the Bahamas and West Indies, using open, sandy beaches, sand flats, and tidal mudflats for foraging, roosting, and loafing. Breeding piping plovers are federally listed as threatened or endangered, depending on the population. Birds wintering in Florida may originate from both threatened and endangered breeding populations. Recovery efforts are geared toward minimizing disturbance to their breeding and wintering areas. Piping plovers use beaches, as well as tidal sand and mudflats, for foraging in the Florida Keys during winter months. Their diet includes polychaete marine worms, crustaceans, insects, and bivalve mollusks (Nicholls,

1989), found on top of or just beneath the surface of moist or wet sand, mud, or shell. Due to the nature of their habitat use, they are susceptible to human disturbance. Increased use of beaches and tidal flats for recreation is of primary concern. From fall through spring, nonbreeding piping plovers use a variety of habitat patches, moving among them according to changes in tide and weather. Protecting these habitat patches from disturbance is important to ensure that plovers are healthy when they begin their spring migration toward breeding grounds from March to May. Critical habitat for the piping plover was designated in 2021 and is within the action area (USFWS, 2023).

Great white heron (*Ardea herodias occidentalis*)

Great white herons breed in South Florida, primarily in the Florida Keys. Recent evidence shows that this heron is either a sub-species or separate species from the great blue heron (*Ardea herodias*; McGuire, 2001). Nesting occurs on select mangrove islands throughout the year, with a pronounced peak between November and February. Birds forage on small fish species such as pipefish (Syngnathidae) and needlefish (*Strongylura spp.*) and on large, intact turtle grass (*Thalassia testudinum*) beds during a limited fraction of the tidal cycle (Stevenson & Anderson, 1994). Foraging herons have high site fidelity and select seagrass meadows that are continuous with few patches. Destruction of seagrass beds by boating impacts can directly limit the availability and quality of forage habitat for these birds (Meyer and Kent, 2011). A peak of 336 nests was documented in 1998, but thereafter nesting declined annually to less than 100 (Wilmers, 2003). Historically, about 40 mangrove islands within the Lower Keys Refuges have been used as rookeries for great white herons (Wilmers, 2010), and the Lower Keys support over 25% of the Florida population (Meyer & Kent, 2011). The great white heron is not ESA listed, but this taxon is recognized by the USFWS as a Bird of Conservation Concern (USFWS, 2021).

White-crowned pigeon (*Patagioenas leucocephala*)

The white-crowned pigeon is a large, slate-gray bird with a conspicuous white crown and an iridescent green scaled nape. The distribution of the white-crowned pigeon ranges from South Florida through the West Indies and the Caribbean coast of the Yucatan Peninsula. This species is not ESA listed, but is recognized by the USFWS as a Bird of Conservation Concern (USFWS, 2021). It is federally listed as near-threatened and state listed as threatened. Nesting colonies are primarily found on isolated mangrove islands from May through September. White-crowned pigeons primarily forage in upland hammock trees with a diet consisting of mainly fruits and berries, including poisonwood (*Metopium toxiferum*), found in low-lying forests on larger islands. Both the nesting and substantial foraging habitats with three to 15 miles (4.8–24 km) are needed by this species to survive (Bancroft & Bowman, 2001). All three Lower Keys Refuges serve as key areas for both nesting and foraging.

Magnificent frigatebird (*Fregata magnificens*)

The magnificent frigatebird is a large seabird that occurs along the Pacific and Atlantic coasts of North and South America, as well as the Caribbean Basin. USFWS recognizes this species as a Bird of Conservation Concern (USFWS, 2021). Nesting habitat in Florida has been on select islands or clusters of red mangroves, where birds build platforms from gathered sticks at ground level or elevated in trees. Nesting on the Marquesas Keys was first confirmed in 1969 as the only known nesting colony in the United States, and was documented annually until this colony was

abandoned in 1989. Magnificent frigatebirds are still present in the Florida Keys; however, due to an extensive time investment in breeding, human disturbance can greatly influence both colony site selection and nesting success. Birds presently nest only within Dry Tortugas National Park. Appropriately managed disturbance-free sites could lead to breeding again elsewhere in the Keys. Magnificent frigatebirds feed by selecting prey from the surface of the sea, mainly fish, squid, jellyfish, and crustaceans (Calixto-Albarran & Osorno, 2000). They are unable to land on water or dive under the surface, as they are incapable of flying when wet. Due to this limitation, they have adapted alternative feeding strategies, such as kleptoparasitism, forcing smaller seabirds to drop their catch or regurgitate food for their benefit.

Reddish egret (*Egretta rufescens*)

The reddish egret is a medium to large long-legged heron found in two color phases: dark phase, consisting of a dark gray body and reddish neck, and white phase, consisting of a white body with a two-toned bill and dark grey legs. This species almost disappeared due to the millinery trade in the late 1800s and has never recovered to former levels. It is a Bird of Conservation Concern (USFWS, 2021). The breeding population in Florida is estimated at 480 pairs (Cox et al., 2019), with many of those birds found in the Florida Keys. This species is often identified by their specialized feeding behavior, which consists of running through shallow water, leaping sideways, and spastically changing directions. They also curve their wings to cast shade over the water in an effort to lure prey fish toward them. Reddish egrets are restricted by the availability of broad, saline coastal flats with considerable tidal flow (Paul, 1991) and can become territorial over high-quality foraging grounds. One of the most important foraging areas for this species in Key West National Wildlife Refuge is on Boca Grande Key.

Mammals

Cetaceans

Endangered cetaceans that may occur in the area under consideration include blue whales, fin whales, sei whales, sperm whales, North Atlantic right whales, and Bryde's whales. Blue whales (*Balaenoptera musculus*) are the largest animals ever to live on our planet. They feed almost exclusively on krill, straining huge volumes of ocean water through their baleen plates (which are like the teeth of a comb). Blue whales are found in all ocean basins except the Arctic Ocean. They occasionally swim in small groups but usually are alone or in pairs. They generally spend summers feeding in polar waters and undertake lengthy migrations towards the equator as winter arrives. Fin whales (*Balaenoptera physalus*) may winter in the area, primarily in offshore waters, and feed on small schooling fishes, pelagic crustaceans, and squid (NMFS, 1989). Sei whales (*Balaenoptera borealis*) may occur in the area and generally skim feed on surface plankton, small schooling fishes, and squid. These baleen whale species are all opportunistic feeders and may feed at or near the surface (McKenzie & Nicolas, 1988).

One endangered odontocete, the sperm whale (*Physeter macrocephalus*), may occur in the area and is most likely to be found at the edge of the continental shelf or in deep oceanic waters. They tend to inhabit areas with a water depth of 1968 feet (600 m) or more and are uncommon in waters less than 984 feet (300 m) deep. Sperm whales are deep diving and feed primarily on squid and deep-water fishes.

Rice's whales (*Balaenoptera ricei*), formerly Bryde's whales (*Balaenoptera edeni*), are found in warm, temperate oceans including the Atlantic, Indian, and Pacific. Some populations of Bryde's whales migrate with the seasons, while others do not migrate, making them unique among other migrating baleen whales. Bryde's whales are vulnerable to many stressors and threats, including vessel strikes, ocean noise, and whaling outside the United States. In 2019, NOAA Fisheries listed the Gulf of Mexico Bryde's resident population of whales as an endangered subspecies under the ESA. In 2021, NOAA Fisheries revised the common and scientific name of the listed entity to Rice's whale, *Balaenoptera ricei*, and classification to species to reflect the new scientifically accepted taxonomy and nomenclature of the species. The Rice's whale is also threatened by oil and gas activities, as well as oil spills and cleanup. Scientists estimate that there are 51 Rice's whales ([NMFS, 2023](#)).

West Indian manatee (*Trichechus manatus*)

Manatees are found in marine, estuarine, and freshwater environments. These herbivores feed opportunistically on a wide variety of marine, estuarine, and freshwater plants, including submerged, floating, and emergent vegetation. Florida manatees are rare in the Lower Florida Keys partly because freshwater outflows into the nearshore marine waters are lacking.

Key deer (*Odocoileus virginianus clavium*)

The Key deer is the smallest subspecies of the North American white-tailed deer (*O. virginianus*). It historically ranged from Key Vaca to Key West, but the current range includes approximately 26 islands from Big Pine Key to Sugarloaf Key, with the center of its population on Big Pine and No-Name keys. Most lands within its current range, including privately owned lands, lie within the administrative boundaries of National Key Deer Refuge. Key deer use all cover types, including those normally above tidal influence (pine rockland, hardwood hammock, freshwater wetlands), as well as tidally influenced types (mangrove, salt marsh transition). They also use residential areas extensively where they feed on ornamental plants and grasses and seek freshwater. The Key deer remains listed as endangered due to its restricted range, sea level rise, habitat fragmentation, and high human-related mortalities and disturbances.

Lower Keys marsh rabbit (*Sylvilagus palustris*)

The Lower Keys marsh rabbit is a subspecies of the marsh rabbit, which is more widely distributed in the southeastern United States. This subspecies originally ranged throughout the Lower Florida Keys, including Key West. The current range appears to consist of three separate metapopulations: the Boca Chica area (Boca Chica, Geiger, East Rockland, and Saddlehill keys), the Sugarloaf area (Sugarloaf and Saddlebunch keys), and the Big Pine area (Big Pine, Annette, East Water, Howe, Johnson, Little Pine, Mayo, Newfound Harbor, Porpoise, and No Name keys) (Forys & Humphrey, 1999). Lower Keys marsh rabbits are predominantly found in salt marsh transition communities that have dense ground cover created by cordgrass (*Spartina spartinae*).

Silver rice rat (*Oryzomys palustris natator*)

The silver rice rat is primarily a nocturnal, semi-aquatic, wetland rodent that forages in intertidal zones, feeding on fish, crabs, grasses, and forbs (Perry et al., 2005). Compared to other small mammals, silver rice rats inhabit large home range areas of five to 27 acres (2–11 hectares) (Mitchell, 1996). Its habitat includes areas of contiguous mangrove swamps and salt

marsh transition. Populations are found at extremely low densities on at least 13 islands, ranging from Big Pine Key to the Saddlebunch Keys. Silver rice rats were listed as endangered due to habitat destruction from human development. Loss of mangrove habitats was greatly curtailed after the passage of the Clean Water Act of 1974 that restricted development in wetlands; however, threats due to sea level rise and competition from black rats are emerging concerns for silver rice rat conservation.

Designated critical habitat

When a species is listed under the ESA, NMFS and/or USFWS is required to determine whether there are areas that meet the definition of “critical habitat.” Critical habitat for a threatened or endangered species is defined as (1) the specific areas within the geographical area occupied by the species at the time of listing that contain physical or biological features essential to conservation of the species and that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (16 U.S.C. § 1532(5)(A)).

Critical habitat within FKNMS has been designated for the following species: loggerhead sea turtle (79 Fed. Reg. 39855 [Aug. 28, 2014]), smalltooth sawfish (74 Fed. Reg. 45353 [Sept. 2, 2009]), Nassau grouper (89 FR 126 [Jan. 1, 2024]), elkhorn and staghorn coral (73 Fed. Reg. 72210 [Nov. 26, 2008]), pillar coral, rough cactus coral, lobed star coral, mountainous star coral, and boulder star coral (89 FR 19511 [Mar. 19, 2023]), American crocodile (42 Fed. Reg. 47840 [Sept. 22, 1977]), Bartram’s hairstreak butterfly (*Strymon acis bartrami*, 79 Fed. Reg. 47179 [Aug. 12, 2014]), Cape Sable thoroughwort (79 Fed. Reg. 1552 [Jan. 8, 2014]), Florida leafwing butterfly (*Anaea troglodyta floridalis*, 79 Fed. Reg. 47179 [Aug. 12, 2014]), Florida semaphore cactus (*Consolea corallicola*, 81 Fed. Reg. 3865 [Jan. 22, 2016]), piping plover (74 Fed. Reg. 23476 [May 19, 2009]), silver rice rat (58 Fed. Reg. 46030 [Aug. 31, 1993]), and West Indian manatee (42 Fed. Reg. 47840 [Sept. 22, 1977]).

4.2.3.2 State listed species

In accordance with Chapter 68A-27 of the Florida Administrative Code, FWC oversees the state’s Threatened and Endangered Species Conservation Program. This chapter of the Florida Administrative Code gives the FWC the authority to list species as state-threatened or endangered; to issue regulations necessary and advisable to provide for the conservation of such species; and to prohibit anyone from taking a species, which includes activities that would harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct.

The state of Florida defines all listed species as imperiled, which includes species listed at the federal level as endangered, threatened, threatened due to similarity of appearance, or non-essential experimental by USFWS and NMFS. It also includes species listed at the state level as state-designated threatened and species of special concern by FWC. State-designated threatened species are not federally listed but at risk of extinction. Species of special concern are those that require review so they can be either designated as state-designated threatened or given a management plan and be removed from the list. For the complete list of imperiled species, see Appendix H.

4.2.3.3 Essential Fish Habitat

EFH is defined under the MSA as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.” EFH is designated in Fishery Management Plans developed by the regional fishery management councils. EFH within FKNMS has been designated for 38 species or species complexes (i.e., snapper-grouper complex). For each species or complex, the fishery management councils have identified life stages of these species that have been identified in this area. Some species such as blue marlin and shortfin mako shark have EFH designated for all life stages. For designated EFH species or complexes within FKNMS, see Appendix H.

4.2.3.4 Migratory birds

USFWS administers the Migratory Bird Treaty Act, which prohibits anyone from taking native migratory birds or their eggs, feathers, or nests without explicit authorization. Regulations under the act define “take” as “to pursue, hunt, shoot, wound, kill, trap, capture, or collect” (50 C.F.R. § 10.12). The act prohibits direct (purposeful) as well as indirect (non-purposeful) take of protected species. Implementing regulations provide means for authorizing purposeful take (e.g., hunting, scientific research). However, many of the potential impacts to migratory birds occurring as a function of the proposed actions pertain to “incidental” (non-purposeful) take, which there are presently no means to authorize. Incidental take occurs when activities such as boating or other recreational disturbance result in adult birds abandoning nests, exposure of young to predators or the elements, trampling of ground nests, and so forth. The act protects a total of 1,007 migratory bird species (75 Fed. Reg. 9282 [Mar. 31, 2010]), several hundred of which occur or may occur on a regular basis as breeders, migrants, or wintering birds in the action area. USFWS (2021) recognizes 35 of these species as Birds of Conservation Concern within Peninsular Florida (Bird Conservation Region 31), and habitats for at least 25 of these occur within the action area. Birds of Conservation Concern as those taxa that could become threatened or endangered under the ESA without proactive stewardship attention (Appendix H).

4.3 Physical Resources

This section addresses the physical environments including air quality, climate, hydrology, hydrography/oceanography, and water quality issues related to the proposed action and alternatives. The study area for physical resources includes the existing FKNMS and a much larger region in the Gulf of Mexico and Straits of Florida that is connected through currents and other physical oceanographic features.

4.3.1 Climate

Impacts from global climate change directly affect the natural resources of the Florida Keys. The key climate change impacts of concern for FKNMS, national wildlife refuges, and adjacent waters include ocean warming, ocean acidification, changes in weather and storm patterns, and sea level rise.

The Florida Keys lie in the subtropics, between latitude 24° 30' and 25° 30' North. As such, the sun's rays strike Earth at a greater angle in the Florida Keys than anywhere else in Florida (Winsberg, 2003). In addition, the Keys are the sunniest region in Florida, with 76% possible

sunshine during an average year. Moreover, the nearness of the Florida Keys to the Gulf of Mexico and Straits of Florida provides a tempering effect on temperatures year-round. The average temperature during the coldest month (January) is only 14° F (10° C) lower than during the warmest month (July). However, temperatures as low as 35° F (1.7° C) have been recorded at John Pennekamp State Park (in January 2010). Diurnal variations in temperature throughout the year average only about 10° F (5.6° C). The Florida Keys region is the driest in Florida, and significant stretches of dry weather have occurred, especially during the winter and spring months, but also occasionally during the summer. Long stretches of dry, sunny weather occurring during the summer in combination with light winds can stress marine ecosystems by raising sea surface temperatures and salinity concentrations (Voss, 1988).

Warming seas are affecting coral reefs by causing mass coral bleaching events, while ocean acidification is likely causing slower growth of coral skeletons (Hoegh-Guldberg et al., 2007; De'ath et al., 2009). Bleaching and infectious disease outbreaks are likely to be more frequent and severe as temperatures rise, increasing coral mortality. Climate changes could have other impacts on marine systems such as sea level rise; altered frequency, intensity, and distribution of tropical storms; and altered ocean circulation, with its effects on water mass distribution, larval connectivity, and productivity. All of these impacts may combine, often synergistically, to affect important ecosystem functions and reduce biodiversity (NOAA, 2009).

Climate observations, critical to understand and monitor changing ocean and atmospheric conditions, are based on direct measurements and remote sensing from satellites. Several studies and programs have been conducted or are in place to understand and monitor these changing conditions. Beginning in 1989, the SEAKEYS Network was initiated to collect oceanographic data to supplement the primarily meteorological data being collected by NOAA's Coastal Marine Automated Network. As part of this program, the sanctuary deployed thermographs in strategic areas throughout the reef tract to record long-term water temperatures. While the specific SEAKEYS project is no longer active, NOAA regularly collects ocean temperature data throughout the Florida Keys at a range of depth gradients, and the Molasses Reef Coastal Marine Automated Network station continues to collect surface sea temperatures in near real time. Ocean acidification data are collected by the Moored Autonomous pCO₂ buoy (MAP-CO) at Cheeca Rocks, offshore Islamorada. Satellite data provide near real time sea surface temperature data that can be used to identify areas at risk for coral bleaching. NOAA's Coral Reef Watch Program releases hot spot, degree heating week, and bleaching alert area products in advance of and throughout the season when bleaching is most possible.

4.3.1.1 Water temperature

Data from both satellite and *in situ* instruments show sea surface temperature increases in the Florida Keys, which is a contributing factor of coral bleaching and some diseases. Temperature data from NOAA's Coastal Marine Automated Network station at Molasses Reef in FKNMS show that these warming trends continue. Data indicate that the summers of 2014 and 2015 and the winter of 2013 to 2014 were the warmest on record (since 1988). However, those records have been surpassed by the 2023 marine heat wave when seawater temperatures in multiple locations in the Florida Keys exceeded all previously recorded data with temperatures on the seafloor in several reef environments of 93–94 F (NOAA, 2023). The oldest known *in situ*

temperature record of any coral reef in the Florida Keys is from Hens and Chickens Reef, which showed significant warming from 1975 to 2014, indicating that thermal stress to corals has increased appreciably over the past 40 years (Manzello, 2015). This analysis predicts that coral bleaching events will become more frequent and severe over the coming decades. The reef-building corals of Florida are now exceeding their upper thermal limits regularly, with eight mass bleaching events since 1987, with the most recent in the summer of 2023, that have impacted the entire reef tract.

Increased sea surface temperatures, reduced freshwater inputs, and increased nutrients can also contribute to episodic die-offs of seagrasses and other important components of coastal and marine communities. A seagrass die-off occurred in Florida Bay in 1987, impacting 9,884 acres (40 km²) of seagrass (Hall et al., 2016) at the same time that a mass coral bleaching event was occurring throughout the Florida Keys and Caribbean. Florida Bay experienced another large-scale seagrass die-off in 2015 due to increased water temperatures, salinity, a stratified water column, and bottom water anoxia (lack of oxygen) (Hall et al., 2016).

The Florida Keys and marine environment have also experienced cold weather impacts. Cold fronts are common during the wintertime in the Florida Keys, with observations showing that most frontal passages have been followed by a short period of cool weather, followed by gradual warming due to the cool, post-frontal air masses modifying quickly during the transit over surrounding warm waters. However, on occasion, significant cold air outbreaks have reached as far south as the Florida Keys (e.g., January 1981 and January 2010). Such strong cold air outbreaks have delivered significant impacts to the Florida Keys marine environment. Shallow areas have experienced rapid decreases in sea surface temperature and increases in turbidity. In addition, both nutrient and salinity levels have been affected. During the particularly cold air outbreaks, fish and coral kills have occurred, with subsequent recovery taking several years or even decades (Voss, 1988).

4.3.1.2 Ocean acidification

On a broader scale, carbon dioxide (CO₂)-induced ocean acidification may also affect coral reefs in the Florida Keys as atmospheric carbon dioxide levels continue to increase. The ocean takes up around 25% of atmospheric CO₂ produced by humans through the burning of fossil fuels and land use changes. This uptake of CO₂ is already decreasing the concentration of the carbonate ion (CO₃²⁻) in sea water, which is a fundamental building block of the calcium carbonate (CaCO₃) skeletons of reef building corals. As ocean acidification increases and the concentration of carbonate ions declines, the rate at which corals build their hard skeletons slows, promoting the breakdown and dissolution of living and fossil coral reef frameworks. The acidity of seawater has increased by 30% since the beginning of the Industrial Revolution over 250 years ago, leading to a global decline of roughly 0.1 pH units, making the ocean less alkaline (Ocean Acidification Reference User Group, 2009).

Due to the increased acidity of seawater, many of the animals and plants in the ocean that have calcium carbonate skeletons or shells, such as corals, may experience reduced growth or ability to generate hard shells. For example, in Australia's Great Barrier Reef, corals have already reduced their calcification rates, most likely in response to elevated water temperature and ocean acidification impacts (De'Ath et al., 2009). A study by Hoegh-Guldberg et al. (2007)

predicts that if atmospheric CO₂ levels continue to increase, the structure and function of coral reef ecosystems around the world will be compromised and some coral species will become extinct. Ocean acidification could prompt a chain reaction of impacts through the marine food web, beginning with larval fish, shellfish, and corals, and cutting valuable ecosystem services provided by coral reefs such as food security, tourism, shoreline protection, and biodiversity (Ocean Acidification Reference User Group, 2009).

To capture real-time data, scientists from NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) installed a CO₂ monitoring buoy at Cheeca Rocks. Data from this instrument, along with continued monitoring of corals and coral health, enable resource managers to make informed decisions regarding reef management as it relates to ocean acidification.

See Section 4.2 for more information on coral and seagrass habitats.

4.3.1.3 Sea level rise

The threat of sea level rise profoundly affects the Florida Keys. The projections from NOAA's Office of Coastal Management indicate that Florida's sea level will rise from 3.84 to 8.56 feet (1.17–2.61 m) by the year 2100 (NOAA, 2017). The updated sea level rise scenarios predict sea level rise between 1.0 to 6.6 feet (NOAA, 2022). The seas in Florida have been rising about 0.1 inches (0.25 cm) per year (Florida Oceans and Coastal Council, 2009). This could have a significant effect on the land of the Florida Keys, as the average elevation of the larger islands range from four to seven feet (1.2 to 2.1 m) above current sea levels (Evans & Bergh, 2016). As a result, there may be significant flooding of property and infrastructure, greater vulnerability to storm surges and erosion, and destruction of coastal habitats and associated species. Rising seas will likely have direct impacts on coastal beaches, infrastructure, and freshwater wetlands due to high tides and storm surges. Sea level rise in South Florida is anticipated to outpace the global average due to ongoing variations in the Florida Current and Gulf Stream.

With its low-lying, elevation-dependent vegetation, the Lower Florida Keys will have dramatic terrestrial impacts even at low (1 ft/0.3 m) levels of sea level rise. LaFever et al. (2007) found that various sea level rise scenarios (1–3 ft/0.3–0.9 m estimated by the Intergovernmental Panel on Climate Change 2001) resulted in loss of both coastal and upland vegetation structure as sea level rise challenged the ability of vegetation to migrate vertically. A recent Florida International University research study also found that South Florida mangrove forests would not be able to adapt to current sea level rise projections (Meeder & Parkinson, 2018). Upland communities will decrease in area extent and fragment based on small differences in elevation. With the concomitant loss of both waterholes and freshwater marshes, the loss of freshwater would be an important limiting factor for many terrestrial wildlife species. With more recent projected sea level rise ranging from <1–6 ft/0.2–2.0 m (10 ft/3.0 m by some sources) by 2100 (Zhang et al., 2011; Intergovernmental Panel on Climate Change, 2014; NASA, 2017) the potential impact on the Lower Florida Keys is not precisely known but likely will be substantial.

Sea level rise is a major concern in conserving all wildlife habitats in the Florida Keys. Habitat shifts and loss have been documented across the Florida Keys, and when compounded with storm surges, can transform the hydrology, soils, and vegetation communities (Alexander & Dickson, 1972; Ross et al., 1994; Ross et al., 2009). Surface elevation tables were installed and

monitored within National Key Deer Refuge to determine vertical accretion and subsidence rates within mangrove habitats (Hester, 2011). Temporal changes in the salinity of freshwater lenses, the main freshwater source for plants and animals in the Lower Keys, highlighted the vulnerability of imperiled habitats such as pine rocklands and freshwater marsh to saltwater inundation (Ogurcak, 2015).

4.3.1.4 Storm frequency and severity

While outside the scope of this final EIS, another potential impact of climate change is changes in the frequency and duration of weather events, including hurricanes. Higher intensity hurricanes have become more frequent. This trend is projected to continue, affecting the Keys as much as or more than any other part of the United States.

The Atlantic Basin Hurricane Season is the six-month period from June through November. Historically, most storms in the Florida Keys have occurred during the months of August, September, and October. However, hurricanes have affected the Florida Keys during every month of hurricane season.

Southern Florida has one of the highest tropical cyclone return periods in the United States (Blake et al., 2011). On average, there is an annual probability of about 20 to 25% of a hurricane passing within 75 miles (120.7 km) of a Florida Keys island community (Sheets & Williams, 2001). The annual probability of a “major” hurricane (Category 3 or higher) passing within 75 miles of a Florida Keys community is about eight to 10% (Sheets & Williams, 2001). Between 1950 and 2012, an average of 0.64 hurricanes per year have made landfall on the Eastern Seaboard of the United States; however, the number of landfalls in an individual year has varied across the range from zero to three (Yan et al., 2015).

Only four Category 5 hurricanes have made landfall in the United States since official hurricane records began in 1871. The Florida Keys Labor Day Storm of 1935 was one of these Category 5 storms, and to this day is the most intense hurricane ever to make landfall in the United States.

More recently, numerous tropical storm and hurricane impacts occurred in the Florida Keys during the hyperactive hurricane seasons of 2004, 2005, and 2017. Hurricane Wilma in October 2005 (see Kasper, 2007) was noteworthy due to its historic storm surge, which caused widespread property damage throughout the Florida Keys. In 2017, Hurricane Irma made landfall at Cudjoe Key as a Category 4 storm producing water levels five to eight feet above ground level for portions of the Lower Keys (Cangialosi et al., 2018).

Both tropical storms and hurricanes have caused major damage to the Florida Keys' natural environment, with a single storm causing changes that would normally take years to occur. Tropical storm and hurricane impacts result from five hazards: (1) storm surge flooding; (2) damaging sustained winds; (3) tornadoes; (4) flooding rains; and (5) powerful waves, surf, and currents. Storm waves and currents can impact entire ecosystems, large blocks of coral can be broken from reefs and moved great distances, sediments can abrade corals or bury them completely, and entire islands can be defoliated. In addition, storm surges can flood aquifer recharge areas with saline water and soils can be completely eliminated (Monroe County Board of County Commissioners, 1986). Recovery from such storms may take several decades (Nalvikin, 1969).

Storm surge is the primary life-threatening hurricane hazard, and both historical evidence and modern computer models indicate that storm surge inundation has occurred and is likely to occur with all categories of hurricanes, and with some tropical storms.

At the landscape level, hurricanes have the potential to reshape shorelines, cause extensive damage to vegetation in forested areas, and change hydrological properties (Lopez et al., 2003). Previous researchers have posited that hurricane storm surge would likely salinize the freshwater sources in the Florida Keys for extended periods of time following hurricanes (Ross et al., 2009; Ogurcak, 2015). Lopez et al. (2003) found that 27% of monitored fresh waterholes in the Lower Keys were too saline for wildlife after Hurricane Georges (1998) and remained so for weeks or months after the hurricane. Ogurcak (2015) reinforced the idea that storm surge has the most impact when she found that the extent of hurricane impacts and the associated recovery time was a function of elevation and community type. As such, hurricanes that cause extensive storm surge in addition to high winds are likely to cause lasting impacts on vegetative communities.

4.3.2 Air quality

The federal Clean Air Act was passed in order to protect human health and welfare from air pollution. As part of the Clean Air Act, National Ambient Air Quality Standards (NAAQS) were established. NAAQS are defined as levels of pollutants above which detrimental effects on human health or welfare may result. NAAQS have been established for six pollutants. These are: particulate matter (PM₁₀ and PM_{2.5}); sulfur dioxide; nitrogen dioxide; ozone; carbon monoxide; and lead.

In Florida, air quality designations are made at the county level. For the purpose of planning and maintaining ambient air quality under NAAQS, the EPA developed air quality control regions. Air quality control regions are intrastate or interstate areas that share a common airshed. Monroe County, the county in which the state waters of FKNMS lie, currently meets or exceeds the requirements for the NAAQS for all six pollutants.

4.3.3 Regional water quality and hydrology

The primary natural source of freshwater in the Florida Keys is rain. Historically, early settlers collected rain water in cisterns or used water from wells and solution holes that tapped small, shallow freshwater lenses. These lenses form from fresh water held in the ground above sea level during the rainy season. During the past century, the pattern and intensity of freshwater flows in the Everglades wetlands to the estuaries of Florida Bay and Biscayne Bay have been significantly altered by intense land use changes for municipal development and agricultural activities. Freshwater flows in South Florida were most notably affected by construction of the Central and Southern Florida Flood Control Project. This surface water management project, which was designed by the USACE in the 1950s, uses an extensive system of canals, levees, and water control structures to drain land, provide flood protection, and regulate South Florida drinking and agricultural water supply. As a result, enormous volumes of freshwater that historically supplied the Everglades and its estuaries have been drained, diverted, or stored in “conservation areas.” The resulting alteration of the natural freshwater cycle has interrupted the volume, timing, and distribution of freshwater throughout the South Florida ecosystem, including

Florida Bay and the Keys. For example, changes in salinity levels, temperatures, and other factors, due primarily to reductions in freshwater inputs, have resulted in seagrass die-offs, extensive phytoplankton blooms, and the loss of estuarine ecological function, including changes in the kinds of fish and invertebrates found in Florida Bay (Zieman, 1999).

Restoration of water flows to the Everglades wetlands and Florida Bay is being undertaken as part of the Comprehensive Everglades Restoration Plan, which is led by USACE and the South Florida Water Management District in partnership with a number of federal, tribal, state, and local agencies.

For more information about the hydrology of South Florida and the Florida Keys, see Folk et al., 1991; Hanson, 1980; Langevin et al., 1998; and Wightman, 1990.

4.3.3.1 Hydrography/oceanography

Hydrography and oceanography are the studies of the physical features of bodies of water and the physical and biological properties of the ocean, respectively. A region's hydrography coupled with changes in salinity, temperature, and circulation can affect water quality and create avenues of physical and biological connectivity in the ocean and nearshore environments. The nearshore and ocean area of the Florida Keys, including Pulley Ridge, are influenced by two main regional currents: the Gulf of Mexico Loop Current and the Florida Current (Figure 4.6). The variability of these currents in conjunction with local meteorology and surface runoff affects the nature of the water and its transport into and within the sanctuary. Tides and wind-driven currents also affect the movement of water in and around the Florida Keys.

Periodic changes in the locations of the Loop and Florida currents result in the formation of circulation gyres that affect both the transport and entrainment of sanctuary waters and its resources. These gyres potentially contribute to the nutrient and larval transport between the Loop Current and the Florida Keys system and may also serve to retain coastal-derived larvae that would otherwise be carried away by the Florida Current (Cowen et al., 2006; Sale, 2006). The combined physical processes in the area tend to form a recirculating retention and recruitment pathway for larvae either spawned in the Florida Keys or transported there from remote areas of the Gulf of Mexico and Caribbean Sea (Lee & Williams, 1999). For species with larval stages ranging from days to several weeks, the variability in the conveyor belt circulation provides ample opportunity for recruitment (Lee & Williams, 1999).

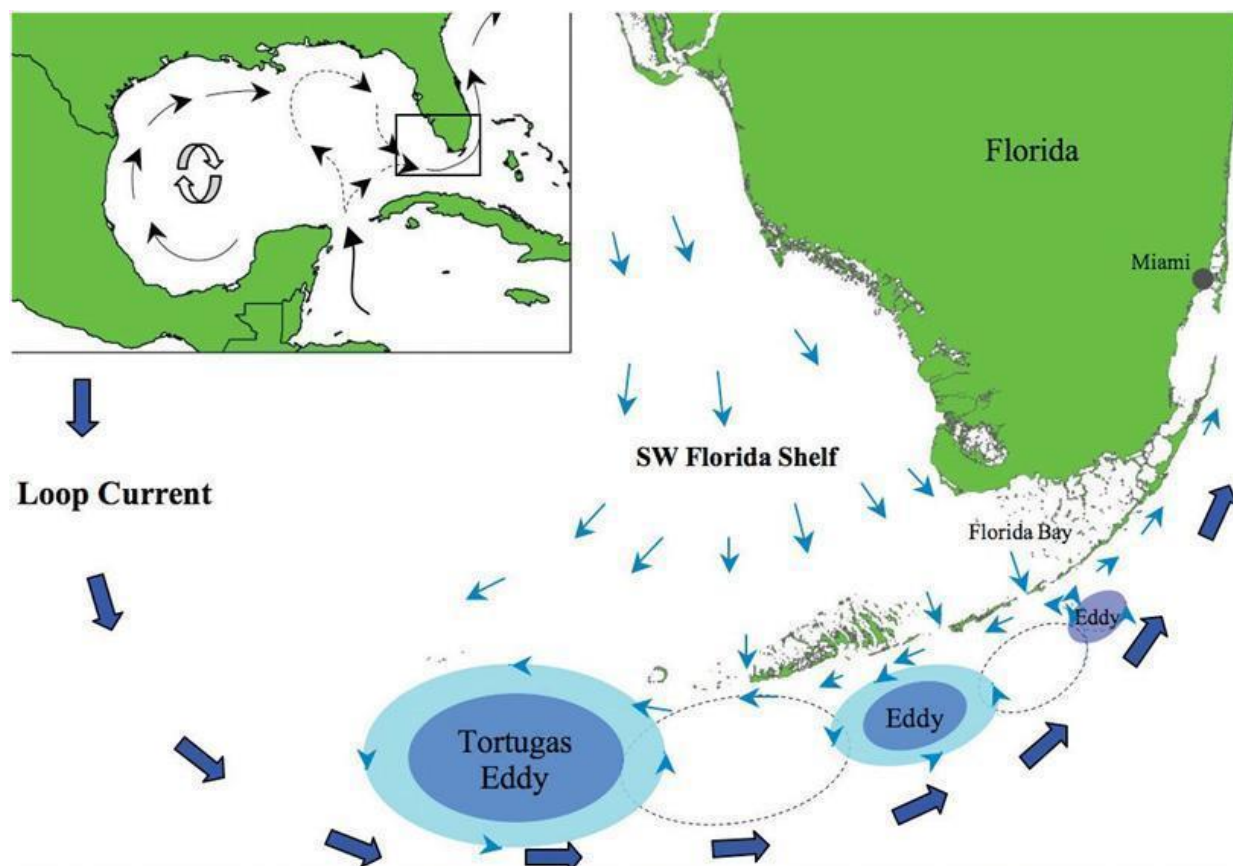


Figure 4.6. Regional currents affect Florida Keys waters and ecosystems. Image redrawn from Lee et. al., 2002

Ocean currents around South Florida drive important physical connectivity between the coral reefs of Pulley Ridge, the Dry Tortugas, the Florida Keys, and beyond. Pulley Ridge is dominated by the western edge of the Loop Current that brings relatively clear, warm, and nutrient-deficient water to the southern ridge. The proximity of Pulley Ridge to the Florida Keys, combined with the influence of the Loop Current, has led scientists to research whether Pulley Ridge serves as an upstream source of invertebrate and fish larvae for the Florida Keys and sanctuary. (See Section 4.4 for more information.)

Tides and wind-driven currents dominate the circulation and transport landward of the regional currents and within Florida Bay (Schomer & Drew, 1982). Additionally, eddies that form along boundary currents paralleling the shoreline can cause periodic upwelling of cold, nutrient-rich waters (e.g., Tortugas and Pourtales gyres) (NOAA, 1997; Szmant & Forrester, 1996; Leichter et al., 2003).

Nearshore waters of the Florida Keys, defined as extending from the shoreline to the seaward edge of Hawk Channel, generally experience high variability in temperature, salinity, and other factors relative to the reef tract further offshore. Differences in circulation and the physical and chemical characteristics of water in the Florida Keys reflect exchange processes between Florida Bay and the Atlantic Ocean, and are influenced by the larger regional currents, smaller-scale wind-driven currents, and tidal exchange between Florida Bay and the Atlantic.

4.3.3.2 Water quality

Ensuring good water quality in the sanctuary is essential to maintaining the richness and diversity of its varied environments. Coral reefs depend on clear, clean, low-nutrient waters to thrive. Seagrass meadows also need a relatively low-nutrient environment and clear water. As noted in the hydrology section above, FKNMS is part of a complex hydrological system that includes the Everglades, Florida Bay, Biscayne Bay, and other adjacent and remote areas. Monitoring within and outside the sanctuary boundary has demonstrated that some conditions observed within the sanctuary are strongly influenced by conditions occurring outside the sanctuary. The Florida Current delivers water to the Florida Keys from the wider Caribbean and the Gulf of Mexico. Water from the southwest Florida Shelf, including riverine waters originating from coastal and agricultural communities, may flow through tidal passes in the Keys or be transported to the Atlantic Ocean south of the Keys. Surface water runoff from the Everglades, tidal exchange from Florida Bay and Biscayne Bay, and atmospheric deposition are additional sources of nutrients and other pollutants to waters surrounding the Florida Keys. Land-based inputs also affect sanctuary water quality, especially near shore where toxins and nutrients can enter the system from stormwater runoff and other sources. Toxins are mainly hydrocarbons, pesticides, herbicides, and heavy metals. Nutrients are derived primarily from fertilizers and wastewater and include nitrogen and phosphorus.

Water quality is generally good in the Florida Keys. However, nearshore water quality is affected by wastewater and stormwater runoff. Since 1999, the county has been working to replace septic tanks, illegal cesspits, and ineffective small treatment units with advanced wastewater treatment systems. Onsite septic tanks and older systems do not effectively remove nitrogen and phosphorus from effluent, which leads to eutrophication of nearshore waters. Wastewater improvement efforts are ongoing, and the majority of the Keys are now connected to centralized systems with advanced wastewater treatment. Similarly, stormwater runoff contributes to nearshore water quality degradation by flushing fertilizers, pesticides, pet waste, and other contaminants into the water during rain events. Most of these pollutants are directly associated with coastal development. Although development has been limited by a Rate of Growth Ordinance (ROGO) system, Monroe County and the various municipalities are currently evaluating this system which could result in the approval of development of an estimated 8,000 vacant lots. Mangroves, where present, in the Florida Keys have an overall beneficial effect for nearshore water quality since they protect land from coastal development and the natural vegetation effectively traps nutrients and contaminants.

Petroleum (hydrocarbon) and other chemical discharges

Petroleum (oil, gasoline, and other hydrocarbons) and chemical spills in the sanctuary can potentially range from small, localized spills to large events that span hundreds of miles of coastline. Small-scale oils spill from refueling activities and derelict vessels degrade water quality on a regular basis. Small boat engine operations constitute the most common type of spill and usually involve small discharges of fuel, oil, or hydraulic fluid that form a sheen on the water's surface. Other small spills tend to be associated with oil and fuel discharges due to small vessel (<65 feet or 20 meters) groundings or sinkings and plane crashes. The effects of small spills have not been adequately documented. The USCG responds to reported oil spills in FKNMS.

Cruise ship discharges

In 2015, the Port of Key West received an average of one cruise ship per day (City of Key West, 2015). While cruise ship visitation provides positive economic benefit to local businesses (see Section 4.6.7 for more information), concerns exist about the environmental impacts of these large vessels. Cruise ships provide many of the same services as land-based facilities and are capable of carrying hundreds to thousands of passengers and crew members. Cruise ships have the potential to generate pollution through discharges such as bilge water (water that collects in the lowest part of the ship's hull that may contain oil, grease, and other contaminants), blackwater (sewage), greywater (waste from showers, sinks, laundries, and kitchens), ballast water (water taken onboard or discharged from a vessel to maintain its stability), wash water from scrubbers (water used in exhaust gas cleaning systems), and solid waste (food waste and garbage). Ocean currents can transport these pollutants into and among sanctuary waters. While recent technology such as engine exhaust gas scrubbers may help reduce air emissions from large vessels that use high-sulfur fuels, including cruise ships, this results in the pollution being discharged as waste water through the scrubbers' open loop system. While the wash water is treated before discharge, the discharge still contains metals, polycyclic aromatic hydrocarbons, and higher pH. The long-term accumulation of metals and hydrocarbons in estuaries or harbors is greater, and of more concern to scientists, than the long-term discharge of these contaminants in the open ocean (Teuchies et al., 2020). Cruise ships also have the potential to cause benthic disturbances with each porting. Wakes generated by vessels and propeller turbulence resuspend sediment, creating localized impacts approaching the port of Key West. While existing long-term water quality monitoring programs were not designed to measure the effect of cruise ships on water quality and marine habitats, a preliminary assessment of water quality changes during the COVID-19 "Anthropause" compared to the business-as-usual baseline detected decreased turbidity in surface waters south of Key West during the period of time when cruise ship operations were suspended. Lingering questions about potential cruise ship impacts instigated additional sampling in and around the Port of Key West (Florida International University, 2021). These studies are ongoing. Under current regulations, discharge of greywater is permitted (see Chapter 3 for more discussion).

Water Quality Protection Program

The importance of water quality was recognized in the 1990 authorizing legislative language for FKNMS, which mandated creation of a WQPP to be administered by the Florida DEP and EPA in consultation with NOAA. The purpose of the WQPP is to identify and implement priority corrective actions to address point and nonpoint sources of pollution in order to maintain the chemical, physical, and biological integrity of the sanctuary. The program is also charged with restoring and maintaining balanced indigenous populations of corals, shellfish, fish, and wildlife, and recreational activities in and on the water (FKNMSPA, EPA, 2013) (for more information on the WQPP, see the institutional environment [supporting material](#)).

The WQPP supports long-term monitoring programs of water quality, coral reefs, and seagrass/benthic communities and selected special studies to address a variety of related topics. Research and monitoring projects are designed to quantify status and trends, answer resource management questions, and develop new scientific hypotheses for the sanctuary.

Since 1995, the Water Quality Monitoring Project of the WQPP has conducted quarterly monitoring at more than 100 fixed stations throughout the sanctuary. A variety of physical and chemical parameters are sampled, including salinity, water temperature, total phosphorus (TP), total nitrogen (TN), dissolved oxygen (DO), dissolved inorganic nitrogen (DIN), and total organic carbon (TOC). These data help document patterns and trajectories in the sanctuary's water quality and help inform likely drivers of large-scale changes. For example, recent monitoring data has detected significant increases in total phosphorus in the Upper and Lower Keys, primarily close to shore, which is indicative of terrestrial sources originating from the Keys themselves.

Since sanctuary designation, more specific regulatory action was taken to address localized water quality issues through establishing a no discharge zone throughout the sanctuary (within Florida state waters in 2002 and in federal waters in 2010).

Regional conditions outside FKNMS also strongly influence sanctuary waters in this highly interconnected system of coastal and estuarine waters. Under certain conditions, external sources adjacent to the sanctuary (such as influences of Florida and Biscayne bays, the Loop and Florida Currents, riverine waters and other land-based activities, and atmospheric inputs) can influence or even dominate water quality conditions. Water quality monitoring shows that the highest chlorophyll-a values, indicative of phytoplankton blooms, are found in southwest shelf waters outside FKNMS. Rivers on Florida's southwest coast carry nutrients from agriculture and other human activities in central and southwest Florida to the southwest shelf and Gulf of Mexico where they can fuel these phytoplankton blooms. Currents can bring "bloomy" shelf waters into Florida Bay and the Lower Keys backcountry where they can flow into sanctuary waters on the ocean side of the Florida Keys. Nutrient sources within Florida Bay such as decaying seagrass and resuspended organic matter may exacerbate or trigger cyanobacterial blooms in the bay itself that can also flow into FKNMS. Widespread cyanobacterial blooms observed in central and northern Florida Bay in the early 1990s were fueled by an extensive seagrass die-off that began in the late 1980s. These blooms were known to flow into sanctuary waters through the channels between the Florida Keys before being dispersed. Similar blooms have occurred since that time and a widespread die-off of *Thalassia testudinum* was documented in 2015 in Florida Bay (Hall et al., 2016).

For more information about water quality status, impacts, and efforts to assess and address these impacts, see:

- [Water Quality Protection Program](#) (NOAA, EPA, Florida DEP)
- [South Florida Ecosystem Restoration Task Force](#) (EvergladesRestoration.gov)
- [Florida Keys Reasonable Assurance Plan](#) (Florida DEP)

4.4 Pulley Ridge Unit

Part of the boundary expansion of Alternative 4 would include a distinct area in the southern portion of Pulley Ridge. The affected biological and physical environments of this area will be discussed together in this section.

Pulley Ridge is a limestone ridge that extends nearly 186 miles (300 km) along the southwestern Florida shelf in the eastern Gulf of Mexico. The southern terminus of Pulley Ridge supports a mesophotic coral ecosystem, which is the deepest known photosynthetic coral reef off the continental United States. The biodiversity consists of 95 species of macroalgae, 92 demosponges, 18 octocorals, 17 scleractinian corals, nine antipatharian corals, and 86 fishes. Twenty managed fishery species occur at Pulley Ridge, including red grouper, and since 2010 the lionfish population has dramatically increased. The dominant scleractinian corals are plate-like corals of the family Agariciidae (*Agaricia* spp. and *Helioseris cucullata*), *Montastraea cavernosa*, *Madracis* spp., and *Oculina diffusa*. The percent cover of benthic biota averaged 49.9% over all regions of Pulley Ridge, and macroalgae were dominant (46.5% cover). Scleractinian corals averaged 1.5% cover, and sponges had 1.2% cover.

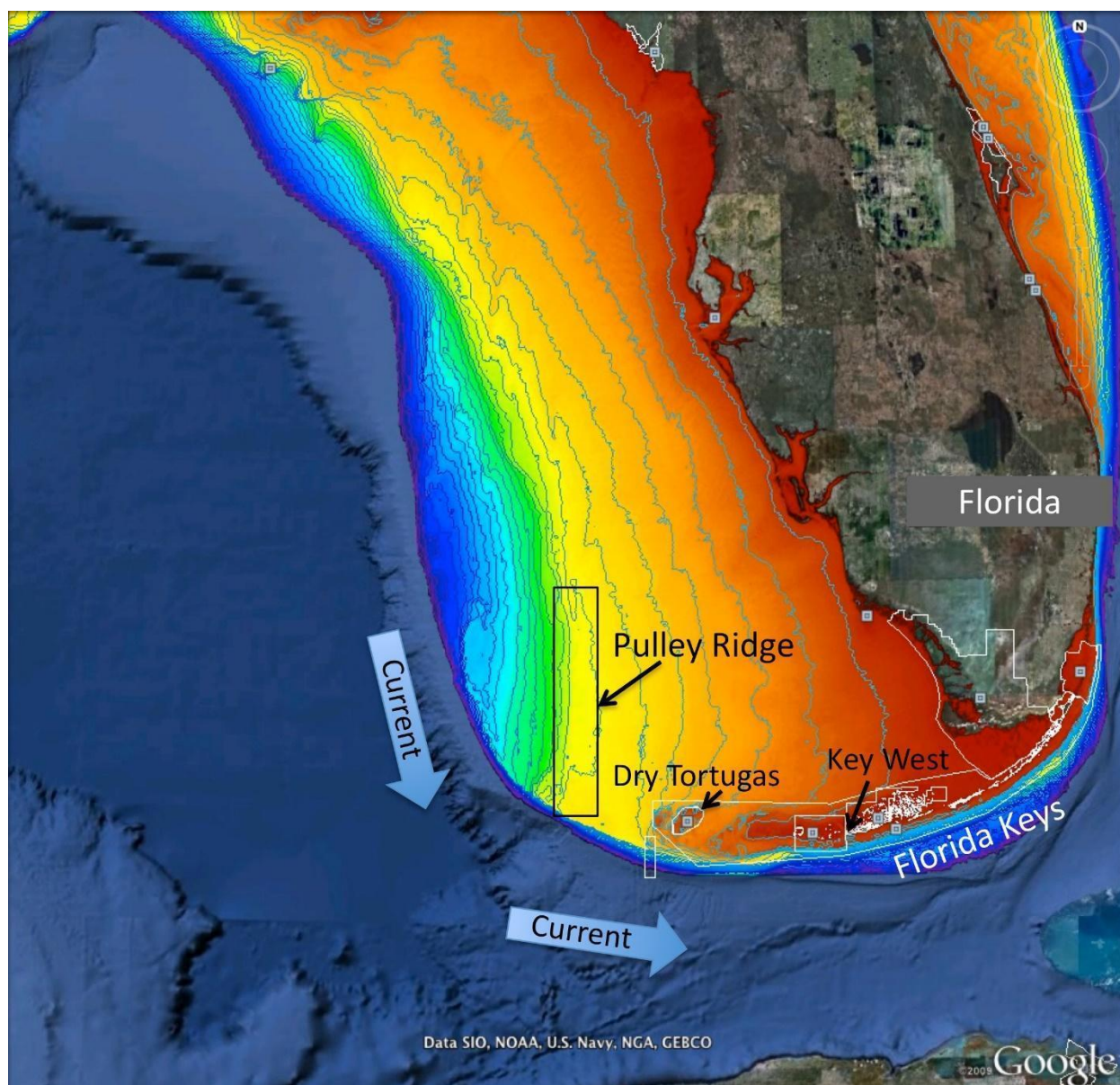


Figure 4.7. Pulley Ridge area in relation to South Florida and FKNMS including depth ranges shown from the shallowest in red to deepest in blue. Image courtesy of Robert Cowen

4.4.1 Mesophotic Reef Habitats

Mesophotic coral ecosystems are characterized by the presence of light-dependent corals and associated communities typically found at depths ranging from 98 to 131 feet (30–40 m) and extending to over 328 feet (100 m) in the Gulf of Mexico. Once established, mesophotic reefs help create hardbottom habitats that become home to a diverse community of plants and animals, many of which are unique to these communities. The dominant communities providing structural habitat in the mesophotic zone can comprise coral, sponge, and algal species.

The southern portion of Pulley Ridge, at depths of 197 to 262 feet (60–80 m), supports the deepest known photosynthetic coral reef off the continental U.S. (Figure 4.7; Cross et al., 2005; Reed et al., 2015). In Pulley Ridge, these mesophotic corals live between 197 and 246 feet (60–75 m) in depth and are dominated by coralline algae and scleractinian corals. The dominant colonial scleractinian corals are the plate-like colonies of the family Agariciidae (*Agaricia* spp. and *Helioseris cucullata*), *Montastraea cavernosa*, several species of *Madracis*, and *Oculina diffusa*. At these depths *M. cavernosa* also forms plate-like colonies, whereas in shallower water, they are commonly conical to mound shaped (Baker et al., 2016).

There are spatial differences within Pulley Ridge in the distribution of these taxa. The depth range for the agariciid corals is from 193 to 344 feet (59–105 m). The distribution of *M. cavernosa* ranges from 203 to 223 feet (62–68 m). Coral cover is greatest in the central basin, which is included in the current HAPC (Reed, 2016; GMFMC, 2018). Except for a few sporadic occurrences, *M. cavernosa* is only found on the Main Ridge. The agariciid plate corals are present in every region of Pulley Ridge but are most dominant on the main ridge and central basin. *Madracis brueggemanni* and *Madracis formosa* are the most abundant corals on the west ridge but are also common on the central basin and main ridge (Reed et al., 2019).

Seismic maps indicate that drowned shoreline ridge complexes and pinnacles extend west of Pulley Ridge to depths of 328 to 492 feet (100–150 m), suggesting the potential for other mesophotic coral habitat in the region (Ballard & Uchupi, 1970; Holmes, 1981; Phillips et al., 1990). Recent research missions have documented an additional 124 square miles (321 km²) of mesophotic coral habitat adjacent to the portion of Pulley Ridge included in the HAPC (Reed et al., 2015).

In the past 10 years, the Pulley Ridge mesophotic coral ecosystem has experienced a substantial loss of scleractinian coral. The percent coral cover on the main ridge dropped from 12.8% in 2003 to 0.9% by 2012–2015, a 93% loss of coral. However, recent surveys show the majority of corals to be relatively healthy; only 1.21% of the colonies counted (38,368) showed signs consistent with “white syndromes” disease. The prevalence of disease on Pulley Ridge is relatively low compared to the Caribbean. The factors causing the decline of the coral communities at Pulley Ridge between 2003 and 2012 are unknown (Reed et al., 2019).

4.4.1.1 Sponge habitat and diversity

Within Pulley Ridge, hardbottom communities include a diverse assemblage of organisms and substrate. Recent surveys of Pulley Ridge have documented a high level of sponge biodiversity (relative to corals and other benthic invertebrates). Sponges are the most species-rich of all macrofauna, with 92 taxa identified to date (Reed et al., 2019). The most common taxa include

Agelas clathrodes, *A. conifera*, *A. flabelliformis*, *Aiolochoiria crassa*, *Amphimedon compressa*, *Aplysina lacunosa*, *Aplysina archeri*, *Auletta* sp., *Axinella corrugata*, *Callyspongia vaginalis*, *Erylus* sp., *Geodia gibberosa*, *G. neptuni*, *Ircinia campana*, *I. felix*, *I. strobilina*, *Niphates erecta*, *Oceanapia* sp., *Placospongia* sp., *Polymastia* sp., *Scopalina ruetzleri*, *Siphonodictyon coralliphagum*, *Spongisorites siliquaria*, *Verongula rigida*, *Xestospongia muta*, and numerous unidentified demosponges (Reed et al., 2017). Sponges are relatively common across Pulley Ridge but are most abundant on the west ridge.

4.4.1.2 Macroalgae habitats

Pulley Ridge includes a wide variety of fleshy macroalgae including *Halimeda tuna*, *Dictyota* sp., *Kallymenia* sp., and the endemic species *Anadyomene menziesii*, which covers many acres and can be as dense as tens of individuals per 10.7 square feet. Although taxonomic analyses are still in progress, a total of 60 species of Rhodophyta, 25 Chlorophyta, and 10 Phaeophyta have been identified. The most common red algae are crustose corallines, which are predominant in the central basin and west ridge (i.e., the deeper regions of Pulley Ridge). Other common red algae are foliose species of *Halymenia* and *Kallymenia* and crustose species of *Peyssonnelia*. In contrast, green algae are predominant on the main ridge, which is the shallowest region. The leafy green alga *Anadyomene menziesii*, which is endemic to Pulley Ridge, is the most common species. The 55.8-foot (17 m) depth differential, from 193.6 feet (59 m) on top of the main ridge to 249.3 feet (76 m) on top of the west ridge, results in the observed spatial changes of the dominant species from green algae to red algae due to reduced light availability. Other common green algae include *Codium* spp., *Caulerpa racemosa*, *Caulerpa sertularioides*, *Halimeda* spp., *Valonia ventricosa*, and *Verdigellas peltata*. The brown algae are less common and dominated by *Dictyota* spp., *Lobophora variegata*, *Sargassum* sp., and *Padina* sp. (Reed et al., 2019).

4.4.2 Fishes

Fish species present at Pulley Ridge represent a mix of both shallow and deep-water species. A total of 86 fish taxa have been documented at Pulley Ridge (Harter et al., 2017; Reed et al., 2017). The most abundant fishes are school bass (*Schultzea beta*), striped grunt (*Haemulon striatum*), yellowtail reef fish (*Chromis enchrysurus*), purple reef fish (*Chromis scotti*), chalk bass (*Serranus tortugarum*), reef butterflyfish (*Chaetodon sedentarius*), roughtongue bass (*Pronotoqrammus martinicensis*), cherubfish (*Centropyge argi*), cardinalfish (*Apogon* sp.), sunshinefish (*Chromis insolata*), and an unidentified *Chromis* sp. Several schooling species are abundant at night. These include schools of vermilion snapper (*Rhomboplites aurorubens*) and mackerel scad (*Decapterus macarellus*), as well as mixed schools of bonnetmouths (Inermiidae) and school bass (*Schultzea beta*). A total of 20 managed fishery species occur at Pulley Ridge. The most abundant are almaco jack (*Seriola rivoliana*), vermilion snapper (*Rhomboplites aurorubens*), and red grouper. Fish diversity was significantly higher on the main ridge compared to all other Pulley Ridge regions (Reed et al., 2019).

A significant feature in Pulley Ridge, particularly in the eastern portion, is a series of large 19 to 33 foot (6–10 m) wide pits in the sand and rubble bottom created by red grouper that provide shelter for numerous smaller reef fish. Red grouper burrow pits ranging from 16 feet to more than 49 feet (5–>15 m) in diameter and three to six feet (1–2 m) deep are visible in multibeam maps that indicate there are nearly 155,000 burrows over the entire southern region of Pulley

Ridge within the area surveyed (360 mi²/580 km²). Most active burrows have one adult male or female grouper of 1.6 feet (50 cm) or more total length. The burrows provide habitat and act as oases for many small reef fish. Most of the burrow pits surveyed in 2013 and 2014 also show a high prevalence of lionfish, ranging from several up to 60 lionfish per burrow (Reed et al., 2014). Additionally, in the central basin, mounds potentially created by sand tilefish (*Malacanthus plumieri*) are evident.

The Pulley Ridge South HAPC regulations, per Amendment 9 to the Gulf of Mexico Coral Fishery Management Plan (GMFMC, 2018), extend most of the Pulley Ridge South fishing regulations to Pulley Ridge South Portion A (Figure 4.8), but do not include a restriction on bottom longlining in Pulley Ridge South Portion A. This extension allows a fishery that has historically used this area to continue to do so, but also include regulations to prevent use of other types of bottom-tending gear including bottom trawling, buoy gear, pots, or traps, and prohibit anchoring by fishing vessels. The Pulley Ridge South and South A HAPCs are areas with confirmed coral reef features and there will not be any impacts to fishing for Gulf reef fish species such as grouper, which are found over sand and mud bottoms.

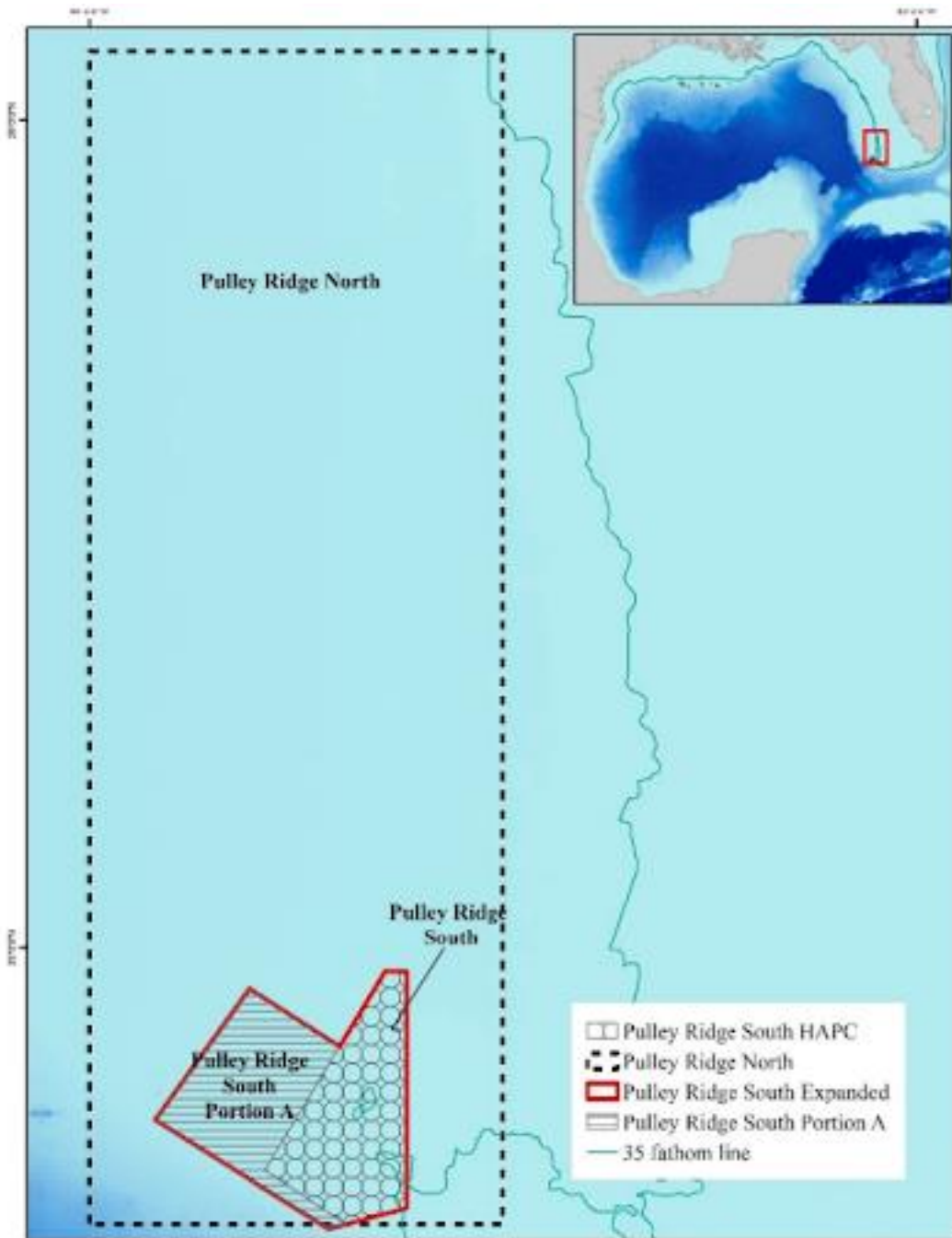


Figure 4.8. Pulley Ridge North (unregulated), Pulley Ridge South HAPC (2005) with Pulley Ridge South Portion A (2020) (fishing restricted). Image: GMFMC

4.5 Historical and Cultural Resources

Historical resources are defined by ONMS regulations as “any resource possessing historical, cultural, archaeological or paleontological significance, including a site, contextual information, structure, district, and object significantly associated with or representative of earlier people, culture, maritime heritage, and human activities and events” (15 C.F.R. § 922.11). Historical resources are not only “historic,” or those pertaining to the most recent period of Florida history

beginning with European exploration, but extend many thousands of years into the past to encompass Native American presence in the area. The ONMS regulations also state, “Historical resource includes ‘cultural resource,’ ‘submerged cultural resource,’ and also include ‘historical property,’ as defined in the National Historic Preservation Act, as amended, and its implementing regulations, as amended” (15 C.F.R. § 922.11). ONMS regulations define the term cultural resource to mean any historical or cultural feature, including archaeological sites, historic structures, shipwrecks, and artifacts. Historical resources will be used henceforth in this document as the inclusive term.

The study area includes the existing sanctuary and proposed expansion areas encompassing a diverse assemblage of historical resources that reflect humanity’s interactions with the marine environment.

4.5.1 Historical Resources Inventory

The sanctuary’s historical resources are unique, non-renewable physical remains of the area’s maritime past and include hundreds of shipwrecks, archaeological sites, isolated artifacts, and historic-period offshore and nearshore structures. Iconic examples of Florida Keys history include sunken fleets of Spanish colonial vessels and U.S. and foreign warships that gave their names to the coral reefs upon which they wrecked. These same reefs hold sunken commercial vessels built in faraway shipyards for global enterprises as well as vessels built locally that supported the lives of Keys residents. Not all of the sanctuary’s historical resources are beneath the waves. The offshore reef lighthouses are readily seen along the reef line and boaters encounter abandoned historic vessels and docks in shallow water. All who drive U.S. Highway 1 experience the engineering marvels of the Overseas Railroad bridges that highlight the sanctuary’s more recent transportation modalities. Archaeological sites arising from Indigenous peoples’ activities in the Florida Keys are believed to occur in the sanctuary but have not yet been located.

Archaeological evidence from elsewhere in Florida suggests that Indigenous peoples inhabited the Florida Keys for millennia. Their lives were likely spent along the littoral margins of a vast coastal plain exposed by lowered sea levels as much as 12,000 years before present (B.P.) (TRC Environmental Corp., 2012). The surrounding shallow marine environment was a rich source of fish, shellfish, turtles, and marine mammals. Rising sea levels over thousands of years slowly decreased the dry land until the ocean divided the Keys into the archipelago of today approximately 4,000 years B.P. This inundative process likely heightened Indigenous people’s maritime adaptation and resulted in greater reliance on watercraft for travel and to access seasonal marine resources. Although the area was freshwater limited, a permanent, native population likely lived in the Keys year-round. (Schneider et al., 2021). Large archaeological sites on Upper Matecumbe Key and Stock Island attest to centuries of inhabitation beginning 2,000 years B.P. (Goggin, 1944).

Indigenous communities encountered Europeans as colonial efforts brought increasing numbers of ships into the area. Shipwrecks led to contact between Indigenous peoples and European survivors (Fonteneda, 1575). Expanded contact with the Keys Indigenous residents by Spanish fishers and salvors introduced European diseases. Combined with hostile interactions with European weapons, this contact greatly diminished indigenous populations in the Florida Keys.

Some survivors sought refuge in the Everglades while others moved to Spanish mission settlements (Goggin, 1950). Within the Everglades, communities of indigenous peoples joined together leading to the Seminole Tribe of Florida and Miccosukee Tribe of Indians of Florida of today. These vibrant cultures steward the Everglades freshwater flow that is a critical component of seagrass and coral reef health.

The Florida Keys' geographical position adjacent to some of the busiest trade routes in the Western Hemisphere along with hazardous shoals and rapidly changing weather has resulted in Keys shipwrecks exemplifying the last 500 years of the Atlantic region's maritime activity. An estimated 2,000 shipwrecks are thought to have occurred in the Florida Keys since European exploration and conquest of the Americas. Archival research has identified more than 1,000 reported shipwrecks to date. The response to shipwrecks is a defining theme in Florida Keys maritime history. Both the 1622 and 1733 Spanish Fleet disasters brought large numbers of Europeans to the Florida Keys to pursue the lost vessels. Following the acquisition of Florida by the U.S., shipwreck salvage remained an important driver of economic activity through the nineteenth century. Key West, as the largest population center in Florida south of St. Augustine, became a wealthy trading port for shipwrecked cargo, sponges, and cigars, attracting a diverse population from American, European, and Caribbean communities.

In testament to the scope of maritime traffic that met calamity in the Florida Keys, the FKNMS historical resource inventory contains information for more than 700 sites and objects including paleoenvironmental deposits, isolated cannons, anchors, shipwrecks, and historical aids to navigation. Currently, 14 shipwrecks and five lighthouses within the sanctuary are listed in the National Register of Historic Places.

Historical resources in the study area are described in several publications and additional information is available from a variety of sources. NOAA staff, contractors, and partners gathered this information for existing and future management efforts, to monitor conservation objectives, and as part of ongoing resource assessment, research, and education efforts. For a more detailed discussion on historical resources within the sanctuary, please refer to the following documents: "Description of the Affected Environment," of the Florida Keys National Marine Sanctuary Environmental Impact Statement (NOAA, 1997), Sanctuary Condition Report (NOAA, 2011), NOAA Technical Memorandum NA87AA-H-CZ007, and An Inventory of Shipwrecks, Groundings, and Cultural Marine Resources within the Florida Keys National Marine Sanctuary (Halas, 1988). See Appendix I for a list of located historical resources and reported shipwrecks believed to have occurred in the sanctuary and the areas included in potential boundary expansion alternatives.

4.5.2 Historical Resources Management

NOAA is a trustee for historical resources located within the sanctuary boundary. For historical resources located in state waters of the sanctuary, NOAA and the state of Florida serve as co-trustees. Current FKNMS regulations and the former Programmatic Agreement for the Management of Submerged Cultural Resources in the Florida Keys National Marine Sanctuary among NOAA, the ACHP, and the state of Florida have guided management decisions related to historical resources in the sanctuary. This programmatic agreement expired March 24, 2016; however, NOAA continued to approach historical resource management in the same manner as

was done under the programmatic agreement and is in the process of finalizing an updated agreement with the ACHP and the state of Florida.

Pursuant to Section 106 of the NHPA, NOAA consults on all proposed undertakings with the potential to affect historical resources in the sanctuary with the SHPO and interested federally-recognized Tribes. When appropriate, the ACHP is also provided an opportunity to comment on sanctuary undertakings. Because these resources are non-renewable, decisions are made with a precautionary approach aiming to achieve a balance between resource protection and public use.

DHR is the primary agency with authority and responsibility for historical resources throughout Florida as set forth in Chapter 267 of the Florida Statutes under Title XVIII. DHR serves as a steward of these resources, engaging in regulatory activities, inventory, assessment, research, education, public interpretation, and grant assistance for historic preservation projects. DHR also maintains the Florida Master Site File (FMSF), which is the official inventory of historical resources throughout the state. The FMSF currently holds information on more than 200,000 historical resources, of which approximately 100 are within sanctuary waters. Under authority of the Federal Abandoned Shipwreck Act (Pub. Law 100-298: 43 U.S.C. §§ 2101-2106), the state of Florida holds title to abandoned shipwrecks on state-owned submerged lands.

The Florida DHR issues permits for archaeological research on state lands pursuant to Florida Administrative Code Chapter 1A-32. Chapter 1A-32 sets forth the standards for individuals and institutions that may be issued an archaeological research permit and the criteria for evaluating research requests. The DHR also administers Chapter 1A-31 of Florida's Administrative Code directed at exploration and salvage of historic shipwreck sites. Chapter 1A-31 expressly prohibits the DHR from issuing permits for exploration and salvage of historic shipwrecks sites in FKNMS pursuant to the policies set forth in that chapter.

NOAA's primary role is to document, interpret, and protect historical resources for current and future generations. This is done through resource inventory, public education, and enforcement activities. NOAA fosters non-consumptive recreational enjoyment and access to historical resources through programs such as the FKNMS Shipwreck Trail (NOAA, 2011). Organizations and individuals may conduct research and educational activities directed at historical resources through a regulatory permitting program. Under its current structure, FKNMS historical resource permitting program provides three categories of permits: survey/inventory of historical resources, research/recovery of historical resources, and deaccession/transfer of historical resources. NOAA consults with the state of Florida via the DHR under Section 106 of the NHPA prior to taking any permit action related to historical resources in the sanctuary. Since implementation of the initial 1996 FKNMS management plan, 61 unique historical resource projects have been granted a survey/inventory or research/recovery of historical resources permit. No deaccession/transfer permits have been applied for or issued.

In the 1996 FKNMS final management plan and final EIS (Vol. 2, pg. 99), NOAA recognized that Federal Admiralty Court rights of access to specific historic shipwrecks had been granted to certain organizations and individuals prior to congressional designation of the sanctuary. NOAA continues to recognize such rights of access for those organizations and individuals that have continued to maintain the underlying admiralty rights. However, in accordance with section

304(c) of the NMSA and ONMS regulations at 15 C.F.R. § 922.47, these rights of access are subject to sanctuary regulation, and must be carried out in a manner consistent with other applicable laws such as the Abandoned Shipwreck Act, Abandoned Shipwreck Act guidelines, NHPA, NMSA, and FKNMSPA.

While no Indigenous archaeological sites have yet been located in sanctuary waters, disturbance of the seafloor and underlying sediment layers have the potential to destroy archeological remains from Indigenous cultures. To prevent this, NOAA seeks to minimize seafloor impacts resulting from its undertakings and consults with federally recognized Tribes that have indicated that the sanctuary is an area of interest including the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida. Additionally, NOAA is seeking additional ways to engage with Indigenous peoples beyond required government-to-government consultation to reveal the stories of the Keys first inhabitants and the connectivity between the reefs and the Everglades.

4.6 Socioeconomic Resources and Human Uses

This section is updated from the 2019 draft EIS and includes excerpts from the 2022 Schwarzmanna et al., document: [*Florida Keys National Marine Sanctuary Restoration Blueprint: Updated socioeconomic supporting documentation for the 2019 draft environmental impact statement and 2022 proposed rule*](#). That 2022 document updates the 2019 analysis with more recent socioeconomic data and information on activities and incorporates new methods into the quantitative analysis of the economic effects of proposed marine zone boundary changes. The 2022 document includes updated analysis of the 2019 draft EIS alternative and the 2022 NOPR Alternative. The decision to conduct this updated analysis is in direct response to public comment received on the draft EIS.

ONMS has developed sanctuary community profiles (SCPs) to describe the socioeconomics of the environment affected by national marine sanctuary regulations. SCPs are designed to provide social, economic, and cultural information on sanctuaries and provide an analytical baseline for local communities and economies' dependence on and relationships to sanctuary resources. SCPs also contain information on how sanctuary resources and programs support and add value to local communities.

SCPs include a county or collection of counties where the majority of economic contributions (e.g., output, income, and employment) and social effects associated with use of sanctuary resources take place. Information in SCPs includes population, population density, demographics, poverty rate, unemployment rate, income, and employment-related variables. All of these measurements are available from existing sources that can be easily updated. These data are then supplemented by studies on the socioeconomics of different uses and users. Additional supporting information will be made available in the FKNMS SCP (Samonte et al., 2022).

4.6.1 Study Area

Defining the geographic scope (i.e., collection of counties that define the study area) for socioeconomic studies of national marine sanctuaries is an evolving process. An initial assessment is done based on past studies of sanctuary resource use and local social and

economic (socioeconomic) effects. In the case of FKNMS, a great deal of research has been done on the various uses of sanctuary resources since 1995–1996. The primary area where socioeconomic impacts related to use of sanctuary resources occur is Monroe County, Florida. Monroe County includes the Florida Keys and Everglades National Park. Therefore, for purposes of this profile, Monroe County and the Florida Keys are synonymous.

The study area, also referred to as the local sanctuary community, is identified by considering county locations relative to the sanctuary and commuter workflows. The study area is identified by first considering the county (or counties) that are adjacent to the sanctuary's boundaries. For FKNMS, this is Monroe County, which is considered a primary county. FKNMS is also adjacent to the southern portion of Miami-Dade County; however, this county was not included because the southern portion of Miami-Dade County includes only undeveloped, protected natural areas. The second step is to consider commuter workflows using data from the American Community Survey. The American Community Survey is an ongoing effort that provides information about the American people. More specifically, the American Community Survey collects information on U.S. residents that travel across county and state lines to work and reports the number of workers that commute into or out of a county and which counties those commuters travel to and from (U.S. Census Bureau, 2013).

The third step is to ensure that counties with a sizable number of residents who commute to primary counties are also included in the study area (as secondary counties). The final determination is based upon the percent and nominal number of commuters in consultation with site staff with place-based knowledge. Commuters may be dependent upon the sanctuary and its resources, whether they are scientists, hospitality workers, recreational providers, or doctors providing services to workers who live in the primary county, or visitors who vacation in the primary county to enjoy the resources and activities offered by the sanctuary (both on and off shore). The reverse relationship is also considered to account for those who choose to live in a primary county and benefit from sanctuary resources and amenities offered by other businesses that utilize the sanctuary and/or its resources, goods, and services, but work elsewhere. Further, those who live in a primary county but commute to other counties are most likely spending much of their income within the primary county.

Net commuter flow was calculated for various counties in the FKNMS region. For the purposes of this assessment, net commuter flow is the number of people that commute from a county of interest to the primary county to work plus the number of primary county residents who work in the county of interest. If this number is greater than 10% of the total labor force of the county of interest, that county is included in the study area as a secondary county. There were no counties with a net commuter flow to or from Monroe County that met these criteria; thus, no secondary counties were identified for FKNMS.

This chapter details the socioeconomics of the study area (Monroe County), provides information on the industries and types of businesses that may be affected by regulatory changes to FKNMS, and considers the existing level of activity for commercial and recreational fishing and non-consumptive recreation.

4.6.2 Sociodemographics

4.6.2.1 Population

According to data from the U.S. Census Bureau, in 2019, the population in the study area was 74,228 while the population in Florida and the U.S. was 21,477,737 and 328,839,523, respectively. As described by Smart Preservation (2022), Monroe County has implemented measures to restrict population growth and development since 1985. Because of its geographic location and susceptibility to flooding, Monroe County restricts permanent population and population growth to ensure that evacuation is possible if necessary. Development restrictions are enforced to restrict population growth and to protect nearby ecosystems.

In 2019, Monroe County was 0.4% of Florida's total population. From 2010 to 2019, the study area's population grew 1.4%. This is slower than population growth in Florida and the U.S. for the same time period (Table 4.1). In 2019, population density for the study area (73.6 people per square mile) was also lower than population density of Florida and the U.S. (Table 4.1). For comparison, Miami-Dade County had a population density of 1,117.6 in 2019.

Table 4.1. Population metrics for the study area, the state of Florida, and the U.S., 2010–2019. Source: U.S. Census Bureau, 2021a

Location	Total Population (2010)	Total Population (2019)	Population Growth (2010–2019)	Population Density (2019)
Florida	18,511,620	21,477,737	14.0%	326.6
Monroe County	73,065	74,228	1.4%	73.6
U.S.	303,965,272	328,239,523	8.0%	92.9

4.6.2.2 Race

In 2019, the proportion of the study area population that identified as White was higher than that of any other racial category. The overall percentage of respondents in Monroe County who identified as White decreased slightly from 2010 to 2019, while the proportion of respondents who identified as Black, Asian, and two or more racial profiles increased slightly during this time. The portion of the population that identified as Alaskan Native or Native American, Native Hawaiian or other Pacific Islander, or selected “other” as a response did not have clear trends. In 2019, the study area and the U.S. had different distributions of races. The study area shared similar proportions of races to Florida (Table 4.2).

Table 4.2. Distribution of race in the study area, 2010–2019. (U.S. Census Bureau, 2021)

Year	White	Black	Alaskan Native or Native American	Asian	Native Hawaiian or Other Pacific Islander	Other	Two or More Racial Profiles
2010	90.1%	7.5%	0.2%	1.3%	0.1%	0.1%	0.8%
2011	89.8%	7.8%	0.2%	1.3%	0.0%	0.1%	0.9%
2012	89.6%	7.7%	0.2%	1.3%	0.0%	0.1%	1.1%
2013	89.1%	7.9%	0.2%	1.4%	0.0%	0.1%	1.3%

Year	White	Black	Alaskan Native or Native American	Asian	Native Hawaiian or Other Pacific Islander	Other	Two or More Racial Profiles
2014	88.8%	7.7%	0.5%	1.3%	0.0%	0.1%	1.6%
2015	88.5%	7.8%	0.6%	1.3%	0.0%	0.1%	1.7%
2016	88.2%	8.5%	0.3%	1.5%	0.0%	0.1%	1.5%
2017	87.9%	8.8%	0.2%	1.6%	0.0%	0.1%	1.4%
2018	87.8%	8.6%	0.2%	1.7%	0.2%	0.2%	1.4%
2019	87.6%	8.9%	0.1%	1.7%	0.2%	0.2%	1.4%

4.6.2.3 Ethnicity

In the study area, the proportion of the population that identified as having Hispanic, Latino, or Spanish origin increased from 2010–2019. Monroe County’s distribution of ethnicity reflected the distribution in Florida. The proportion of the population that identified as Hispanic in 2019 was higher in both the study area (24.3%) and in Florida (25.6%) than the U.S. in 2018 (18.0%).

4.6.2.4 Income and Unemployment

This section describes sources of income and the status of the labor force in the study area. The labor force, total employment, and their respective growth rates are indicators of the health of the local economy and opportunities for employment. NOAA also analyzed economic measures related to proprietors (small business owners), including proprietors’ income and employment, and the proportion of the study area’s employment accounted for by proprietors. This can be an indicator of the importance of small businesses in their communities, which are often connected to resource use in national marine sanctuaries (e.g., recreation and tourism-related businesses, such as dive shops or recreational fishing charters).

Per capita income is the average income earned per person in a given area. It indicates the health and economic status of a community. In 2019, per capita income for Monroe County was \$101,261. This figure is higher than 2019 per capita income in the state of Florida (\$52,426) and the U.S. (\$56,490). From 2010–2015, real per capita income (adjusted for inflation using the consumer price index[1]) for Monroe County grew slower than that of the state of Florida (2.0% and 16.8%, respectively). However, per capita income in Monroe County grew faster than that of the state of Florida from 2015–2019 (18.4% and -0.5%, respectively; Table 4.3).

The unemployment rate is another indicator of economic health. In 2019, the unemployment rate in Monroe County was 3.3%. For the same year, Florida had an unemployment rate of 2.1%. Unemployment rates in the study area and Florida were lower than the U.S. rate of 3.7% in 2019.

Table 4.3. Selected socioeconomic measures for Monroe County, the state of Florida, and the U.S. (\$2019). (U.S. Census Bureau, 2021)

Location	Per Capita Income (2010)	Per Capita Income (2019)	Real Per Capita Income Growth Rate (2010–2015)	Real Per Capita Income Growth Rate (2015–2019)	Unemployment Rate (2010)	Unemployment Rate (2019)	Poverty Rate (2019)
Florida	\$45,110	\$52,426	16.8%	-0.5%	7.5%	2.1%	12.7%
Monroe County	\$83,814	\$101,262	2.0%	18.4%	10.8%	3.3%	8.7%
U.S.	\$47,539	\$56,490	11.2%	6.8%	9.6%	3.7%	10.5%

Further, in 2019, income by place of work as a percent of income by place of residence for the study area was 28.8% (income from work in the study area divided by total income in the study area). This means that the majority (nearly three quarters) of the income in the study area was earned outside the study area. This figure was less than that of the state of Florida (37.4%) in 2019; however, this value indicates that most of the income in Florida did not come from working in Florida in that year (income also includes government and business transfer payments).

Proprietors' (business owners) income and employment were examined as an indicator of the presence of small businesses and related resource use in the study area. The contribution of proprietors' income and employment to the study area was also analyzed. Typically, larger values for proprietors' income and employment indicate a larger number of small businesses in the area. The larger the contribution of proprietors to the study area's total income and employment, the more dependent the economy is on small businesses.

In 2019, there were 20,387 proprietors in the study area, representing nearly 45% of total employment in Monroe County. Proprietors accounted for a larger percentage of total employment in the study area than in Florida (35.2%), indicating that the economy in the study area may be especially dependent on small businesses. In 2019, proprietors' income was \$409.8 million in Monroe County and \$69.0 billion in Florida.

4.6.2.5 Environmental Justice

The concept of environmental justice has expanded over the years with additional regulations and greater inclusion of populations at potential risk for disproportionate environmental and management impacts. Regulations and policies guiding the identification, assessment, and treatment of underserved communities' environmental justice populations include the following:

- Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations," which requires consideration of how federally assisted projects may exert disproportionately high and adverse human health or environmental effects on minority and low-income populations.

- EO 13985, “Advancing Racial Equity and Support for Underserved Communities Through the Federal Government,” which establishes that the federal government must provide employment that develops, promotes, and retains a diversity of workers and provide resources and opportunities to strengthen and advance diversity, equity, inclusion, and accessibility in the federal government.
- The Justice40 Initiative, which set a goal for the federal government that 40% of the overall benefits of certain federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution.
- EO 14008, “Tackling the Climate Crisis at Home and Abroad,” which directs federal agencies to make achieving environmental justice part of their missions by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related, and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts.
- EO 14096, “Revitalizing Our Nation’s Commitment to Environmental Justice for All,” which directs the federal government to build upon and strengthen its commitment to deliver environmental justice to all communities across America through an approach that is informed by scientific research, high-quality data, and meaningful federal engagement with communities with environmental justice concerns.

The demographic information presented in the 2022 socioeconomic report and section 4.6 of this final EIS describes the potential underserved communities’ environmental justice populations in the socioeconomic study area (Monroe County, Florida), including race, ethnicity, age distribution, gender distribution, education level, and poverty.

4.6.2.5.1 Disadvantaged and Underserved Communities

In response to many of the executive orders relating to Environmental Justice, the White House CEQ developed a Climate and Economic Justice Screening Tool (CEQ, 2024). The tool uses an interactive map and datasets that are indicators of burdens in eight categories: climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. The tool uses this information to identify disadvantaged communities that are overburdened by the issues above and are underserved in being able to address them. Based on information from this tool, there are seven tracts of land in Monroe County, Florida that are considered disadvantaged due to flood risk, population loss, low income, linguistic isolation, and/or lack of high school education (Climate and Economic Justice Screening Tool, 2024).

The NMFS Equity and Environmental Justice Strategy refers to underserved communities as those that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life. These include geographic communities as well as populations sharing a particular characteristic, history, or identity. The identification of such vulnerable communities helps agencies consider the impacts of their actions on these communities and ensure they do not add to the burdens they already face. It can also help agencies identify services, programs, and initiatives that can help make these communities more economically and environmentally resilient in the face of these stressors.

4.6.3 Human Uses

4.6.3.1 Commercial Fishing

In Florida, commercial fishing waters are divided into statistical areas (and subdivided into subareas) by NOAA Fisheries and FWC's Fish and Wildlife Research Institute (referred to as FWC from this point forward) to record where fish are caught. The waters off of Monroe County are divided into five statistical areas comprising 24 subareas, 15 of which overlap with FKNMS. Commercial fishing in the statistical areas associated with Monroe County supports the sanctuary community, the state of Florida, and the U.S. Commercial fishing represents a direct use of natural resources within FKNMS. FWC maintains information on Florida's commercial fisheries. Data for commercial fisheries and marine life collection from 2010–2019 were obtained by ONMS through a non-disclosure agreement that allows for analysis and provision of summary-level data without sharing individual observation data. FWC collects and compiles data from "trip tickets" that contain information on where fish are caught (subarea) and landed, landings by weight, and harvest revenue.

The analysis provided here presents the total harvest revenue and pounds landed by species group and gear type for 2010–2019. Trend data are shown for some of the top species by harvest revenue that are most likely to be affected by the proposed rule, including reef species. Table 4.4 describes the statistical subareas associated with Monroe County, their associated fishery management council, and whether they overlap with FKNMS. There are two fishery management councils (Gulf of Mexico and South Atlantic) responsible for fisheries in the 24 subareas adjacent to Monroe County. All data used in this analysis are from the trip tickets submitted to FWC.

Table 4.4. Monroe County statistical subarea information.

Statistical Subarea Description	Statistical Subarea Number	Fishery Management Council	Overlap with FKNMS?
South of US 1	1.0	South Atlantic	Yes
North of US 1	1.1	Gulf of Mexico	Yes
Federal waters north of US 1	1.8	Gulf of Mexico	No
Federal waters south of US 1	1.9	South Atlantic	Yes
State waters—Gulf	2.0	Gulf of Mexico	Yes
State waters—South Atlantic	2.2	South Atlantic	Yes
Federal waters—Gulf	2.8	Gulf of Mexico	Yes
Federal waters—South Atlantic	2.9	South Atlantic	No
Offshore waters	3.0	Gulf of Mexico	No
Whitewater Bay	3.1	Gulf of Mexico	No
All other inland waters	3.2	Gulf of Mexico	No
Federal waters	3.9	Gulf of Mexico	No
Offshore waters	744.0	Gulf of Mexico	Yes
Florida Bay	744.1	Gulf of Mexico	Yes
Biscayne Bay (non-national park)	744.3	South Atlantic	No

Statistical Subarea Description	Statistical Subarea Number	Fishery Management Council	Overlap with FKNMS?
Biscayne Bay National Park (inside)	744.4	South Atlantic	Yes
Biscayne Bay National Park (outside)	744.5	South Atlantic	No
Biscayne Bay National Park (Federal)	744.8	South Atlantic	No
Card Sound	744.6	South Atlantic	Yes
Barnes Sound	744.7	South Atlantic	Yes
Federal waters	744.9	South Atlantic	Yes
South of U.S. 1	748.0	South Atlantic	Yes
North of U.S. 1 (Florida Bay)	748.1	Gulf of Mexico	Yes
Federal waters (south of U.S. 1)	748.9	South Atlantic	Yes

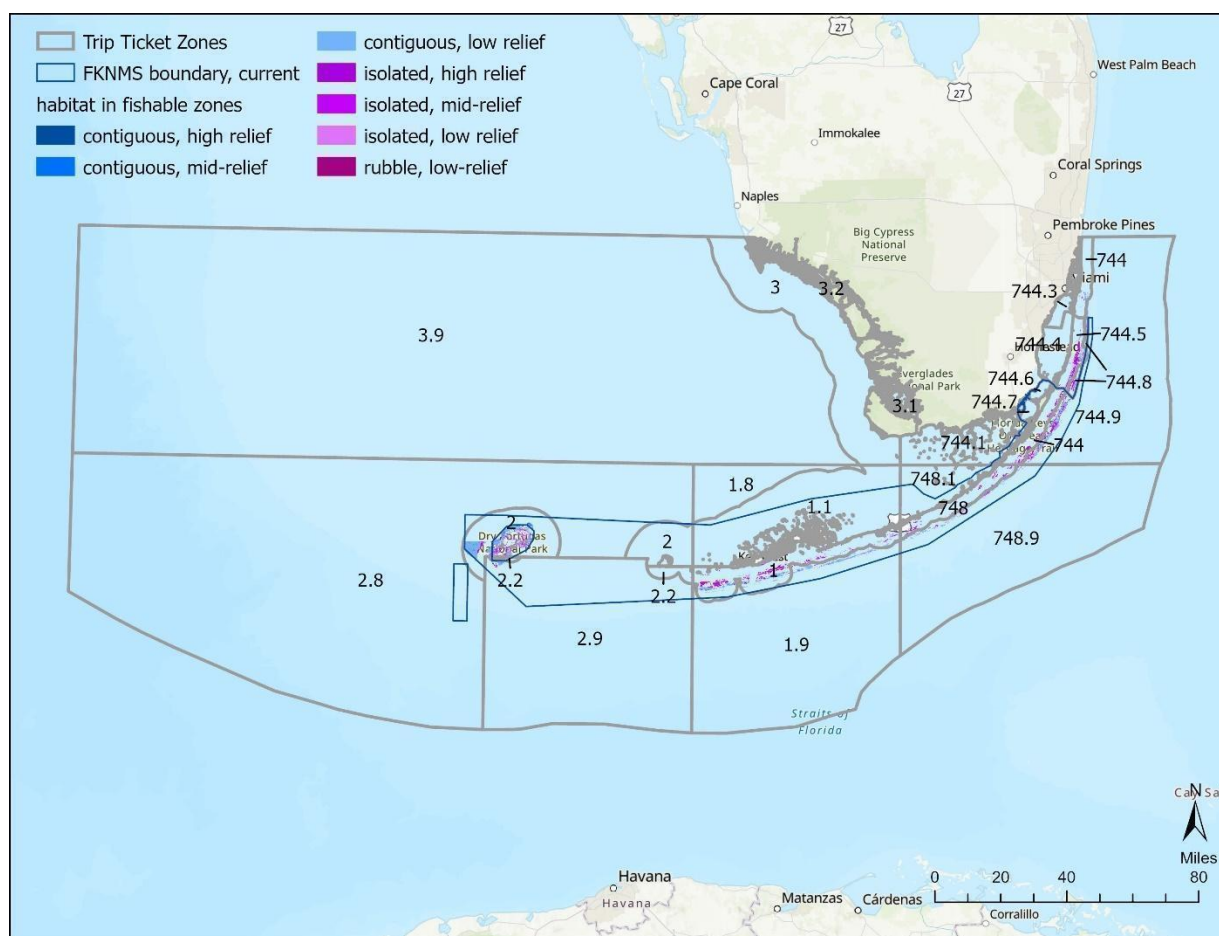


Figure 4.9. Map of current FKNMS boundary and statistical subareas (NMFS).

Ten reef species (nine fishes and Caribbean spiny lobster), shrimp (including pink, rock, brown, royal red, white, and other shrimp), and stone crab were considered in this analysis. The reef fish considered were black, red, and gag grouper; grunts; hogfish; and gray, lane, mutton, and yellowtail snapper. There were several reasons the analysis focused on reef species. First, the

spatial management zones considered are concentrated in the reef tract, and consequently will primarily impact reef-based fishing and species. Secondly, the species analyzed had species-habitat relationships, which allowed for a spatially explicit estimation of effort based on where the fish are known to congregate. Third, many of these species are among the most valuable reef species when considering total harvest revenue (ex-vessel price per pound multiplied by landings). While there are a number of species with large harvest revenues caught in FKNMS, they are not reef obligate and tend to be pelagic, with large habitat ranges; these species were therefore not included in the analysis. However, shrimp and stone crab were considered; although these species are not reef obligate, they fall within the top 10 fisheries in the region based on total harvest revenue and are generally more site attached, making these fisheries potentially more sensitive to regulatory changes within FKNMS. A more detailed description of the process used to identify species for further analysis may be found in Schwarzmann et al. (2022).

4.6.3.1.1 Summary of Commercial Fishing Activity in Statistical Areas Adjacent to Monroe County

The table below shows summary data for the periods from 2010–2019 and 2015–2019. Both time periods are presented to identify whether there have been any major shifts in trends or activity in terms of species targeted or gear used in the past 10 years or when considering the more recent five-year period for which data are available. During this time period several events affected the FKNMS ecosystem, including coral bleaching and hurricanes. Despite this, the top species and gear type by harvest revenue were consistent between time periods. The 10 highest value species by harvest revenue were the same in Monroe County and FKNMS for the period from 2010–2019. For the 2015–2019 period, snowy grouper replaced swordfish as a top 10 species in Monroe County. More harvest revenue came from shrimp than stone crab from 2015–2019, but stone crab landings created more revenue over the whole decade. Caribbean spiny lobster was the most valuable species by harvest revenue in Monroe County and FKNMS. The top 10 species by value from 2010–2019 are presented in Table 4.5. Additionally, mutton and gray snapper are included in the table since they are part of the nine reef species analyzed in more detail throughout this report. King mackerel, swordfish, greater amberjack, and golden crab are not reef-associated and consequently not included in more detailed analysis outside of this section. Results are presented in 2019 dollars and converted using the consumer price index.

Table 4.5. Top commercially harvested species by total value in statistical areas adjacent to Monroe County from 2010–2019 and 2015–2019 (\$2019). Asterisks (*) denote species that are not reef associated and were thus not included in subsequent analyses in this report. Two time ranges are presented in the table below. The 2010–2019 averages provide longer-term information to inform the affected environment in FKNMS. The 2015–2019 averages were used in the regulatory analysis required for this proposed action. Source: FWC, 2021

Species	2010–2019: Rank	2010–2019: Total Harvest Revenue (\$2019)	2010–2019: Average Annual Harvest Revenue (\$2019)	2015–2019: Rank	2015–2019: Total Harvest Revenue (\$2019)	2015–2019: Average Annual Harvest Revenue (\$2019)
Caribbean spiny lobster	1	\$437,653,634	\$43,765,363	1	\$209,870,754	\$41,974,151
Stone crab	2	\$190,119,826	\$19,011,983	3	\$100,746,664	\$20,149,333
Shrimp	3	\$184,308,597	\$18,430,860	2	\$104,113,636	\$20,822,727
Yellowtail snapper	4	\$67,938,240	\$6,793,824	4	\$37,128,817	\$7,425,763
King mackerel*	5	\$18,226,354	\$1,822,635	5	\$8,829,221	\$1,765,844
Red grouper	6	\$14,032,786	\$1,403,279	6	\$8,153,797	\$1,630,759
Swordfish*	7	\$6,315,632	\$631,563	12	\$1,650,511	\$330,102
Greater amberjack*	8	\$5,381,889	\$538,189	7	\$2,407,448	\$481,490
Golden crab*	9	\$4,648,788	\$464,879	9	\$1,794,663	\$358,933
Black grouper (carberita)	10	\$3,565,377	\$356,538	8	\$2,007,747	\$401,549
Mutton snapper	11	\$3,215,210	\$321,521	11	\$1,673,009	\$334,602
Gray (mangrove) snapper	13	\$2,972,987	\$297,299	14	\$1,499,215	\$299,843

There is no clear trend in Caribbean spiny lobster harvest revenue from 2010–2019. Lobster revenue peaked in 2014 at \$62.4 million. Shrimp harvest revenue showed a moderately increasing trend with a peak in 2017 at roughly \$27.7 million. Higher-than-average shrimp prices in 2013 and 2014 resulted in a small revenue spike. Stone crab revenue showed a weakly increasing trend over the decade. There was a statistically significant[3] increasing trend in yellowtail snapper harvest revenue with a peak in 2017 at nearly \$8.8 million. There was no clear trend in harvest revenue for king mackerel; revenue reached a low in 2015 at roughly \$1.25 million and a high in 2018 at over \$2.4 million (FWC, 2021).

Harvest revenue for red grouper increased from a low of under \$500,000 in 2010 to a maximum of roughly \$2.18 million in 2014. Revenues gradually decreased over the latter half of the decade. Black grouper harvest revenues trended slightly upwards over 2010–2019. Years 2012

and 2013 were strong years for swordfish harvest revenue with over \$1.1 million in landings for both years. Following that period, revenue fell to a low of approximately \$220,000 in 2015.

There was a statistically significant, steady decline in grunt harvest revenue from 2010–2019. Hogfish harvest revenue was roughly \$31,000 in 2010 and then increased to a peak of approximately \$83,400 in 2015 before declining steeply to a low of roughly \$7,000 in 2019. There was no clear trend in harvest revenue for mutton snapper in Monroe County from 2010–2019; revenue peaked at roughly \$401,600 in 2014 and \$421,000 in 2019. Gray (mangrove) snapper harvest revenue varied without trend over the study period. Lane snapper harvest and harvest revenue increased significantly from 2010–2019; harvest revenue peaked in 2018 at nearly \$25,000. Gag grouper harvest revenue increased from a low of roughly \$67,500 in 2011 to a high of over \$235,000 in 2015. Following the 2015 peak, gag grouper revenue declined to around \$90,000 in 2019.

Summary data for commercial harvest revenue in Monroe County by gear type are presented below. The top five gears by harvest revenue are the same for Monroe County and FKNMS, with the exception that stone crab traps generate more revenue than the “trawl, quad rig” gear category in Monroe County than in FKNMS. The list of the 10 highest revenue-generating gears for 2010–2019 is similar to the list for 2015–2019 in FKNMS, with slight differences in the order of ranking. As in statistical areas within FKNMS, the “traps (not specified)” gear type is ranked lower in the later study period than for the entire decade. Traps, trawl, and hook and line are the top three gear categories by harvest revenue when aggregating across similar gear types.

Table 4.6. Top gear types by harvest revenue in statistical areas adjacent to Monroe County from 2010–2019 and 2015–2019 (\$2019). Two time ranges are presented in the table below. The 2010–2019 averages provide longer-term information to inform the affected environment in FKNMS. The 2015–2019 averages were used in the regulatory analysis required for this proposed action. Source: FWC, 2021

Gear	2010–2019: Rank	2010–2019: Harvest Revenue (\$2019)	2010–2019: Average Annual Harvest Revenue (\$2019)	2015–2019: Rank	2015–2019: Harvest Revenue (\$2019)	2015–2019: Average Annual Harvest Revenue (\$2019)
Lobster traps	1	\$299,095,344	\$29,909,534	1	\$170,633,268	\$34,126,654
Traps (not specified)	2	\$167,391,168	\$16,739,117	4	\$45,925,187	\$9,185,037
Stone crab traps	3	\$145,569,829	\$14,556,983	2	\$85,389,199	\$17,077,840
Quad rig trawl	4	\$92,087,053	\$9,208,705	3	\$57,656,404	\$11,531,281

Gear	2010–2019: Rank	2010–2019: Harvest Revenue (\$2019)	2010–2019: Average Annual Harvest Revenue (\$2019)	2015–2019: Rank	2015–2019: Harvest Revenue (\$2019)	2015–2019: Average Annual Harvest Revenue (\$2019)
Trawl (not specified)	5	\$73,120,373	\$7,312,037	5	\$33,057,162	\$6,611,432
Hook and line	6	\$53,625,177	\$5,362,518	6	\$24,686,423	\$4,937,285
Rod and reel	7	\$33,674,063	\$3,367,406	7	\$19,883,679	\$3,976,736
Longline	8	\$24,381,855	\$2,438,186	9	\$12,088,431	\$2,417,686
Double trawl	9	\$15,505,083	\$1,550,508	8	\$12,373,065	\$2,474,613
Electric reel	10	\$12,809,161	\$1,280,916	10	\$7,820,166	\$1,564,033

Harvest revenue from the traps (not specified) gear category experienced a statistically significant decline from 2010–2019 in Monroe County. There was a small spike in revenue from traps (not specified) in 2013–2014, when revenues reached just over \$25 million. There was no significant trend in revenue from lobster traps, although the average revenue in the second part of the decade was slightly higher than the average for the first five years. From 2014–2016, lobster trap revenues hovered near a maximum of around \$39 million. No trend in harvest revenue from trawl (not specified) was evident from 2010–2019. Trawl revenue during the study period peaked at over \$12 million in 2010 and reached a low of \$4.8 million in 2019. There were spikes in trawl revenue in 2014 and 2017. Revenue from stone crab traps increased significantly from 2010–2019, reaching a maximum of nearly \$18.7 million in 2015. Harvest revenue from the quad rig trawl gear type also experienced a statistically significant increase over the study period. Quad rig trawl revenues spiked in 2014 at close to \$13.3 million and peaked in 2017 at around \$16.1 million.

4.6.3.1.2 Summary of Commercial Fishing Activity in Statistical Areas that Overlap FKNMS

The top 12 species by total harvest revenue within statistical areas that overlap FKNMS are presented in Table 4.7. The top 12 species are presented so ensure additional species evaluated in this report are presented. For commercial fishery landings in FKNMS, the list of the 10 highest value species by harvest revenue (in 2019 dollars) was identical for 2010–2019 and

2015–2019. In both periods, the harvest revenue for Caribbean spiny lobster was more than double the value for shrimp, the next most valuable species. Stone crab and yellowtail snapper were the next most valuable species landed after Caribbean spiny lobster and shrimp. Harvest revenue for king mackerel, the fifth most valuable species, was roughly 10 times less than revenue for yellowtail snapper, the fourth ranked species.

A separate analysis of the economic effects of proposed zone changes on small business entities considered nine reef-associated fish, along with high-value shrimp, Caribbean spiny lobster, and stone crab. Six of those species—grunts, hogfish, mutton snapper, gray (mangrove) snapper, lane snapper, and gag grouper—did not fall within the top 10 species by harvest revenue.

Table 4.7. Top commercially harvested species by harvest revenue in statistical areas that overlap FKNMS from 2010–2019 and 2015–2019 (\$2019). Asterisks (*) denotes species that are not reef associated and thus were not included in subsequent analyses in this report. Two time ranges are presented in the table below. The 2010–2019 averages provide longer-term information to inform the affected environment in FKNMS. The 2015–2019 averages were used in the regulatory analysis required for this proposed action. Source: FWC, 2021

Species	2010–2019: Rank	2010–2019: Harvest Revenue (\$2019)	2010–2019: Average Annual Harvest Revenue (\$2019)	2015–2019: Rank	2015–2019: Harvest Revenue (\$2019)	2015–2019: Average Annual Harvest Revenue (\$2019)
Caribbean spiny lobster	1	\$391,805,069	\$39,180,507	1	\$181,630,677	\$36,326,135
Shrimp	2	\$160,344,142	\$16,034,414	2	\$88,360,506	\$17,672,101
Stone crab	3	\$94,429,905	\$9,442,990	3	\$52,210,708	\$10,442,142
Yellowtail snapper	4	\$51,787,944	\$5,178,794	4	\$27,925,557	\$5,585,111
King mackerel*	5	\$7,391,524	\$739,152	5	\$2,506,993	\$501,399
Great amberjack*	6	\$4,896,423	\$489,642	7	\$2,198,025	\$439,605
Swordfish*	7	\$4,885,147	\$488,515	10	\$1,440,035	\$288,007
Red grouper	8	\$4,655,513	\$465,551	6	\$2,231,243	\$446,249
Golden crab*	9	\$4,484,499	\$448,450	8	\$1,794,663	\$358,933
Black grouper (carberita)	10	\$3,014,190	\$301,419	9	\$1,710,912	\$342,182
Mutton snapper	11	\$2,562,019	\$256,202	11	\$1,274,694	\$254,939
Gray (mangrove) snapper	12	\$2,428,694	\$242,869	13	\$1,200,752	\$240,150

There is some variation in Caribbean spiny lobster harvest revenue from 2010–2019, with no clear trend. Revenue peaked at nearly \$56.25 million in 2015 and subsequently declined to around \$26.1 million in 2019. Shrimp harvest revenue shows a weakly increasing, but statistically insignificant, trend over the ten-year study period. Harvest revenue for shrimp

caught in FKNMS peaked in 2017 at roughly \$23.25 million. Harvest revenue for both stone crab and yellowtail snapper increased significantly from 2010–2019. Relatively large stone crab harvests in 2011 and 2016 were accompanied by declines in price per pound (roughly \$11.11/lb and \$11.92/lb, respectively, compared to a decadal average of \$14.39/lb). Comparatively, the price of yellowtail snapper was less variable, and trends in harvest revenue closely track trends in harvest. King mackerel harvest revenue declined significantly over the study period, from a high of around \$1.2 million in 2010 to a low of \$0.3 million in 2017.

There was no trend in red grouper harvest or harvest revenue over the study period. Harvest revenue increased to a peak of roughly \$870,000 in 2014 and subsequently decreased to \$274,000 in 2019. Black grouper harvest revenue exhibited a weakly increasing trend from 2010–2019, rising above \$400,000 in 2014 and 2017. Harvest revenue for grunts in FKNMS declined significantly over the time series from a peak of \$47,241 to a low of just under \$5,000 in 2019. Hogfish revenue increased gradually to a peak of around \$77,700 in 2015, then declined considerably to a low of around \$6,100 in 2019. There was no clear trend in harvest revenue or pounds landed for mutton snapper from 2010–2019. Lane snapper harvest revenue showed a statistically significant, increasing trend, peaking in 2018 at roughly \$21,200 pounds. There was no statistically significant trend in gray (mangrove) snapper harvest or harvest revenue over the study period. Harvest revenue for gag grouper increased from just under \$18,000 in 2011 to nearly \$87,500 in 2014. Revenue subsequently declined to around \$25,200 in 2019 after another, smaller peak at \$50,400 in 2018.

The table below ranks the top commercial gear types by harvest revenue from 2010–2019 and 2015–2019. As with Monroe County, the top three gear categories were traps, trawl, and hook and line. The list of top five gear types by harvest revenue were identical for FKNMS in both study periods. For the 2015–2019 period, electric reel gear replaced scuba gear as the tenth ranked gear type on the list. Lobster traps were the top ranked gear type by harvest revenue in both study periods. The next top gear types over the entire decade were, in order: traps (not specified), quad rig trawls, stone crab traps, and trawls (not specified). In the 2015–2019 period, the “traps (not specified)” gear type fell to the fourth ranked position, but the rank order for the top five gear types were otherwise the same between the two periods.

Table 4.8. Top gear types by harvest revenue in statistical areas that overlap FKNMS from 2010–2019 and 2015–2019 (\$2019). Two time ranges are presented in the table below. The 2010–2019 averages provide longer-term information to inform the affected environment in FKNMS. The 2015–2019 averages were used in the regulatory analysis required for this proposed action. Source: FWC, 2021

Gear	2010–2019: Rank	2010–2019: Harvest Revenue (\$2019)	2010–2019: Average Annual Harvest Revenue (\$2019)	2015–2019: Rank	2015–2019: Harvest Revenue (\$2019)	2015–2019: Average Annual Harvest Revenue (\$2019)
Lobster traps	1	\$265,302,932	\$26,530,293	1	\$148,585,212	\$29,717,042
Traps (not specified)	2	\$148,650,381	\$14,865,038	4	\$37,692,702	\$7,538,540
Quad rig trawl	3	\$89,374,295	\$8,937,429	2	\$55,950,409	\$11,190,082

Gear	2010–2019: Rank	2010–2019: Harvest Revenue (\$2019)	2010–2019: Average Annual Harvest Revenue (\$2019)	2015–2019: Rank	2015–2019: Harvest Revenue (\$2019)	2015–2019: Average Annual Harvest Revenue (\$2019)
Stone crab traps	4	\$56,539,031	\$5,653,903	3	\$38,911,621	\$7,782,324
Trawl (not specified)	5	\$55,505,876	\$5,550,588	5	\$22,570,160	\$4,514,032
Hook and line	6	\$41,569,445	\$4,156,945	6	\$17,700,033	\$3,540,007
Rod and reel	7	\$24,972,027	\$2,497,203	7	\$15,061,788	\$3,012,358
Long line	8	\$12,332,842	\$1,233,284	9	\$5,702,925	\$1,140,585
Double trawl	9	\$12,135,204	\$1,213,520	8	\$9,726,361	\$1,945,272
Scuba	10	\$8,645,515	\$864,552	11	\$4,412,868	\$882,574
Electric reel	12	\$7,990,994	\$799,099	10	\$4,482,538	\$896,508

Harvest revenue from the traps (not specified) gear type declined significantly from 2010–2019. Nearly \$30 million in harvest revenue came from traps (not specified) in 2010, but that figure declined to under \$5 million by 2019. There was a moderate spike in harvest revenue from traps (not specified) in 2013. There was no statistically significant trend in harvest revenue from lobster traps from 2010–2019, although revenue in the latter half of the decade was slightly higher on average compared to the first half. Lobster trap revenue from FKNMS peaked in 2014 at over \$35.5 million. Harvest revenue from the general “trawl (not specified)” gear type declined over the study period from a maximum of roughly \$10.5 million in 2010 to a low of around \$2.6 million in 2019. Trawl (not specified) revenue spiked in 2014 and again in 2017. On the other hand, revenue from quad rig trawls increased significantly from 2010–2019, reaching a peak of nearly \$15.5 million in 2017. Revenue from quad rig trawls was only about \$2.2 million in 2010. Harvest revenue from stone crab traps also increased significantly over the study period, starting at approximately \$1.3 million in 2010 and increasing to about \$9.07 million by 2018. The figure below shows trends for the top five gear types by harvest revenue (FWC, 2021).

4.6.3.2 Recreational Fishing

Wallmo et al. (2021a) analyzed recreational fishing on Florida Reefs. Although the study focused on use of the entire reef tract in Southeast Florida, estimates are provided at the county level. Utilizing data from NOAA Fisheries’ National Marine Recreation Fishing Expenditure Survey and Marine Recreational Information Program (MRIP), Wallmo et al. (2021a) found that trip-based expenditures for recreational fishing on the Southeast Florida reef tract supported nearly 3,800 jobs and \$400.5 million in output. The economic effects were highest in Monroe County, supporting nearly 1,700 jobs and \$180.4 million in output. Additionally, there were 1,201,552 shore-based angler trips, 215,064 charter boat trips, and 1,287,848 private/rental boat trips in Monroe County in 2016.

Using MRIP data, researchers from University of Miami’s Rosenstiel School of Marine and Atmospheric Science estimated a five-year average (2014–2018) for the number of charter and private vessel trips that specifically targeted reef-obligated species within Monroe County. Shoreline estimates were not provided, since the proposed marine zone changes would not affect the shoreline. Charter vessels that reported targeting reef fish had an average of 117,119 annual, non-duplicative angler trips for hook and line fishing. Private vessels targeting reef fish had an annual average of 983,006 non-duplicative hook and line trips and 123,863 non-duplicative spear fishing trips. Headboat vessels fishing within the current FKNMS boundary had an annual average of 298,846 angler-hours, or roughly 37,356 non-duplicative angler trips (Southeast Fisheries Science Center, 2021). The mean annual numbers of private and charter recreational angler-trips for 2014–2018 for nine reef-associated species are presented in Table 4.9. The table below may show duplicative trips, meaning that if someone reported targeting multiple species on the same trip, they would have an angler-trip added to each of the species categories.

Table 4.9. Mean annual angler-trips for charter and private vessels, 2014–2018. Source: S. Smith, personal communication, May 3, 2021; NMFS, Fisheries Statistics Division, personal communication, January 15, 2021

Species	Mode	Average Annual Angler Trips (2014–2018)
Black grouper	Charter vessels	101,621
	Private vessels	598,505
Gag grouper	Charter vessels	91,473
	Private vessels	482,519
Red grouper	Charter vessels	89,731
	Private vessels	834,598
Gray snapper	Charter vessels	91,189
	Private vessels	876,181
Lane snapper	Charter vessels	83,401
	Private vessels	657,688
Mutton snapper	Charter vessels	111,930
	Private vessels	687,134
Yellowtail snapper	Charter vessels	98,724
	Private vessels	864,001
White grunt	Charter vessels	85,565
	Private vessels	848,761
Hogfish	Charter vessels	83,270
	Private vessels	895,367

4.6.3.3 Tourism and Visitation

Tourism (including recreation) is one of the most important economic sectors to the Monroe County economy. Both the status of demand and supply are discussed below. The number of visitors and residents in Monroe County were evaluated to inform the demand for recreation and tourism. The number of parks, recreational operators, and infrastructure all speak to the

supply and capacity to provide these services to people. The number of visitors to the Florida Keys was estimated to be 5.13 million in 2018, 5.05 million in 2017, 5.07 million in 2016, 5.04 million in 2015, and 4.89 million in 2014 (Rockport Analytics, 2019). Tourism value to the Florida Keys economy was estimated at \$2.4 billion (in 2018, the most recent year data were available), supporting 44% of jobs and employment in Monroe County and \$500.9 million in tax receipts (Rockport Analytics, 2019). Without tourism, an additional amount of \$3,818 would be needed in local annual taxes from each of the county's 30,200 households to maintain receipts. Although these estimates do not include COVID-19 impacts, the 10-year trend does include the impact of Hurricane Irma, which made landfall in the Florida Keys in September 2017, destroying infrastructure, shuttering businesses, and damaging visitor perceptions (Rockport Analytics, 2019). The Florida Keys were closed as a result of Hurricane Irma from September 10–October 1, 2017. These statistics, and the discussion of tourism below, describe recent tourism patterns in FKNMS. They do not provide an estimate of an incremental change to tourism due to the rule.

Insights, Inc. (2021) conducted a study of visitors to FKNMS for the years 2019 and 2020; data from this study were provided for quarters 1, 3, and 4 of each year. During quarter 2 of 2020, the Florida Keys were closed to visitors due to the COVID-19 pandemic. Surveys did not occur from March 22, 2020 until the start of the third quarter of 2020, when the Florida Keys were reopened to visitors. In 2019, 63.1% of respondents reported visiting for recreation/vacation and 30.1% of respondents reporting visiting family and friends. In 2019, 95.1% of visitors to the Florida Keys also reported visiting Monroe County within the previous three years. Further, in 2019, 34.0% of respondents reported staying 1–3 nights, 52.3% reported staying 4–7 nights, and 13.7% reported staying 8 or more nights. In 2020, shorter stays were more common, with 40.8% of respondents reporting stays of 1–3 nights, 50.8% reporting 4–7 nights, and 8.4% reporting 8 or more nights. The mean size of the visitor party was 4.33 in 2019 and 4.07 in 2020, with an average of 0.77 visitors per group under the age of 17 in both 2019 and 2020. Lastly, 92.5% of visitors in 2019 and 90.5% of visitors in 2020 were likely to recommend the Florida Keys to a friend. The study did not include information on residents or non-resident day-trippers.

Table 4.10. Select information on overnight visitors to the Florida Keys (% of total respondents indicating each response). Source: Insights, Inc., 2021

Question		2019	2020
Which of the following best describes your trip?	Recreation/vacation trip	63.1%	64.1%
	Visiting family/friends	30.1%	31.3%
Did you visit the Florida Keys in the previous three years? (Yes)		95.1%	87.0%
Total nights spent in the Florida Keys	1–3	34.0%	40.8%
	4–7	52.3%	50.8%
	8 or more	13.7%	8.4%
How likely are you to recommend the Florida Keys to a friend? (Likely)		92.5%	90.5%

When assessing tourism, it is also useful to evaluate the frequency and methods of travel that are used to access Monroe County. Visitors may enter Monroe County via U.S. Route 1, fly into

Key West International Airport, or arrive by boat. The number of arrivals via Key West International Airport has increased since 2015. The top three carriers in 2018 were Republic Airways, Delta Air Lines, and Silver Airways (which exclusively serves Florida and the Bahamas). These three carriers accounted for 93% of all passenger arrivals at Key West International Airport. However, there was a large, temporary drop in passengers in September 2017 due to Hurricane Irma, and the data do not include 2020 (Rockport Analytics, 2021).

During the same time period, vehicular traffic entering and traveling throughout Monroe County increased (Rockport Analytics, 2021). Annual daily traffic in Marathon and Islamorada increased consistently since 2013.

These data show that total visitor volume to the Florida Keys has increased steadily since 2014 (except for 2017, due to the passage of Hurricane Irma). The sharpest increase occurred from 2017–2019, when both the number of vehicles on U.S. Route 1 (the only road that leads into the Florida Keys) and passengers arriving via Key West International Airport increased (Rockport Analytics, 2021). This increase in visitation resulted in increased travel delays due to congestion. This is important to note, as increased travel time and strain on infrastructure may impact visitor satisfaction in the long term without infrastructure improvement.

Cruise ship data are also available for the city of Key West. However, unlike other modes of transportation, cruise ship passengers primarily stay within Key West and are unlikely to participate in activities that use FKNMS resources at the same rates as non-cruise ship passengers due to the limited duration of their stays. The number of cruise ship passengers remained stable from 2010–2019, with a low point occurring in 2016 (E. Dawicki/Key West Chamber of Commerce, personal communication, May 11, 2021). The reduced number of passengers in 2020 is attributed to COVID-19. Analysis of monthly cruise ship passenger counts shows that peak cruise ship visitation consistently occurs in the winter (November–February).

4.6.3.4 Non-Consumptive Recreation

A comprehensive study of Monroe County visitors and residents has not been conducted since 2007–2008. A summary of these data can also be found in the socioeconomic supporting analysis for the draft EIS, but is not presented here (Leeworthy et al., 2019). This section provides summary information from the Monroe County Tourism Development Council (TDC) and a more recent study by West Virginia University focusing on the northern portion of Monroe County.

The table below summarizes participation in various activities across all areas of Monroe County in 2019 and 2020 (Insights, Inc., 2021). Although participation rates were lower in 2020 compared to 2019, the data show that visitors participate in a diverse set of activities. (It is unknown whether lower participation rates in 2020 were a result of the COVID-19 pandemic.) In 2019, the most common activities that rely on FKNMS resources were beach activities, viewing wildlife, sightseeing, boating, and snorkeling. Non-sanctuary-related activities and the business that provide these services and goods may indirectly benefit from the existence of a healthy marine environment and sanctuary that people want to visit. Participation rates account for visitors participating in multiple activities during their visit to Monroe County.

Table 4.11. Rates of participation in recreational activities, 2019 and 2020 (reported as percentages of respondents who indicated they participated in a given activity). Source: Insights, Inc., 2021

Activity	2020	2019	Change from 2019–2020
Scuba diving	20.7%	21.4%	-0.7%
Snorkeling	28.7%	52.6%	-23.9%
Fishing	31.4%	47.8%	-16.4%
Viewing wildlife	50.9%	64.9%	-14.0%
Boating	48.3%	60.8%	-12.6%
Beach activities	59.7%	70.2%	-10.5%
Dining out	64.6%	74.4%	-9.8%
Visit museums/historical areas	40.1%	69.0%	-28.9%
Sightseeing and attractions	19.8%	64.6%	-14.8%
Cultural events	27.9%	53.9%	-26.0%
Wedding/commitment ceremony	16.9%	22.4%	-5.4%
Bars/nightlife	61.4%	70.3%	-8.8%
Spa/health club/gym	39.8%	51.8%	-12.0%

The report by Insights, Inc. (2021) also provides expenditure estimates for non-resident overnight visitors. In 2019, the average amount spent per party per night was \$242 on lodging, \$112 on transportation in the Florida Keys, \$130 on water-related activities, \$129 on land-oriented activities, \$166 on food/beverages, and \$48 on souvenirs, gifts, and clothing (sample size of 2,700). These values declined slightly across all categories except food and beverage in 2020. In 2020, average expenditures per party per night were \$228 for lodging, \$112 for transportation in the Florida Keys, \$125 for water-related activities, \$116 for land-oriented activities, \$176 for food/beverages, and \$39 for souvenirs, gifts, and clothing (sample size of 2,574). The table below summarizes this information.

Table 4.12. Mean expenditures per party per night (\$2019). Source: Insights, Inc., 2021

Expenditure	Mean expenditures per night, 2019 (\$2019)	Mean expenditures per night, 2020 (\$2019)
Lodging	\$242	\$228
Transportation	\$112	\$112
Water-oriented activities	\$130	\$125
Land-oriented activities	\$129	\$116
Food/beverages	\$166	\$176
Souvenirs, gifts, film, clothing	\$48	\$39

A more recent study found that reef-related diving and snorkeling trips support 1,756 jobs, nearly \$52.2 million in labor income, and roughly \$155.4 million in output (Wallmo et al., 2021b). Mean expenditure per respondent for trip-level goods was roughly \$62 for charter dive/snorkeling trips, \$47 for lodging, \$45 for food and beverages from restaurants, \$39 for food and beverages from stores, and \$29 for boat fuel/oil. These data reflect responses from residents and non-residents, and expenditure estimates were not separated based on residency. This means that several zero values for lodging were included in the estimates. Additionally,

32% of respondents indicated that their most recent trip was a paid charter trip, 21% indicated their most recent trip was part of a longer work trip or vacation, and 20% indicated their most recent trip was from a private/rental boat.

Chapter 5: Environmental Consequences

5.1 Introduction

This chapter evaluates the anticipated environmental effects on the biological, physical, cultural and historical, and socioeconomic and human use issues associated with the proposed action and alternatives, including the No Action Alternative (Alternative 1), presented in Chapter 3. The potential impacts apply to the affected environment described in Chapter 4. Also discussed are the potential cumulative impacts and unavoidable adverse impacts. As described in Chapter 3, the proposed action and alternatives include proposals for changes to five specific components of FKNMS management: (1) the sanctuary boundary, (2) sanctuary-wide regulations, (3) marine zone boundaries within the sanctuary, (4) marine zone regulations, and (5) changes to the sanctuary's management plan.

For this action, public comments were solicited at three different phases: (1) notice of intent and public scoping meetings including Sanctuary Advisory Council input; (2) draft EIS comment period; and (3) NOPR public comment period. Throughout these comment periods, numerous issues were raised, and this analysis has been updated where pertinent. This final EIS includes a response to comments included in Appendix C.

5.1.1 Scope of the environmental consequences analysis

In this chapter, the potential impacts associated with the proposed action and alternatives are described by their type (direct, indirect, or cumulative) and significance (negligible, less than significant, or significant). The impact analysis considers the beneficial and adverse impacts of each alternative, and the impacts common to all alternatives. The affected resources and types of use examined for the proposed action and alternatives are:

- Biological resources;
- Physical resources;
- Cultural and historical resources; and
- Socioeconomic resources and human uses (The socioeconomic impact analysis has been updated from the draft EIS. The updated analysis includes more recent socioeconomic data and methods. Relevant impacts are summarized in the below sections; however see [Schwarzmann et al., 2022](#) for the full report).

5.1.1.2 Resources not analyzed

Of the resources commonly analyzed during the NEPA process, Table 5.1 provides a list of those not addressed in this final EIS and the rationale as to why the action would not affect these resources.

Table 5.1. Resources not analyzed in this EIS

Resource	Rationale
Land use	None of the alternatives include activities that will impact land use.
Utilities	None of the alternatives include activities that require or impact utilities.
Visual	None of the alternatives include activities that will impact visual resources.

In addition to the categories of resources listed in Table 5.1, a number of natural and cultural resources discussed in Chapter 4 would not be impacted by any of the proposed actions. These resources are included in Chapter 4 to provide the public with a complete picture of the land and sea ecosystems of the Florida Keys, and specifically the proposed action area.

Physical features discussed in Chapter 4, such as oceanic conditions (i.e., currents, hydrography, and climate), are beyond the scope of plausible effects as their status and equilibrium are largely independent of human-imposed boundaries and policies.

5.1.2 Framework for the consequences analysis

Below describes the framework for the consequences analysis and the basis for NOAA's conclusions regarding the type of potential impacts, significance of potential impacts, and quality of potential impacts.

5.1.2.1 Type of potential impacts

The following categories of types of potential impacts are used to describe the nature, timing, and proximity of potential impacts on the affected environment.

- Direct impact: A known or potential impact which is caused by the action and occurs at the same time or place (40 C.F.R. § 1508.8(a)).
- Indirect impact: A known or potential impact which is caused by the action and is later in time or farther removed in distance, but is still reasonably foreseeable (40 C.F.R. § 1508.8(b)).
- Cumulative impact: 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 (40 C.F.R. § 1508.7).

5.1.2.2 Significance of potential impacts

To determine whether an impact is significant, the CEQ regulations (40 C.F.R. § 1508.27) (1978) and NOAA NEPA procedures (NAO 216-6A) require the consideration of context and intensity of potential impacts.

Context is the setting within which an impact is analyzed, such as the affected region or locality and the affected interests. In this final EIS, the direct and indirect impacts are evaluated within a local context, primarily examining how each alternative would affect the human environment within a specified portion of the sanctuary, and whether those effects would be short-term or long-term. The geographic area of interest for cumulative impacts is a slightly broader regional

(i.e., Florida Keys and Southeast Florida) context in order to consider overlapping and compound effects with other past, present, or reasonably foreseeable future actions.

Level of intensity refers to the severity of the impact. The various levels of impact used in this analysis are:

- **Negligible:** Impacts to a resource can barely be detected (whether beneficial or adverse) and are therefore discountable.
- **Less than significant:** Minor impacts that do not rise to the level of significance as defined below.
- **Significant:** Impacts resulting in an alteration in the state of a biological, physical, cultural and historical, or socioeconomic resource. Long-term or permanent impacts or impacts with a high intensity or frequency of alteration to a resource, whether beneficial or adverse, would be considered significant. The significance threshold is evaluated on a case-by-case basis, taking into consideration the context and intensity of each action.

5.1.2.3 Quality of potential impacts

Potential impacts are described as either beneficial or adverse as follows:

- **Beneficial impact:** Beneficial impacts are believed to promote favorable conditions for the resource.
- **Adverse impact:** Adverse impacts are considered contrary to the goals, objectives, management policies, and practices of NOAA and the public interest or welfare. These impacts are likely to be damaging, harmful, or unfavorable to one or more of the resources.

5.1.4 Overview of the environmental consequences analysis

Sections 5.2 through 5.7 evaluate the impacts of the six alternatives on the resource areas described in Chapter 4. NOAA evaluated the impacts within the context of each of the following alternative components:

Sanctuary boundary:

How does the amount of area within FKNMS affect the human and natural environment?

Sanctuary-wide regulations:

How do the type and number of regulations to protect sanctuary resources affect the human and natural environment?

Marine zone boundaries and regulations:

How does the amount of area within each marine zone and the management approach for each marine zone affect the human and natural environment?

FKNMS management plan:

How do the activities to manage and operate FKNMS affect the human and natural environment?

To efficiently evaluate the potential impacts from the alternatives, NOAA first evaluated the impacts common to all alternatives and then considered the impacts specific to each alternative, as summarized below.

Common impacts: Section 5.2 describes the impacts that would be the same for all alternatives, such as the impacts from managing and operating the sanctuary (Section 5.2.1) and impacts to protected species and habitats (Section 5.2.2).

Impacts from Alternative 1: Section 5.3 describes the impacts from the No Action Alternative (Alternative 1) whereby NOAA would continue to manage FKNMS within the current boundary and under the current regulations, zoning regime, and management plan.

Impacts from Alternative 2: Section 5.4 describes the impacts specific to Alternative 2, which would expand the sanctuary, revise and add new regulations to protect sanctuary resources, expand the marine zones, make the regulations within certain marine zone more protective of sanctuary resources, and update FKNMS management plan to respond to current threats to sanctuary resources and increase public involvement and outreach.

Impacts from Alternative 3: Section 5.5 describes the impacts specific to Alternative 3. Because many of the components of alternatives 2 and 3 are the same, this section also briefly summarizes the impacts that would be the same as those described for Alternative 2.

Impacts from Alternative 4: Section 5.6 describes the impacts specific to Alternative 4. Because many of the components of alternatives 2, 3, and 4 are the same, this section also briefly summarizes the impacts that would be the same as those described for alternatives 2 and 3.

Impacts from the NOPR Alternative and Final Preferred Alternative: Section 5.7 describes and compares the impacts specific to the NOPR and Final Preferred Alternatives. Because many of the components of these alternatives are the same as components of the other action alternatives, and there are nominal changes between these two alternatives, they are discussed together and the information is presented in a comparison table.

5.2 Impacts Common to All Alternatives

Under the No Action Alternative and all of the action alternatives, FKNMS would continue to conduct existing field operations to protect and manage sanctuary resources within the existing boundary and, for the action alternatives, within the expanded boundaries. Based on NOAA's extensive experience in managing the unique natural and historical resources of the Florida Keys, NOAA expects that the following broad management activity types would continue in the sanctuary. These operations are described in detail in this final EIS Appendix L and include: operating and maintaining vessels and aircraft, training staff, conducting research and resource documentation, continuing existing education and outreach activities, and installing and maintaining permanent moorings or other installations to protect fragile ecosystems and cultural and historical resources.

5.2.1 Impacts of existing field operations to biological, physical, cultural, and socioeconomic resources (common to all alternatives)

NOAA determined that FKNMS field operations would result in overall **beneficial** effects to the environment because managers would gain information to inform decisions related to resource protection activities; the public would become more educated about sanctuary resources; important habitat and wildlife would continue to be protected and managed; and damaged resources would be restored. In addition, NOAA identified some **direct** and **indirect adverse** impacts, such as minor disturbances to habitats and wildlife from NOAA vessel operations and research activities. Detailed analysis of the impacts of existing field operations by activity and resource area is provided in Appendix L. A summary of these beneficial and adverse impacts from the ongoing field activities in FKNMS is provided below in Table 5.2.

NOAA has determined that the adverse effects of field operations would be **less than significant** because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices (see Appendix L for a list) to avoid or minimize impacts to the natural and human environment. The field operations (described in Appendix L) and their impacts would continue under all of the alternatives.

Table 5.2a. Summary of impacts to biological resources from the existing field operations at Florida Keys National Marine Sanctuary

Resource	Activity	Impacts
Habitat	Debris removal, biological monitoring of biota and habitat conditions or other on-shore research activities, and educational outreach activities	• Direct beneficial impacts due to habitat improvements when debris is removed. • Indirect beneficial impacts from biological monitoring information and research activities that provide information to enhance management of the sanctuary. • Indirect beneficial impact from increased awareness among members of the public who participate in educational or outreach activities. • Negligible adverse impact if research activities require localized, short-term disturbance to habitats, such as collection of habitat-building species (e.g., corals). The impact would be minimized with the implementation of best management practices.
Habitat	Removal of derelict vessels, installation of mooring buoys, and offshore research activities, including the use of airplanes, vessels, and deployment of research equipment	• Less than significant beneficial impact due to the removal of derelict vessels which would result in increased habitat availability and improved habitat quality. The use of mooring buoys prevents habitat degradation by not allowing anchoring and disturbing benthic habitats. • Less than significant adverse impact due to localized, short-term disturbance to habitats from equipment used to remove derelict vessels and the installation of mooring buoys. Habitat that could be directly disturbed would be very small (generally <10 ft² [1m²]) and the change may not be noticeable with the implementation of best management practices that minimize the likelihood of disturbing important habitats.
Habitat	Vessel and aircraft operation	• Negligible adverse impact due to potential localized disturbances to benthic habitats if vessels anchor in an area without mooring buoys. However, relatively infrequent use of sanctuary vessels and aircraft, training requirements for vessel operators and pilots, and adherence to ONMS best management practices and NOAA Small Boat Program guidelines would limit impacts.

Resource	Activity	Impacts
Biota	Biological monitoring, research activities, and educational outreach activities	• Less than significant direct adverse impact due to the localized collection of organisms during monitoring or research activities. Sampling activities would likely result in negligible impacts on marine biota populations due to the small sample sizes typically collected. • Less than significant adverse impact due to the potential localized disturbance to the benthic habitats during anchoring (when mooring buoys are not available) and unintentional striking or grounding of operational aircraft or vessels. Impact would be negligible due to the low likelihood of occurrence, training requirements for vessel operators and pilots, and adherence to ONMS best management practices and NOAA Small Boat Program guidelines. Effects due to noise-producing activity that may cause biota to be disturbed or displaced would be minimal, because human activities are limited to a certain portion of the sanctuary, would occur for limited amounts of time, and staff would implement best management practices to minimize the disturbances. • Indirect beneficial impacts from biological monitoring information and research activities that provide information to enhance management of the sanctuary. • Indirect beneficial impact from increased awareness among the members of the public who participate in educational or outreach activities.
Biota	Debris removal and disentangling trapped marine mammals, turtles, or other species	• Direct beneficial impacts to marine organisms and wildlife due to the increased health and safety conditions when debris is removed and organisms are disentangled. • Indirect beneficial impact from increased awareness among members of the public who participate in educational or outreach activities. • Negligible adverse impact due to noise-producing activity that may cause biota to be disturbed or displaced for short periods of time.
Biota	Vessel and aircraft operations	• Negligible adverse impact from potential localized disturbance to the benthic immobile organisms during anchoring (when mooring buoys are not available) and unintentional striking or grounding of operational aircraft or vessels. Impact would be negligible due to the low likelihood of occurrence, training requirements for vessel operators and pilots, and adherence to ONMS best management practices and NOAA Small Boat Program guidelines.

Table 5.2b. Summary of impacts to physical resources from the existing field operations at Florida Keys National Marine Sanctuary

Resource	Activity	Impacts
Geology	Removal of derelict vessels, installation of mooring buoys, and research activities, including the use of airplanes and vessels and deployment of research equipment	• Less than significant adverse impact due to the direct disturbance to the seafloor. However, the area of impact would be very small (generally <10 ft² (1m²)) and the change may not be noticeable with the use of best management practices that minimize the likelihood of disturbing important seafloor structures. • Less than significant beneficial impact from removal of derelict vessels, prevention of anchoring upon sensitive seafloor areas, and research activities that would provide characterization of the seafloor and other information that would enhance the management of the sanctuary.
Geology	Vessel and aircraft operations	• Negligible adverse impact due to the low likelihood of unintentional striking or grounding of operational aircraft or vessels, training requirements for vessel operators and pilots, and adherence to ONMS best management practices and NOAA Small Boat Program guidelines.
Water Quality	Removal of derelict vessels, installation of mooring buoys, and research activities, including the use of airplanes, vessels, and deployment of research equipment	• Less than significant adverse impact due to the minimal potential for localized decline in water quality if gas, fuel, or other contaminants leak or spill during derelict vessel collection or unintended fuel, lubricant, sewage, or garbage spills from sanctuary vessels. Adherence to ONMS best management practices and NOAA Small Boat Program guidance would also minimize impacts. Research equipment would not directly discharge harmful waste into the water. • Less than significant beneficial impact from removal of derelict vessels that may be leaking and characterization of the seafloor and other information provided by research activities that would enhance management of the sanctuary.
Air Quality	Vessel and aircraft operations and use of research equipment	• Less than significant or negligible adverse impact from the low generation of emissions during operation of sanctuary aircraft, vessel operation and maintenance, and use of research equipment. Vehicles and equipment would be used infrequently, and adherence to ONMS best management practices and NOAA Small Boat Program guidelines would minimize impacts.

Table 5.2c. Summary of impacts to cultural and historical resources from the existing field operations at Florida Keys National Marine Sanctuary

Resource	Activity	Impacts
Cultural and heritage resources	Deployment of equipment (e.g., autonomous underwater vehicles/remotely operated vehicles/gliders/drifters, seafloor equipment, and remote sensing equipment)	• Positive and beneficial effects are anticipated with these activities because they lead to enhanced resource characterization and the location and documentation of new archaeological sites. These activities also raise public awareness and foster greater appreciation of the sanctuary's maritime archaeological history. • Less than significant beneficial effects by fostering learning opportunities about sanctuary resources so that managers can better protect these resources. • Less than significant adverse impacts are possible from these activities; however, they are minimized by training operators and using equipment that is very visible to the public. Additionally, there may be impacts from the highly improbable physical impact of the equipment on heritage resources and a slightly increased risk of memento-seekers carrying off important newly documented historical resources.
Cultural and heritage resources	Onshore fieldwork and other sampling activities	• Less than significant beneficial effects by promoting understanding and protection of resources that can lead to enhanced environmental stewardship. These activities also help managers locate and document new archaeological sites. • Less than significant adverse impacts by using best management practices to ensure there is no unnecessary harm to the surrounding environment. Some sampling activities could occur in the vicinity of historical and cultural resources, but these activities will be conducted by knowledgeable personnel working in compliance with the NHPA.
Cultural and heritage resources	Snorkel, scuba, vessel, and aircraft operations	• Less than significant beneficial effects because these projects are long term and designed to protect, restore, and preserve maritime resources. • Less than significant adverse impacts from accidental or improper diving or snorkeling actions or overuse of specific locations. These may be mitigated by the use of best management practices. • Negligible effects are anticipated from non-motorized vessels because they are lightweight, slow, and maneuverable, and therefore able to avoid contact with sensitive historical and cultural resources. The effects of vessel and aircraft operations are also expected to be negligible due to their infrequent activity (fewer than ten flights per year). Vessel operations would employ best management practices and impacts would not be concentrated in any one area.

Table 5.2d. Summary of socioeconomic impacts from the existing field operations at Florida Keys National Marine Sanctuary

Resource	Activity	Impacts
Marine transportation	Sampling activities	• Less than significant beneficial impacts because scientific study and inquiry create greater awareness and appreciation of sanctuary resources and promote public and commercial uses. • Less than significant adverse effects by operations that may temporarily interfere with the conduct of commercial or recreational activities, but these effects are expected to be short-term and localized.
Marine Transportation	Deployment of equipment	• Less than significant beneficial impacts from deployment of buoys that assist in navigation. Data generated by seabed-deployed equipment can increase knowledge of sanctuary resources, leading to better resource management. Additional bathymetry knowledge is used to aid in marine navigation. • Negligible adverse effects because buoys and other equipment may temporarily interfere with the conduct of commercial or recreational activities (such as fishing or transit), but most operations are limited in scope and time.
Marine Transportation	Aircraft operations	• Less than significant beneficial impacts from species and habitat surveys that can lead to better characterization of habitats and species, aiding in education and outreach efforts which aim to increase informed management decisions.
Research and education	Sampling activities	• Less than significant beneficial impacts from research and monitoring programs, which offer related socioeconomic opportunities to users and constituents. • Less than significant adverse effects by operations that may temporarily interfere with the conduct of commercial or recreational activities, but these effects are expected to be short-term and localized.
Research and education	Deployment of equipment	• Less than significant beneficial impacts because research and education benefit sanctuary resources and can benefit small businesses. • Negligible adverse effects because buoys and other equipment may temporarily interfere with other activities, but operations are limited in scope and time.
Research and education	Aircraft operations	• Less than significant beneficial impacts from species and habitat surveys that can lead to better characterization of habitats and species, aiding in education and outreach efforts which aim to increase informed management decisions.
Fishing, recreation, and tourism	Research and educational outreach activities (onshore and vessel operations)	• Less than significant beneficial impacts on trade, tourism, recreation, and commerce in the area, which greatly depend on the long-term health of the sanctuary and may benefit from knowledge gained through research and outreach activities.
Fishing, recreation, and tourism	Deployment of navigational buoys and research equipment	• Less than significant adverse impacts from short-term and localized interruptions to recreational and commercial activities. • Less than significant beneficial long-term effects to safety and knowledge for better management of sanctuary resources. • Negligible impacts from incremental addition of markers to existing marker network and short-term interference with other activities.

Resource	Activity	Impacts
Fishing, recreation, and tourism	Aircraft operations	• Less than significant beneficial long-term and short-term gains to knowledge for better management of sanctuary resources.
Fishing, recreation, and tourism	Vessel maintenance	• Negligible impacts because vessel maintenance is conducted pier-side or on land, and therefore would not significantly interfere with other activities.

5.2.2 Impacts to federally protected species and habitats (common to all alternatives)

Managing and operating the sanctuary, including NOAA's routine field operations, could impact species and habitats protected under the ESA, EFH protected under the MSA, and migratory birds protected under the Migratory Bird Treaty Act. NOAA analyzed the potential environmental consequences on protected species and habitats of continued FKNMS management and field operations and the proposed spatial and regulatory updates in the proposed action, consistent with the regulatory framework of the relevant statute. NOAA determined that impacts on protected species and habitats would be the same across the No Action and all action alternatives. Impacts specific to each alternative on physical and biological resources, which include protected species and habitats, are discussed in more detail below in sections 5.3–5.7. There is some minor variation in the impacts across the alternatives, but these variations do not alter NOAA's overall impact determinations for protected species and habitats identified in this section, which is the same for all alternatives. Statute-specific determinations are defined below. See Appendix E for additional information regarding these consultations, the MMPA, and the regulatory framework for other federal and state laws.

5.2.2.1 *Endangered Species Act*

This section describes the potential impacts to species listed under the ESA and their designated critical habitat. NOAA analyzed the potential impacts to ESA-listed species and designated critical habitat within the context of the ESA regulatory framework, including ESA-specific determinations regarding the potential impacts to listed species and designated critical habitat.

For ESA-listed species, effect determinations include the following:

- No effect: When the proposed action will not affect a listed species or designated critical habitat.
- May affect, but not likely to adversely affect: When effects on listed species are expected to be discountable, insignificant, or completely beneficial.
 - Beneficial effects: Contemporaneous positive effects without any adverse effects to the species.
 - Insignificant effects: Relate to the size of the impact and should never reach the scale where take occurs.
 - Discountable effects: Those extremely unlikely to occur.
- May affect, and is likely to adversely affect: If any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial.

For designated critical habitat, the effect determination must discuss whether the proposed action may result in a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of an ESA-listed species.

5.2.2.1.1 ESA-listed species under NMFS jurisdiction

Section 4.2.3.1 describes the 26 species under NMFS jurisdiction that may occur in the action area. The below analysis evaluates the potential adverse and beneficial impacts to these listed species.

Impacts to ESA-listed marine mammals, sea turtles, and fish under NMFS jurisdiction

As described in Section 4.2.3.1, NOAA determined that six species of marine mammals, five species of sea turtles, and seven species of fish listed under the ESA may occur within the action area. The potential routes of effect of the proposed actions to these species include disturbances from human and vessel activities, entanglement, vessel strikes, and water quality degradation, as well as potential beneficial impacts from restricting recreational activities in certain areas of FKNMS, improvements in water quality, and protection of marine habitat.

Disturbances from human and vessel activities

When NOAA-authorized vessels transit throughout the sanctuary, a minor acoustic disturbance from engine noise is a potential impact on marine mammals, sea turtles, and fish. If any listed species were to be within close enough proximity to a vessel, the interaction could result in a response ranging from no reaction to a startled reaction that leads to a rapid fleeing from the area. Sea turtles, whales, and fish usually avoid human activity. As a result, the most likely effect from this interaction would be a moderate to high energy avoidance behavior resulting in the animal temporarily leaving the immediate area unharmed. This disturbance would be brief and is not likely to significantly impact the organism's ability to feed, reproduce, or avoid predators. In addition, noise and recreational activity levels during the next five to 10 years are expected to remain similar to current levels. Listed species within portions of the sanctuary with vessel traffic are likely familiar with the current levels of recreational and operational activities. Therefore, future human activity is unlikely to cause listed species to avoid or abandon habitat within the action area.

Human and vessel disturbances would be minimized because many portions of FKNMS restrict human activity within areas that provide important habitat for listed species. As described below, under "Protection of marine habitat," the level of protection would increase if the sanctuary is expanded and new regulations are implemented. Current and proposed revisions to include the new or expanded idle speed no wake, no motor, and no entry marine zones would limit noise and disturbance from vessel activities. In addition, disturbances from recreational use would be minimized because many management plan activities involve educating the public about and promoting the responsible use of sanctuary resources (see Appendix A). These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize disturbing listed species.

In summary, human and vessel disturbances within FKNMS would be **insignificant or discountable** given that noise from recreational or operational activity would be of limited duration, NOAA-authorized vessels would follow best management practices, disturbed individuals could move to adequate suitable habitat nearby, and public outreach efforts would help minimize any negative effects from public use. The proposed action would also result in

beneficial impacts because human activity would be restricted within portions of the sanctuary, particularly those areas known to be used by these listed species.

Entanglement

Entanglements can create physical damage to an animal through constriction which can partially sever limbs or flippers, create penetrating injuries, and can potentially immobilize an animal (Andersen et al., 2008; Parga, 2012). If an entanglement is severe enough, it may also result in drowning. The potential for entanglement could occur if a listed species encounters mooring buoy lines, or during the implementation of management plan activities that require long line attachments, such as some field research and restoration activities. The risk of entanglement is greater for marine mammals and sea turtles than fish due to their movements and size. Nonetheless, the likelihood that any listed species would come in contact with a NOAA-authorized vessel or other FKNMS gear would be highly unlikely based on the species distribution and abundance within the action area, adherence to ONMS best management practices that include maintaining a watch for listed species around research vessels, and termination of some operations if listed species are observed. (See Appendix L of this final EIS at for a full description of best management practices.) Therefore, NOAA has determined that the likelihood of an entanglement of a listed marine mammal, sea turtle, or fish species would be **discountable**.

Vessel strike

ESA-listed vertebrates that collide with vessels could be injured or killed by the vessel strike. The risk of a collision is greater for marine mammals and sea turtles than fish due to their movements and size. Nonetheless, NOAA determined that the proposed action would result in an unlikely potential for vessel strikes because of the relatively few NOAA-authorized vessel trips that would occur each year. The sanctuary expansion could result in a small increase in vessel traffic within the proposed expanded area as a part of NOAA's regulatory enforcement, research, and educational activities. NOAA-authorized vessels would follow standing orders imposed by ONMS management (see final EIS Appendix L) to minimize impacts on resources, particularly sea turtles and marine mammals, within the sanctuary and while transiting between sites or from/to shore. These standing orders include keeping a sharp lookout, staying at the helm, and maintaining a cautious distance from whales. Due to the implementation of best management practices, the lack of previous collisions between NOAA-authorized vessels and listed species during the past several decades, and a similar level of vessel traffic within the foreseeable future, the potential for the proposed action to result in vessel strikes with listed species is extremely unlikely and **discountable**.

Changes to water quality

The proposed action could result in both adverse and beneficial impacts to water quality. Adverse impacts could occur if a listed species comes into contact with waste or discharge from NOAA-authorized vessels. Possible pollutants which could pose a risk to listed species include (but are not limited to) oil, fuel, detergents, and hydraulic fluid. In order to minimize the likelihood of a listed species coming into contact with waste or discharge from NOAA's vessel activities, FKNMS staff would adhere to discharge protocols and U.S. laws and regulations that implement the International Convention for the Prevention of Pollution by Ships, widely known

as MARPOL 73/78 (International Convention for the Prevention of Pollution by Ships). Sanctuary staff would also follow NOAA guidance for vessel operations in the presence of marine protected species, which include: to follow the NOAA Small Boats Policy (NOAA Administrative Order 209-125),¹⁰ and USCG requirements, for example: avoid discharge of ballast water in designated critical habitat, avoid cleaners with nonylphenols, use anti-fouling coatings, and clean hull regularly to remove aquatic nuisance species. These best management practices greatly reduce the risk of a spill or leak (see also best management practices in final EIS Appendix L). If a spill or leak did occur, only a small amount of area would experience a localized, temporary decrease in water quality because the plume of contamination would dissipate quickly. Based on NOAA's use of the best management practices and the protocols mentioned, as well as the low likelihood of a spill, NOAA has determined that the likelihood of a listed species coming into contact with waste or discharge from FKNMS vessels would be very low, particularly because the ESA-listed species are sparsely distributed throughout the action area and are limited in abundance. Therefore, the impacts of changes to water quality on ESA-listed species would be **insignificant**.

The proposed action would also result in beneficial impacts from water quality and habitat improvements. The sanctuary's management activities include removal of derelict vessels that may be leaking pollutants (e.g., oil, fuel, detergents) and enforcement of current regulations that restrict certain discharges in the sanctuary. In addition, all action alternatives would update regulations, such as the restrictions on cruise ship discharges and new derelict vessel regulations, to further minimize the potential for pollutants to enter the sanctuary. Therefore, the proposed action would have a **beneficial** impact on listed species.

Protection of marine habitat

Marine habitats would continue to be protected under the No Action Alternative. Additional habitat would be protected under all action alternatives other than Alternative 1 (no action). For example, certain activities that could degrade the quality of marine habitats would be restricted to varying degrees under all action alternatives, and the permitting process would help to ensure that the impacts from any activities that could harm sanctuary resources would be minimized. In addition, habitat disturbances from recreational use would be minimized because many management plan activities involve educating the public about and promoting the responsible use of sanctuary resources (see Appendix A). These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to habitat for listed species. Therefore, the proposed action would have a **beneficial** impact on listed species by protecting habitat used by listed species.

Impacts to ESA-listed invertebrates under NMFS jurisdiction

As described in Section 4.2.3.1, NOAA determined that eight species of invertebrates listed under ESA may occur within the action area. Seven species of ESA-listed invertebrates that may occur within the action area are immobile (see Appendix H). Potential adverse impacts to these species include direct disturbances and degradation of water quality. Potential beneficial

¹⁰ <https://www.noaa.gov/organization/administration/nao-209-125-noaa-small-boat-safety-program>

impacts to these species include protection from direct disturbances and improvements in water quality.

Direct disturbances

Listed corals could be affected by some sanctuary management activities that would directly disturb immobile invertebrates, such as buoy and navigational signage installation. Though highly unlikely, corals could be directly disturbed by the installation of mooring buoys. However, direct impacts would likely be avoided because sanctuary staff would select locations to place buoy anchors or navigational signage that include bare bottom substrate to limit any possible adverse disturbances to listed species or other immobile species. In addition, the disturbed area would be extremely limited (less than approximately 10 square feet).

Other physical direct disturbances to listed invertebrate species could occur from recreational activities, such as boating and diving. Such activities would be limited in frequency and duration. In addition, disturbances from recreational use would be minimized because many management plan activities involve educating the public about and promoting the responsible use of sanctuary resources (see Appendix A). These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize disturbing listed species.

Based on the negligible potential for direct disturbances and the implementation of public outreach activities, NOAA determined that the potential impact to listed invertebrates is **discountable**.

As described above, human and vessel disturbances would be minimized because many portions of FKNMS restrict human activity within areas that provide important habitat for listed species. This level of protection would increase if the sanctuary is expanded and additional regulations are implemented. Therefore, the proposed action would also result in **beneficial** impacts to listed invertebrate species.

Changes to water quality

Maintenance and other management activities may affect water quality and habitat quality for sessile invertebrates that cannot move to avoid localized plumes of pollutants. Potential negligible adverse impacts could result from installation of mounting hardware for mooring buoys. These activities may cause localized and temporary increases in water turbidity during the installation process. However, effects on ESA-listed corals would be **insignificant** because of the small amount of chemical that would be used and because those chemicals would quickly dissipate. Grounded vessel removal may also have a temporary adverse impact on a small area of ESA-listed invertebrates because there is the potential for chemical seepage and habitat disturbance during the removal and, if needed, remediation processes. These activities could also result in a slight temporary increase in turbidity in and near the site. To minimize impacts, NOAA would work with the towing and salvage industry to develop a suite of guidelines and best management practices and apply the current general permit to certain towing and salvage operations. Based on the small amount of area that could experience a localized temporary decrease in water quality, NOAA determined that the potential impacts to listed species from degradation in water quality is **discountable**.

As described above, the proposed action would also result in beneficial impacts to water quality from the removal of derelict vessels that may be leaking pollutants and enforcement of current regulations that restrict certain discharges in the sanctuary. In addition, all action alternatives would update FKNMS regulations to further minimize the potential for pollutants to enter the sanctuary, including updating the restrictions on cruise ship discharges and adding a new regulation pertaining to derelict vessels. Therefore, the proposed action would have a **beneficial** impact on listed invertebrate species.

Protection of habitat and benthic sessile listed species

As described above, marine habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives. For example, certain activities that could degrade the quality of marine habitats would be restricted and the permitting process would help to ensure that the impacts from any activities that could harm sanctuary resources would be minimized. In addition, habitat disturbances from recreational use would be minimized because many management plan activities involve educating the public about and promoting the responsible use of sanctuary resources (see Appendix A). These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to habitat for listed species. Therefore, the proposed action would have a **beneficial** impact on listed species by protecting habitat used by listed species.

Impacts to designated critical habitat under NMFS jurisdiction

Loggerhead sea turtle (*Caretta caretta*)

As described in Section 4.2.3.1 and in Appendix E, designated critical habitat for the loggerhead sea turtle occurs throughout the action area. Routine sanctuary management activities such as vessel operations, debris removal, and monitoring would have minimal adverse effects on designated critical habitat for the loggerhead sea turtle. The activities that may potentially lead to disturbance include walking along beaches, vessel grounding, and pollution discharging in nearshore seagrass habitats. All of these activities would be limited in duration and extent and education and outreach efforts would minimize negative effects. Beneficial effects from the actions described in this final EIS would include expanding sanctuary boundaries and regulations, which would protect habitats and water quality, as well as protecting seagrass foraging habitat and nesting beaches through updated regulations and marine zones. NOAA has determined that the proposed action **would not adversely modify** loggerhead sea turtle designated critical habitat.

As described above, marine habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives. In addition, public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to designated critical habitat. Therefore, the proposed action would have a **beneficial** impact on loggerhead sea turtle designated critical habitat.

Elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) corals

As described in Section 4.2.3.1, designated critical habitat for these corals occur in the Dry Tortugas and on the Atlantic side of the Florida Keys from Key West National Wildlife Refuge to Dania Beach. Direct effects to designated critical habitat could occur from buoy and navigational

signage installation. These impacts would be avoided because sanctuary staff would select locations to place buoy anchors or navigational signage that include bare bottom substrate to limit any possible adverse disturbances to designated critical habitat. In addition, the disturbed area would be extremely limited (less than approximately one square meter). Beneficial impacts to designated critical habitat would include the boundary expansion; more protective marine zones; more protective regulations, such as restrictions on vessel size on mooring buoys; and implementation of management plan activities, such as planning and support of coral restoration projects. NOAA has determined that the proposed action **would not adversely modify** elkhorn or staghorn critical habitat.

As described above, marine habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives. In addition, public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to designated critical habitat. Therefore, the proposed action would have a **beneficial** impact on elkhorn and staghorn designated critical habitat.

Smalltooth sawfish (*Pristis pectinata*)

As described in Section 4.2.3.1, designated critical habitat for smalltooth sawfish includes Florida Bay and borders FKNMS from Blackwater Sound southwest to Long Key. Indirect impacts to this designated critical habitat could occur from localized declines in water quality due to vessel operations, mooring buoy and signage installation, debris removal, and derelict vessel removal. These activities may cause localized and temporary increases in water turbidity during the installation or removal process. However, effects on designated critical habitat would be insignificant because of the small amount of chemicals that would be used and because any inadvertent release of chemicals would quickly dissipate. To minimize impacts, NOAA would work with the towing and salvage industry to develop a suite of guidelines and best management practices and apply the current general permit to certain towing and salvage operations. Based on the small amount of area that could experience a localized, temporary decrease in water quality, NOAA has determined that the proposed action **would not adversely modify** smalltooth sawfish critical habitat.

As described above, marine habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives. In addition, public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to designated critical habitat. Therefore, the proposed action would have a **beneficial** impact on smalltooth sawfish designated critical habitat.

Conclusion for ESA-listed species and designated critical habitat under NMFS jurisdiction

NOAA determined that 23 federally listed species and designated critical habitats for three species under NMFS jurisdiction may occur within the action area. The proposed action would result in beneficial, insignificant, or discountable impacts to these species and would not adversely modify designated critical habitat for the following reasons:

1. Disturbance, vessel collision, and entanglement is highly unlikely due to NOAA's implementation of best management practices and the relatively low level of vessel activity that would occur within the sanctuary.

2. Noise and disturbances from recreational or operational activity would be of limited duration, human activity would be restricted within several portions of the sanctuary, and management activities and outreach would help to reduce disturbance.
3. The proposed action would result in beneficial impacts because marine habitats would continue to be protected under the No Action Alternative, and additional habitats would be protected under all action alternatives.

Based on the above information, NOAA finds that the proposed action **may affect, but is not likely to adversely affect** ESA-listed species under NMFS jurisdiction (see Appendix H for full list). In addition, the proposed action **would not adversely modify** designated critical habitat under NMFS jurisdiction.

5.2.2.1.2 ESA-listed species under USFWS jurisdiction

Section 4.2.3.1 describes ESA-listed species under USFWS jurisdiction that are most likely to occur in the action area. In that section, NOAA concludes that ESA-listed terrestrial plants (22 species) would not be affected. These species do not occur in the action area because this action is limited to marine waters. Following discussions with USFWS, NOAA also determined that the proposed action would have no effects for four species of birds (red-cockaded woodpeckers, Florida scrub-jays, Florida grasshopper sparrows, and Bachman's warbler) given that these species are outside the action area. Further, the action would have no effect on five mammals (Florida bonneted bat, Florida panther, Key Largo cotton mouse, Key Largo woodrat, and Lower Keys marsh rabbit), two birds (Cape Sable seaside sparrow and Kirtland's warbler), or five invertebrates (Stock Island tree snail, Bartram's hairstreak butterfly, Florida leafwing butterfly, Miami blue butterfly, and Schaus swallowtail butterfly), as these species are also unlikely to occur in the action area.

The analysis below evaluates the possible routes of effect and potential impacts to the remaining 19 ESA-listed species including six birds, three mammals, nine reptiles, and one fish species. The analysis below includes potential adverse impacts to critical habitat from human disturbances and water quality degradation, as well as potential beneficial impacts from restricting recreational activities in certain areas, improvements in water quality, and protection of wetland and mangrove habitats.

Impacts to ESA-listed birds and terrestrial mammals under USFWS jurisdiction

In Section 4.2.3.1, NOAA determined that six species of birds (Everglade snail kite, piping plover, red knot, roseate tern, woodstork, and eastern black rail) and two species of terrestrial mammals (key deer and silver rice rat) may occur within the action area. Unlike terrestrial plants, these animals are coastal, or can be found in marine waters (key deer can swim between islands, and silver rice rats can be found in intertidal zones). Potential adverse impacts to all of these species include human disturbances from recreational and sanctuary management activities and potential degradation of water quality. Potential beneficial impacts include the potential improvements in water quality and protection of wetland and mangrove habitats.

Human disturbances

Intense human disturbance may disrupt nesting, foraging, or resting activities for listed birds and terrestrial species. For example, intense disturbances to birds can reduce their ability to

maintain adequate weight or provide sufficient care to eggs or chicks (USFWS, 2007; Niles, 2009; USFWS 2015).

Within FKNMS, human disturbance is limited to vessel traffic and noise from recreational activities, removal of marine debris, and vessel traffic to support operations of the sanctuary, such as research or educational activities. Noise from these activities could disturb or displace listed birds or terrestrial mammals within an audible range of the sanctuary. However, this noise would be of short duration and within a limited portion of the sanctuary. In addition, some species would be more susceptible to these disruptions. The piping plover, for example, may be subject to slightly more disturbances from normal sanctuary management activities because this species spends more time foraging near or on water, whereas other listed species are more commonly found inland, where the noises would be less audible. For some species, human activities may be more likely to disrupt certain behaviors. For example, USFWS (2007) determined that human disturbances may disrupt nesting behavior for the wood stork, but the USFWS did not find evidence that human disturbances significantly affect foraging behavior for the wood stork.

If noise levels were audible enough to disturb listed terrestrial species, adequate similar habitat could be found nearby in other portions of the sanctuary that would be beyond the audible range of sanctuary activities. In addition, noise and recreational activity levels during the next five to 10 years are expected to remain similar to current levels. Therefore, listed birds within active portions of the sanctuary are likely familiar with the current levels of recreational and operational activities within FKNMS and future human activity is unlikely to cause listed terrestrial species to avoid or abandon habitat within the action area.

Human disturbances would be minimized because many portions of FKNMS restrict human activity within several areas of the sanctuary that provide important habitat for listed species. As described below, under “Protection of wetland and mangrove habitats,” the level of protection would increase if the sanctuary is expanded and new regulations are implemented. For example, current and proposed revisions to include the new idle speed no wake, no motor, and no entry marine zones would limit noise and disturbance from human activities. Restricting activities within certain portions of the sanctuary would result in beneficial impacts.

In addition, disturbances from recreational use would be minimized because many management plan activities (see Appendix A) involve educating the public about and promoting the responsible use of sanctuary resources. These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize disturbing listed species.

In summary, human disturbances to listed birds and terrestrial species within FKNMS would be **insignificant** or **discountable** given that noise from recreational or operational activity would be of limited duration, disturbed individuals could move to adequate suitable habitat nearby, and public outreach efforts would help minimize any negative effects from public use. The proposed action would also result in **beneficial** impacts because human activity would be restricted within portions of the sanctuary, particularly those areas known to be used by these listed species.

Changes to water quality

The proposed action could result in both adverse and beneficial impacts to water quality. Vessel operations could result in minimal adverse impacts to water quality due to the small potential for a localized decline in water quality if gas, fuel, or other contaminants leak or spill during derelict vessel collection or from unintended fuel, lubricant, sewage, or garbage spills from sanctuary vessels. Adherence to ONMS best management practices and NOAA Small Boat Program guidance would minimize impacts. Therefore, any adverse impacts to listed species and habitats from water quality degradation would be **discountable** given the low potential for a localized decline in water quality and the implementation of best management practices.

The proposed action would also result in beneficial impact from water quality and habitat improvements. The sanctuary's management activities include removal of derelict vessels that may be leaking and enforcement of current regulations that restrict certain discharges in the sanctuary. In addition, all action alternatives would update regulations, such as the restrictions on cruise ship discharges and new derelict vessel regulations, to further minimize the potential for pollutants to enter the sanctuary. Therefore, the proposed action would have a **beneficial** impact on listed birds and terrestrial mammal resources.

Protection of wetland and mangrove habitats

The principal threat to the survival and recovery of many listed terrestrial species is the loss, fragmentation, alteration, and degradation of its wetland habitat (USFWS, 2017). In addition, runoff from phosphorus and nitrogen from agricultural and urban sources has degraded water quality within wetland habitats by altering the composition and structure of wetland plant communities used by listed species. These threats have resulted in reduced foraging and nesting opportunities for the listed species (USFWS, 2017). Similarly, USFWS (2007) determined that a key to the recovery of wetland habitat located adjacent to FKNMS is the implementation of the Comprehensive Everglades Restoration Plan. The primary goal of these projects is to restore and protect wetland habitat.

Wetland and mangrove habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives. For example, certain activities that could fragment or degrade wetland habitat would be restricted and the permitting process would help to ensure that the impacts from any activities that could harm sanctuary resources would be minimized. In addition, habitat disturbances from recreational use would be minimized because many management plan activities involve educating the public about and promoting the responsible use of sanctuary resources (see Appendix A). These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to habitat for listed species. Therefore, the proposed action would have a **beneficial** impact on listed species by protected habitat used by listed species.

Impacts to ESA-listed marine mammals and reptiles under USFWS jurisdiction

In Section 4.2.3.1, NOAA determined that the West Indian manatee (*Trichechus manatus*), American crocodile (*Crocodylus acutus*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), Eastern indigo snake (*Drymarchon couperi*), and Florida Keys

mole skink (*Plestiodon egregius*) may occur within the action area. In addition, two snake species, Key ring-necked snake and rim rock crowned snake, are proposed endangered and may occur within the action area. Potential adverse impacts to these species include human disturbances from recreational and sanctuary management activities and potential degradation of water quality. Potential beneficial impacts include the protection of foraging, wetland, and mangrove habitats, and potential improvements in water quality.

Impacts to marine mammal and reptile species under USFWS's jurisdiction would be similar to the impacts described above for the impacts to marine mammals and sea turtles described within Section 5.2.2.1.2. As described above, these impacts would be **insignificant, discountable, or beneficial** based on the following:

1. Vessel collisions and entanglement is highly unlikely due to NOAA's implementation of best management practices and the relatively low level of vessel and research activity that would occur within the sanctuary.
2. Noise and disturbances from recreational or operational activity would be of limited duration, human activity would be restricted within several portions of the sanctuary, and management activities and outreach efforts would help to reduce or avoid disturbances.
3. The proposed action would result in beneficial impacts because marine habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives.

Impacts to ESA-listed plants under USFWS jurisdiction

As described in Chapter 4 and Appendix H, the 22 listed plants and one fern listed under USFWS jurisdiction are all terrestrial. The proposed action would have **no effect** on these species because FKNMS is limited to marine and estuarine waters.

Impacts to designated critical habitat under USFWS jurisdiction

As described in Section 4.2.3.1, the action area includes designated critical habitats under USFWS jurisdiction for the following species: American crocodile (*Crocodylus acutus*), Bartram's hairstreak butterfly (*Strymon acis bartrami*), Cape Sable thoroughwort (*Chromolaena frustrata*), Florida leafwing butterfly (*Anaea troglodyta floridae*), Florida semaphore cactus (*Consolea corallicola*), loggerhead sea turtle (*Caretta caretta*), piping plover (*Charadrius melodus*), silver rice rat (*Oryzomys palustris natator*), and West Indian manatee (*Trichechus manatus*). As discussed above, designated critical habitat for insects, plants, and the rice rats are not within the normal regulated area for FKNMS and the proposed action would not result in any direct disturbances or impacts to designated critical habitat for these species.

For the crocodile, sea turtle, and piping plover, potential adverse impacts would include minor disturbances from research or educational activities that may include walking through designated critical habitat, or from any recreational activities that occur near designated critical habitat. For these activities, negligible impacts may include soil compaction, trampling vegetation, or increased sedimentation from snorkeling, diving, or boating activities that stir up sediments. Impacts would be negligible because recreational activity would be of limited duration, human activity would be restricted within several portions of the sanctuary, and management activities and outreach efforts would help to educate the public and researchers

about reducing or avoiding disturbances. Regulatory changes to add new sanctuary water quality protections and vessel speed and access restrictions would result in direct protection for seagrass foraging habitat and nesting beaches through updated regulations and marine zones. Additionally, as described above, shoreline and marine habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives. In addition, public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize impacts to designated critical habitat. Therefore, the proposed action **would not adversely modify** designated critical habitat within the action area.

Conclusion for ESA-listed species and designated critical habitat under USFWS jurisdiction

NOAA determined that 19 federally listed species under the jurisdiction of USFWS may occur within the action area and that any impacts on these species from the proposed action would be beneficial, insignificant, or discountable for the following reasons, in addition to those reasons detailed above:

1. Vessel collision and entanglement is highly unlikely due to NOAA's implementation of best management practices and the relatively low level of vessel activity that would occur within the sanctuary.
2. Noise and disturbances from recreational or operational activity would be of limited duration, human activity would be restricted within several portions of the sanctuary, and management activities and outreach would help to reduce disturbance.
3. The proposed action would result in beneficial impacts because marine and wetland habitats would continue to be protected under the No Action Alternative, and additional habitat would be protected under all action alternatives.

Based on the above information, NOAA finds that the proposed action **may affect, but is not likely to adversely affect** 19 ESA-listed species under USFWS jurisdiction (see Appendix H for full list). In addition, the proposed action **would not adversely modify** designated critical habitat under USFWS jurisdiction.

5.2.2.1.3 Cumulative impacts to ESA-listed species

The ESA regulations at 50 C.F.R. § 402.12(f)(4) note that federal agencies may want to consider cumulative effects as part of the effects analysis for the proposed action if the federal agency is developing a biological assessment to conduct formal Section 7 consultation. Under the ESA, cumulative effects are defined as “those effects of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation” (50 C.F.R. § 402.02, “Definitions”). Unlike the NEPA definition of cumulative impacts (see Section 5.4), cumulative effects under the ESA do not include past actions or other federal actions requiring separate ESA Section 7 consultation. For the proposed action, NOAA determined that formal Section 7 consultation is not required because the proposed action **may affect, but is not likely to adversely affect** any ESA-listed species. As such, NOAA did not consider the cumulative impacts of the proposed action to the ESA-listed species under the ESA, but did consider cumulative impacts of the proposed action under NEPA. See Section 5.9 for the cumulative impacts analysis under NEPA.

5.2.2.2 Essential Fish Habitat

As noted in Section 4.2.3.3, EFH for 38 species or species complexes and life stages occurs within FKNMS. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” NOAA analyzed the potential impacts to EFH within the context of the MSA regulatory framework, including MSA-specific determinations regarding the potential impacts to EFH. Specifically, an EFH assessment under MSA must include a determination of either “adverse impact” or “no adverse impact” to EFH. Adverse effect is any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH.

ONMS analyzed the impacts of the proposed action on EFH in final EIS Appendix L, and those impacts are summarized in Table 5.2 above. In consultation with NMFS on field operations, NMFS concurred with NOAA/ONMS’s conclusion that field operations to manage FKNMS would not result in adverse impacts to EFH. However, NMFS stated that ONMS should consider whether future actions that include coral or seagrass restoration or non-emergency grounded vessel removal could adversely affect EFH on a case-by-case basis. As part of the proposed action, FKNMS proposes to conduct coral restoration, non-emergency removal of grounded vessels, and an expanded mooring buoy program. The mooring buoy program would be expanded beyond that analyzed in the EFH Assessment associated with the ongoing field operations. No other changes to the management plan or regulatory updates would result in activities that would adversely impact EFH. Below is an assessment of the potential impacts to EFH from the expanded buoy program, non-emergency grounded vessel removal, and restoration activities.

5.2.2.2.1 Impacts to EFH under NMFS jurisdiction

Mooring buoy regulations

The installation of mooring buoys could cause permanent disturbance to benthic habitats. However, it would be an extremely limited area (less than approximately 10 square feet), and locations would be selected to place buoy anchors on bare bottom substrate to limit possible adverse disturbances. Potential negligible adverse impacts could result from installation of more substantial mounting hardware for buoys intended for large vessels which may cause additional damage to habitat. FKNMS provides access to mooring buoys, which wherever provided, may result in negligible damage to EFH in specific areas by attracting more users to these areas, particularly the numbers that may result from facilitating use by larger vessels. During the installation of anchoring equipment for mooring buoys, there could be minimal effects to benthic habitat because equipment could crush or block water access to habitat-forming benthic organisms (e.g., coral species). The long-term effects from the permanent placement of mooring buoys may adversely affect sessile surface or subsurface organisms, which provide habitat that support EFH species such as corals, by preventing settlement and growth of organisms in areas where sand or other substrates are covered by mooring anchors or associated equipment. However, the affected area on the bottom is very small (less than approximately 10 square feet), allowing habitat-supporting organisms to colonize adjacent substrate. ONMS would determine the buoy location to minimize impacts, such as avoiding EFH. Therefore, the proposed action

would result in minimal adverse effects from the installation of long-term buoys and moorings because impacts would be minimized by the best management practices described above and any increase in water turbidity during the installation process would be localized and temporary.

Vessel groundings and deserted vessel regulations

Grounded vessel removal may have a temporary adverse impact on a small area of EFH because there is the potential for chemical seepage and habitat disturbance during the removal and, if needed, remediation processes. Derelict or deserted vessels can release toxic paint, chemicals, and petroleum products, among other contaminants, from the vessel and matter left aboard the vessel. If disturbed or deteriorating, they can disturb the surrounding benthic habitats, potentially creating plumes of sediment. During vessel removal activities, disturbance to habitat would be minimized so that plumes would be limited in size and dissipate quickly, therefore not resulting in adverse impacts to EFH. If species associated with EFH were intolerant to the temporary decline in water quality, mobile organisms such as fish could swim to nearby waters that would not be affected by a localized decline in water quality. Any areas with temporarily diminished water quality would likely recover quickly so that nearby habitat and any associated EFH species would not be affected. NOAA would work with the towing and salvage industry to develop a suite of guidelines and best management practices, incorporating relevant USCG regulations and best management practices and apply the current sanctuary general permit to certain towing and salvage operations. Therefore, the proposed action would result in minimal adverse effects based on the slight temporary increase in turbidity that could occur during removal activities. The best management practices developed for certain towing and salvage operations would reduce or avoid any such impacts.

Coral and seagrass restoration

Coral and seagrass restoration activities could cause a temporary disturbance to a limited area of EFH. Equipment, vessels, and divers may cause minor disturbance to EFH during restoration activities by deploying instrumentation used to monitor restoration efforts or by harvesting material either to remove invasive species or for transplantation to another restoration site. Additionally, restoration activities could cause temporary resuspension of sediments into the water column from vessels or other *in situ* activities. Any temporary decline in water quality caused by increased turbidity at a restoration site would be localized, and fish associated with EFH could swim to less turbid waters. When conducting coral and seagrass restoration activities, if these activities occurred within EFH, NOAA would follow best management practices such as anchoring in sandy substrate and deploying instrumentation slowly with constant supervision to minimize any potential loss or disturbance to EFH. Therefore, the proposed action would result in minimal adverse effects that would be limited spatially and temporally. Potential beneficial impacts associated with these proposed activities include marine zone regulations that would protect EFH associated with coral nurseries from anchor damage and potential impacts from fishing gear while also allowing the public to access and learn about coral restoration efforts. Additional activities to facilitate coral reef restoration are included in the proposed management plan (see Appendix A).

5.2.2.2 Conclusion for Essential Fish Habitat

Based on the above analysis, impacts to designated EFH would be **beneficial or result in minimal adverse impacts** based on the following:

1. The limited number of activities that would result in direct habitat degradation, disturbance, or loss;
2. Any degradation in water quality would be localized, temporary, and dissipate quickly; and
3. Best management practices would limit the likelihood of accidental spills or releases within the sanctuary.

5.2.2.3 Migratory birds

USFWS has jurisdiction over birds that are protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act as listed in Appendix H. These birds may be found transiting through the sanctuary and resting or foraging within the action area.

The primary potential impact to migratory birds would occur from human disturbances, which would be limited to vessel traffic and noise from recreational activities, removal of marine debris, or vessel traffic to support operations of the sanctuary, such as research or educational activities. Noise from these activities could disturb or displace migratory birds within an audible range of the sanctuary. If noise levels were audible enough to disturb migratory birds, adequate similar habitat could be found nearby in other portions of the sanctuary that would be beyond the audible range of sanctuary activities. In addition, noise and recreational activity levels during the next five to 10 years are expected to remain similar to current levels. Therefore, migratory birds within active portions of the sanctuary are likely familiar with the current levels of recreational and operational activities within FKNMS and future human activity is unlikely to cause listed terrestrial species to avoid or abandon habitat within the action area.

Human disturbances would be minimized because many portions of FKNMS restrict human activity within several areas of the sanctuary that provide important habitat for listed species. This level of protection would increase if the sanctuary is expanded and new regulations are implemented. For example, current and proposed revisions to include the idle speed no wake, new no motor, and no entry marine zones would limit noise and disturbance from human activities. Restricting these activities within certain portions of the sanctuary would result in beneficial impacts. In addition, disturbances from recreational use would be minimized because many management plan activities (see Appendix A) involve educating the public about and promoting the responsible use of sanctuary resources. These public outreach and educational activities would help ensure that the public is aware of the need to avoid or minimize disturbing listed species.

In summary, the proposed action **would not result in a take** of a migratory bird given that noise from recreational or operational activities would be of limited duration, disturbed individuals could move to adequate suitable habitat nearby, and public outreach efforts would help minimize any negative effects from public use. The proposed action would also result in **beneficial** impacts because human activity would be restricted within portions of the sanctuary.

5.3 Impacts Specific to Alternative 1: No Action (Status Quo)

Under the No Action Alternative (Alternative 1), FKNMS would continue to manage the sanctuary under the current 1996 management plan/EIS, augmented in 2000 with the Tortugas ER supplemental EIS, the 2007 revised management plan, and FKNMS regulations codified at 15 C.F.R. part 922, subpart P. No new regulations would be proposed, and the sanctuary and marine zone boundaries would remain the same. This section describes the beneficial and adverse impacts of continued management of FKNMS under Alternative 1.

The No Action Alternative does not fulfill the purpose and need of the proposed action (see sections 2.2 and 2.3). The No Action Alternative would not provide the beneficial effects associated with updating the sanctuary boundaries, regulations, zoning, and management plan to include:

- addressing the exacerbated long-term threats to sanctuary resources from local and regional sources,
- incorporating improved scientific data on the status and trends of the health of environmental resources within the sanctuary, and
- increasing public involvement in marine resource protection.

5.3.1 Impacts to biological and physical resources (Alternative 1)

Under the No Action Alternative, the sanctuary boundary and regulations would not change. FKNMS currently encompasses 3,800 square miles (9,842 square km). Sanctuary-wide regulations would remain as currently codified in 15 C.F.R. part 922, subpart P. Similarly, the number, configuration, boundaries, location, and regulations of marine zones within the sanctuary would not change and the current management plan would remain in place.

Beneficial impacts: The beneficial impacts from managing the current boundaries of the sanctuary would continue. For example, sanctuary resources would continue to be managed under the current management plan and regulations; research efforts would provide managers with information to inform decisions related to resource protection activities; the public would become more educated about sanctuary resources; important habitat and wildlife would continue to be protected and managed; and damaged resources would be restored. As described in final EIS Appendix L and summarized in Table 5.2, these **beneficial** impacts to biological and physical resources would be **direct** and **less than significant**.

Adverse impacts: The No Action Alternative would forego additional protections from the proposed boundary expansion. This forgone benefit would be most significant for the benthic habitats in the Tortugas region and the proposed ATBA due to the high-quality habitat that they provide for a variety of fish, marine mammals, and sea turtles. Specifically, the No Action Alternative would not provide the additional water quality protection from the current sanctuary-wide prohibition on discharge because the boundary would not be expanded. The No Action Alternative would also forego additional sanctuary protections to the Pulley Ridge unit, which includes unique mesophotic coral reef ecosystems found there. This missed opportunity to strengthen the protection of these high-quality, important habitats would risk degrading the

beneficial connectivity of these ecosystems to the Florida Keys and the ability of these reef systems to serve as a biological source for the Florida Keys in light of changing conditions.

Taking no action would forego the opportunity to update FKNMS's regulations to account for the increasing vessel traffic and use of sanctuary resources. For example, sanctuary-wide regulations on vessel discharge, fish feeding, vessel grounding, use of mooring buoys, and emergency regulations would not be updated or established, and therefore negative impacts to the biological environment from these activities would continue. Negative consequences such as pollution to coral reefs from cruise ship discharges; altered fish behavior from feeding activities; and damage to coral, sponges, and seagrass from vessel groundings and misuse of mooring buoys would continue to degrade biological resources in the sanctuary. These adverse impacts to biological and physical resources from continued management of FKNMS under the current boundaries, sanctuary-wide regulations, and management plan would be **direct** and **less than significant**.

Under the No Action Alternative, the number, configuration, boundaries, location, and regulations of marine zones within the sanctuary would not change. Therefore, the No Action Alternative would not provide necessary additional protections for deep reef, patch reef, hardbottom, seagrass, and mangrove habitats. Habitats that support sea turtle nesting and foraging; bird nesting, roosting, and foraging; and other habitats used by fish and invertebrates would not have additional protections. There would be no additional protections for areas with known or historical ESA-listed coral and associated critical habitat. There would be no additional protection of areas known to support fish spawning aggregations and/or the areas where fish transit for spawning. The No Action Alternative would also forgo application of several more restrictive regulations aimed at addressing declines in habitat condition from vessel prop-scarring and anchor damage, among others, and wildlife disturbance from vessel proximity and noise. There would be no changes to baitfish permitting and catch and release fishing by trolling regulations in SPAs, which could potentially result in a decline of fish abundance and diversity as well as continued reduction of prey species for predatory fish and seabirds. These adverse impacts to biological and physical resources from continued management of FKNMS marine zones under current regulations would be **direct** and **less than significant**.

The management plan would not be updated under the No Action Alternative. As a result, the management plan would not provide further management clarity and direction for FKNMS, management and research partners, or those seeking to do research and education/outreach work in the sanctuary, among others.

5.3.2 Impacts to cultural and historical resources (Alternative 1)

Under the No Action Alternative, current FKNMS regulations and permitting categories would continue to guide management decisions related to cultural and historical resources in the sanctuary.

Beneficial impacts: The No Action Alternative would maintain the sanctuary regulations that apply to cultural and historical resources within the current boundaries of FKNMS. Cultural and historical resources benefit from these regulations particularly in federal waters of FKNMS

through protection from looting and other physical disturbance. Beneficial impacts to cultural and historical resources under the No Action Alternative would be **indirect** and **less than significant**.

Adverse impacts: The No Action Alternative would not provide necessary additional protections for any cultural and historical resources that may be found in the proposed boundary expansion area or in the updated and proposed new marine zones. The No Action Alternative would not provide the enhanced protection of cultural and historical resources that would result from better coordination and alignment with Florida DHR permitting regulations and better alignment with the Federal Archaeological Program. In addition, under the No Action Alternative, NOAA would be less likely to assess known cultural and historical resources located outside the existing sanctuary boundary. Likewise, NOAA's ability to improve the public's understanding of cultural and historical resources in the Florida Keys beyond the current sanctuary boundary would be limited.

With the exception of U.S. and foreign sunken military craft protected under the Sunken Military Craft Act, most cultural and historical resources located beyond the sanctuary's existing boundary in U.S. federal waters lack protection from activities that can harm or destroy cultural and historical resources. The result of the No Action Alternative would be that these nonrenewable cultural and historical resources located beyond the existing sanctuary boundary would be more likely to be damaged or disturbed without commensurate information being generated for the American public. The potential adverse impacts to these nonrenewable cultural and historical resources under the No Action Alternative would be **indirect** and **significant**.

5.3.3 Impacts to socioeconomic resources and human uses (Alternative 1)

Under the No Action Alternative, the sanctuary boundary and regulations would not change. Similarly, the number, configuration, boundaries, location, and regulations of marine zones within the sanctuary would not change and the current management plan would remain in place. This section describes the impacts to socioeconomic resources and human uses that would occur under the No Action Alternative.

Beneficial impacts: The beneficial impacts of the No Action Alternative would include the avoided costs of adopting the proposed regulatory alternatives and the continued economic benefits of managing the sanctuary within its current boundaries, regulations, marine zones, and management plan. These beneficial impacts to socioeconomic resources and human uses from the No Action Alternative would be **direct** and **less than significant**.

Adverse impacts: The adverse impacts to socioeconomic resources and human uses under the No Action Alternative would be the opportunity costs of not adopting more protective alternatives. Additional protection of resources within the current and proposed expanded sanctuary could increase the level and quality of ecosystem services (how humans benefit from the environment). Implementing the No Action Alternative would not realize the associated benefits for ecosystem services, commercial fisheries, recreational activities including fishing, snorkeling, scuba, eco-tourism, and other passive nonuse values that are associated with the

more protective alternatives. Additionally, the No Action Alternative would have an **indirect adverse** impact on environmental justice initiatives. These adverse impacts to socioeconomic resources and human resources would be **indirect** and **less than significant**.

5.4 Impacts Specific to Alternative 2

This section describes the beneficial and adverse impacts from (1) boundary expansion, (2) updated and new sanctuary-wide regulations, (3) marine zone boundary and regulatory changes, and (4) an updated management plan. Under Alternative 2, NOAA would implement the following:

Sanctuary boundary expansion to include:

- The Area to be Avoided.
- The area in the Tortugas region between the existing sanctuary boundary and the Tortugas South ER.

Updated and new sanctuary-wide regulations to include:

- Three proposed updates to the following existing sanctuary-wide regulations:
 1. prohibiting certain discharges by cruise ships;
 2. increasing the time frame for emergency regulation application; and
 3. updating the historical resources permit categories.
- Four proposed new sanctuary-wide regulations, including:
 1. prohibiting fish feeding;
 2. prohibiting actions related to derelict or deserted vessels;
 3. prohibiting leaving harmful matter aboard grounded, deserted vessels, derelict, or at risk of becoming derelict; and
 4. restrictions on the use of smaller mooring buoys by large vessels and overnight use of mooring buoys.

Marine zone boundary and regulatory changes to include:

- Expanding the total number of different marine zones from 57 areas to 96.
- Implementing new and revised marine zone regulations within four zones, including:
 1. WMAs;
 2. SPAs;
 3. CAs; and
 4. MAs.
- Updating two zoning regulations, including:
 1. Eliminating fishing for baitfish in all SPAs and eliminating catch and release fishing in four SPAs (as described in Section 3.4.3); and
 2. Revising motorized PWC restrictions within Key West National Wildlife Refuge (as described in Section 3.4).

Updated management plan to include:

- The non-regulatory actions that NOAA intends to implement to further protect and manage sanctuary resources. (For the final management plan see Appendix A.)

Alternative 2 aims for greater overall protection than the No Action Alternative. This is primarily achieved through expanding the sanctuary boundary, revising current and adding new sanctuary-wide regulations that are more protective of sanctuary resources, changing the number and configuration of marine zones and the access restrictions/regulations proposed for the marine zones, and revising the FKNMS management plan.

Impacts from Alternative 2 would include the impacts common to all alternatives (see Section 5.2) in addition to the impacts specific to Alternative 2, which are described below.

5.4.1 Impacts to biological resources (Alternative 2)

This section describes the specific impacts to fish, birds, turtles, marine mammals, and wildlife that would occur under Alternative 2.

5.4.1.1 Impacts to biological resources from proposed sanctuary boundary expansion (Alternative 2)

Under Alternative 2, NOAA would expand the boundary of FKNMS to encompass the area currently regulated as the ATBA along the northeast to southeast boundary in the Upper Keys region and the area within the Tortugas region to encompass Tortugas South, and capture additional ecological features known to support fish aggregation activity and to the west of the Tortugas ER North unit to encompass additional areas of the Tortugas Bank.

Beneficial impacts: Expanding the sanctuary boundary would provide additional protections for biological resources because FKNMS would implement existing and proposed new or modified sanctuary regulations in the expanded area, as described in Section 3.2. Within the Tortugas region, beneficial impacts would be **direct** and **significant** due to the biological importance of the region, which includes a high diversity and abundance of coral and other hardbottom species, high fish biomass and abundance, and spawning grounds for multiple fish species. Specific proposed regulatory changes that would result in beneficial impacts within the proposed expansion area would include: (1) prohibiting alteration of or construction on the seabed; (2) prohibiting certain vessel operations that could strike or injure coral, seagrass, or other immobile organisms attached to the seabed or that could collide with marine mammals or other biota; and (3) restricting anchoring on live coral.

Sessile, motile, and interstitial species (e.g., coral, sponge, lobster, and conch) that make their home within the benthic habitats and sediment would benefit from this prohibition because of avoided adverse impacts associated with injury or habitat disturbance or destruction.

Implementing a prohibition on drilling into, dredging, prop dredging, or placing/abandoning any matter on the seafloor would also help to avoid adverse impacts to hardbottom and coral reef habitats in the proposed expansion areas. Restricting anchoring on live coral would have **direct, beneficial** impacts to coral habitat resources in the expansion areas.

Biological resources within the proposed expansion area would experience **significant, direct, beneficial impacts** due to the protections provided by inclusion within the boundary of a national marine sanctuary. In addition to these current sanctuary regulations, biological resources in the current sanctuary and proposed expansion area would be protected by the proposed sanctuary wide-regulatory changes, which are discussed below in Section 5.4.1.2.

Adverse impacts: Expansion of the sanctuary boundary would spread the adverse impacts of current field operations on biological resources (summarized in Table 5.2) over a larger geographic area. As described in Table 5.2, these adverse impacts to biological resources would be **direct** and **less than significant**. Consistent with the analysis in final EIS Appendix L, ONMS expects that these **adverse** effects of field operations would be less than significant because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment (NOAA, 2018b). In addition to these current sanctuary regulations, any additional impacts to biological resources in the current sanctuary and proposed expansion area from proposed sanctuary wide-regulatory changes, changes to marine zones and related regulations, and the revised management plan are discussed below in sections 5.4.1.2 through 5.4.1.4. Overall, the significant benefits to biological resources would outweigh the negligible and less than significant adverse impacts from expanding the site boundary.

5.4.1.2 Impacts to biological resources from additions and revisions to sanctuary-wide regulations (Alternative 2)

Under Alternative 2, ONMS would update or modify the sanctuary-wide regulations to include (1) prohibiting certain discharges by cruise ships; (2) increasing the time frame for emergency regulation application; (3) updating the historical resources permit categories; (4) prohibiting fish feeding; (5) prohibiting actions related to derelict or deserted vessels and leaving harmful matter aboard such vessels; and (6) restricting the use of smaller mooring buoys by large vessels and the overnight use of mooring buoys. The potential beneficial and adverse impacts to biological resources of each of these proposed updates or modifications are discussed below.

Proposed sanctuary-wide regulation update: Prohibit certain cruise ship discharges

Beneficial impacts: The application of the proposed regulation prohibiting certain discharges from cruise ships would benefit habitats and wildlife in the vicinity of cruise ship transit lanes within the sanctuary by preventing contact with pollutants such as bacteria, pathogens, oil and grease, detergent and soap residue, metals (e.g., cadmium, chromium, lead, copper, zinc, silver, nickel, and mercury), solids, acidic water, and nutrients (EPA, 2008b; EPA, 2010). Many of these waste products are directly harmful to filtering organisms found in the sanctuary, such as sponges and corals, which may ingest them. In addition, heavy metals can bioaccumulate and decrease the overall health of many aquatic biota, especially larger predators. A reduction in the pollutants and improvements to habitat quality would result in **direct, less than significant, beneficial** impacts.

The proposed discharge regulation may also cause **indirect, beneficial** effects by reducing waste nutrients in the sanctuary which promote algal blooms that shade photosynthesizing

corals and lower oxygen levels as they are degraded by bacteria, affecting a wide range of marine life.

Adverse impacts: This proposed regulatory update would result in increased protection of water quality and would not increase the amount of boat traffic or other activities that could result in adverse impacts associated with cruise operations. **No adverse impacts** to biological resources would be expected from the implementation of this regulatory change.

Proposed sanctuary-wide regulation update: Extend time period for emergency regulations

Beneficial impacts: The proposed modification to the existing emergency regulation would extend the amount of time that an emergency regulation can be in place for FKNMS to respond to emergencies occurring within the sanctuary that threaten biological resources. This proposed regulatory change would have a **direct, beneficial** impact on habitats and wildlife within the sanctuary because it would allow NOAA more time to take necessary remedial action or to conduct restoration activities to avoid or prevent impacts to biological resources. With an extended 180-day time frame (and potential for a 186-day extension) for an emergency regulation, NOAA would have more time to better evaluate conditions of sanctuary resources to determine if longer-term management action would be needed to address the resource issue, thus enhancing resource management decisions. The **significance** of these beneficial impacts would depend on the threat to sanctuary resources that the management action addresses. See Section 3.2.4 for examples of how the emergency regulation has been applied in the past.

Adverse impacts: ONMS finds that extension of the time frame that an emergency regulation can be in place would further resource protection within the sanctuary and is unlikely to result in any adverse impacts to biological species or habitat. All emergency response activities would be conducted in a manner that is consistent with sanctuary regulations and other environmental statutes in order to protect biological resources. Any adverse impacts to biological resources associated with FKNMS-authorized vessel operations or other emergency response activities are described in Table 5.2. **No additional adverse impacts** to biological resources are expected from the proposed modification to the emergency regulations beyond those already described for currently existing field operations and management of the sanctuary in Section 5.2.1.

Proposed sanctuary-wide regulation update: Historical resources permit categories

Beneficial impacts: Some historical resources function in the marine environment as structures that provide valuable three-dimensional habitat for marine life. Disturbance of the historical resource not only jeopardizes its preservation, but also reduces its value as habitat for marine biota. Protecting this role is recognized in the new archaeological research permit category that would require proposals for archaeological research to be scientifically-based investigations that result in the least amount of disturbance to the historical resource needed to answer project research questions. Similarly, the new archaeological research permit category would require that investigators provide a scientifically-justified rationale for excavations that disturb substrate or sediment while searching for or investigating historical resources. Constraining excavation activities conducted under an archaeological research permit to only those necessary to answer research questions would also protect water quality through impacts

from turbidity caused by sediment disturbance. Given that the proposed regulation would protect sunken artifacts that provide habitat for marine biota and would reduce the possibility of increased turbidity associated with excavation of sunken historical artifacts, the proposed update would result in **less than significant, beneficial impacts** to biological resources.

Adverse impacts: The proposed regulatory update would not increase the amount of research or other activities that could result in adverse impacts to biological resources. Therefore, **no additional adverse impacts** beyond the impacts applicable to all alternatives (see Section 5.2.1) would result from the proposed regulatory change.

Proposed new sanctuary-wide regulation: Prohibit fish feeding

Beneficial impacts: The proposed new regulation would clarify prohibitions specific to the practice of fish feeding and would reduce negative effects on wildlife behavior associated with fish feeding and habituation of some wildlife to areas where fish feeding is common. Fish that are often fed from boats or by divers begin anticipating such food and may alter or stop normal foraging patterns. In addition, the food offered from vessels or by divers is generally low quality and provides minimal nutrients to fish. Hand-fed fish may become malnourished, stressed, and even die. Fish feeding can also result in changes to fish community structure and dynamics because certain fish species tend to benefit more from human food than others. The proposed regulation would result in **direct** and **less than significant, beneficial** impacts because these adverse outcomes would be avoided.

Adverse impacts: ONMS concluded that this proposed new regulation would not change human behavior or the type or intensity of activities occurring within the sanctuary in a manner that would result in adverse impacts to biological resources. **No adverse impacts** to biological resources are expected from the implementation of this new prohibition on fish feeding.

Proposed new sanctuary-wide regulation: Reduce impacts from vessel groundings, deserted vessels, and harmful matter

Beneficial impacts: The proposed new regulations related to derelict and deserted vessels and leaving harmful matter aboard such vessels would have both **direct** and **indirect, significant, beneficial** impacts on habitats and wildlife within the expanded sanctuary. These proposed regulations are intended to reduce the number of derelict and deserted vessels and the length of time they may be present in the sanctuary. This could result in avoided direct adverse impacts on habitats such as scouring of sediment; destroying, shading, and covering seagrass; and breaking hardbottom and coral. These adverse impacts can all be exacerbated if the vessel breaks apart, is moved great distances in storm events, or deteriorates. Other impacts harmful to the biological environment that may be reduced by the implementation of these new regulations would include the release of toxic paint, chemicals, petroleum products and other contaminants, and debris from both the vessel and matter left aboard the vessel. These disturbances can be locally **significant** and given the overall size of the sanctuary and number of derelict vessels that occur, can also be cumulatively **significant**. As vessel traffic continues to increase throughout the Florida Keys, the need to better regulate damage from these impacts, establish improved standards regarding damage assessment procedures, and improve notice and response time increases as well. Prohibiting these activities and requiring notification and a removal plan could decrease and shorten the duration of potential impact from derelict and

deserted vessels, resulting in an overall **direct, significant benefit** to biological resources within the sanctuary.

Adverse impacts: These proposed new regulations could result in **direct, less than significant, adverse** impacts to biological resources during derelict vessel removal due to the minimal potential for localized decline in water quality associated with accidental spills or leaks. Fuel, lubricant, sewage, garbage, or other contaminants could accidentally leak or spill from derelict vessels or sanctuary vessels during removal operations. Adherence to ONMS best management practices and the NOAA Small Boat Program's standard operating procedures would also minimize potential for adverse impacts.

Proposed new sanctuary-wide regulation: Implement regulations for large vessel and overnight mooring buoy use

Beneficial impacts: Mooring buoys have been used successfully in the sanctuary to minimize the direct impacts of anchoring and the cumulative effects of overuse of sanctuary resources. When used, monitored, and managed properly, mooring buoys have **beneficial** impacts on wildlife and habitats by minimizing anchor damage and controlling resource use. Under Alternative 2, proposed mooring buoy regulations would implement vessel size limits at buoys in sensitive and/or high use areas, prohibit general overnight use of mooring buoys, and designate large vessel mooring buoys. These regulatory changes would have a **direct, beneficial, less than significant** impact on coral and hardbottom habitat in the areas where mooring buoys would be located by reducing physical damage from anchoring. The large buoy hardware used and installation process would be specifically designed to withstand the size and weight of larger vessels and would therefore have less likelihood of breaking and impacting benthic habitat in which the mooring hardware is embedded. The proposed vessel size limitation for use of mooring buoys would minimize damage to the coral reef and reef structure, result in healthier reefs, and facilitate reef restoration activities. The impact of prohibiting overnight use of mooring buoys would depend upon the activities overnight moored vessels are undertaking.

Adverse impacts: The adoption and implementation of proposed revised mooring buoy regulations would allow access to mooring buoys that, wherever provided, may result in **direct, adverse, less than significant** impacts to corals or hardbottom habitat. Localized habitat damage could occur where mooring buoys are installed because the buoys attract more users to these areas. In particular, the proposed regulation would facilitate the use of certain mooring buoys by larger vessels. Installation of substantial mounting hardware for large vessel buoys could result in localized disturbance of benthic habitats, immobile biota, and biota that are unable to move away from the area prior to the disturbance.

5.4.1.3 Impacts to biological resources from revisions to marine zone boundaries and regulations (Alternative 2)

Under Alternative 2, ONMS would modify existing marine zones and create new marine zones to provide additional protection for specific habitat types, habitat areas that are heavily impacted by human use, and wildlife associated with these habitats. The total number of marine zones would increase from 57 to 96. In addition, ONMS would revise regulations governing uses of

individual marine zones. See Section 3.6 for details on the individual marine zones, and Section 3.3 for a summary of access restrictions in the marine zones.

The discussion of impacts below is divided into four marine zone types and two proposed regulatory changes: (1) WMAs, (2) SPAs, (3) CAs, (4) MAs, (5) revision of baitfish and catch and release fishing prohibitions, and (6) revision of motorized PWC use restrictions.

The general benefits of modifying existing marine zones, establishing new marine zones, and updating regulations applied in these areas would be increased protection of vulnerable habitats and their associated species, including ESA-listed species, critical habitat, and EFH. Species abundance, diversity, and distribution are intricately related to the habitats within the Florida Keys that those species depend on for their survival. Many species in the Florida Keys are vulnerable to changing habitat conditions, and their populations may be supported by protecting the various habitats that species use throughout their life.

Proposed marine zone modification: Wildlife management areas

There are 28 WMAs in the current FKNMS. Under Alternative 2, ONMS would revise the boundaries of some existing WMAs and create 31 new WMAs. WMAs are primarily designed to protect shallow water and near shore habitats and the critical wildlife dependent upon those habitats, especially birds and ESA-listed threatened or endangered species (NOAA, 1997). Each WMA would have zone-specific regulations designed to meet the resource protection needs of the zoned area.

In Alternative 2, ONMS would implement access restrictions in each WMA, including idle speed no-wake, no-motor, no-anchor, and a limited number of no-entry areas. In addition, ONMS would modify the existing no-access buffer zone and closed zone regulations to no-entry zone to be consistent with the intent of these existing regulations and similar state regulations. By modifying access restrictions, ONMS aims to reduce impacts to benthic habitats from prop scarring, anchor damage, and impacts to wildlife species, including interrupting foraging sea turtles and birds and flushing nesting and roosting birds.

Beneficial impacts: Under Alternative 2, implementing the proposed modified and new WMAs would have **direct, beneficial** impacts on the habitats included in the proposed WMAs as well as wildlife included within or associated with each WMA. The WMAs proposed under Alternative 2 would protect new habitat types, including hardbottom and shallow bank habitats. A sampling of the wildlife these marine zones aim to support includes: roosting, nesting and foraging birds; nesting and foraging sea turtles; and juvenile fish. Modifications to WMA zones and implementing new WMAs would also have an **indirect, beneficial** impact on mangrove habitats by restricting access to certain zones that encircle or are adjacent to mangrove coastlines and/or islands. Additionally, implementing access restrictions in WMAs would provide **direct, beneficial** impacts to biological resources by reducing overuse of sanctuary resources and limiting habitat degradation that can disrupt the community structure of an area. A selection of modified or new WMAs, proposed in Alternative 2, are described below to provide specific examples of the direct and indirect beneficial impacts to habitat and wildlife associated with implementing this alternative. Except where otherwise stated below, these beneficial impacts would be **less than significant**.

New Whitmore Bight WMA: Under Alternative 2, ONMS would implement a proposed new no-motor WMA at Whitmore Bight, which would have **direct, beneficial** impacts on hardbottom habitat and associated invertebrate and juvenile fish species in this new WMA. This action would provide a new approach for protecting hardbottom habitat and associated fish in this WMA.

Expanding Snake Creek and Cotton Key WMAs and New Marathon Oceanside WMA: Under Alternative 2, ONMS would expand two existing no-motor WMAs, Snake Creek and Cotton Key, to include additional areas with known impacts to seagrass from prop-scarring. Including these areas in the WMAs would provide **direct, beneficial** impacts to seagrass. For much the same reason, implementing the proposed new speed-restricted Marathon Oceanside Shoreline WMA under Alternative 2 would provide **direct, beneficial** impacts to heavily prop-scar-impacted seagrass areas by minimizing the potential for further habitat disturbance or destruction.

New Gulfside Banks and Moser Channel WMAs: Under Alternative 2, ONMS would implement proposed new idle speed no-wake marine zones at Gulfside Banks and Moser Channel. This would provide **direct, beneficial** impacts to shallow water seagrass and hardbottom habitats that support juvenile invertebrate and fish species.

New WMAs in the Florida Keys Wildlife Refuge Complex: Under Alternative 2, ONMS would implement several proposed new no-motor zones in the Florida Keys Wildlife Refuge Complex that would provide **direct, beneficial** impacts to bird species that use these areas for nesting, roosting, and/or foraging. These proposed zones would also have **direct, beneficial** impacts on shallow water habitat and associated wildlife and mangroves, where the marine zone encompasses a mangrove island.

Within the Florida Keys Wildlife Refuge Complex, wading bird and seabird species forage during specific windows of the tidal cycle when prey species can be found at accessible water depths in seagrass and hardbottom habitats. Adopting the proposed modified and proposed new speed-restriction, no-motor, and no-entry marine zones in Alternative 2 would minimize disturbance to the most critical seagrass and hardbottom areas used for foraging and would provide a **significant, direct, beneficial** impact to numerous bird species who forage in these habitats. By minimizing disturbance, these proposed marine zones would provide a **significant, direct, beneficial** impact to over 16 species of state-threatened nesting and roosting birds on mangrove islands, intratidal, and beach berm habitats adjacent to the zones. Numerous research studies have documented the negative impacts of human disturbance on breeding bird colonies (Vos et al., 1985; Carney & Sydeman, 1999). The use of 100-yard (300 feet/100 m) no-motor buffers around nesting colonies and roosting and foraging areas would alleviate many of these negative effects (Burger et al., 1995; Rodgers & Smith, 1995; Rodgers & Smith, 1997; Carney & Sydeman, 1999).

New Western Dry Rocks WMA: Under Alternative 2, ONMS would implement a proposed new WMA at Western Dry Rocks, which would provide **direct, beneficial** impacts to habitats and wildlife, particularly fish species, which use this area for spawning. The trolling-only regulation proposed at this site would facilitate these benefits.

New Marquesas Keys Turtle WMA: Under Alternative 2, ONMS would implement the proposed new speed-restricted Marquesas Keys Turtle WMA, which would provide **significant, direct, beneficial** impacts to seagrass habitats that are recognized as internationally important foraging areas for green sea turtles. Enacting speed restrictions would reduce adverse impacts to seagrass habitats and foraging areas by decreasing the risk of propeller-related damage.

Adverse impacts: The proposed new WMAs or modifications to existing WMAs and implementation of speed restrictions would expand protection of habitat and wildlife and include additional habitat types not currently well-represented in the FKNMS marine zones. This would reduce the risk of adverse impacts to biological resources from human use of these areas. ONMS does not anticipate that revising WMA boundaries or speed restrictions would result in adverse impacts to biological resources because the speed restrictions and boundary changes would not increase use of these areas or result in a higher risk of interactions between humans and sensitive wildlife or habitats. As such, **no adverse impacts** to biological resources are expected from the proposed modified or new WMAs.

Proposed marine zone modification: Sanctuary preservation areas

FKNMS currently includes 18 SPAs, which are areas set aside to protect shallow coral reefs along the reef tract. Under Alternative 2, ONMS would revise the boundaries of some existing SPAs and create six new SPAs. SPAs are primarily designed to protect shallow, heavily-used coral reef communities where conflicts between user groups occur (NOAA, 1997), particularly between fishing activities and diving/snorkeling activities. Due to the existing sanctuary-wide regulation prohibiting anchoring on live coral, the placement of mooring buoys to facilitate compliance with the anchoring prohibition, and the SPA-specific regulation prohibiting the take of marine species, SPAs also serve to protect the habitats within their zone boundaries. Under Alternative 2, ONMS would also revise SPA regulations to be consistent across all SPAs and add idle speed no-wake and no-anchor restrictions. Under Alternative 2, ONMS would implement two modifications related to fishing within SPAs: eliminate (1) the issuance of baitfish permits, and (2) the exception for catch and release fishing in four SPAs (Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key). As described above, these proposed regulatory changes are designed to create more consistency in the allowed and restricted activities in SPAs. This change would also provide greater clarity for users of SPAs and enhance compliance with sanctuary regulations.

Beneficial impacts: In Alternative 2, ONMS would modify existing SPAs and propose new SPAs which would have a **direct, beneficial** impact on habitats that are added to existing marine zones or are newly protected through proposed new zones. This **direct** benefit would extend to wildlife that have a small home range and may remain within the zoned area for their full life cycle. This action could also have an **indirect, beneficial** impact on more motile or pelagic species that have a larger home range than the area proposed for inclusion in the SPAs. Some of the proposed modified or new SPAs are designed to specifically include known fish aggregation sites, which would have a **direct, beneficial** impact for those fish species. Under Alternative 2, ONMS would also propose specific SPAs that are targeted for ecosystem restoration, which would provide benefits to resources within these areas and to advancing research and understanding of restoration techniques.

The proposed modification to eliminate the issuance of baitfish permits would have a **negligible** impact on the target baitfish species because collecting baitfish is not restricted in the non-zoned areas of the sanctuary, and therefore collecting baitfish would continue in non-zoned areas. Reduced baitfish availability has been documented to impact numerous seabird and wading bird populations (Gawlik, 2002; Cury et al., 2011; Sherley et al., 2015; Essington et al., 2015). Therefore, depending on shifting fishing effort and any potential decrease of baitfish extraction, the proposed regulation would have an **indirect, beneficial** impact on baitfish-dependent birds and other species higher on the trophic chain (e.g., barracuda, dolphins, wading birds, and seabirds) that eat the baitfish species. This beneficial impact would be less than significant.

The proposed modification to remove the existing exception that currently allows catch and release fishing in four SPAs (Conch Reef, Alligator Reef, Sombrero Reef, and Sand Key) would have a **direct, negligible** impact on the wildlife of the Florida Keys, specifically those pelagic fish species targeted for catch and release in these deeper reef areas. Similar to the impacts to baitfish species described above, this benefit would be negligible because catch and release fishing would continue unrestricted in the non-zoned areas of the sanctuary outside of SPAs.

These direct and indirect benefits to biological resources are expected to be **less than significant** because of the moderate increase in the size of the zones managed as SPAs. A selection of modified or new SPAs, proposed in Alternative 2, are described below to provide specific examples of the **direct, beneficial** impacts to habitat and wildlife associated with implementing this alternative:

Expanding Carysfort Reef SPA; expanding Key Largo Dry Rocks and Grecian Rocks SPA: Under Alternative 2, ONMS would modify the existing Carysfort Reef SPA to include an area of deep reef habitat and a historical fish aggregation site, which would have a **direct, beneficial** impact on these reef habitats and associated wildlife by expanding protections and regulations to these new areas. In addition, ONMS would combine and expand the existing Key Largo Dry Rocks and Grecian Rocks SPAs to include an area at North Dry Rocks that would protect an area containing one of the largest remaining healthy populations of ESA-listed star corals on outer reefs in the Upper Keys. This action to expand regulatory protections to these habitats would have a **direct, beneficial** impact on these reef habitats and associated wildlife, particularly furthering the protection of threatened star corals present in these areas.

Expanding Alligator Reef SPA: Under Alternative 2, ONMS would expand the existing Alligator Reef SPA seaward to protect deeper reef habitats and to include a historical fish aggregation site. This action would have a **direct, beneficial** impact on these habitats and associated wildlife that would be newly protected from human activities that could cause adverse impacts to reef habitats, such as anchor damage or impacts from fishing gear.

New Turtle Rocks SPA and new Turtle Shoals SPA: Under Alternative 2, ONMS would implement two new SPAs, Turtle Rocks and Turtle Shoals, in order to protect patch reef coral habitats, which are not well represented in the current marine zoning scheme. This action would have a **direct, beneficial** impact on these reef habitats and associated wildlife by reducing or minimizing potential adverse impacts associated with human use of these sensitive areas.

Additionally, ONMS would propose protections at Turtle Rocks that would enhance the no lobster trap gear regulations implemented at this site by John Pennekamp Coral Reef State Park.

Expanding Western Sambo SPA: Under Alternative 2, ONMS would include the existing Western Sambo ER as a SPA and continue to allow the current level of access to this area. In Alternative 2, ONMS would also expand Western Sambo seaward to include additional deep reef habitat known to be important for the spiny lobster life cycle (Bertelson, 2013, 2009). This proposed expansion would provide **direct, beneficial** impacts for these deeper reef habitats and associated wildlife by protecting important habitat for spiny lobster from adverse impacts of human use of this area, such as anchor damage and fishing gear.

New Tortugas Corridor SPA: Under Alternative 2, ONMS would implement a new SPA in the Tortugas Corridor in the Tortugas region. This area is known to serve as a transit corridor between Tortugas ER South and Dry Tortugas National Park for spawning fish. This proposed new zone would provide **direct, beneficial** impacts by protecting the fish species transiting through this area from human disturbance.

New Pickles Reef, Marathon, Delta Shoals, and Key West SPAs: Under Alternative 2, ONMS would implement four new SPAs as coral restoration demonstration sites. These sites are Pickles Reef, Marathon, Delta Shoals, and Key West SPAs. These areas are currently active coral reef nursery and/or restoration sites. By creating marine zones at these sites and applying SPA regulations, the sanctuary would protect the nursery coral from anchor damage and potential impacts from fishing gear while also allowing the public to access and learn about coral restoration efforts. These proposed new zones would provide **direct, beneficial** impacts to the habitats and coral nursery sites. Additional activities to facilitate ecosystem restoration for coral nursery sites are included in the final management plan (see Section 3.5 for more details).

Adverse impacts: The proposed new SPAs, modifications to existing SPAs, and implementation of restrictions on fishing gear use and vessel anchoring would expand the protection of habitat and wildlife and include additional habitat types not currently well represented in FKNMS marine zones. This would reduce the risk of adverse impacts to biological resources from human use of these areas. ONMS does not anticipate that revising SPA boundaries or implementing regulatory restrictions would result in adverse impacts to biological resources because these changes would not increase human use of these areas or result in a higher frequency of interactions between humans and sensitive wildlife or habitats. **No adverse impacts** to biological resources are expected from the proposed modified or new SPAs.

ONMS does not anticipate that eliminating baitfish permitting and revising regulatory restrictions on catch and release fishing in SPAs would result in adverse impacts to biological resources because these changes would not increase human use of the sanctuary or result in a higher frequency of interactions between humans and sensitive wildlife or habitats. Although some bait fishing that would have occurred within a SPA may now occur in other parts of the sanctuary, ONMS does not expect that this action would increase the intensity of bait fishing in other areas of the sanctuary where these restrictions are not in place at such a scale that it would cause adverse impacts to baitfish populations in the Florida Keys or other wildlife and habitats.

No adverse impacts to biological resources are expected from the proposed regulatory changes in SPAs.

Proposed marine zone modification: Conservation areas

Under Alternative 2, ONMS would adopt CAs as a new marine zone type that would replace the existing SUA and ER zones. There are currently four SUAs and two ERs in FKNMS. Under Alternative 2, ONMS would create eight CAs, which includes the existing four SUAs and two ERs. FKNMS staff would continue to manage CAs consistent with the original intent of SUAs and ERs. SUAs were intended to address the need for education, science, restoration, monitoring, or research. ERs were designed to maintain a natural assemblage of living resources in the sanctuary by setting aside areas to ensure minimal human disturbance (NOAA, 1997). Under Alternative 2, the current transit-only regulation applicable in SUAs and ERs would continue to apply in the new CAs.

Beneficial impacts: Under Alternative 2, applying the transit-only regulation in areas proposed as CAs would limit degradation of habitats and potential loss of wildlife in these zones. In addition, implementing CAs would have **direct, beneficial** impacts on the habitats and wildlife included in the proposed marine zones. This action would expand regulatory protections restricting human use of these areas to additional habitat types not currently well represented in the FKNMS marine zones, specifically hardbottom, bank, and seagrass, providing **direct, beneficial** impacts to these habitats and the species that depend on them. The impacts of proposed changes to CAs and access restrictions would be **less than significant** because of the moderate change in the area of marine zones protected as CAs. A selection of modified or new CAs, proposed in Alternative 2, are described below to provide specific examples of the **direct, beneficial** impacts to habitat and wildlife associated with implementing this alternative:

New Channel Key Bank and Red Bay Bank CAs: Under Alternative 2, ONMS would propose two new CAs, Channel Key Bank and Red Bay Bank, to protect hardbottom and bank habitats, both of which are not well represented in the current zoning scheme. Managing these new areas as CAs would have a **direct, beneficial** impact on the associated habitats and wildlife in this area by minimizing the interactions between human use and wildlife and facilitating continued research and restoration activities in these areas. These proposed CAs are associated with other new idle speed no-wake WMAs, proposed in Alternative 2, that are intended to address impacts to benthic habitats and associated wildlife from vessel prop scarring (see the above WMA section and Section 3.6 for more details).

Expanding Tennessee Reef CA: Under Alternative 2, ONMS would expand the Tennessee Reef CA (currently referred to as a SUA) to include deep reef habitats which are not well represented in the current zoning scheme. The expansion of this CA would have **direct, beneficial** impacts on the habitats and wildlife that reside or forage in this area.

Expanding Tortugas South CA: Under Alternative 2, ONMS would expand the Tortugas South CA (currently referred to as an ER) to include an additional area to the west of the existing boundary that includes ecological features associated with Riley's Hump and is known to support multi-species fish spawning aggregations. This proposed modification would have a **direct, beneficial** impact on the associated habitats and wildlife using this area through the additional spatial protections and applications of CA regulations.

Adverse impacts: The management and implementation of CAs as proposed in Alternative 2 would expand the areas within the Florida Keys that are afforded protection from human disturbance and set aside for monitoring, research, restoration, or education. This would reduce the risk of adverse impacts to biological resources from human use of these areas. ONMS does not anticipate that creating CAs and applying current regulatory restrictions to these new areas would result in adverse impacts to biological resources because these changes would not increase human use of these areas or result in a higher frequency of interactions between humans and sensitive wildlife or habitats. **No adverse impacts** to biological resources are expected from the proposed modified or new areas included as CAs.

Proposed marine zone modification: Existing management areas

EMAs are those marine zones that were already in place at the time FKNMS was designated. These zones include what at the time of designation were the Key Largo and Looe Key National Marine Sanctuaries and the four national wildlife refuges that make up the Florida National Wildlife Refuge Complex. In addition, a suite of parks and similar areas managed by the state of Florida that existed at the time of sanctuary designation are referred to as EMAs. Under Alternative 2, ONMS would change the zone name for these areas from “EMAs” to “MAs.” This proposal would not create any new MAs and would only modify the spatial area of Looe Key MA (described below and depicted in Section 3.6). As a result, for all but Looe Key, ONMS expects that this proposed name change would have no impact on biological resources because the change is purely administrative and would not impact management of these areas or the activities occurring in these areas.

Additionally, under Alternative 2, ONMS would implement two regulatory changes: (1) no anchoring in Key Largo and Looe Key MAs, and (2) allowing PWC use in a small portion of Key West National Wildlife Refuge.

Decreasing Looe Key MA: Under Alternative 2, ONMS would decrease the Looe Key MA to include only the western portion of the existing Looe Key MA. The remaining area would be included in a larger Looe Key SPA. This change to the Looe Key MA and Looe Key SPA would have **direct, beneficial** impacts on the habitats and wildlife that reside or forage in this area due to the additional protections afforded by the SPA regulations including no take and no anchoring.

Beneficial impacts: The no-anchor prohibition that would be applicable to the Key Largo and Looe Key MAs would have a **direct, significant, beneficial** impact on habitat and associated wildlife that live or forage in these management areas. These beneficial impacts would be significant, particularly to the Key Largo MA, because the proposed no-anchor prohibition would be applied to a large area, thus providing long-term benefits to species that inhabit, forage, or transit in these areas. Prohibiting vessel anchoring would have the direct impact of protecting the coral and hardbottom habitats within this area from the potential impacts of anchor and anchor chain damage. Avoiding impacts to coral and hardbottom habitats would result in an **indirect, beneficial** impact to wildlife associated with these habitat types by preventing disturbance of these habitats. The impacts of the regulatory change related to PWC use in the Key West National Wildlife Refuge are discussed below (see Marine zone modification: Motorized PWC).

Adverse impacts: Implementing a prohibition on anchoring within the Key Largo and Looe Key MAs would not result in adverse impacts to biological resources because this regulatory change would not increase human use of these MAs or result in a higher likelihood of interactions between humans and sensitive wildlife or habitats. ONMS does not expect that this action would shift vessel anchoring activity to other areas of the sanctuary where these restrictions are not in place at such a scale that it would cause adverse impacts to other wildlife and habitats. **No adverse impacts** to biological resources are expected from the proposed new or modified regulations applied in these MAs.

Proposed marine zone modification: Motorized personal watercraft

Under Alternative 2, ONMS would revise existing regulations related to motorized PWC use in FKNMS to allow PWC access to a small portion of Key West National Wildlife Refuge. Under current FKNMS regulations, PWCs are prohibited throughout the Florida Keys National Wildlife Refuge Complex. This proposed update is not expected to increase the overall number of PWC operating in the area but, rather, it is intended to allow for a minor shift in the area where PWCs can operate.

Beneficial impacts: This modification is proposed largely to address a human safety and user conflict issue related to PWC use in Key West. This proposal also has the potential to benefit wildlife in this area, particularly tarpon that are known to congregate in and around this area during their spring migration. The proposed change would move PWC use away from areas frequently used by tarpon and thus reduce the likelihood of vessel disturbance of this species. This would provide a **direct, beneficial** impact to biological resources by reducing disturbance to wildlife in the area. This beneficial impact would be **less than significant** because of the small size of the area where PWC use would be allowed.

Adverse impacts: ONMS anticipates that this proposed regulatory change would result in a minor change in the level of PWC use compared to existing levels. Currently, the area of Key West National Wildlife Refuge where PWC use would be permitted is an area with other recreational vessel activity. As such, many organisms occurring in this area are likely tolerant of human activity or avoid human activity. As a result, this proposed regulatory change would likely result in **negligible, adverse** impacts to marine wildlife from disturbance due to use of PWC in the new area.

5.4.1.4 Impacts to biological resources from updates to the FKNMS management plan (Alternative 2)

Under Alternative 2, FKNMS would adopt a proposed updated management plan which includes non-regulatory actions that NOAA would implement to further protect and manage sanctuary resources. See Appendix A for the final management plan.

Beneficial impacts: The updated management plan activities proposed under Alternative 2 would provide **direct, long-term benefits** to living marine and marine-dependent resources in FKNMS. The management plan goals and associated activities are intended to increase understanding of sanctuary resources, to maintain and improve sanctuary resources, and to maintain or increase efforts to reduce threats to sanctuary resources. FKNMS staff would undertake the following activities to work toward achieving these goals: developing a sanctuary

restoration plan, testing new ecological restoration approaches, facilitating recovery of ESA-listed coral species, evaluating fishing gear impacts to sanctuary resources, developing best management practices to mitigate impacts, and working with fishery management agency partners to further ecosystem-based management approaches and advance understanding and management of fish aggregation sites. Under Alternative 2, ONMS is also proposing to conduct several activities focused on managing human uses of the sanctuary that may impact sanctuary resources and facilitating a strengthened stewardship ethic. These would include: implementing an updated marine zoning scheme, working with users to inform placement of mooring buoys, implementing a voluntary boater education course, and maintaining and enhancing the Blue Star programs.

These routine education, outreach, research, monitoring, and resource protection activities and coordination with stakeholders would have **indirect, beneficial** impacts on the biological resources within FKNMS. These management plan activities would promote ocean literacy and stewardship, and improve the understanding, management, and protection of the sanctuary's biological resources, which provide **indirect, beneficial** impacts to habitat, wildlife, and protected species in FKNMS. By promoting ocean stewardship principles with partners, local communities, and the general public, FKNMS has the opportunity to influence the behavior and decision-making of individuals, businesses, communities, organizations, and agencies in ways that could **indirectly benefit** biological resources within the sanctuary.

In general, updating the management plan would allow for a more coordinated and priority-driven effort and, as a result, would support more effective management and conservation-based outcomes for FKNMS. Beneficial impacts to biological resources from revised management plan activities would be **less than significant** because they would not result in a significant change in the state of sanctuary resources over the five-to-10-year lifetime of the management plan.

Adverse impacts: Under Alternative 2, some adverse impacts may occur when implementing activities described in the management plan, such as educational outreach activities, research activities, enforcement activities, and vessel and aircraft operations. Potential adverse impacts associated with these field activities are described in Table 5.2. If ONMS implemented Alternative 2, the potential adverse impacts described in Table 5.2 would be spread over a larger area because this alternative would expand the boundary of the sanctuary. ONMS does not expect that expanding these activities over a larger area would change the intensity of the impacts. As described in Section 5.2.1, these adverse impacts to physical resources would be **direct** and **less than significant**. Consistent with the analysis of field operations in final EIS Appendix L, ONMS expects that these **direct** and **indirect, adverse effects would be less than significant** because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment.

5.4.2 Impacts to physical resources (Alternative 2)

This section describes the impacts to physical resources that would occur under Alternative 2. The resource areas analyzed here are oceanography, climate, climate change, and water quality.

5.4.2.1 Impacts to physical resources from proposed sanctuary boundary expansion (Alternative 2)

Under Alternative 2, ONMS would expand the boundary of FKNMS as described above.

Beneficial impacts: Under Alternative 2, the application of current regulations regarding discharge or deposit of materials or other matter into waters of the sanctuary would provide both **direct** and **indirect** benefits to the water quality of the sanctuary and its resources, which includes the habitats and wildlife of the Florida Keys. The sanctuary-wide prohibitions at 15 C.F.R. § 922.163 would apply in the expanded areas proposed in Alternative 2. The application of these regulatory prohibitions to the expansion areas proposed under Alternative 2 would have a **less than significant, beneficial** impact on water quality in FKNMS.

For the proposed boundary expansion areas included in Alternative 2, hardbottom and coral reef habitats would benefit from improved water quality. The application of existing sanctuary regulations regarding discharge and human use to newly-expanded areas would provide **direct, beneficial** impacts to water quality by minimizing potential pollution and discharge related to vessel transit, operations, and accidental spills or leaks.

In addition, the proposed boundary expansion could result in **indirect, beneficial** impacts by increasing potential for carbon sequestration within mangrove and seagrass habitats that would be newly protected under Alternative 2. The inclusion of the Tortugas area in FKNMS would have an **indirect, beneficial** impact as the existing sanctuary-wide prohibition on mineral and hydrocarbon exploration, development, and production would apply in this proposed expansion area. Implementing Alternative 2 would therefore avoid emissions associated with any mineral and hydrocarbon exploration, development, and production that could otherwise have taken place in these areas. As indicated through consultation with the Bureau of Ocean Energy Management (BOEM), this activity was not likely to occur in the boundary expansion areas regardless of whether they were included in the sanctuary or not. However, the hardbottom and coral reef habitats in the proposed expansion area would benefit through application of sanctuary-wide regulations restricting this activity.

These beneficial impacts would be **less than significant** because of the small scale of the boundary expansion relative to the existing boundary. Under Alternative 2, no regulatory changes are proposed that would restrict vessel emissions. Therefore, ONMS expects no direct or indirect impact on the level of vessel emissions resulting from activities conducted within the sanctuary, and therefore no long-term effect on atmospheric CO₂ impacts on climate change.

Adverse impacts: Expansion of the sanctuary boundary would spread the adverse impacts of current field operations on physical resources (summarized in Table 5.2) over a larger geographic area. As described in Section 5.2.1, these adverse impacts to physical resources would be **direct** and **less than significant**. Consistent with the analysis in final EIS Appendix L, ONMS expects that these adverse effects of field operations would not be significant because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment (NOAA, 2018b). In addition to these current sanctuary regulations, any additional impacts to physical resources in the current sanctuary and proposed expansion area from proposed

sanctuary wide-regulatory changes, changes to marine zones and related regulations, and the revised management plan are discussed below in sections 5.4.2.2 through 5.4.2.4. Overall, the beneficial impacts to physical resources would outweigh the **negligible** and **less than significant** adverse impacts from expanding the site boundary.

5.4.2.2 Impacts to physical resources from additions and revisions to sanctuary-wide regulations (Alternative 2)

The potential beneficial and adverse impacts to physical resources of each of the additions or updates to sanctuary-wide regulations, proposed under Alternative 2, are discussed below:

Proposed sanctuary-wide regulation update: Prohibit certain cruise ship discharges

Beneficial impacts: Under Alternative 2, ONMS would revise the sanctuary-wide regulations to prohibit certain discharges from cruise ships, such as graywater, scrubber wash water, and other discharges that occur during vessel operations. This proposed update would increase protection of water quality and sanctuary resources from pollutants present in cruise ship discharges. While cruise ship discharges can impact water quality, impacts depend on the characteristics of the discharge (e.g., constituents present, levels of discharge) and the characteristics of the receiving waters (e.g., currents, temperature). Overall, the proposed prohibition of certain discharges from cruise ships would have a **direct, beneficial** impact on water quality in the area transited by the cruise ship and **indirect** impacts in areas further from the source where the water may disperse. These effects to water quality would be **less than significant** given that cruise ships transverse through a relatively small portion of the sanctuary.

Adverse impacts: Implementing the prohibition for certain discharges from cruise ships as proposed in Alternative 2 would not change the level or intensity of current cruise ship activity in FKNMS. Therefore, the proposed regulatory change would have **no adverse** impacts on oceanography, climate, climate change, or water quality in FKNMS.

Proposed sanctuary-wide regulation update: Extend time period for emergency regulations

Beneficial impacts: The proposed modification to the existing emergency regulation at 15 C.F.R. § 922.165 would extend the amount of time that an emergency regulation could be in place. This could have a **direct, beneficial** impact on water quality in the existing and proposed boundary expansion areas if an emergency regulation were established to reduce a direct threat to water quality. The significance of these beneficial impacts would depend upon the specific threat to sanctuary resources that this management action would be intended to address.

Adverse impacts: ONMS concluded that extension of the timeframe that an emergency regulation can be in place would further resource protection within the sanctuary and is unlikely to result in any adverse impacts to water quality or other physical resources. All emergency response activities would be conducted in a manner consistent with sanctuary regulations and other statutory requirements in order to protect physical resources. Any adverse impacts to physical resources associated with FKNMS-authorized vessel operations or other emergency

response activities are described in Table 5.2. **No adverse impacts** to physical resources are expected from the proposed modification to emergency regulations under Alternative 2.

Proposed sanctuary-wide regulation update: Historical resources permit categories

Beneficial impacts: Historical resource preservation is intimately linked with the physical environment in which the historical resource resides. After a period of degradation, historical resources reach equilibrium with the environment and deterioration slows. ONMS has determined that *in situ* preservation of historical resources is preferred. Limiting excavations to only those necessary to answer scientifically-proposed research questions would reduce impacts to the physical environment. Excavations directed at locating or uncovering historical resources disturb the seafloor and change its character. Additionally, the increased turbidity associated with excavation may degrade water quality by suspending long-buried sediment. Recognizing that human disturbance to historical resources not only affects the resource's preservation, but also its surrounding physical environment, the proposed historical resources permit category update would result in increased scrutiny of research methodologies to ensure that any proposed excavations are scientifically justified. Given that review of proposed excavations under the new archaeological research permit category is expected to reduce direct changes to the seafloor, sediment disturbance, and turbidity, the proposed regulatory update would result in **direct, less than significant, beneficial** impacts to physical resources.

Adverse impacts: This proposed regulatory update would not increase the amount of research or other activities that could result in adverse impacts to physical resources. Therefore, **no additional adverse** impacts beyond those impacts applicable to all alternatives (see Section 5.2.1) would result from the proposed regulatory change.

Proposed new sanctuary-wide regulation: Prohibit fish feeding

Beneficial impacts: Under Alternative 2, the proposed new prohibition of fish feeding in FKNMS would have a **less than significant, beneficial** impact on water quality by reducing localized degradation of sanctuary water quality. While the known practice of fish feeding from vessels is minimal, this prohibition would restrict any additional input of fish food and other products intended to feed and attract fish that could also have an adverse impact on water quality in the immediate and surrounding areas of fish feeding activities. This proposed regulation would have no impact on climate change or oceanographic conditions.

Adverse impacts: This action would not change human behavior or activities occurring within the sanctuary in a manner that would result in adverse impacts to physical resources. **No adverse** impacts to physical resources are expected from this proposed new regulation on fish feeding.

Proposed new sanctuary-wide regulation: Reduce impacts from vessel groundings, deserted vessels, and harmful matter

Beneficial impacts: The proposed new regulations related to derelict and deserted vessels and leaving harmful matter aboard such vessels would reduce localized degradation of sanctuary water quality. Prohibiting these activities and requiring notification and a removal plan would decrease and shorten the duration of potential adverse impacts to water quality from derelict

and deserted vessels. This would result in both **direct** and **indirect, less than significant, beneficial** impacts on water quality within the sanctuary in both the existing and proposed expanded areas.

Adverse impacts: Due to the minimal potential for localized decline in water quality associated with accidental spills or leaks, **less than significant, adverse** impacts would occur from this proposed regulation. Adherence to ONMS best management practices and the NOAA Small Boat Program guidelines would also minimize the potential for adverse impacts. Adverse impacts to physical resources would be similar to those that would occur under Alternative 1 as described in Table 5.2.

Proposed new sanctuary-wide regulation: Clarify appropriate mooring buoy use

Beneficial impacts: Under Alternative 2, there would be no additional water quality impacts specific to the proposed mooring buoy regulations that would prohibit large vessels from using small vessel mooring buoys and that would prohibit overnight use of mooring buoys. These proposed regulations would provide **direct, beneficial** impacts to the physical resources of the sanctuary by reducing damage to physical seafloor and reef habitat from large vessels breaking or dislodging buoy anchoring hardware. These proposed regulations would also reduce the total area of seafloor disturbance by providing more mooring buoys for public use and therefore reducing the amount of anchoring damage.

Adverse impacts: The potential adverse impacts to the physical resources could result from local physical substrate disturbance and short-term degradation of water quality during the installation of new and more substantial mooring buoy hardware. Nonetheless, adverse impacts from the expanded mooring buoy program would be **less than significant** due to the implementation of best management practices to minimize **direct** impacts such as disturbance of important seafloor structures and **indirect** impact, such as degradation of water quality from unintended spills or leaks.

5.4.2.3 Impacts to physical resources from revisions to marine zone boundaries and regulations (Alternative 2)

Under Alternative 2, there would be no additional beneficial or adverse impacts to the physical (i.e., oceanographic, climate, and climate change or water and water quality) resources of the sanctuary as a result of the proposed marine zone modifications, creation of proposed new marine zones, and modification of associated regulations beyond those impacts discussed in Table 5.2 and Section 5.4.2.2.

5.4.2.4 Impacts to physical resources from updates to the FKNMS management plan (Alternative 2)

Under Alternative 2, FKNMS would adopt a proposed updated management plan which includes non-regulatory actions that NOAA would implement to further protect and manage sanctuary resources. See Appendix A for the final management plan.

Beneficial impacts: The updated management plan activities proposed under Alternative 2 would provide both **direct** and **indirect, long-term** benefits to physical resources within the

sanctuary through improved stewardship of sanctuary resources, and further research and restoration activities. Specific examples of these potential impacts are described below.

The final management plan would not result in targeted oceanographic impacts. However, some actions in the management plan acknowledge and aim to take advantage of oceanographic currents to provide for long-term protection of resources. For example, activities related to seagrass restoration could indirectly improve water quality by resulting in better nutrient management.

Several management plan activities focus on understanding and addressing potential impacts from climate change. These include, but would not be limited to, continued engagement with the Florida Reef Resilience Program, facilitating recovery of ESA-listed coral species, supporting targeted research activities, and advancing understanding and potential additional stewardship through education and outreach efforts. All these activities are intended to have a **beneficial** impact; however, the impact would likely be **negligible** or **less than significant**.

The management plan includes several activities related to sanctuary water quality. These are generally included in Goal 2, Objective 2 and include: strengthened engagement with the WQPP, engagement at the regional level with the South Florida Ecosystem Restoration Task Force, and a few targeted activities to better identify the sources and potential strategies to address water quality impacts. All of these activities are intended to provide **beneficial** impacts to sanctuary water quality. The magnitude of these specific activities would be largely dependent on actions undertaken by partner agencies with direct authority over water quality. The associated impacts of these activities could range from **negligible** to **significant** (for example, if some key actions outlined in the Comprehensive Everglades Restoration Plan are completed).

Adverse impacts: Under Alternative 2, some adverse impacts may occur when implementing activities described in the management plan, such as educational outreach activities, research activities, enforcement activities, and vessel and aircraft operations. These potential **direct, adverse** impacts to physical resources would be similar to those associated with field operations, which are described in final EIS Appendix L and summarized in Table 5.2. The adverse impacts to physical resources from field operations would be **direct** and **less than significant**. If ONMS implemented Alternative 2, the potential adverse effects to water quality and other physical resources would be spread over a larger area because this alternative would expand the sanctuary. ONMS does not anticipate that expanding these activities over a larger area would change the intensity of the impacts. Therefore, ONMS expects that implementing a revised management plan would result in **less than significant, adverse impacts** because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment.

5.4.3 Impacts to cultural and historical resources (Alternative 2)

This section describes the impacts to cultural and historical resources that would occur under Alternative 2.

5.4.3.1 Impacts to cultural and historical resources from the proposed sanctuary boundary expansion (Alternative 2)

Beneficial impacts: Under Alternative 2, the proposed expansion of FKNMS would have a **direct, beneficial** impact on cultural and historical resources in the expansion areas through application of the existing regulation prohibiting movement of, removal of, injury to, or possession of sanctuary historical resources. This beneficial impact is expected to be **significant** as it extends protections to several known shipwrecks just outside the current FKNMS boundary but within the ATBA. Boundary expansion may further protect historically-reported vessels sunk in deep water that are expected to have even greater site integrity due to their inaccessibility.

Adverse impacts: NOAA research activities that seek to locate and document newly-included cultural and historical resources could result in **direct or indirect, less than significant, adverse impacts** to these resources. For example, there is a slightly increased risk of looters targeting and illegally removing artifacts from newly discovered historical resources if they, for example, observed NOAA conducting research at a site then returned at a later time to conduct illegal activities. However, the likelihood of this occurring is minimal since such conduct would be illegal and subject to civil penalties and criminal punishment under the NMSA. As a result, the adverse impacts on cultural and historical sanctuary resources from the proposed expansion would likely be **less than significant** due to the use of best management practices to minimize direct impacts.

5.4.3.2 Impacts to cultural and historical resources from additions and revisions to sanctuary-wide regulations (Alternative 2)

Proposed sanctuary-wide regulation update: Improve historical resource permitting process

Under Alternative 2, NOAA would update the historical resources permitting process to improve resource protection and more closely align NOAA permitting regulations with those of the Florida Department of State DHR. The specific updates, as described in more detail in Section 3.2.5, consider the sensitive, non-renewable character of historical resources and the shared stewardship responsibilities of NOAA and Florida DHR. Changes to historical resources permitting would eliminate the current survey/inventory, research/recovery, and deaccession/transfer permit categories and institute an archaeological research permit category.

Beneficial impacts: Under Alternative 2, the proposed update to historical resources permit categories would have a **direct, beneficial** impact on historical resources in the sanctuary. This benefit would be **significant** as it would improve the quality of information generated from historical resource permits. Proposed changes would better align FKNMS permitting regulations with Florida DHR archaeological research permit standards and the Federal Archaeological Program. The result would be a more efficient permitting process that limits permits to scientifically-justified investigations and better accounts for the non-renewable nature of historical resources.

Adverse impacts: Under Alternative 2, the potential adverse impacts to cultural and historical resources from implementing this proposed regulation to the sanctuary's cultural and

historical resources would be **negligible**. Revised permit standards and conditions would limit impacts to historical resources and their surrounding habitat. The proposed updated permit category is intended to address concerns about unscientific investigations, ensure resources would not be damaged, and facilitate greater coordination across historical resource management partners in the state and sanctuary.

5.4.3.3 Impacts to cultural and historical resources from revisions to marine zone boundaries and regulations (Alternative 2)

Beneficial impacts: Several of the existing and proposed modified or new marine zones under Alternative 2 would encompass historical resources, including lighthouses and shipwrecks listed on the National Register of Historic Places. Such historical resources include, among others, the Austrian ship *Slobodna* at Molasses Reef SPA, HMS *Winchester* at Carysfort SPA, and the British warship HMS *Looe* at Looe Key MA. Under Alternative 2, ONMS would strengthen regulations in these marine zones to include some no-anchor areas. This would have potential **direct, beneficial** impacts on these resources by reducing the risk of potential anchor damage to historical resources present in these zones. Expanding marine zones to encompass historical resources and applying a no-anchor prohibition in those marine zones would prevent additional degradation of known, and potentially some unknown, historical resources. Similarly, limiting fishing activity in new marine zones would prevent **direct, adverse** impacts to historical resources that could result from contact with fishing gear when it is deployed or recovered. These beneficial impacts would be **negligible** because of the wide distribution of historical resources throughout marine zones in FKNMS and the associated low likelihood of anchor damage from vessels operating in these areas.

Adverse impacts: Encompassing more historical resources within marine zones, or within marine zones with additional activity regulations designed to protect sanctuary habitats and natural resources, conveys additional protections to the historical resources as well. ONMS does not expect that the proposed changes to marine zones in Alternative 2 would change activities occurring within the sanctuary in a way that would result in adverse impacts to cultural and historical resources. **No adverse impacts** to cultural and historical resources are expected from the proposed updated zones and regulations.

5.4.3.4 Impacts to cultural and historical resources from updates to the FKNMS management plan (Alternative 2)

Beneficial impacts: Under Alternative 2, ONMS would implement several management plan activities that focus on understanding and managing historical resources in the sanctuary; most notably Goal 1, Objective 2 and, to a lesser degree, Goal 4, which focuses on increasing awareness of sanctuary resources. Specific activities include: improving the inventory and characterization of historical resources, better understanding visitor use and mitigating potential impacts of that use, and implementing archaeological research standards through the proposed updated permit categories. Management plan activities directed at interpreting historical resources for the public provide an avenue to disseminate the results of permitted research and ONMS inventory efforts. All of these activities would have **direct, beneficial, significant** impacts on historical resources in the sanctuary because they would support the long-term protection, preservation, and appreciation of these resources.

Adverse impacts: Under Alternative 2, **direct, adverse** impacts to historical resources may occur when implementing activities described in the management plan. In situations where management activities identify historical resources for public visitation, visitors using improper anchoring, diving, or snorkeling techniques may adversely impact the historical resource. Similarly, identification of a historical resource for visitation may lead to its overuse, which could result in exacerbated impact from improper techniques. The adverse impacts of these activities are expected to be **less than significant** because they would be mitigated by the use of best management practices to avoid improper techniques. **Direct, adverse** impacts to historical resources associated with other categories of routine field activities are described in Table 5.2.

5.4.4 Impacts to socioeconomic resources and human uses (Alternative 2)

This section describes the impacts to socioeconomic resources and human uses that would occur under Alternative 2.

5.4.4.1 Impacts to socioeconomic resources and human uses from the proposed sanctuary boundary expansion (Alternative 2)

Alternative 2 would expand the sanctuary boundary to include the ATBA and Tortugas region, for a total of 4,539 square miles.

Beneficial impacts: Applying existing and proposed updated and new sanctuary-wide regulations in the proposed expansion area would protect coral reef habitats from discharge pollution and damage caused by groundings of large vessels transiting the region. Past groundings have resulted in millions of dollars in damages and restoration costs, both in terms of **direct** costs to industry to clean up the grounding as well as in **indirect** cost by degrading sanctuary habitats that serve as an important driver for tourism. A significant portion of the Monroe County economy is dependent on coral reef resources. Applying sanctuary regulations to the expanded area would ensure the NMSA and FKNMS regulations apply to protect additional resources, bring enforcement actions, and recover damages and restoration costs for any harm done to such resources.

Expanding the boundary would also increase opportunities for passive economic use,¹¹ science, and education values. Sobel (1996) described the many benefits provided by marine reserves, including scientific and educational activities that increase knowledge and understanding of marine systems. A summary of these benefits include:

Scientific benefits

- Provides long-term monitoring sites;
- Provides focus for study;

¹¹ Nonuse or passive use economic values encompass what economists refer to as option value, existence value, and other nonuse values. All nonuse economic values are based on the fact that people are willing to pay some dollar amount for a good or service they currently do not use or consume directly. In the case of an ecological reserve, they are not current visitors (users), but derive some benefit from the knowledge that the reserve exists in a certain state and are willing to pay some dollar amount to ensure that actions are taken to keep the reserve in that state.

- Provides continuity of knowledge in undisturbed site;
- Provides opportunity to restore or maintain natural behaviors;
- Reduces risks to long-term experiments; and
- Provides controlled natural areas for assessing anthropogenic impacts, including fishing and other impacts.

Educational benefits

- Provides sites for enhanced primary and adult education; and
- Provides sites for high-level graduate education.

Environmental Justice

- Provides job opportunities in underserved communities where unemployment and poverty are disproportionate.
- Reduces impacts to climate change, which disproportionately affects underserved communities that are prone to flooding in Monroe County.

Adverse impacts: The primary adverse impact from expanding the proposed sanctuary would be an increase in administrative and enforcement costs in order to manage the expanded areas of the sanctuary. These costs would include those currently expended to operate and manage the current sanctuary, as described in Section 5.2.1, as well as the minimal additional cost to operate and manage the proposed expansion area. The net increase in costs would be non-significant because the sanctuary would be conducting the same activities as those described in Section 5.2.1, but over a slightly larger area. Therefore, expanding the sanctuary would result in **insignificant, direct, adverse impacts**.

5.4.4.2 Impacts to socioeconomic resources and human uses from additions and revisions to sanctuary-wide regulations (Alternative 2)

The potential beneficial and adverse impacts to socioeconomic resources and human uses from additional and revisions to sanctuary wide regulations are described below.

Proposed sanctuary-wide regulation update: Prohibit certain cruise ship discharges

Under Alternative 2, updated regulations would prohibit certain discharges from cruise ships within the sanctuary.

Beneficial impacts: Water quality is fundamental to all water-based recreation-tourism uses in FKNMS, as well as to commercial fishing and the protection of the quality of the food supplied by this industry. Prohibiting certain discharges from cruise ships would result in better protection of water quality and habitat for corals, fish, and other species that directly support the water-based recreation-tourism and commercial fisheries within FKNMS. As described in Section 5.4.2.2, the proposed prohibition of certain discharges from cruise ships would have a **direct, beneficial** impact on water quality in the area transited by the cruise ship and **indirect** impact in areas further from the source where the water may disperse. Therefore, prohibiting certain cruise ship discharges would result in **indirect and direct, beneficial impacts** to the water-based recreation-tourism and commercial fishery within FKNMS.

Adverse impacts: In order to comply with the proposed regulatory change under Alternative 2, cruise ships would need to refrain from discharging scrubber washwater or switch to a higher grade fuel while operating in FKNMS since scrubber wash water is one of the types of discharges that would be prohibited. In addition, cruise ships would need to either install improved technology to treat various waste streams prior to discharging within the sanctuary or wait until the cruise ship has exited the sanctuary prior to discharging waste. Given that cruise ships generally travel through the sanctuary for a limited amount of time (12 operational hours or less), costs to the cruise ship industry would be minimal since they would be able to discharge once outside sanctuary boundaries and would only need to use higher grade fuel for a limited time. For cruise ships that dock in Key West, the vessel(s) would have to suspend most discharge activity until departing the sanctuary. However, given that cruise ships are restricted from docking overnight in Key West, the amount of time that a ship would be required to alter some discharge activities would be minor. Due to the short amount of transit time during which discharge practices would be altered, the increased regulation would have **direct, negligible, adverse** impacts to the cruise ship industry.

Proposed sanctuary-wide regulation update: Extend time period for emergency regulations

Under Alternative 2, existing regulations would be updated to allow a temporary emergency regulation to be in effect for up to six months (180 days), with one six-month (additional 186-day) extension.

Beneficial impacts: Emergency regulations would allow the sanctuary to respond to emergencies and unforeseen impacts to sanctuary resources to prevent or minimize the destruction of, loss of, or injury to a sanctuary resource or the quality of the resources, as described in Section 5.4.1.2. Better protection of sanctuary resources, such as corals, seagrass, fish, and other biota, would have **direct, beneficial impacts** because these natural resources directly support the water-based recreation-tourism and commercial fishery within FKNMS.

In order for sanctuary staff to implement emergency regulations and associated clean-up or other measures, some recreation, research, and other activities may be temporarily disrupted to ensure that the emergency response is conducted efficiently and to minimize the potential for the public to be exposed to any unsafe conditions. These activities would result in short-term benefits for public safety and, as discussed above, long-term gains in the protection of sanctuary resources to ensure the future flow of recreational-based benefits.

Adverse impacts: Extending the length of emergency regulations could result in a temporary disruption to some recreational, research, and other activities to ensure that the emergency response is conducted efficiently and to minimize the potential for the public to be exposed to any unsafe conditions. This disruption would be short-term, and nearby alternative locations would most likely be available for recreational, research, and other activities. Therefore, the **adverse impacts** would be **negligible** and **short-term**. In the long-term, there would be no adverse impacts since NOAA is proposing temporary regulations.

Proposed sanctuary-wide regulation update: Improve historical resource permitting process

Under Alternative 2, NOAA would update the historical resources permitting process to improve resource protection and more closely align NOAA permitting regulations with those of the Florida DHR. The specific updates, as described in more detail in Section 3.2.5, consider the sensitive, non-renewable character of historical resources and the shared stewardship responsibilities of NOAA and Florida DHR.

Beneficial impacts: Although an economic valuation study has not been conducted in the Florida Keys on historical and cultural resources, a study completed on the Graveyard of the Atlantic (Mires, 2014), which includes Monitor National Marine Sanctuary, found that people's willingness to pay for historical resource protection and interpretation of maritime heritage increased with:

- Expansion of the number of shipwrecks protected;
- The level of investment in museum exhibits;
- Educational workshops on maritime heritage and training in maritime archaeology; and
- Maritime heritage trails, including virtual trails using video and mobile phone technology.

The expanded protections offered by improving the research permit process for the historical resources in FKNMS would be expected to yield more of each of the benefits estimated by Mires (2014). Changes to historical resources regulations are expected to favor professional archaeological investigations that provide the greatest benefit to the public. Information generated by scientifically-rigorous investigations focused on revealing the sanctuary's past would benefit dive shops, charter operators, other tour operators, museums, and cultural institutions, and add depth to the history that many people seek to learn about the Florida Keys. An example of the value of these investigations are archaeological site maps and documentation of the historical context of shipwrecks commonly visited by divers.

The impacts from revisions to historical resource permitting processes, proposed in Alternative 2, would be **beneficial** and **less than significant** in both the short-term and long-term. Professionally-conducted, scientifically-rigorous historical resource investigations would increase enjoyment of these non-renewable resources by current and future generations.

Adverse impacts: Historical resource permittees would be the most likely to be adversely impacted by the regulatory update; however, adverse impacts would be **less than significant** as most, if not all, permittees are expected to be able to continue their investigations if they make minor changes to their methodologies and personnel. In several cases, no changes would need to be made by the permittees because they already conduct their research using scientifically-based, minimally-intrusive methods that would be in compliance with the proposed permitting updates.

As the likelihood of locating monetarily valuable artifacts through historical resource surveys is fleetingly small, the adverse impacts from removal of the deaccession/transfer permit category of historical resources permits is **less than significant**. The last significant treasure find outside of the salvage of *Nuestra Señora de Atocha* and *Santa Margarita* was made in 1991

(NOAA, 1997). The administrative costs associated with permitting should decline with the streamlined and more efficient permit process proposed. NOAA's costs relating to the inventory of historical resources are also not expected to increase as most, if not all, permittees would transition to the new permit structure.

In some cases, costs to current permittees may increase due to the need to work with a professional archaeologist, whose training and experience meets the Secretary of the Interior's professional qualification standards for archaeology. Under the proposed permitting process, an individual meeting these standards must be involved in the project to direct the archaeological research. Prospective permittees may wish to partner with universities or other organizations specializing in underwater archaeological research to satisfy the requirement. Similarly, operational costs may increase as permittees may need to invest more resources in scientific survey methodologies and reporting of their survey results.

The proposed permit revision eliminating provisions for a deaccession/transfer permit would not affect any current permittees as no such permits have ever been issued. Removal of this permit category may decrease the potential incentive/reward for locating certain varieties of artifacts; however, it is in keeping with the NMSA purposes and policies to enhance the sustainable use of the National Marine Sanctuary System's historical resources. In addition, dispersal of artifacts is contrary to archaeological standards set forth by the Federal Archaeology Program. The Federal Archaeological Program comprises a collection of historical and archaeological resource protection laws, including, among others, the NHPA, Archaeological Resources Protection Act, Antiquities Act, and Abandoned Shipwreck Act, to which federal managers must adhere. Archaeological recovery of sanctuary artifacts must be justified by scientific research questions and be in the public's interest, and would only be allowed for abandoned vessels or with express permission from the owner or sovereign. Permittees must demonstrate the financial ability to conserve and curate the artifacts. Permittees may exhibit recovered artifacts under a curatorial services agreement with NOAA, but such recovered artifacts would remain public resources. The proposed regulatory changes would not terminate valid Federal Admiralty Court rights of access granted prior to sanctuary designation, which FKNMS recognized at the time of sanctuary designation. (See NOAA, 1997, p. 99.) Likewise, elimination of the deaccession/transfer permit would not affect such rights of access and adjudication of title to artifacts recovered in accordance with such valid Federal Admiralty Court orders. However, all historical resource activities conducted in FKNMS are subject to and must comply with the NMSA, the FKNMSPA, and sanctuary regulations.

The effects of this regulatory change can best be determined by examining who it may affect. While the lure of discovering shipwrecks and sunken treasures appeals to many, the reality is that underwater archaeological survey and excavation is an expensive undertaking with an exceedingly small chance of recouping costs. Most FKNMS historical resources permittees investigate the sanctuary's waters for the thrill of discovering untold stories of the past and sharing that information with the public. Currently, one individual holds a FKNMS historical resources survey/inventory permit. The permit authorizes non-intrusive archaeological research as part of a university program. Beyond the individual permittees themselves, the number of persons engaged in work on these permits has varied from more than a dozen for the research/recovery permits, to one or two persons for the survey/inventory permits.

Proposed new sanctuary-wide regulation: Prohibit fish feeding

Fish feeding is conducted throughout the Florida Keys in order to quickly attract relatively high numbers of fish. This activity may occur from boats, or within the water by divers and snorkelers. Very few dive operators feed fish during recreational outings. Fish feeding activities also occur from shore-based facilities; however, regulating that activity was considered but eliminated from this analysis (see Section 3.7). NOAA is proposing a new regulation to explicitly prohibit fish feeding and its threat to sanctuary resources.

Beneficial impacts: The proposed regulation would benefit the water-based tourism industry in the long term because it would prevent the damaging ecological impacts fish feeding can have on fish communities, as described in Section 5.4.1.2. This benefit would be **negligible** because very few diving operations in the Florida Keys conduct this type of activity. Given the competition among dive operations in the Florida Keys, and the ease with which fish feeding could provide a marketing edge, the proposed regulation would also prevent any future increase in fish feeding practices. In addition, the proposed regulation would increase human safety as fish who are not habituated to being fed would be less likely to approach snorkelers or divers looking for food.

Adverse impacts: The main adverse impact would be a cost to dive operators who currently feed fish and would lose potential customers if they stopped this practice. The overall costs spread across all businesses would be **less than significant**, since few dive operations engage in this practice, as it is already prohibited by state rules. However, for the few operators that feed fish, the proposed regulations could have substantial impacts on their individual businesses. The dive business is a highly competitive and low margin of profit business. The few businesses that are impacted might struggle to stay in business if the market niche that they have carved out for themselves is eliminated. Over the long-term, these costs might be expected to increase as the tourist market grows.

Proposed new sanctuary-wide regulation: Reduce impacts from vessel groundings, deserted vessels, and harmful matter

Currently, removal of grounded or deserted vessels and the harmful matter aboard such vessels (e.g., motor oil, fishing gear that could cause entanglement) is not specifically required unless a discharge has occurred, there is an alteration to the seabed, or there is destruction, loss, or injury to a sanctuary resource. Existing FKNMS regulations also do not include a requirement to provide notice of a grounded vessel.

To address concerns regarding the potential threats to the marine environment from derelict or deserted vessels, NOAA is proposing regulations that would enable NOAA to require owners of derelict, grounded, or deserted vessels to remove their vessels from the sanctuary and minimize resulting impacts.

Beneficial impacts: The potential for harm to sanctuary resources from derelict and/or deserted vessels is very high: damage assessments and restoration activities to remove and remediate vessel groundings have cost millions of dollars. The proposed additional regulations would minimize future damage to sanctuary resources and help to protect a multi-billion-dollar economy dependent on the sanctuary's resources. In addition, proposed regulations would

better enable NOAA to enforce removal of deserted vessels to prevent potential groundings, collisions, or discharge of harmful materials that could harm FKNMS resources. Further, industries engaged in vessel removal may see an increase in business. Therefore, the protections from the proposed regulation would result in **significant, potential, beneficial** impacts in the short and long-term.

Adverse impacts: The main adverse impact from these regulations would be the cost to industry or owners of vessels that become derelict, grounded, or deserted within FKNMS. The vessel owner would be required to contact the sanctuary and to pay for the removal of the vessel. However, the costs associated with removal would likely still be less than costs that could result if no such immediate activities were taken and the vessel discharged harmful matter into the sanctuary. The cumulative costs to industry or individuals is minimal compared to the liability associated with damage to sanctuary resources caused by derelict or abandoned vessels or Natural Resource Damage Assessment cases that are brought to recover damages and restoration costs from responsible parties. Therefore, the proposed regulation would result in **insignificant adverse** impacts.

Proposed new sanctuary-wide regulation: Clarify appropriate mooring buoy use

Mooring buoy use by large vessels can damage the mooring buoy hardware and in some cases the substrate in which the hardware has been secured. Alternative 2 proposes to implement a large vessel mooring buoy requirement that helps to clarify appropriate mooring buoy use for large vessels.

Beneficial impacts: By clarifying which type of mooring buoys large vessels would use, the mooring buoy repair costs, and the damage to the hardbottom and surrounding habitat when the mooring buoys are pulled loose, would be reduced. Large vessel owners would also benefit from avoiding fines for damaging the natural environment. Therefore, the proposed regulation would result in **insignificant, beneficial** impacts.

Adverse impacts: The adverse impacts to the sanctuary would include the cost of supplies to construct more substantial mooring buoys that could sustain the weight of larger vessels and develop signage for boat operators that clearly label mooring buoys appropriate for larger vessels. In addition, implementation of these regulations would result in costs related to staff or contractor time to modify the mooring buoys and place the signs near the mooring buoys. The resource requirements (in terms of staff time and money) would be a very small portion of the FKNMS overall budget. Therefore, the proposed regulation would result in **negligible, adverse** impacts.

5.4.4.3 Impacts to socioeconomic resources and human uses from changes to marine zone boundaries and regulations (Alternative 2)

Under Alternative 2, ONMS would modify existing marine zones and create new marine zones to provide additional protection for specific habitat types that are heavily impacted by human use. The below analysis is divided into two main sections. First, ONMS evaluated the impact from all the marine zone changes that would result in greater habitat protection and human use

restrictions due to the integrated nature of the impacts. This includes the following zoning and regulatory changes:

- Expand the total number of marine zones from 57 zones to 96 zones.
- Implement new and revised marine zone regulations within four zone types, including:
 1. WMAs,
 2. SPAs,
 3. CAs, and
 4. MAs.
- Implement two new zoning regulations, including:
 1. Eliminate catch and release fishing in four SPAs (as described in Section 3.4.3), and
 2. Revise motorized PWC restrictions within Key West National Wildlife Refuge (as described in Section 3.4.1).

Second, ONMS evaluated the impacts of the proposed modifications that would eliminate the issuance of baitfish permits in all SPAs. Eliminating the issuance of baitfish permits in all SPAs would have a direct cost to some fishermen who would need to purchase baitfish rather than fish for them in SPAs.

Proposed marine zone modifications: Increased zones and more protective regulations within wildlife management areas, sanctuary preservation areas, conservation areas, and management areas.

Alternative 2 would expand the total number of different marine zones from 57 zones in the No Action Alternative (Alternative 1) to 96 zones. Many of these zoning changes would further restrict human use and recreational activities throughout the sanctuary. An overview of the main beneficial and adverse impacts from the proposed changes is provided below. See Schwarzmann et al. (2022) for additional information, including the methods, assumptions, and detailed quantified costs and benefits for each component of Alternative 2.

Beneficial impacts: Adding more restrictive marine zones that limit human use and activities would provide areas for fish, whales, sea turtles, and other aquatic biota to forage, breed, and tend to young without the adverse impacts associated with fishing, recreational activities, and other human uses. These restricted areas often lead to increased population health and growth for fish and other aquatic biota. Some mobile organisms may breed, hatch, or grow within the restricted areas, and then migrate to other non-restricted areas within the sanctuary. The overflow of organisms from restricted areas to non-restricted areas increases the overall density and abundance within the non-restricted areas. This phenomenon is often referred to as replenishment. Previous studies in other marine sanctuaries have shown significant long-term benefits from adding restrictive zones that lead to replenishment within non-restrictive zones (e.g., Leeworth et al., 2019; see also Schwarzmann et. al., 2022). For example, restricting certain areas within marine sanctuaries has shown to increase the quality of marine life in the non-restricted areas, thus benefiting those engaged in non-consumptive forms of recreation via scuba diving, snorkeling, and wildlife viewing. Similarly, fish stocks surrounding restricted areas are often higher due to the greater reproductive and growth rates within the restricted area, and then subsequent migration to non-restricted areas. Further, Leeworthy et al. (2012) found little

to no economic impact on fishermen as a result of the no-take marine reserve within the Tortugas ER because fishermen were able to relocate to other fishing grounds and make up for the lost catch due to the closure of the restricted areas (see Leeworthy Chapter 6 in Jeffrey et al., 2012).

For this analysis, Schwarzmann et al. (2022) quantified the benefit to the tourism industry by estimating the increased recreational activity, assuming that a larger, healthy ecosystem would attract more recreational tourists to the sanctuary. The most relevant effects of marine zone boundary changes in Alternative 2 for current and prospective non-consumptive users will be increased quality of habitat and reduced user conflicts. Both will improve the experience of the user, potentially increasing the value (consumer surplus) of their experience within FKNMS. However, without survey data, this increase in value could not be quantified. The draft EIS estimated that as the area of protected waters increased, there would be a similar increase in person-days of use. After extensive public comment and additional research, NOAA has revised the approach to estimating the benefits of the proposed action to non-consumptive users. Hotels are near capacity year-round (Schwarzmann et al., 2022), Monroe County has restrictions on development, there are limited entry points to Monroe County, and the distance of the protected areas would, in some cases, require overnight trips on larger vessels. These factors limit the potential increase in visitation and consequently the person-days of non-consumptive recreation. The benefits likely to accrue to non-consumptive users are improved quality of experience and some increase in person-days, but this cannot be estimated without further data from both current and potential users. Increasing the number of person-days may have a measurable impact on the local economy if users spend more money in Monroe County because of improvements to FKNMS ecosystem services. If users simply substitute non-consumptive activities for other activities without changing their overall expenditures, this would result in a transfer of economic activity from one industry (or business) to another. Additionally, improved quality of experience may increase consumer surplus.

Therefore, the revisions to the marine zone boundaries and regulations under Alternative 2 would likely result in **long-term, direct, less than significant, beneficial impacts** to the water-based recreational tourism industry and commercial fishermen. In the long term, these beneficial impacts associated with increased biota and fishing stocks outside the restricted areas may be larger than the costs associated with the loss of area for fishing. In this case, the overall impact would be net-beneficial to the Monroe County Economy.

In addition, replenishment would also result in **indirect, negligible benefits** to the local tourism industry due to the increase in visitors to the region and concomitant spending within Monroe County.

Adverse impacts: Restricting access to certain areas could result in **less than significant, adverse** impacts because it would decrease the amount of area available for recreational users, the tourism industry, and commercial fishermen. In some areas, such as in a CA, the proposed marine zoning under Alternative 2 would completely displace all users because of the transit-only regulation. Nonetheless, non-restricted areas would remain available and could adequately support current levels of recreation, tourism, and fishing within the sanctuary. In the longer-term, if these areas experience replenishment effects (e.g., increasing the total stock sizes and

the health of coral reef ecosystems), the benefits may outweigh the costs, resulting in a net benefit.

Alternative 2 would result in a maximum potential loss of \$17,000 annually of ex-vessel value (harvest revenue), one job and \$68,000 in sales from the commercial fishing industry. For more information see Schwarzmenn et al., 2022. When considering recreational fishing, a maximum potential loss of 1,139 charter/head boat angler days and 343 private angler-fishing days. This would result in a loss of \$448,000 in sales from charter/head boats and \$14,000 in sales from private/rental boats. These numbers do not account for the likelihood that businesses and people may find alternative places to fish, such as just outside the marine zones.

Proposed update to marine zoning regulations: Elimination of baitfish permits

Under Alternative 2, NOAA would eliminate the practice of issuing baitfish permits over a three-year period following the effective date of final regulations. During this time, only individuals who have historically held baitfish permits would be issued any further permits. Baitfish permit data from 2024 would be used to determine those eligible for permits in the three-year phase out period. (Additional background on baitfishing activity is available at Schwarzmenn et al. 2022.)

Beneficial impacts: Eliminating baitfish permits would create consistent no take regulations within all SPAs. This regulatory change would result in reduced cost to the sanctuary because of the lower enforcement costs and would eliminate the administrative costs associated with issuing baitfish permits. Given the potential ecological harm that baitfishing can result in (as described in Section 5.4.1.3), the regulation may also help increase the density and abundance of baitfish and their predators, thereby increasing the recreational value for water-based users of the sanctuary. Thus, the proposed regulatory change is expected to result in **direct and indirect, less than significant, beneficial** impacts.

Adverse impacts: In order to comply with the baitfish regulatory change proposed in Alternative 2, fishermen currently catching their own bait would either have to buy their bait or catch their bait outside the SPAs. Assuming cast net permit holders that are displaced by the prohibition must purchase bait to replace lost catch, it is estimated that the maximum average annual cost is between \$17,426 (13,941 fish multiplied by \$1.25 per frozen ballyhoo) and \$27,882 (13,941 fish multiplied by \$2 per baitfish) to replace what the fishers were catching. The estimated average annual cost per active permit holder (i.e., those who report using the permit at least once) is between \$681 and \$1,089. If fishermen are able to pass these costs onto customers, fishermen would not experience lost profits, but the losses would be transferred to customers in the form of increased fish prices. Fishermen would likely be able to catch their bait outside the SPAs, given that 50% of current fishermen catch baitfish outside the SPAs. Under this scenario, fishermen and their customers would not experience increased costs. Given the value of water-based recreational uses, primarily scuba diving and snorkeling, the enhanced value of the recreational experience would more than offset the potential costs to baitfish permit holders. In addition, the **indirect benefit** from increased tourism that would result in increased income to residents of Monroe County would more than offset the potential losses

from bait fishing. Therefore, this regulation is expected to result in an overall net benefit and **direct, negligible, adverse** impacts.

5.4.4.4 Impacts to socioeconomic resources and human uses from updates to the FKNMS management plan (Alternative 2)

Beneficial impacts: Under Alternative 2, ONMS would conduct several activities focused on managing human uses of the sanctuary that would facilitate a strengthened stewardship ethic. These would include: working with users to inform placement of mooring buoys, implementing a voluntary boater education course, and maintaining and enhancing the Blue Star programs. These routine education, outreach, research, monitoring, and resource protection activities and coordination with stakeholders would have both **direct** and **indirect, beneficial** impacts on the socioeconomic resources and human uses within FKNMS. These management plan activities would promote ocean literacy and stewardship and improve the understanding, management, and protection of the sanctuary's biological resources, which provide **indirect, beneficial** impacts for recreational activities and tourism. By promoting ocean stewardship principles with partners, local communities, and the general public, FKNMS has the opportunity to influence the behavior and decision-making of individuals, businesses, communities, organizations, and agencies in ways that could **indirectly benefit** the sanctuary.

Adverse impacts: Under Alternative 2, some adverse impacts may occur when implementing activities described in the management plan, such as research activities, enforcement activities, and vessel and aircraft operations. These potential **direct, adverse** impacts, such as disruptions to recreational activities, would be similar to those associated with field operations, which are described in Appendix L and summarized in Table 5.2. If ONMS implemented Alternative 2, the potential adverse impacts described in Table 5.2 would be spread over a larger area because this alternative would expand the sanctuary. ONMS does not expect that expanding these activities over a larger area would change the intensity of the impacts. As described in Section 5.2.1, these adverse impacts to socioeconomic resources and human uses would be **direct** and **less than significant**. Therefore, ONMS expects that **direct** and **indirect adverse impacts** from a revised management plan would be **less than significant** because the disruptions would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment.

5.5 Impacts Specific to Alternative 3

This section describes the beneficial and adverse impacts of (1) boundary expansion, (2) updated and new sanctuary-wide regulations, (3) marine zone boundary and regulatory changes, and (4) a new management plan. Alternative 3 includes many of the same components as Alternative 2. Alternative 3, however, aims for greater overall protection than Alternative 2 by updating one sanctuary-wide regulation, adding additional marine zones, and implementing more protective marine zone regulations and access restrictions than Alternative 2. Specifically, Alternative 3 would include the following:

Sanctuary boundary expansions:

- The same boundary as Alternative 2.

Revised and new sanctuary-wide regulations:

- The same proposed new and revised sanctuary-wide regulations as Alternative 2.
- A non-regulatory update to provide additional coordination of live rock aquaculture activities.
 - Note that the non-regulatory update would not result in direct, indirect, or cumulative impacts on any sanctuary resources in the existing sanctuary or proposed expansion area because activities would be limited to administrative tasks.

Marine zone boundary and regulatory changes:

- Expand the total number of marine zones from 57 areas to 98 (two more marine zones than Alternative 2).
- More protective marine zone regulations and access restrictions than would be implemented in Alternative 2.

Updated management plan:

- The same management plan as Alternative 2.

Impacts from Alternative 3 would include:

- The impacts common to all alternatives (see section 5.2);
- Several of the same impacts as Alternative 2, given that both alternatives have the same proposed boundary expansion, sanctuary-wide regulations, and management plan, as specified below; and
- Impacts specific to Alternative 3, as described below.

5.5.1 Impacts to biological resources (Alternative 3)

This section describes the impacts to biological resources that would occur under Alternative 3.

5.5.1.1 Impacts to biological resources from proposed sanctuary boundary expansion (Alternative 3)

The impacts to biological resources from the proposed sanctuary boundary expansion under Alternative 3 would be the same as the impacts under Alternative 2 (as described in Section 5.4.1) because the proposed boundary expansion would be the same under alternatives 2 and 3.

5.5.1.2 Impacts to biological resources from additions and revisions to sanctuary-wide regulations (Alternative 3)

The impacts to biological resources from changes to sanctuary-wide regulations under Alternative 3 would be the same as the impacts under Alternative 2 (as described in Section 5.4.2) because the proposed changes would be the same under alternatives 2 and 3.

5.5.1.3 Impacts to biological resources from revisions to marine zone boundaries and regulations (Alternative 3)

Under Alternative 3, ONMS would modify existing marine zones and create new marine zones to provide additional protection for specific habitat types, for habitat areas that are heavily impacted by human use, and for wildlife associated with these habitats. ONMS would also revise regulations governing uses of individual marine zones. See Section 3.6 for details on the individual marine zones, and Section 3.3 for a summary of access restrictions in the marine zones.

The marine zone scheme proposed in Alternative 3 would protect additional habitat types and, in some cases, create zones to facilitate connectivity of habitat and wildlife. The higher level of habitat encompassed in marine zones is intended to provide a higher level of protection for wildlife species that use these habitats for nesting, roosting, and foraging, for a portion of or for the entirety of their life, and to a lesser degree those wildlife that transit through these areas. Under Alternative 3, ONMS also proposes to pilot limited-use zones to inform sanctuary management of concentrated and high levels of use and potential or associated natural resource impacts from that use.

The impacts to biological resources from changes to marine zone boundaries and regulations proposed under Alternative 3 are generally the same as Alternative 2 (as described in Section 5.4.1.3), except for some additional impacts unique to changes to WMAs and SPAs proposed under Alternative 3. There would be no additional impacts to biological resources specific to the proposed CA zones, MAs, national wildlife refuges, and associated regulations under Alternative 3. The discussion of impacts below is divided into two marine zone types: (1) WMAs, and (2) SPAs.

Proposed marine zone modification: Wildlife management areas

There are 28 WMAs in the current FKNMS. Under Alternative 3, ONMS would revise the boundaries of some existing WMAs and create 32 new WMAs. In Alternative 3, ONMS would also implement access restrictions in each WMA, including idle speed no-wake, no-motor, no-anchor, and a greater number of no-entry zones compared to Alternative 2. By modifying access restrictions, ONMS aims to address impacts to benthic habitats from prop scarring, anchor damage, and impacts to wildlife species including flushing nesting and roosting birds. The general impacts to biological resources of modifications to WMAs proposed under Alternative 3 are the same as Alternative 2 (described in Section 5.4.1.3).

Beneficial impacts: Under Alternative 3, a WMA would be created that would protect additional seagrass habitat (described below).

Alternative 3 would also include several changes to zone-specific regulations/access restrictions that would be more protective than those proposed under Alternative 2 and would therefore result in a greater **direct, beneficial** impact for habitats included in those marine zones. Under Alternative 3, more WMAs would have no-entry restrictions. The greater number of no-entry zones included in Alternative 3 would provide enhanced overall protections to these areas from vessel impacts and wildlife disturbance that could result in potential behavior change, including bird flushing and/or foraging habitat and nesting abandonment. The proposed WMAs

and zone-specific regulations under Alternative 3 would result in a **direct, beneficial, less than significant** effect for the habitats and wildlife dependent on those habitats within the marine zone. A selection of modified or new WMAs proposed in Alternative 3 are described below to provide specific examples of the additional **direct, beneficial** impacts to habitat and wildlife associated with implementing this alternative:

New Key Lois and Loggerhead Basin WMA: Under Alternative 3, ONMS would create a new speed-restricted WMA at Key Lois and Loggerhead Basin. This action would provide **direct, beneficial** impact to prop-scar-impacted seagrass and wildlife, particularly tarpon during their winter-spring migration, by reducing the risk of human disturbance of this habitat from vessel activity.

Modified and new WMAs in the Florida Keys National Wildlife Refuge Complex: Under Alternative 3, ONMS would create several new, or modify existing, WMA zones in the Florida Keys National Wildlife Refuge Complex. These zones would have increased access restrictions: the idle speed no-wake restriction would be changed to a no-motor restriction, and more no-entry WMAs would be included. These increased access restrictions would have **direct, beneficial** impacts to mangrove habitat, shallow-water habitat, and important bird species by creating a 100-yard no entry buffer around select mangrove islands with critical nesting, roosting, and/or foraging areas to minimize disturbance. By further minimizing disturbance of these areas compared to Alternative 2, these proposed marine zones with increased access restrictions would provide a greater **direct, beneficial, significant** impact to 16 species of nesting and roosting birds listed by the state as threatened on mangrove island, intratidal, and beach berm habitats adjacent to the zones.

Adverse impacts: As described under impacts from Alternative 2 in Section 5.4.1.3, **no adverse impacts** to biological resources are expected from the proposed modified or new WMAs and associated access restrictions.

Proposed marine zone modification: Sanctuary preservation areas

There are 19 SPAs in the current FKNMS. Under Alternative 3, ONMS would revise the boundaries of some existing SPAs and create seven new SPAs (one more than is included in Alternative 2). Alternative 3 would include implementation of a pilot program to create limited-use areas at three SPAs (Carysfort, Sombbrero, and Sand Key, see Section 3.4.5 for details). All other proposed regulations included in Alternative 2 would apply. The general impacts to biological resources of modifications to SPAs proposed under Alternative 3 are the same as Alternative 2 (described in Section 5.4.1.3).

Beneficial impacts: In Alternative 3, the proposed SPAs would have a **direct, beneficial** effect on habitats that would be added to existing marine zones or would be protected through proposed new zones. Additional habitat types targeted for protection through Alternative 3 would include patch reefs and deeper coral reef habitats; high-relief, resilient, or ESA-listed coral species; and ecological features that are known to support fish aggregations. A selection of modified or new SPAs proposed in Alternative 3 are described below to provide specific examples of the additional **direct, beneficial** impacts to habitat and wildlife associated with implementing this alternative:

New Long Key Tennessee Reef SPA: Under Alternative 3, ONMS would create a new SPA adjacent to Long Key State Park and extending to the deep reef at Tennessee Reef. This new SPA would protect large, contiguous, interconnected seagrass, shallow hardbottom, aggregate patch reef, and deep, drowned spur-and-groove reef habitats. This SPA would also provide a corridor for migration of different life stages of fishes from Florida Bay into the Middle Keys. Protection of this area and application of existing and proposed new SPA regulations (described in Section 5.4.1.3) would have a **direct, beneficial** impact on the habitats and associated wildlife in this area by avoiding potential adverse impacts to biological resources associated with human use of this area, including anchoring.

Limited-use area pilot program: Implementation of a pilot limited-use program at three SPAs (Carysfort, Sombrero, and Sand Key) would provide a **direct, beneficial** impact to resources in these areas from a decreased level of concentrated and overall use. Easy access to recreational sites in the Florida Keys has increased the burden on numerous habitats and the species with which they are associated. Implementing the limited-use SPAs proposed in this alternative would also provide **indirect, beneficial** impacts to biological resources by increasing the information available to assess carrying capacity in sensitive areas and associated wildlife disturbances, impacts to species diversity, abundance, and distribution, and direct impacts of overuse.

Adverse impacts: As described in Section 5.4.1.3, **no adverse impacts** to biological resources are expected from the proposed modified or new SPAs and pilot program for limited use areas.

5.5.1.4 Impacts to biological resources from updates to the FKNMS management plan (Alternative 3)

The impacts to biological resources from the final management plan under Alternative 3 would be the same as the impacts under Alternative 2 (as described in Section 5.4.1.4) because the management plan would be the same under alternatives 2 and 3.

5.5.2 Impacts to physical resources (Alternative 3)

The impacts to physical resources from changes to the sanctuary boundary, sanctuary-wide regulations, marine zone boundaries and regulations, and the FKNMS management plan proposed under Alternative 3 would be the same impacts as those described under Alternative 2 (as described in Section 5.4.2) given that these components of the alternatives would result in the same impacts to physical resources under alternatives 2 and 3.

5.5.3 Impacts to cultural and historical resources (Alternative 3)

The impacts to cultural and historical resources from changes to the sanctuary boundary, sanctuary-wide regulations, marine zone boundaries and regulations, and the FKNMS management plan proposed under Alternative 3 would be the same impacts as those described under Alternative 2 (as described in Section 5.4.3) given that these components of the alternatives would result in the same impacts to physical resources for alternatives 2 and 3.

5.5.4 Impacts to socioeconomic resources and human uses (Alternative 3)

This section describes the impacts to socioeconomic resources and human uses that would occur under Alternative 3.

5.5.4.1 Impacts to socioeconomic resources and human uses from changes to the sanctuary boundary (Alternative 3)

The impacts to socioeconomic resources and human uses from the proposed sanctuary boundary expansion under Alternative 3 would be the same as the impacts under Alternative 2 (as described in Section 5.4.4.1) because the proposed boundary expansion would be the same under alternatives 2 and 3.

5.5.4.2 Impacts to socioeconomic resources and human uses from changes to sanctuary-wide regulations (Alternative 3)

The impacts to socioeconomic resources, environmental justice, and human uses from changes to sanctuary-wide regulations would be the same as for those under Alternative 2 (as described in Section 5.4.4.2) because the proposed sanctuary-wide regulations would be the same under alternatives 2 and 3.

5.5.4.3 Impacts to socioeconomic resources and human uses from revisions to marine zone boundaries and regulations (Alternative 3)

Alternative 3 would expand the total number of marine zones from 57 zones in the No Action Alternative (Alternative 1) to 98 zones in Alternative 3. This change would result in a 10.45% increase in the amount of habitat that would be protected by the sanctuary. Changes to the zones will result in displacement of some consumptive users, but as the habitat improves, so too would the quality and quantity of scuba and snorkeling opportunities. Consequently, non-consumptive recreation in these areas is likely to increase with the habitat improvements.

Socioeconomic impacts are largely the same for alternatives 2 and 3. See Section 5.4.4.3 for detailed analysis.

Beneficial impacts: Adding more restrictive marine zones that limit human use and recreational activities would provide areas for fish, whales, sea turtles, and other aquatic biota to forage, breed, and tend to young without the adverse impacts associated with fishing, recreational activities, and other human uses. These restricted areas often lead to increased population health and growth for fish and other aquatic biota. As described in Section 5.4.4.3, migration from restricted-access areas to non-restricted areas can lead to replenishment or increased densities within the non-restricted areas.

Schwarzmann et al. (2022) quantified the impact to the tourism industry in Florida Keys by estimating the increased recreational activity, assuming that a larger, healthy ecosystem would attract more recreational tourists to the sanctuary. Increased recreational activity in the Florida Keys may not be a net increase in tourism, but rather represent consumers switching from recreational activities elsewhere. Alternative 3 would protect slightly more area than Alternative 2, and therefore, would have slightly higher potential benefits than Alternative 2. In addition to

the non-market economic value in potential benefits, the increase in activity facilitated by this alternative would have potential benefits in increased spending in the Monroe County economy and the associated economic impacts on output, income, and the number of full- and part-time jobs. These indirect benefits would be slightly higher for Alternative 3 than Alternative 2.

Therefore, the revisions to the marine zone boundaries and regulations under Alternative 3 would likely result in **long-term, direct, less than significant, beneficial** impacts to the water-based recreational tourism industry and commercial fishermen. In the long term, these beneficial impacts associated with increased biota and fishing stocks outside the restricted areas may be larger than the costs associated with the loss of area for fishing. In this case, the overall impact would be net-beneficial to the Monroe County economy.

In addition, replenishment would also result in **indirect, negligible benefits** to the local tourism industry due to the increase in visitors to the region and concomitant spending within Monroe County.

Adverse impacts: Adverse impacts could result due to increased cost to fishermen and lost area for recreational users. Due to the overall similarities to Alternative 2 and the likelihood that fishermen would be able to relocate and fish within non-restricted areas, the cost estimates would be the same as those described for Alternative 2 in Section 5.4.4.3, and result in **less than significant, adverse** impacts.

5.5.4.4 Impacts to socioeconomic resources and human uses from updates to the FKNMS management plan (Alternative 3)

The impacts to socioeconomic resources and human uses from changes to the FKNMS management plan would be the same as for those under Alternative 2 (as described in Section 5.4.4.4) because the management plan would be the same under alternatives 2 and 3.

5.6 Impacts Specific to Alternative 4

This section describes the beneficial and adverse impacts of (1) boundary expansion, (2) updated and new sanctuary-wide regulations, (3) marine zone boundary and regulatory changes, and (4) a new management plan. Alternative 4 includes many of the same components as Alternative 3. Specifically, Alternative 4 would include the following:

Sanctuary boundary expansions:

- The same boundary as Alternative 2, with the addition of Pulley Ridge.

Revised and new sanctuary-wide regulations:

- The same proposed new and revised sanctuary-wide regulations as Alternative 2.
- Update to live rock aquaculture activities to provide additional sanctuary oversight.
- Update to the shoreline slow speed zone regulation at 15 C.F.R. § 922.163(a)(5)(iii)(D).

Marine zone boundary and regulatory changes:

- Expand the total number of marine zones from 57 zones to 98 zones (the same number of marine zones as Alternative 3).

- More protective marine zone regulations and access restrictions than would be implemented in alternatives 2 and 3.
- Combine some marine zones and include larger zones in each of the five geographic regions to protect large areas of contiguous habitats.

Updated management plan:

- The same management plan as alternatives 2 and 3.

Impacts from Alternative 4 include:

- Impacts common to all alternatives (see Section 5.2);
- Several of the same impacts as Alternative 3, as specified below; and
- Impacts specific to Alternative 4, as described below.

5.6.1 Impacts to biological resources (Alternative 4)

This section describes the impacts to habitats and wildlife that would occur under Alternative 4.

5.6.1.1 Impacts to biological resources from the proposed sanctuary boundary (Alternative 4)

The **beneficial** and **adverse** impacts to biological resources from changes to the sanctuary boundary proposed under Alternative 4 are the same as Alternative 2 (as described in Section 5.4.1.1) and Alternative 3, except for the additional benefits of inclusion of the Pulley Ridge expansion area.

Pulley Ridge has demonstrated connectivity with the Florida Keys as shown through ocean current speed and direction studies and genetic analyses of species in Pulley Ridge, the Dry Tortugas, and the wider Florida Keys region. This proposed boundary expansion is aligned with an existing and proposed update to a GMFMC HAPC. This boundary expansion would provide additional protections to unique mesophotic coral reefs and other endemic species found only in this region. Protecting the resources of Pulley Ridge through expansion of FKNMS would provide direct benefits to the mesophotic reef and hardbottom habitats present at Pulley Ridge. This action could also provide **long-term, indirect benefits** to the habitats and species of the Florida Keys by serving as a source of fish and coral larvae and specifically as a source for resilient coral reef species. Under Alternative 4, ONMS would also implement a no-anchor regulation at Pulley Ridge, which would provide **direct, beneficial, less than significant** impacts to benthic habitats and associated wildlife. Since the 2019 draft EIS, the United States proposed the IMO designate a No Anchoring Area in the southern portion of Pulley Ridge, which was approved and implemented starting June 1, 2023 (IMO SN.1/Circ.342).¹² Including Pulley Ridge as a distinct unit in FKNMS with a regulatory no anchoring prohibition would provide NOAA the authority to enforce violations of the anchoring prohibition.

¹² See also <https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/NCSR-9th-session.aspx>

5.6.1.2 Impacts to biological resources from additions and revisions to sanctuary-wide regulations (Alternative 4)

The **beneficial** and **adverse** impacts to biological resources from changes to sanctuary-wide regulations proposed under Alternative 4 are the same as Alternative 3 (as described in Section 5.5.1.2), except for the additional impacts of the proposed sanctuary authorization for live rock aquaculture activities and shoreline slow speed zones.

Proposed sanctuary-wide regulation update: Coral and live rock prohibition

Under Alternative 4, ONMS would require a sanctuary authorization to conduct live rock aquaculture activities in sanctuary waters. An authorization is a type of approval, similar to a permit, which allows activities under another agency's permit to occur in the sanctuary. With authorizations, ONMS is able to add conditions to ensure that sanctuary resources are protected during the conduct of the activity. Authorizations would be issued for the existing submerged lands lease issued by Florida Department of Agriculture and Consumer Services for live rock aquaculture in state waters and the existing NMFS permit for live rock aquaculture in federal waters of the sanctuary.

Beneficial impacts: Requiring sanctuary authorization for this activity would have both **direct** and **indirect, beneficial** impacts for biological resources within FKNMS. Under its authorization, ONMS would be able to add conditions currently not addressed in state or federal permits that would further protect sanctuary resources, such as requiring that aquaculture material not be moved between areas to reduce potential spread of pathogens or disease. Similarly, conditions would be applied for notification to FKNMS if aquaculture materials were dispersed or disturbed from storms, which would ensure the indirect protection of associated habitat and wildlife present in these areas. Requiring notification to FKNMS law enforcement during rock harvest or deposition would have **indirect, beneficial** impacts to wildlife and habitats if it reduces the chance of illegal poaching of wild (non-aquaculture) live rock.

Adverse impacts: Requiring authorization of live rock aquaculture activities would serve to further protect wildlife and habitats from adverse impacts associated with live rock aquaculture. ONMS does not expect that implementing this regulatory change would increase the amount of live rock aquaculture activities that take place in FKNMS or the expanded areas in a manner that would cause adverse impacts to biological resources. **No adverse impacts** to biological resources are expected from amending the sanctuary regulations to require FKNMS authorization of permitted live rock aquaculture activities.

Proposed sanctuary-wide regulation update: Shoreline slow speed zone

Under Alternative 4, ONMS would revise the sanctuary-wide regulation at 15 C.F.R. § 922.163(a)(5)(iii)(D) to require that motorized vessels operate at slow speeds within 100 yards along all shorelines in the existing and expanded sanctuary.

Beneficial impacts: This proposed regulatory change would have a **direct, beneficial** impact to habitats located along the shoreline, near shore, and in shallow water, as well as wildlife that inhabit or forage in these areas, by reducing adverse impacts associated with disturbance from vessel use.

Adverse impacts: The proposed regulation is intended to reduce wildlife disturbance and disturbance or destruction of shoreline, nearshore, and shallow-water habitat. ONMS does not expect that this regulatory change would change the intensity or location of vessel activity within FKNMS in a way that would cause adverse impacts to biological resources. **No adverse impacts** to biological resources are expected from this proposed regulation to limit vessel speeds within 100 yards of all shorelines in the sanctuary.

5.6.1.3 Impacts to biological resources from revisions to marine zone boundaries and regulations (Alternative 4)

Under Alternative 4, ONMS would modify existing marine zones and create new marine zones to provide additional protection for specific habitat types, for habitat areas that are heavily impacted by human use, and for wildlife associated with these habitats. ONMS would also revise regulations governing uses of individual marine zones. See Section 3.6 for details on the individual marine zones, and Section 3.3 for a summary of access restrictions in the marine zones.

The marine zone scheme proposed in Alternative 4 would create targeted and larger continuous zones and apply the most protective regulatory restrictions. The access restrictions would still be aligned with and dependent upon the resource protection goals of the marine zone type and the individual marine zone. To do this, some marine zones would be combined and larger marine zones would be included in each of the five geographic regions (Upper Keys, Middle Keys, Lower Keys, Marquesas, and Tortugas). The proposed marine-zone-specific regulations and access restrictions would be more restrictive in Alternative 4 than in the other proposed alternatives.

The impacts to biological resources from changes to marine zone boundaries and regulations proposed under Alternative 4 are generally the same as Alternative 3 (as described in Section 5.5.1.3), except for some additional impacts unique to changes to WMAs, SPAs, and CAs proposed under Alternative 4. There would be no additional impacts to biological resources specific to the proposed MAs, national wildlife refuges, and associated regulations under Alternative 4. The discussion of impacts below is divided into three marine zone types: (1) WMAs, (2) SPAs, and (3) CAs.

Proposed marine zone modification: Wildlife management areas

There are 28 WMAs in the current FKNMS. Under Alternative 4, ONMS would revise the boundaries of some existing WMAs and create 31 new WMAs. Alternative 4 would maintain most of the zone-specific WMA regulations and access restrictions proposed in Alternative 3 with only a few proposed increased access restrictions that are intended to provide further protection for habitats and associated wildlife. The majority of WMAs in Alternative 4 would have small spatial changes, including a straight-line configuration rather than a contour around the islands for WMAs in the Florida Keys National Wildlife Refuge Complex. This design is primarily proposed to facilitate marking of these zones and subsequently support compliance and enforcement of these zones and regulations. The general impacts to biological resources of modifications to WMAs proposed under Alternative 4 are the same as alternatives 2 and 3 (described in sections 5.4.1.3 and 5.5.1.3).

Beneficial impacts: In Alternative 4, additional habitat area would be included through expansion of existing WMAs and through the one proposed new zone at Content Keys and Upper Harbor Key. This proposed marine zone would protect a larger area of habitat, therefore providing **direct, beneficial** impacts to habitat and wildlife through expanding protections and access restrictions to these new zones. Alternative 4 would propose increased access restrictions in some WMAs that would provide further protection and greater **direct, beneficial** impacts for these habitats and wildlife that inhabit, forage, or transit through these WMAs. The proposed marine zones would provide some additional **direct, beneficial** impacts to shallow water habitats and associated wildlife species. However, these impacts would be **negligible** because the area of the zones would be a similar size under alternatives 3 and 4. A selection of modified or new WMAs proposed in Alternative 4 are described below to provide specific examples of the **direct, beneficial** impacts to habitat and wildlife associated with implementing this alternative:

Modified and new WMAs in the Florida Keys Wildlife Refuge Complex: As described above, under Alternative 4, several proposed new WMA zones included in the Florida Keys Wildlife Refuge Complex would have changes to the spatial area protected to facilitate placement of marker buoys and user compliance and enforcement. This action would create additional buffer areas for the targeted habitats and wildlife species which would result in additional **direct, beneficial impacts**. However, the increase would be **negligible** because of the minor change in size of the buffer areas.

New Content Keys and Upper Harbor Key WMA: Under Alternative 4, ONMS would create new marine zones at Content Keys and Upper Harbor Key which would provide **direct, beneficial** impacts to seagrass and hardbottom habitat in this area by reducing the potential for prop scarring due to human use of these areas. Implementation of speed restrictions in these zones would also provide **direct, beneficial** impacts to the wildlife using this area, in particular the most heavily-used foraging area for great white heron in the Lower Florida Keys.

Adverse impacts: As described in Section 5.4.1.3, **no adverse impacts** to biological resources are expected from the proposed modified or new WMAs and associated access restrictions. The potential adverse impacts to biological resources associated with placement of marker buoys and enforcement activities are described in Table 5.2.

Proposed marine zone modification: Sanctuary preservation areas

There are 19 SPAs in the current FKNMS. Under Alternative 4, ONMS would revise the boundaries of some existing SPAs and create three new SPAs. Alternative 4 would include implementation of a pilot program to create limited-use areas at two SPAs (Sombrero and Sand Key). All other proposed regulations included in Alternative 2 would apply (see sections 3.3 and 3.4). The general impacts to biological resources of modifications to SPAs proposed under Alternative 4 are the same as alternatives 2 and 3 (described in sections 5.4.1.3 and 5.5.1.3). The general impacts to biological resources of implementation of a pilot program for limited use areas proposed under Alternative 4 are the same as Alternative 3, with the exception that this proposal would not apply in the Carysfort SPA in Alternative 4.

Beneficial impacts: In Alternative 4, the proposed modified existing and proposed new SPAs would have a **direct, beneficial** impact on habitats that are added to existing marine zones or

would be protected through proposed new zones. There would be no additional habitat types targeted for protection in SPAs in Alternative 4 other than those protected in other alternatives. However, additional areas that encompass these habitats would be included in Alternative 4 (e.g., Carysfort SPA). Under Alternative 4, ONMS would change the shape of four existing SPAs to be straight-lined marine zones (The Elbow, French Reef, Molasses Key, and Sombrero Key; see Appendix B). This change would make the marking of these zones clearer to facilitate enforcement and compliance with regulations applied in these areas. This would have a **negligible** impact on habitats and associated wildlife within these zones because the change in the size of the zone would be minor. A selection of modified or new SPAs proposed in Alternative 4 are described below to provide specific examples of the additional **direct, beneficial** impacts to habitat and wildlife associated with implementing this alternative:

New Snapper Ledge SPA: Under Alternative 4, ONMS would create a new SPA at Snapper Ledge to protect ESA-listed coral species. This action would provide **direct, beneficial** impacts to ESA-listed coral species by expanding protections and access restrictions to address existing user conflicts known to occur at this site.

Expanding Carysfort SPA: Under Alternative 4, ONMS would modify the existing Carysfort SPA to extend the zone to the shoreline to encompass and protect large, contiguous interconnected seagrass, shallow hardbottom, aggregate patch reef, and deep, drowned spur-and-groove reef habitats, and to provide a corridor for migration of fishes at different life stages. Protection of this area and application of existing and proposed new SPA regulations would have a **direct, beneficial** impact on the habitats and associated wildlife in this area by avoiding the potential adverse impacts to biological resources associated with human use of this area, including anchoring.

Adverse impacts: As described in Section 5.4.1.3, **no adverse impacts** to biological resources are expected from the proposed modified or new SPAs.

Proposed marine zone modification: Conservation areas

Under Alternative 4, ONMS would adopt “CA” as a new marine zone type that will take the place of the existing SUA and ER zones (see CA descriptions in Section 3.3). There are currently four SUAs and two ERs in FKNMS. Under Alternative 4, ONMS would create 13 CAs. The proposed transit-only regulation for CAs included in Alternative 2 would apply. Alternative 4 would have the greatest number and area of CAs.

Beneficial impacts: The general **direct, beneficial** impacts to biological resources of creating CAs proposed under Alternative 4 are the same as Alternative 2 (described in Section 5.4.1.3), except that these direct beneficial impacts would be spread over a larger area through additional protections and application of transit-only regulations to more CAs. Several of the areas included as CAs in Alternative 4, including Tortugas Corridor, Marquesas Keys turtle area, Western Dry Rocks, Turtle Shoal, Long Key Tennessee Reef, and El Radobob Key, are included in other alternatives but as different zone types with less restrictive regulations. By zoning these areas as CAs, Alternative 4 would provide greater **direct, beneficial** impacts to fish spawning aggregations, seagrass habitat critical to foraging green sea turtles, patch reefs, interconnected habitats, targeted seagrass and hardbottom habitats, and associated wildlife.

Adverse impacts: As described in Section 5.4.1.3, **no adverse impacts** to biological resources are expected from the proposed modified or new CAs.

5.6.1.4 Impacts to biological resources from updates to the FKNMS management plan (Alternative 4)

The impacts to biological resources from the final management plan would be the same as for those under Alternatives 2 (as described in Section 5.4.1) because the management plan would be the same under alternatives 2, 3, and 4.

5.6.2 Impacts to physical resources (Alternative 4)

This section describes the impacts to physical resources that would occur under Alternative 4.

5.6.2.1 Impacts to physical resources from the proposed sanctuary boundary expansion (Alternative 4)

The impacts to physical resources from changes to the sanctuary boundary proposed under Alternative 4 are the same as Alternative 2 (as described in Section 5.4.2.1), except for the additional benefits of inclusion of the Pulley Ridge expansion area. The proposed boundary expansion to include Pulley Ridge acknowledges and aims to take advantage of oceanographic currents to provide long-term benefits and protection of resources. Specifically, protecting the habitats and ecosystem of Pulley Ridge could have **direct, long-term, beneficial impacts** for downstream habitats, species, and ecosystems in the Florida Keys, as there is demonstrated connectivity between Pulley Ridge and the Florida Keys via the Loop and Florida Current. This beneficial impact would be **less than significant**.

5.6.2.2 Impacts to physical resources from changes to sanctuary-wide regulations (Alternative 4)

The impacts to physical resources from changes to sanctuary-wide regulations proposed under Alternative 4 are the same as Alternative 2 (as described in Section 5.4.2.2).

5.6.2.3 Impacts to physical resources from revisions to marine zone boundaries and regulations (Alternative 4)

The impacts to physical resources from changes to marine zone boundaries and regulations proposed under Alternative 4 are the same as Alternative 2 (as described in Section 5.4.2.2).

5.6.2.4 Impacts to physical resources from updates to the FKNMS management plan (Alternative 4)

The impacts to physical resources from changes to the FKNMS management plan proposed under Alternative 4 would be the same as that described for Alternative 2 (as described in Section 5.4.2.4) because the final management plan would be the same under alternatives 2, 3, and 4.

5.6.3 Impacts to cultural and historical resources (Alternative 4)

The impacts to cultural and historical resources from changes to the sanctuary boundary, sanctuary-wide regulations, marine zone boundaries and regulations, and FKNMS management plan proposed under Alternative 4 would be the same as Alternative 2 (as described in Section 5.4.3) because the differences in alternative components between alternatives 2 and 4 would not have any indirect or direct impacts on cultural or historical resources beyond those discussed for impact common to all alternatives. However, if additional cultural and historical resources are located in Pulley Ridge, such resources would benefit from the sanctuary regulations that would apply to protect them.

5.6.4 Impacts to socioeconomic resources and human uses (Alternative 4)

This section describes the impacts to socioeconomic resources and human uses that would occur under Alternative 4.

5.6.4.1 Impacts to socioeconomic resources and human uses from changes to the sanctuary boundary (Alternative 4)

The impacts to socioeconomic resources, environmental justice, and human uses from changes to the sanctuary boundary proposed under Alternative 4 are the same as under Alternative 2 (as described in Section 5.6.4.1), except for the additional impacts from including the Pulley Ridge expansion area.

Beneficial impacts: Benefits from proposed boundary expansion are the same as Alternative 2, applied over a larger geographic area. Alternative 4 would include the same sanctuary boundary expansions as alternatives 2 and 3, but would also include the expansion to include Pulley Ridge. Currently, there is limited recreational use of Pulley Ridge. Therefore, the **direct benefits** of coral reef protections for recreational use would be expected to be minor in the short-term. Over the long-term, more recreational “for hire” fishing and diving operations could develop using these resources and thus generate future benefits. Some people may visit Pulley Ridge, increasing the recreational use in this area. The greatest benefit would likely be from nonuse or passive economic use value such as increasing opportunities for research and educational activities. These passive economic benefits would be the same as those described in Section 5.4.4.1 but spread over a greater area within the Pulley Ridge area. As described in Section 5.4.4.1, these benefits would be **less than significant**.

Adverse impacts: Currently, the NMFS regulations in the existing HAPC (Pulley Ridge South and Portion A) prohibit bottom tending fishing gear and anchoring by fishing vessels; however, they include an exception for bottom longlining in Pulley Ridge South Portion A. As such, the proposed sanctuary boundary expansion, application of the sanctuary wide regulations, and application of a proposed no-anchor regulation in Pulley Ridge would result in **direct, adverse impacts** that would be **less than significant**.

Therefore, in the area proposed for FKNMS boundary expansion (which would mirror the NMFS HAPC to include both the Pulley Ridge South and South Portion A, see Figure 4.8), the **adverse impacts** to fishing activity would be **less than significant**. The primary adverse

impact from expanding the proposed sanctuary would be an increase in NOAA's administrative and enforcement costs in order to manage the expanded areas of the sanctuary. These costs would include those currently expended to operate and manage the current sanctuary, as described in Section 5.2.1, as well as the minimal additional cost to operate and manage the proposed expansion area. The net increase in costs would be **less than significant** because the sanctuary would be conducting the same activities as those described in Section 5.2.1, but over a slightly larger area. Therefore, expanding the sanctuary would result in **less than significant, direct, adverse impacts**.

5.6.4.2 Impacts to socioeconomic resources and human uses from changes to sanctuary-wide regulations (Alternative 4)

The impacts to socioeconomic resources and human uses from changes to sanctuary-wide regulations proposed under Alternative 4 are the same as Alternative 2 (as described in Section 5.4.4.2), except for the additional impacts of the proposed sanctuary-wide regulatory changes related to coral and live rock prohibitions and shoreline slow speed zones.

Proposed sanctuary-wide regulation update: Coral and live rock prohibition

Alternative 4 would require sanctuary authorization for existing and future live rock aquaculture activities that occur within FKNMS.

Beneficial impacts: The benefits of requiring a sanctuary authorization for existing and future live rock aquaculture activities in FKNMS would be largely administrative, except that enforcement and the avoidance of illegal poaching would be a **direct benefit** to the industry in both the short and long-term. These impacts would be **negligible**.

Adverse impacts: The proposed regulatory change would result in minimal costs to permittees in terms of time because the application(s) permittees use to apply for state or federal live rock aquaculture purposes could be used to apply for the FKNMS authorization, with the addition of a small amount of supplemental information. This **direct, adverse** impact would be **negligible** given the supplemental application information should take less than four hours to complete.

Proposed sanctuary-wide regulation update: Shoreline slow speed zone

Alternative 4 would extend this existing prohibition to apply to all shorelines within the sanctuary.

Beneficial impacts: The benefits to human users of FKNMS of slow speeds close to shore would include enhanced boating safety, shoreline erosion protection, avoidance of property damage, lower disturbance to wildlife, and sometimes avoidance of strikes to manatees and other marine life. These impacts would be **direct** and **less than significant**.

Adverse impacts: The main adverse impacts from the proposed regulation of shoreline speeds would be the added time for boat operators to drive a slower speed and enforcement costs for the sanctuary or other resource protection agency to ensure boaters comply with the slow speed restrictions.

5.6.4.3 Impacts to socioeconomic resources and human uses from changes to marine zone boundaries and regulations (Alternative 4)

Alternative 4 would expand the total number of marine zones from 57 areas (No Action Alternative) to 98 areas. This change would result in a 44.24% increase in the amount of habitat that would be protected by the sanctuary.

Socioeconomic impacts of Alternative 4, particularly for commercial and recreational fisheries, are higher than alternatives 2 and 3, as this alternative includes the largest amount of habitat area protected through marine zones. For comparison of impacts across the alternatives, see Section 5.8.

Beneficial impacts: Adding more restrictive marine zones that limit human use and recreational activities within certain areas would provide places for fish, whales, sea turtles, and other aquatic biota to forage, breed, and tend to young without the adverse impacts associated with fishing, recreational activities, and other human uses. These restricted areas often lead to increased population health and growth for fish and other aquatic biota. As described in Section 5.4.4.3, migration from restricted-access areas to non-restricted areas can lead to replenishment or increased densities within the non-restricted areas.

Therefore, the revisions to the marine zone boundaries and regulations under Alternative 4 would likely result in **long-term, direct, less than significant, beneficial** impacts to the water-based recreational tourism industry and commercial fishermen. In the long term, these beneficial impacts associated with increased biota and fishing stocks outside the restricted areas may be larger than the costs associated with the loss of area for fishing (as described below). In this case, the overall impact would be net-beneficial to the Monroe County economy.

In addition, replenishment would also result in **indirect, less than significant benefits** to the local tourism industry due to the increase in visitors to the region and associated spending within Monroe County.

Adverse impacts: Adverse impacts could result due to the area lost for recreational users and fishermen. Alternative 4 would result in a net maximum potential loss of \$2,038,000 annually of ex-vessel value (harvest revenue), 84 jobs of which 56 are harvester jobs, and \$8,215,000 in sales from commercial fishing to the state of Florida. This loss is the result of newly established marine zones that prohibit fishing. Fishing would still occur elsewhere within the sanctuary. For more information see Schwarzmann et al., 2022. This represents a slight increase in maximum potential loss from the 2019 draft EIS analysis; however, this change between the 2019 and 2022 economic analysis, matches with a relatively proportional overall increase in the economy, and this effect does not change the level of impact between draft and final EIS. These **adverse impacts** would be **less than significant** because the lost revenue, output, and jobs would be a very small percent of the overall revenue, output, and jobs provided by the commercial fishing industry within the Florida Keys.

When considering recreational fishing, there is a net maximum potential loss of 5,214 charter/head boat angler days and 31,757 private angler-fishing days annually for which users would otherwise have conducted recreational activities within the sanctuary. Since many recreational users would have paid tour companies or boat operators to access the sanctuary, the

closures would also result in a potential loss in spending of \$2,052,000 in sales from charter/head boats and \$1,305,000 in sales from private/rental boats to the state of Florida. This loss is the result of newly established marine zones that prohibit fishing. Fishing would still occur elsewhere within the sanctuary. These **adverse impacts** would be **less than significant** because the lost revenue, output, and jobs would be a very small percent of the overall revenue, output, and revenue provided by the tourism industry within the Florida Keys.

5.6.4.4 Impacts from socioeconomic resources and human uses from updates to the FKNMS management plan (Alternative 4)

The impacts to socioeconomic resources and human uses from changes to the FKNMS management plan proposed under Alternative 4 would be the same as Alternative 2 (as described in Section 5.4.4.4).

5.7 Impacts Specific to the 2022 NOPR and Final Preferred Alternatives

This section describes the beneficial and adverse impacts of the 2022 NOPR Alternative and the Final Preferred Alternative. These are discussed together because for several components there are nominal changes between these alternatives. The biggest difference between these alternatives is the proposed boundary expansion: the 2022 NOPR Alternative includes the same boundary as Alternative 4 while the Final Preferred Alternative includes the same boundary as alternatives 2 and 3. Both alternatives include many of the same sanctuary wide regulations and marine zone components as Alternative 2. The greatest difference is the number and configuration of the individual marine zones and associated regulations. These alternatives both aim to reduce stressors to sanctuary resources and create a balance between additional protection of sanctuary resources and allowing the greatest level of use given those resource protection goals.

The impacts are also presented in table form because the impacts do not differ substantially from the impacts described in the 2019 draft EIS. At the time NOAA published the NOPR, NOAA determined that a supplemental NEPA analysis was not required for the proposed rule because the 2019 draft EIS presented the public with a comprehensive analysis of the spectrum of environmental impacts among several alternative scenarios from which the NOPR Alternative was derived. Any changes reflected in the NOPR were determined insubstantial in that they do not differ from the nature and scale of the impacts already analyzed in the draft EIS. The specific combination of elements from the alternatives analyzed in the draft EIS and reflected in the NOPR also would not have any synergistic or cumulative impacts not already analyzed in the draft EIS. Based on the evaluation of the alternatives, NOAA determined that no significant adverse impacts to resources and the human environment are expected if any of the alternatives are adopted, and this conclusion applies to the NOPR Alternative and the Final Preferred Alternative (described below).

While the NOPR Alternative and Final Preferred Alternative would not have substantial impacts that would trigger the requirement to supplement, this final EIS has been updated to analyze the NOPR and the Final Preferred Alternatives. The analysis below confirms that the changes do not

result in substantial changes to the impacts. The table also notes any differences in impacts for the two new alternatives, however slight, from the original conclusions in the 2019 draft EIS.

The following tables include the 2022 NOPR and Final Preferred Alternatives impact analysis. Due to the fact that many of the components are the same as or include aspects from the other alternatives, the relevant sections are referenced and summarized in these tables.

Table 5.3: Sanctuary Boundary Impact Analysis 2022 NOPR and Final Preferred Alternatives

Component	NOPR Alternative	Final Preferred Alternative
Sanctuary boundary (Section 3.1)	The sanctuary boundary is the same as Alternative 4. The sanctuary boundary is expanded to include: • The ATBA; • The Tortugas Region; and • A distinct unit at Pulley Ridge The total area of the sanctuary boundary would be 4,800 square miles	The sanctuary boundary is the same as Alternative 2. The sanctuary boundary is expanded to include: • The ATBA; and • The Tortugas Region The total area of the sanctuary boundary would be 4,539 square miles
Biological	The impacts of the NOPR Alternative on the biological environment would be the same as those described for Alternative 4 (as described in Section 5.6.1). A summary of impacts specific to the inclusion of a distinct unit at Pulley Ridge are included here: Protecting the resources of Pulley Ridge through expansion of FKNMS would provide direct benefits to the mesophotic reef and hardbottom habitats present at Pulley Ridge. This action could also provide long-term, indirect benefits to the habitats and species of the Florida Keys by serving as a source of fish and coral larvae and specifically as a source for resilient coral reef species. Under the NOPR Alternative, ONMS would also implement a no-anchor regulation at Pulley Ridge, which would provide direct, beneficial, less than significant impacts to benthic habitats and associated wildlife.	The impacts of the Final Preferred Alternative on the biological environment would be the same as those described for Alternative 2 (as described in Section 5.4.1). The impacts to Pulley Ridge are the same for this alternative even though Pulley Ridge is not included in the sanctuary, because the IMO established a No Anchor Area for Pulley Ridge after publication of the proposed rule. A summary of impacts specific to the inclusion of the ATBA and the Tortugas region are included here: Within the Tortugas region, beneficial impacts would be direct and significant due to the biological importance of the region. Restricting anchoring on live coral would have direct, beneficial impacts to coral habitat resources in the expansion areas. Expansion of the sanctuary boundary would spread the adverse impacts of current field operations on biological resources (summarized in Table 5.2) over a larger geographic area. These adverse impacts to biological resources would be direct and less than significant. Consistent with the analysis in Appendix L, ONMS expects that these adverse effects of field operations would be less than significant because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment.

Component	NOPR Alternative	Final Preferred Alternative
Physical	The impacts of the NOPR Alternative on the physical environment would be the same as Alternative 2 (as described in Section 5.4.2.1) with the addition of specific impacts due to the inclusion of Pulley Ridge as a distinct unit described in Alternative 4 (see Section 5.6.2.1). A summary follows: For the proposed boundary expansion areas included in Alternative 2, hardbottom and coral reef habitats would benefit from improved water quality. The application of existing sanctuary regulations regarding discharge and human use to newly-expanded areas would provide direct, beneficial impacts to water quality by minimizing potential pollution and discharge related to vessel transit, operations, and accidental spills or leaks. Increased potential for carbon sequestration within mangrove and seagrass habitats that would be newly protected under the NOPR Alternative. The inclusion of the Tortugas area in FKNMS would have an indirect, beneficial impact as the existing sanctuary-wide prohibition on mineral and hydrocarbon exploration, development, and production would apply in this proposed expansion area. Protecting the habitats and ecosystem of Pulley Ridge could have direct, long-term, beneficial impacts for downstream habitats, species, and ecosystems in the Florida Keys, as there is demonstrated connectivity between Pulley Ridge and the Florida Keys via the Loop and Florida Current. This beneficial impact would be less than significant.	The impacts of the Final Preferred Alternative on the physical environment would be the same as Alternative 2 (as described in Section 5.4.2.1) and Alternative 4 (as described in Section 5.6.2.1) and summarized in the NOPR Alternative column to the left. The impacts to Pulley Ridge are the same for this alternative even though Pulley Ridge is not included in the sanctuary, because the IMO established a No Anchor Area for Pulley Ridge after publication of the proposed rule.

Component	NOPR Alternative	Final Preferred Alternative
Cultural	The impacts of the NOPR Alternative on the cultural environment would be the same as Alternative 2 (as described in Section 5.4.3.1). However, if additional cultural and historical resources are located in Pulley Ridge, such resources would benefit from the sanctuary regulations that would apply to protect them. A summary follows: The proposed expansion of FKNMS would have a direct, beneficial impact on cultural and historical resources in the expansion areas through application of the existing regulation prohibiting movement of, removal of, injury to, or possession of sanctuary historical resources. This beneficial impact is expected to be significant as it extends protections to several known shipwrecks just outside the current FKNMS boundary but within the ATBA. Boundary expansion may further protect historically-reported vessels sunk in deep water that are expected to have even greater site integrity due to their inaccessibility. NOAA research activities that seek to locate and document newly-included cultural and historical resources could result in direct or indirect, less than significant, adverse impacts to these resources. However, the adverse impacts on cultural and historical sanctuary resources from the proposed expansion would likely be less than significant due to the use of best management practices to minimize direct impacts.	The impacts of the Final Preferred Alternative on the cultural environment would be the same as Alternative 2 (as described in Section 5.4.3.1) and summarized in the NOPR Alternative column to the left.
Socioeconomic resources, environmental justice, and human uses	The impacts of the NOPR Alternative on the socioeconomic resources, environmental justice, and human uses would be the same as Alternative 4 (as described in Section 5.6.4.1). Benefits from proposed boundary expansion are the same as Alternative 2, applied over a larger geographic area with the inclusion of Pulley Ridge.	The impacts of the Final Preferred Alternative on socioeconomic resources, environmental justice, and human uses would be the same as Alternative 2 (as described in Section 5.4.4.1) and summarized in the NOPR Alternative column to the left.

Table 5.4: Sanctuary-wide Regulations Impact Analysis 2022 NOPR and Final Preferred Alternatives

Component	NOPR Alternative	Final Preferred Alternative
Sanctuary-wide regulations (Section 3.2)	The NOPR Alternative is identical to Alternative 2 for Sanctuary-wide regulations, except that the NOPR Alternative prohibits all discharges by cruise ships, except cooling water, while Alternative 2 included exceptions for clean vessel engine cooling water, clean vessel generator cooling water, vessel engine or generator exhaust gas, clean bilge water, or clean anchor wash water. All other sanctuary-wide regulations are the same as Alternative 2 including: increasing the time frame for temporary and emergency regulation application (this proposal includes additional details regarding the instance this regulation could be applied and how it would be executed (the impact analysis is not affected); updating the historical resources permit categories; prohibiting fish feeding; prohibiting actions related to derelict or deserted vessels and leaving harmful matter aboard such vessels; and requiring large vessels use large vessel mooring buoys. These changes would not change the NOPR Alternative's impacts on the environment, compared to Alternative 2.	The Final Preferred Alternative is the same as the NOPR Alternative with the exception of a technical change to the temporary and emergency regulation which changes the term "shall" to "may" in regards to taking public comment. This change would have no impact on the environment.

Biological	While the discharge regulation is modified in the NOPR Alternative, the impacts of the NOPR Alternative on the biological environment would be the same as Alternative 2 (as described in Section 5.4.1.2). A summary follows: The application of the proposed regulation prohibiting discharges from cruise ships would benefit habitats and wildlife in the vicinity of cruise ship transit lanes within the sanctuary by preventing contact with pollutants. A reduction in the pollutants and improvements to habitat quality would result in direct, less than significant, beneficial impacts. The NOPR Alternative would have the potential for slightly greater beneficial impacts given that all discharges from cruise ships except cooling water are prohibited. The proposed modification to the existing emergency regulation would extend the amount of time that an emergency regulation can be in place for FKNMS to respond to emergencies occurring within the sanctuary that threaten biological resources. This proposed regulatory change would have a direct, beneficial impact on habitats and wildlife within the sanctuary because it would allow NOAA more time to take necessary remedial action or to conduct restoration activities to avoid or prevent impacts to biological resources. Updating the historical resources permit categories would protect sunken artifacts that provide habitat for marine biota and would reduce the possibility of increased turbidity associated with excavation of sunken historical artifacts. The proposed update would result in less than significant, beneficial impacts to biological resources. As vessel traffic continues to increase throughout the Florida Keys, the need to better regulate derelict and/or deserted vessels, establish improved standards regarding damage assessment procedures, and improve notice and response time increases as well. Prohibiting these activities and requiring notification and a removal plan could decrease and shorten the duration of potential impact from derelict and deserted vessels, resulting in an overall direct, significant benefit to biological resources within the sanctuary. However, direct, less than significant, adverse impacts to biological resources during derelict vessel removal may occur due to the minimal potential for localized decline in water quality associated with accidental spills or leaks. Under the NOPR Alternative, as with Alternative 2, proposed mooring buoy regulations would designate large vessel mooring buoys. These regulatory changes would have a direct, beneficial, less than significant impact on coral and hardbottom habitat in the areas where mooring buoys would be located by reducing physical damage from anchoring.	The impacts of the Final Preferred Alternative on the biological environment would be largely the same as Alternative 2 (as described in Section 5.4.1.2) and summarized in the NOPR Alternative column to the left. Under the Final Preferred Alternative, NOAA would delay implementation of the requirement for large vessels to use large vessel mooring buoys for two years. This will delay the implementation of the benefits of this regulation, but would not cause adverse impacts compared to Alternative 1, the status quo, as large buoys may continue to use regular vessel buoys. Anchoring on corals will continue to be prohibited.
Physical	The impacts of the NOPR Alternative on the physical environment would be the	The impacts of the Final Preferred

Component	NOPR Alternative	Final Preferred Alternative
	same as Alternative 2 (as described in Section 5.4.2.2) with additional impacts as a result of more restrictive discharge regulations for cruise ships. Due to the NOPR Alternative prohibiting all discharges from cruise ships except cooling water, benefits to water quality could have a slightly greater beneficial impact given the more restrictive cruise ship discharge regulation prohibiting all discharges while in the sanctuary. There would be direct, beneficial impact on water quality in the existing and proposed boundary expansion areas if an emergency regulation were established to reduce a direct threat to water quality. Given that review of proposed excavations under the new archaeological research permit category is expected to reduce direct changes to the seafloor, sediment disturbance, and turbidity, the proposed regulatory update would result in direct, less than significant, beneficial impacts to physical resources. Requiring notification and a removal plan for derelict and/or deserted vessels would decrease and shorten the duration of potential adverse impacts to water quality from derelict and deserted vessels. This would result in both direct and indirect, less than significant, beneficial impacts on water quality within the sanctuary in both the existing and proposed expanded areas. However, due to the minimal potential for localized decline in water quality associated with accidental spills or leaks, less than significant, adverse impacts would occur from this proposed regulation. Reducing damage to physical seafloor and reef habitat from large vessels breaking or dislodging buoy anchoring hardware would provide direct, beneficial impacts to the physical resources of the sanctuary. These proposed regulations would also reduce the total area of seafloor disturbance by providing more mooring buoys for public use and therefore reducing the amount of anchoring damage. Adverse impacts from the expanded mooring buoy program would be less than significant due to the implementation of best management practices to minimize direct impacts such as disturbance of important seafloor structures and indirect impact, such as degradation of water quality from unintended spills or leaks.	Alternative on the physical environment would be the same as Alternative 2 (as described in Section 5.4.1.2) and summarized in the NOPR Alternative column to the left. Under the Final Preferred Alternative, NOAA would delay implementation of the requirement for large vessels to use large vessel mooring buoys for two years. This will delay the realization of the benefits of this regulation in reducing anchoring damage for two years, but would not cause adverse impacts compared to Alternative 1, the status quo, as large buoys may continue to use regular vessel buoys and anchoring on corals will continue to be prohibited.

Component	NOPR Alternative	Final Preferred Alternative
Cultural	The NOPR Alternative is expected to have the same effects on cultural resources as Alternative 2 (as described in Section 5.4.3.2). The NOPR Alternative only varies from Alternative 2 by having a total prohibition on cruise ship discharges, and this change is not expected to affect cultural resources. A summary follows: The proposed update to historical resources permit categories would have a direct, beneficial impact on historical resources in the sanctuary. This benefit would be significant as it would improve the quality of information generated from historical resource permits. The potential adverse impacts to cultural and historical resources from implementing this proposed regulation to the sanctuary's cultural and historical resources would be negligible.	The Final Preferred Alternative is expected to have the same effects on cultural resources as Alternative 2 (as described in Section 5.4.3.2). The Final Preferred Alternative, like the NOPR Alternative, only varies from Alternative 2 by having a total prohibition on cruise ship discharges, and this change is not expected to affect cultural resources. A summary of effects is included in the NOPR Alternative to the left.
Socioeconomic resources, environmental justice, and human uses	The NOPR Alternative is expected to have the same effects on socioeconomic resources, environmental justice, and human uses as Alternative 2 (as described in Section 5.4.4.2). The NOPR Alternative only varies from Alternative 2 by having a prohibition on all cruise ship discharges except cooling water, and this change is not expected to change from Alternative 2. A summary follows: Prohibiting cruise ship discharges would result in indirect and direct, beneficial impacts to the water-based recreation-tourism and commercial fishery within FKNMS. The amount of time that a ship would be required to alter its discharge activities would be minor. Due to the short amount of transit time during which discharge practices would be altered, the increased regulation would have direct, negligible, adverse impacts to the cruise ship industry.	The Final Preferred Alternative is expected to have the same effects on socioeconomic resources, environmental justice, and human uses as Alternative 2 (as described in Section 5.4.4.2). The Final Preferred Alternative, like the NOPR Alternative, only varies from Alternative 2 by having a prohibition on all cruise ship discharges except cooling water, and this change is not expected to change from Alternative 2. A summary is included in the NOPR Alternative column to the left.

Table 5.5. Marine Zone Boundary and Regulation Impact Analysis 2022 NOPR and Final Preferred Alternatives

Component	NOPR Alternative	Final Preferred Alternative
Additional marine zone boundaries and regulations (Section 3.3 and 3.4)	The NOPR Alternative includes a total of 87 marine zones, totaling 1080 square miles of sanctuary area included in a marine zone. The additional marine zone regulations included in the NOPR Alternative are the same as Alternative 2 including: Eliminate 2 existing exceptions: • Baitfishing permits in SPAs (non-regulatory) • Catch and Release fishing in 4 SPAs Update 2 existing regulations • PWC operation • Tortugas North access permits The individual marine zones are similar to Alternative 2 in area included (1131 square miles in Alternative 2) in marine zones and similar to Alternative 3 in regulations applied within zones (e.g., more no entry areas for WMAs). See section 3.3 for a description and Appendix B for maps.	The Final Preferred Alternative includes a total of 86 marine zones, totaling 1081 square miles of sanctuary area included in a marine zone. Like the NOPR Alternative, the additional marine zone regulations included in the Final Preferred Alternative are the same as Alternative 2. Like the NOPR Alternative, the marine zones in the Final Preferred Alternative are similar to Alternative 2 in area included in marine zones and similar to Alternative 3 in regulations applied within zones. See section 3.3 for a description and Appendix B for maps. Under the Final Preferred Alternative, NOAA would delay implementation of the prohibition on anchoring in SPAs, Western Sambo Conservation Area, and habitat restoration areas for two years. This will delay the realization of the benefits of this regulation in reducing anchoring damage for two years, but would not cause adverse impacts compared to Alternative 1, the status quo, as buoys will remain available in all existing areas and anchoring on corals will continue to be prohibited in existing areas and all new areas.

Biological	WMAs: The general impacts to biological resources of modifications to WMAs proposed under the NOPR Alternative are most closely aligned to Alternative 2 for the total area included in marine zones and Alternative 3 for the regulations applied in the individual marine zones (described in section and 5.5.1.3). Implementing the proposed modified and new WMAs would have direct, beneficial impacts on the habitats included in the proposed WMAs as well as wildlife included within or associated with each WMA. Modifications to WMA zones and implementing new WMAs would also have an indirect, beneficial impact on mangrove habitats by restricting access to certain zones that encircle or are adjacent to mangrove coastlines and/or islands. Additionally, implementing access restrictions in WMAs would provide direct, beneficial impacts to biological resources. SPAs: The general impacts to biological resources of modifications to SPAs proposed under the NOPR Alternative are the same as Alternative 2 (described in sections 5.4.1.3), however over a much smaller area (see Table 5.8). This includes impacts of eliminating the exception for baitfishing in all SPAs and catch and release in four existing SPAs. Implementing the changes with the SPAs would have a direct, beneficial impact on habitats that are added to existing marine zones or are newly protected through proposed new zones. This direct benefit would extend to wildlife that have a small home range and may remain within the zoned area for their full life cycle. CAs: The general impacts to biological resources of modifications to CAs proposed under the NOPR Alternative are the same as Alternative 2 (described in sections 5.4.1.3); however, they occur over a smaller area and the NOPR Alternative does not include bank habitats within the CA zone type. Implementing CAs would have direct, beneficial impacts on the habitats and wildlife included in the proposed marine zones. The impacts of proposed changes to CAs and access restrictions would be less than significant because of the moderate change in the area of marine zones protected as CAs. RAs: RAs are a new zone type included in the NOPR Alternative; however, these areas are generally very small and apply the same regulations as SPAs (Habitat RAs) and Conservation Areas (Nursery	Like the NOPR Alternative, for the Final Preferred Alternative, the general impacts to biological resources of modifications to the marine zones proposed under the Final Preferred Alternative are most closely aligned with Alternative 3 for the regulations applied in the individual marine zones, particularly for WMAs which have zone-specific regulations (described in section 5.5.1.3). See the summary in the NOPR Alternative column to the left. The Final Preferred Alternative includes two additional Nursery RAs with similar impacts as the NOPR Alternative. Under the Final Preferred Alternative, NOAA would delay implementation of the prohibition on anchoring in SPAs, Western Sambo Conservation Area, and habitat restoration areas for two years. This will delay the realization of the benefits of this regulation in reducing anchoring damage for two years, but would not cause adverse impacts compared to Alternative 1, the status quo, as buoys will remain available in all existing areas and anchoring on corals will continue to be prohibited in existing areas and all new areas.

Component	NOPR Alternative	Final Preferred Alternative
	RAs) so would have similar impacts as described above. The 2022 NOPR Alternative includes four Habitat RAs and nine Nursery RAs. The Habitat RAs would provide direct, beneficial impacts on coral reef habitat that are being restored in those areas (utilizing nursery corals being propagated in the Nursery RAs).	
Physical	The general impacts to physical resources of modifications to the marine zones proposed under the NOPR Alternative is the same as Alternative 2 (as described in Section 5.4.2.3). A summary follows: No additional beneficial or adverse impacts to the physical (i.e., oceanographic, climate, and climate change or water and water quality) resources of the sanctuary are expected as a result of the proposed marine zone modifications, creation of proposed new marine zones, and modification of associated regulations beyond those discussed under the sanctuary-wide regulations, which indicate either a direct, indirect or direct, less than significant, beneficial impact to physical resources. (Section 5.4.2.2).	The general impacts to physical resources of modifications to the marine zones proposed under the Final Preferred Alternative is the same as Alternative 2 (as described in Section 5.4.2.3). See the summary in the NOPR Alternative column to the left. Under the Final Preferred Alternative, NOAA would delay implementation of the prohibition on anchoring in SPAs, Western Sambo Conservation Area, and habitat restoration areas for two years. This will delay the realization of the benefits of this regulation in reducing anchoring damage for two years, but would not cause adverse impacts compared to Alternative 1, the status quo, as buoys will remain available in all existing areas and anchoring on corals will continue to be prohibited in existing areas and all new areas.

Component	NOPR Alternative	Final Preferred Alternative
Cultural	The general impacts to cultural resources of modifications to the marine zones proposed under the NOPR Alternative is the same as Alternative 2 (as described in Section 5.4.3.3). A summary follows: Several of the existing and proposed modified or new marine zones the NOPR Alternative would encompass historical resources, including lighthouses and shipwrecks listed on the National Register of Historic Places. ONMS would strengthen regulations in these marine zones to include some no-anchor areas. This would have potential negligible, direct, beneficial impacts on these resources by reducing the risk of potential anchor damage to historical resources present in these zones. Limiting fishing activity in new marine zones would prevent impacts to historical resources that could result from contact with fishing gear when it is deployed or recovered. These beneficial impacts would be direct, beneficial, and negligible because of the wide distribution of historical resources throughout marine zones	The general impacts to cultural resources of modifications to the marine zones proposed under the Final Preferred Alternative are the same as Alternative 2 (as described in Section 5.4.3.3). See the summary in the NOPR Alternative column to the left.

Component	NOPR Alternative	Final Preferred Alternative
Socioeconomic resources, environmental justice, and human uses	The general beneficial impacts to socioeconomic resources, environmental justice, and human uses of modifications to the marine zones proposed under the NOPR Alternative are most aligned with Alternative 2 (see section 5.4.4.3). Under the NOPR Alternative, the adverse impacts resulting from restricting access to certain areas could result in less than significant, adverse impacts because it would decrease the amount of area available for recreational users, the tourism industry, and commercial fishermen. The NOPR Alternative impacts are greater than Alternative 3 but less than Alternative 4. The NOPR Alternative proposes to eliminate two existing SPAs, thereby opening these previously closed areas to fishing. Specifically, the NOPR Alternative would result in a maximum potential loss of \$1,025,000 annually ex-vessel (harvest value), 42 jobs of which 28 are harvester jobs, and \$4,130,000 in sales from commercial fishing to the state of Florida (for more information see Schwarzmann et al., 2022). These adverse impacts would be less than significant because the lost revenue, output, and jobs would be a very small percent of the overall revenue, output, and jobs provided by the commercial fishing industry within the Florida Keys. When considering recreational fishing, there is a maximum potential loss of 1,972 charter/head boat angler days and 4,198 private angler fishing days annually for which users would have otherwise conducted recreational activities within the sanctuary. Since many recreational users would have paid tour companies or boat operators to access the sanctuary, the closures would also result in a potential loss in spending of \$776,000 in sales from charter/head boats and \$173,000 in sales from private/rental boats in the state of Florida. These adverse impacts would be less than significant because the lost revenue, output, and jobs would be a very small percent of the overall revenue, output, and revenue provided by the tourism industry within the Florida Keys.	The general impacts to the socioeconomic resources, environmental justice, and human uses of modifications to the marine zones proposed under the Final Preferred Alternative are the same as the NOPR Alternative. The Final Preferred Alternative includes nominal differences from the NOPR Alternative for the specific marine zone proposals.

Table 5.6: Management Plan Impact Analysis 2022 NOPR and Final Preferred Alternatives

Component	NOPR Alternative	Final Preferred Alternative
Management plan (Section 3.5 and Appendix A)	The NOPR Alternative is the same as Alternative 2 with edits to include a suite of six management priorities and the addition of Appendix III: List of Exempted Military Activities.	The Final Preferred Alternative is the same as the NOPR Alternative with edits to include greater specificity and clarification of priorities and other minor edits. The NOPR Alternative Appendix III is now included in this final EIS as Appendix F. The potential impacts resulting from exempted military activities have been fully analyzed in the 1996 FKNMS Final EIS or the Navy's 2018 Atlantic Fleet Testing and Training Environmental Impact Statement¹³ and associated consultation with ONMS.
Biological	The general impacts to cultural resources of modifications to the management plan proposed under the NOPR Alternative is the same as Alternative 2 (as described in Section 5.4.1.4). A summary follows: Routine education, outreach, research, monitoring, and resource protection activities and coordination with stakeholders would have both direct and indirect, beneficial impacts on the biological resources within FKNMS. These management plan activities would promote ocean literacy and stewardship, and improve the understanding, management, and protection of the sanctuary's biological resources, which provide indirect, beneficial impacts to habitat, wildlife, and protected species in FKNMS.	The general impacts to biological resources of the Final Preferred Alternative management plan are the same as Alternative 2 (as described in Section 5.4.1.4). See the summary in the NOPR Alternative column to the left.

¹³ <https://www.nepa.navy.mil/AFTT-Phase-III/>

Component	NOPR Alternative	Final Preferred Alternative
Physical	The general impacts to cultural resources of modifications to the management plan proposed under the NOPR Alternative is the same as Alternative 2 (as described in Section 5.4.2.4). A summary follows: The updated management plan activities proposed under Alternative 2 would provide both direct and indirect, long-term benefits to physical resources within the sanctuary through improved stewardship of sanctuary resources and further research and restoration activities. ONMS expects that implementing a revised management plan would result in less than significant, adverse impacts because the activities would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment.	The general impacts to physical resources of the Final Preferred Alternative management plan are the same as Alternative 2 (as described in Section 5.4.2.4). See the summary in the NOPR Alternative column to the left.
Cultural	The general impacts to cultural resources of modifications to the management plan proposed under the NOPR Alternative is the same as Alternative 2 (as described in Section 5.4.3.4). A summary follows: Specific activities include: improving the inventory and characterization of historical resources, better understanding visitor use and mitigating potential impacts of that use, and implementing archaeological research standards through the proposed updated permit categories. Visitors using improper anchoring, diving, or snorkeling techniques may adversely impact the historical resource. The adverse impacts of these activities are expected to be less than significant because they would be mitigated by the use of best management practices to avoid improper techniques.	The general impacts to cultural resources of the Final Preferred Alternative management plan are the same as Alternative 2 (as described in Section 5.4.3.4). See the summary in the NOPR Alternative column to the left.

Component	NOPR Alternative	Final Preferred Alternative
Socioeconomic resources, environmental justice, and human uses	The general impacts to cultural resources of modifications to the management plan proposed under the NOPR Alternative is the same as Alternative 2 (as described in Section 5.4.4.4). A summary follows: Routine education, outreach, research, monitoring, resource protection activities, and coordination with stakeholders would have both direct and indirect, beneficial impacts on the socioeconomic resources and human uses within FKNMS. ONMS expects that direct and indirect, adverse impacts from a revised management plan would be less than significant because the disruptions would be short-term and localized, and FKNMS would employ a variety of best management practices to avoid or minimize impacts to the natural and human environment.	The general impacts to socioeconomic resources and human uses of the Final Preferred Alternative management plan are the same as Alternative 2 (as described in Section 5.4.4.4). See the summary in the NOPR Alternative column to the left.

5.8 Comparison of Impacts Across Alternatives

This section presents a comparison of the overall potential environmental and socioeconomic impacts of the proposed action and alternatives. Sections 5.1 through 5.8 addresses the individual impacts associated with each alternative by topic. The alternatives, as described in Chapter 3, include the No Action Alternative (Alternative 1) and a range of three progressively more protective alternatives (alternatives 2, 3, and 4), and the Final Preferred Alternative, which pulls from each of the alternatives to create a balance between resource protection and access. In the 2019 draft EIS, NOAA identified Alternative 3 as NOAA's preferred alternative. Following public comment on the draft EIS, and the development of the 2022 NOPR Alternative, NOAA has also included a Final Preferred Alternative. Alternatives that were eliminated from further evaluation are listed in Section 3.7.

Alternative 2 aims for greater overall protection than the No Action Alternative (Table 5.7). This would primarily be achieved through changes to the number and configuration of marine zones and the access restrictions/regulations proposed for the marine zones. Overall, Alternative 2 would include a total of 1,131 square miles of zoned area, 98 square miles more than the status quo (Table 5.8). Additionally, Alternative 2 would result in a decrease of approximately 42.1 jobs in the Florida Keys region (Table 5.9).

Alternative 3 aims for greater overall protection than Alternative 2 by updating one sanctuary-wide regulation, adding two additional marine zones, and implementing more protective marine zone regulations and access restrictions than Alternative 2. Overall, Alternative 3 would include a total of 1,144 square miles of zoned area, 111 square miles more than the status quo and would implement more protective access restrictions than those proposed in Alternative 2 in order to meet greater environmental protection goals (Table 5.8). Alternative 3 places greater emphasis on resource protection over allowing a high level of use. Alternative 3 also presents economic benefits relative to Alternative 2, whereby all metrics for benefits would increase and metrics for adverse impacts would remain the same between alternatives 2 and 3.

Alternative 4 is designed to have the most environmental and ecological protections of all alternatives and would have the most protective access restrictions within the marine zone-specific regulations; therefore, Alternative 4 is the environmentally preferred alternative (see further discussion below in Section 5.8.1). Overall, Alternative 4 would include a total of 1,168 square miles of zoned area, 135 square miles more than the status quo (Table 5.8). Alternative 4 strives to meet a balance between protection of targeted site-specific locations where resource damage is evident while also providing protection of the largest area of contiguous habitats compared to the other proposed alternatives. To do this, larger marine zones would be included in each of the five geographic regions (Upper Keys, Middle Keys, Lower Keys, Marquesas, and Tortugas). This approach aims to more fully meet Goal 2 of the Advisory Council Regulatory and Zoning Alternatives Development Workplan: "Protect large, contiguous, diverse, and interconnected habitats that provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic protection of marine life and protect and preserve all habitats and species." In addition, Alternative 4 includes protections for a new habitat type—mesophotic coral reefs—through a proposed sanctuary boundary expansion that would include Pulley Ridge. This proposed boundary expansion is aligned with an existing GMFMC HAPC, and would

provide additional protections to unique mesophotic coral reefs and other endemic species found only in this region.

The 2022 NOPR Alternative was developed based on public and agency comment on the draft EIS regarding alternatives 1 through 4. The NOPR Alternative combined individual aspects of each of the four alternatives to achieve a balance between resource protection and user access. The NOPR Alternative includes the sanctuary boundary alternative included in Alternative 4 and the sanctuary-wide regulations as proposed in Alternative 2 with a few exceptions, including greater discharge restrictions for cruise ships and additional process detail for the temporary regulation for emergencies and adaptive management. Specifically for the marine zone component, the area included in new or expanded marine zones is very targeted, which is similar to Alternative 2. However, the regulations applied in the marine zones are more restrictive, much like in Alternative 3. The NOPR Alternative includes 1,080 square miles of area within individual marine zones, 47 square miles more than the status quo. The NOPR Alternative includes the greatest area in the overall sanctuary boundary (Alternative 4); otherwise it most closely aligns with Alternative 2 in every aspect except that the regulations applied within individual WMAs more closely aligns with Alternative 3 (more protective than Alternative 2 but less protective than Alternative 4).

The Final Preferred Alternative provides additional management and protection of sanctuary resources from the status quo and aims to create a balance between resource protection and sustainable use. As compared to the other alternatives presented here, like the NOPR Alternative, the Final Preferred Alternative is the middle path between resource protection and user access. In addition, in light of the increasing stressors sanctuary resources are experiencing, the Final Preferred Alternative considered action that would support and facilitate resilience and recovery of habitats and species throughout the sanctuary and within or moving through the individual marine zones. The Final Preferred Alternative would include 1,081 square miles of area within individual marine zones, 48 square miles more than the status quo (which more closely aligns with Alternative 2). However, in some marine zones (e.g., WMAs) the Final Preferred Alternative would implement more protective access restrictions than those proposed in Alternative 2 in order to meet greater environmental protection goals. The Final Preferred Alternative most closely aligns with Alternative 2 in every aspect except that the regulations applied within individual WMAs more closely aligns with Alternative 3 (more protective than Alternative 2 but less protective than Alternative 4).

5.8.1 Analysis of the environmentally preferable alternative

There are environmental tradeoffs among the alternatives and within resource areas or topics, making it difficult to summarize the net effect of the alternatives. Overall, all of the action alternatives would result in beneficial impacts in one or more environmental resource areas, and none of the action alternatives would result in a significant adverse impact.

The analyses below in tables 5.7 and 5.8 demonstrate the scale of the increasing protection of sanctuary area and area protected within marine zones from Alternative 2 to Alternative 4 and the shift towards more targeted protection in the 2022 NOPR and Final Preferred Alternatives. All action alternatives (that is, all but Alternative 1) include expansion in the overall area of the sanctuary and the addition of the ABTA and Tortugas. Alternative 4 and the 2022 NOPR

Alternative also include the addition of the Pulley Ridge expansion area. The size of marine zone protection across alternatives (Table 5.8) further indicates increased ecological protection of habitats compared to the No Action Alternative, where Alternative 2 protects 1,131 square miles in marine zones, Alternative 3 protects 1,144 square miles in marine zones, and Alternative 4 protects 1,168 square miles in marine zones. The 2022 NOPR Alternative and Final Preferred Alternatives protect 1,080 and 1,081 square miles in marine zones, respectively. In the economic comparison across alternatives (Table 5.9), each category experiences economic benefit with increasing environmental protection. For more details on the socio-economic analysis see Schwarzmann et al., 2022.

The environmental consequences analysis shows that all of the action alternatives would result in beneficial impacts (e.g., protect biological, physical, cultural, and socioeconomic resources), and none of the action alternatives would result in significant adverse impacts. NOAA has identified Alternative 4 as the most environmentally protective because it would protect the greatest total area; therefore, Alternative 4 is the environmentally preferable alternative.

Comparison of proposed sanctuary boundary alternatives

Table 5.7. Boundary expansions in FKNMS by alternative (square miles)

Alternatives	Total area	Expansion area	ATBA expansion	Tortugas expansion	Pulley Ridge ¹
1 – no action	3,800	0	0	0	0
2	4,539	743	472	271	0
3 – 2019 draft EIS preferred	4,539	743	472	271	0
4	4,800	1,002	472	271	259
2022 NOPR	4,800	1,002	472	271	259
Final Preferred	4,539	743	472	271	0

1. Pulley Ridge comprises two habitat areas of particular concern (HAPCs): Pulley Ridge South and Pulley Ridge South Portion A. Both areas protect corals.

Comparison of proposed marine zone alternatives

Table 5.8. Number and size of marine zones by type of zone and regulatory alternative

Alternatives	Sanctuary boundary (sq. miles)	Total zoned (sq. miles) ¹	Number of WMAs ²	Number of SPAs ³	Number of ERs/ SUAs/ CAs ^{4,5,6}	Number of RAs	Number of EMAs/ MAs ⁷	Total marine zones
1 – No Action	3,800	1,033	28	18	7	0	4	57
2	4,539	1,131	59	24	9	0	4	96

Alternatives	Sanctuary boundary (sq. miles)	Total zoned (sq. miles) ¹	Number of WMAs ²	Number of SPAs ³	Number of ERs/ SUAs/ CAs ^{4,5,6}	Number of RAs	Number of EMAs/ MAs ⁷	Total marine zones
3 – 2019 draft EIS preferred	4,539	1,144	60	25	9	0	4	98
4	4,800	1,168	58	21	14	0	4	98
2022 NOPR	4,800	1,080	47	17	6	13	4	85
Final Preferred	4,539	1,081	44	17	6	15	4	88

1. Includes area included in national wildlife refuges
2. Wildlife management areas
3. Sanctuary preservation areas, no-take areas
4. Ecological reserves, no-take areas
5. Special use areas, set aside for restoration or research only
6. ERs and SUAs changed to conservation areas in all action alternatives
7. Existing management areas and management areas, includes national wildlife refuges

Comparison of socioeconomic impacts across alternatives

The socioeconomic benefits across the action alternatives are expected to be positive due to an increase in non-consumptive recreational activities. These include an increase in the number of person days engaged in non-consumptive recreation activities, increased spending in direct expenditures (e.g., with tour companies), increased spending within Monroe County, and increased income within Monroe County (e.g., jobs).

The table below shows net impacts from measurable changes to market outcomes, assuming there is no substitution or replacement of lost activity in each industry described. This summary table does not include non-market impacts or changes to non-monetized benefits and costs, such as conservation and restoration values. Further, this table presents the maximum potential loss due to closure of fishing areas and does not account for the likelihood that fishers will fish outside of newly established protected areas or shift activities, minimizing losses. The decreased number of jobs is a reflection of the maximum potential loss in the fishing industries and does not provide an estimate for job growth in other sectors that may benefit from increased protections like science, research, education, and non-consumptive recreation.

Table 5.9. Comparison of adverse socioeconomic impacts across the action alternatives. The No Action Alternative was not included because there would be no changes to economic indices under the No Action Alternative.

Adverse Impacts ¹	Alternative 2	Alternative 3	Alternative 4	2022 NOPR/Final Preferred Alternative
Lost fishing revenue	\$17,000	\$17,000	\$2,038,000	\$1,025,000

Adverse Impacts ¹	Alternative 2	Alternative 3	Alternative 4	2022 NOPR/Final Preferred Alternative
Lost number of person-days	\$379,000	\$379,000	\$35,040,000	\$6,170,000
Decreased spending within Monroe County (sales/output)	\$96,000	\$96,000	\$10,812,000	\$5,079,000
Decreased income within Monroe County (jobs)	\$29,000	\$29,000	\$3,138,000	\$1,464,000
Decreased number of jobs	42.1	42.1	80.8	37.3

1. All of the adverse impacts are due to losses to recreational and commercial fishermen.

Benefits: Managing use through the creation of marine zones has been shown to increase the quality of marine life, thus benefiting those engaged in both consumptive use and non-consumptive forms of recreation. Increasing the number of protected areas may also result in increases in non-market value. Non-market values are likely to be larger than any market value impact that the proposed action would have (Tortugas ER: Leeworthy & Wiley, 2000; Hawai'i: Bishop et al., 2011; Flower Garden Banks National Marine Sanctuary: Stefanski & Shimshack, 2016). In addition, there may be long-term benefits in terms of scientific value.

Costs: In the short term, there may be some financial losses due to the closure of new areas to fishing and anchoring. In the longer term, if these areas have replenishment effects (increasing total stock sizes), as observed in the Tortugas region, commercial fisheries may actually receive benefits instead of costs. However, this may not occur if, for example, more catch is allocated to recreational fisheries or the size of the commercial fishery is reduced.

The maximum potential costs of the 2022 NOPR Alternative and Final Preferred Alternative to fisheries (commercial and recreational; Table 5.5) and associated impacts on the Monroe County economy are not likely to occur. In the long term, if there are positive impacts to fishery resources outside the protected areas (spillover effect), then there will likely be net benefits to fisheries and overall positive impacts to the Monroe County economy. Additionally, non-market economic values¹⁴ are the appropriate values to include in formal benefit-cost analyses and are the values used in damage assessment cases to sue responsible parties for damages to natural resources. When non-market values are included, NOAA believes the net benefits of the proposed action are likely to be positive.

For the full socioeconomic analysis of the 2022 NOPR Alternative see Schwarzmenn et. al., 2022. This analysis also applies to the Final Preferred Alternative due to nominal differences between these two alternatives.

¹⁴ Non-market values are the benefits people receive from natural and cultural resources through both direct and indirect use that are not traded in markets.

5.9 Cumulative Impacts

CEQ's NEPA regulations at 40 C.F.R. § 1508.7 define cumulative impacts 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” (CEQ, 1997). Cumulative impacts can result from individually minor but collectively significant actions that take place over time. CEQ's guidance for considering cumulative effects states that NEPA documents “should compare the cumulative effects of multiple actions with appropriate national, regional, state, or community goals to determine whether the total effect is significant” (CEQ, 1997).

Under the No Action Alternative (Alternative 1), NOAA would continue to implement sanctuary protections and management activities in the existing sanctuary and marine zone boundaries. Under alternatives 2, 3, 4, and the Final Preferred alternative, NOAA would expand the sanctuary boundary, modify and propose new marine zones, update sanctuary-wide and marine zone-specific regulations, and update management plan activities.

The actions considered below are similar to the proposed action, large enough to have far-reaching effects, or are in proximity to the proposed action with similar types of impacts.

This section presents the methods used to evaluate cumulative impacts, lists projects that may have cumulative effects when combined with the impacts from the proposed action or alternatives discussed in this final EIS, and evaluates potential cumulative impacts.

5.9.1 Cumulative impact assessment methods

CEQ's cumulative effects guidance sets out several different methods for assessment such as checklists, modeling, forecasting, and economic impact assessment, where changes in employment, income, and population are evaluated (CEQ, 1997). This final EIS uses a variety of methods, depending on the resource area, to determine cumulative effects. In general, past, present, and future foreseeable projects are assessed by topic area. Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Interactive effects may be countervailing, where the adverse cumulative effect is less than the sum of the individual effects, or synergistic, where the net adverse effect is greater than the sum of the individual effects (CEQ, 1997). The projects in Table 5.8 are anticipated to occur in the reasonably foreseeable future within the study area. NOAA has considered the effects of these actions in combination with the impacts of the proposed action to determine the overall cumulative impact on the resources in the study area.

Table 5.8. Actions with potential to contribute to cumulative impacts

Action	Action location	Action agency	Action description	Projected completion
National Park Service management plan implementation	Biscayne, Everglades, and Dry Tortugas	Department of Interior	Biscayne National Park and Everglades National Park have finalized and are implementing updated management plans	Ongoing
National wildlife refuge management	Key Largo and Middle to Lower Keys	Department of Interior	Implementation of comprehensive conservation plans and review and update of backcountry management plan	Ongoing
Federal and State Fishery management	South Florida, Florida Keys, Gulf of Mexico	FWC, GMFMC, SAFMC	Implementation of fishery management action	Ongoing
Other regional land management efforts	South Florida	Miami Dade and Monroe counties	State and local land management	Ongoing
EFH and HAPC designations and management	Pulley Ridge	NMFS/ GMFMC	GMFMC is mandated to identify, describe, map, and protect EFH. The HAPC at Pulley Ridge has recently been modified.	Designation complete, management ongoing
Central Everglades Planning Project	South Florida	USACE	USACE is required to identify a suite of restoration projects for congressional authorization as part of the Comprehensive Everglades Restoration Plan.	Ongoing
Florida DEP National Pollutant Discharge Elimination System (NPDES) permit review	South Florida, Card Sound	Florida DEP	NPDES permit reviews and renewals	Ongoing
Monroe County canal demonstration projects	Monroe County, nearshore canals	EPA, Federal Emergency Management Agency	Execution of canal demonstration projects as part of the WQPP priorities and general canal clean-up following Hurricane Irma	Ongoing
Urbanization	South Florida	State, county, local, and private entities	Continued growth and development	Ongoing

5.9.2.1 Biological and physical resources

The proposed action would not contribute to any significant adverse impacts on habitats, wildlife, protected species, climate, water, or historical resources, as identified above. The proposed action, combined with ongoing National Park System management plan implementation, EFH and HAPC designations, Florida DEP National Pollutant Discharge Elimination System permit reviews, Central Everglades Planning Project implementation, and Monroe County canal demonstration projects, would have an overall beneficial cumulative effect on biological and physical resources in the region. The combined resource protection provided by these programs and associated regulations would result in positive influences on marine habitats and resources.

Cumulative impacts analysis related to threats identified in the condition report and current sanctuary resource condition

Current threats to biological sanctuary resources include continued discharges including soil, nutrients, and other pollutants washing into wetlands and coastal waters from urban and agricultural stormwater runoff; continued conversion and fragmentation of wildlife habitat from development, habitat loss, and overexploitation of large fish and keystone species; and introduction of invasive species. The condition of the sanctuary is also influenced by factors which occur outside its boundaries, such as regional impacts to water quality and global climate change. Human actions, such as poaching, vessel groundings, and discharging of marine debris, continue to negatively affect the habitat and living resources of the sanctuary. These activities will likely decrease the overall availability and quality of marine and wetland habitats. Species with threatened, endangered, or declining populations are likely to be more sensitive to declines in habitat availability and quality and the introduction of invasive species. However, the proposed action is designed to address, and where possible, ameliorate these threats. Overall, the cumulative effects of the proposed action in combination with other past, present, and reasonably foreseeable future actions would be an overall net benefit.

Cumulative impacts analysis related to other federal, state, and local parks

Federal, state, and local parks and wildlife refuges located near FKNMS provide valuable habitat to native wildlife, migratory birds, fish, and other mobile biota. As agricultural activities, development, and urbanization increase habitat conversion and fragmentation, these protected areas will become ecologically more important as the amount of minimally-disturbed habitat decreases. Habitat loss, in general, can negatively affect breeding success, dispersal success, predation rates, and other animal behaviors. In addition, the cumulative area protected by FKNMS and other federally-, state-, or locally-managed areas and associated regulations provide biota with a larger area of contiguous, or minimally fragmented, habitat. Habitat fragmentation (the breaking up of a larger area of habitat into smaller patches) disrupts many basic ecological interactions of a community, including predator-prey, parasite-host, and plant-pollinator, and can result in cascading extinctions. Therefore, the cumulative effects of proposed action in combination with the continued management of other federal, state, and local parks and refuges would be a net benefit to aquatic and terrestrial biota.

Cumulative impacts analysis related to regional hydrography and water quality

Regional conditions outside FKNMS strongly influence sanctuary waters in this highly interconnected system of coastal and estuarine waters. Under certain conditions, external sources adjacent to the sanctuary (such as Florida and Biscayne bays, the Loop and Florida Currents, riverine waters and other land-based activities, and atmospheric inputs) can influence or even dominate water quality conditions. Specifically, the South Florida ecosystem has been extensively altered through development of drainage canals completed to facilitate coastal development, agriculture, and flood control. These canals have significantly altered the distribution, timing, and quality of freshwater flow within the South Florida watershed, resulting in degraded marine habitats and other environmental changes that continue to impact the estuaries of Florida Bay and the Florida Keys. Therefore, the cumulative effects of the proposed action in combination with the continued implementation of Central Everglades Planning Projects would be a net benefit to aquatic and terrestrial biota.

5.9.2.2 Cultural and historical resources

The proposed action would contribute toward preservation of important resources throughout FKNMS, and no significant adverse effects on cultural and historical resources are anticipated from the proposed action. Cumulative effects that could impact cultural and historical resources may include impacts from increased visitation to historic shipwrecks resulting from interpretation of the resources. However, the sanctuary would continue to extend education and outreach to minimize any unforeseen adverse impacts to historic shipwrecks as a result of the potential increased visitation.

Population growth and increased tourism may lead to minor adverse impacts. These unintended cumulative impacts would be minimized by education and research activities both at the sanctuary and through collaborative efforts. One effort to foster partnerships among agencies to protect historical resources is the draft programmatic agreement among NOAA, the state of Florida's SHPO, and the ACHP for compliance under Section 106 of the NHPA to further joint management of FKNMS historical resources.

5.9.2.3 Socioeconomic resources and human uses

As identified above, the proposed action would result in net beneficial impacts on tourism, recreation, local economies, research, education, and passive economic use. Cumulative impacts from other reasonably foreseeable action could result from population growth, and increased tourism may lead to minor adverse impacts beyond what the sanctuary can effectively manage. These actions could increase the number of recreational users and fishermen within the sanctuary, potentially resulting in more densely-used areas within FKNMS. Nonetheless, FKNMS regularly reviews its management plan and regulations and could update these documents, if necessary, should increased urbanization or tourism lead to competition for access to the sanctuary. Thus, the actions listed in Table 5.8 would not be expected to result in significant cumulative impacts on socioeconomic resources or human uses in FKNMS.

Chapter 6: Conclusions

6.1 Summary of Final Preferred Alternative

NOAA's Final Preferred Alternative includes the following components: (1) changes to the sanctuary boundary, (2) updating sanctuary-wide regulations, (3) modifying existing marine zones and creating new ones, (4) updating marine zone-specific regulations, and (5) updating the sanctuary management plan. A summary of each of these components is included below.

6.1.1 Sanctuary expansion to encompass the ATBA and the Tortugas Region

For the sanctuary boundary, the Final Preferred Alternative includes: (1) the Tortugas region and (2) expansion to encompass the ATBA. The Final Preferred Alternative would not include a distinct unit at Pulley Ridge. The expanded sanctuary boundary for the Final Preferred Alternative would encompass a total area of 4,539 square miles, which is 739 square miles greater than the existing sanctuary boundary area.

The expansion in the Tortugas region aligns with the existing particularly sensitive sea area, encompasses the existing Tortugas South ER, and extends to the west of the existing Tortugas South ER by one mile. This expansion provides additional protections for important ecological resources and the ecological connectivity in the region, particularly between Tortugas North and South ERs and Tortugas Bank. The ATBA boundary expansion proposes aligning the geographic boundary of the sanctuary with the existing ATBA boundaries. This proposed boundary expansion would clarify NOAA's area of responsibility and enhance compliance and enforcement. For a summary across alternatives see Figure 3.1 and Table 3.1. For more details, see also Section 3.6.

6.1.2 Sanctuary-wide regulations

For sanctuary-wide regulation updates, the Final Preferred Alternative would update three existing sanctuary-wide regulations and add three new sanctuary-wide regulations. In general, these proposed updates and new regulations provide NOAA additional authority to protect sanctuary resources, more rapidly respond to impacts to sanctuary resources, and in some cases create consistency with other sanctuary and state regulations.

6.1.3 Marine zone boundaries and associated regulations

For marine zone boundaries and associated regulations, the Final Preferred Alternative would maintain many of the marine zones in the No Action Alternative (Alternative 1) and would add new marine zones to provide additional site-specific protection where resource damage is evident. The Final Preferred Alternative would place greater emphasis on resource protection as compared to the level of use. The Final Preferred Alternative aims to balance conservation protection measures and access to sensitive areas by applying access recommendations that would be more restrictive than the No Action Alternative and Alternative 2, and less restrictive

than Alternative 4. The Final Preferred Alternative would also establish a new RA zone type to facilitate active habitat restoration activities within the sanctuary.

Specifically, the Final Preferred Alternative would add 28 WMAs and 15 RAs compared to the No Action Alternative.

6.1.4 Management plan

The management plan component of the Final Preferred Alternative includes an updated management plan with a vision, mission, goals, objectives, and activities designed to facilitate understanding of sanctuary resource condition and value. This understanding will be applied to target management action, reduce impacts to resources, and enhance stewardship and collaboration. The Final Preferred Alternative management plan also includes specific priorities for management action. This updated management plan would allow for a more coordinated and priority-driven effort. As a result, it would support more effective management, strategic partnerships, and conservation-based outcomes.

6.2 Unavoidable Adverse Impacts

An EIS must describe any significant unavoidable impacts for which either no mitigation or only partial mitigation is feasible. The environmental impacts of the proposed action and alternatives are described in Chapter 5. No unavoidable significant adverse impacts were identified for any of the action alternatives (alternatives 2, 3, 4, 2022 NOPR, and Final Preferred). The No Action Alternative (Alternative 1) could result in significant adverse impacts to cultural and historical resources outside the existing sanctuary but within U.S. federal waters of the proposed expansion area that would not be adequately protected from activities that could harm or destroy such nonrenewable resources.

6.3 Relationship of Short-term Uses and Long-term Productivity

NEPA requires consideration of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity (42 U.S.C. § 4332(C)(iv); 40 C.F.R. § 1502.16). The short-term uses of the environment as a sanctuary that balances between resource protection and sustainable use limits some recreational and commercial activities. For example, the sanctuary-wide and marine zoning regulations would improve the health and quality of the marine environment by protecting living marine resources and habitats by (1) modifying and adding new marine zones with associated regulations designed to protect sensitive habitats and wildlife; (2) providing a mechanism to respond to groundings and release of harmful matter; and (3) monitoring human activities through regulations and non-regulatory programs that incorporate community involvement in the stewardship of sanctuary resources. In addition, the marine zones would allow for recreational and commercial use within certain parts of the sanctuary.

Long-term productivity derived from the proposed action is based on the goals of the Sanctuary Advisory Council for this management plan review process and the suite of proposed management activities designed to achieve these goals as identified in Section 3.5, which

includes a revised FKNMS draft management plan. These include goals related to improving understanding of the ecosystem services and economic value of sanctuary resources, maintaining or improving the condition of sanctuary resources, reducing threats and managing human uses and associated impacts, increasing awareness and support for the sanctuary, and advancing collaborative and coordinated management.

6.4 Irreversible and Irretrievable Commitments of Resources

NEPA requires an analysis of the extent to which the proposed project's primary and secondary effects would commit nonrenewable resources to uses that future generations would be unable to reverse (42 U.S.C. § 4332(C)(v); 40 C.F.R. § 1502.16). The mission of the national marine sanctuary is to conserve resources for future users, but routine management activities and protective regulations may require some irreversible and irretrievable commitments of resources.

Irreversible commitments of natural resources include the consumption or destruction of non-renewable resources or degradation of renewable resources over long periods of time. The proposed action would result in the following irreversible commitments of natural resources:

- Nonrenewable resources that would be consumed during management and research activities include fuel, water, power, and other resources necessary to maintain and operate the sanctuary's research vessels and the sanctuary offices.
- Electricity to power sanctuary facilities would be an irreversible use of resources, if derived from a non-renewable electrical power source (e.g., natural gas or nuclear energy).

Irretrievable commitment of resources includes opportunities foregone, expenditure of funds, loss of production, and restrictions on resource use. The proposed action would result in the following irretrievable commitments of resources:

- Monetary funds would be expended to support management activities in the purchase of fuels, electricity, water, and other non-renewable supplies, for wages and rents, and for construction of facilities.
- As part of the balance to protect natural resources versus limiting human uses within the sanctuary, marine zones that restrict access would prevent recreational and commercial uses in parts of the sanctuary. Human uses would be less restricted within other portions of the sanctuary.
- Natural resources may be used in construction of sanctuary facilities and structures, such as buildings, signs, navigational markers, and mooring buoys.
- Benthic habitat would be physically altered in the installation of mooring buoy anchors, navigational markers, and other permanently fixed informational and regulatory signs.
- Cultural resources would be protected from long term damage, but some research use may be restricted.

The irreversible and irretrievable commitment of resources would be minimized and mitigated by best management practices, staff training, and sustainability goals and procedures documented in the sanctuary management plan.

References

- Acosta, A., C. Bartels, J. Colvocoresses, and M.F.D. Greenwood. 2007. Fish assemblages in seagrass habitats of the Florida Keys, Florida: spatial and temporal characteristics. *Bull Mar Sci.* 81(1): 1-19.
- Adams, C. 1992. Economic Activities Associated with Commercial Fishing Industry in Monroe County, Florida. Staff Paper, SP92-27. Food and Resource Economics Department, Institute of Food and Agricultural Sciences, University of Florida: Gainesville, Florida.
- Adams, C. and D. Mulkey. 1988. An Economic Overview of Commercial Fisheries Production and Marketing in Lee County, Florida. Economic Information Report 251. Food and Resource Economics Department, Institute of Food and Agricultural Sciences, University of Florida: Gainesville, Florida.
- Albuquerque Tiago, Loiola Miguel, Nunes José de Anchieta C. C., Reis-Filho José Amorim, Sampaio Cláudio L. S., Leduc Antoine O. H. C. (2014) *In situ* effects of human disturbances on coral reef-fish assemblage structure: temporary and persisting changes are reflected as a result of intensive tourism. *Marine and Freshwater Research* 66, 23-32.
- Alexander, T.R. and J.D. Dickson, III. 1972. Vegetational changes in the National Key Deer Refuge. *Quarterly Journal of the Florida Academy of Sciences.* 35: 85-96.
- Alligood, C. and A. Savage. 2011. Invasive Species Management: An essential part of the Key Largo woodrat recovery plan.
- Andersen, M.S., K.A. Forney, T.V.N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating Serious and Non-Serious Injury of Marine Mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-39. 94 pp.
- Antonius, A. 1973. New observations on coral destruction in reefs. Abstract. Tenth meeting of the association of island marine laboratories of the Caribbean, University of Puerto Rico, Mayaguez, Puerto Rico. 3 p.
- Ault, J.S., J.A. Bohnsack, S.G. Smith, and J. Luo. 2005. Towards sustainable multispecies fisheries in the Florida, USA, coral reef ecosystem. *Bulletin of Marine Science.* 76(2): 595-622.
- Ault, J., J. Boyer, J. Fourqurean, C. Kelble, T. Lee, V. Leeworthy, D. Lirman, D. Loomis, J. Lorenz, P. Ortner, and P. Fletcher. 2012. Integrated conceptual ecosystem model development for the Florida Keys/Dry Tortugas coastal marine ecosystem. NOAA Technical Report. NOAA, Miami, Florida.
- Ault, J. and S.H. Smith. 2016. Habitat Species Relationships for Nine Reef Species in the Florida Keys National Marine Sanctuary. Personal Communications, University of Miami, Rosenstiel School for Marine and Atmospheric Science (RSMAS).
- Ault, J.S., S.G. Smith, J.A. Bohnsack, J. Luo, N. Zurcher, D.B. McClellan, T.A. Ziegler, D.E. Hallac, M. Patterson, M.W. Feeley, and B.I. Ruttenberg. 2013. Assessing coral reef fish population and community changes in response to marine reserves in the Dry Tortugas, Florida, USA. *Fisheries Research.* 144: 28-37.
- Ault, J.S., S.G. Smith, J.A. Browder, W. Nuttle, E.C. Franklin, J. Luo, G.T. DiNardo, and J.A. Bohnsack. 2014. Indicators for assessing the ecological dynamics and sustainability of southern Florida's coral reef and coastal fisheries. *Ecological Indicators.* 44: 164-172.
- Baker, E.K., K.A. Puglise, and P.T. Harris (Eds.). 2016. Mesophotic Coral Ecosystems – A Lifeboat For Coral Reefs? The United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal. www.unep.org, www.grida.no.

- Ballard, R.D. and E. Uchupi. 1970. Morphology and Quaternary history of the continental shelf of the Gulf Coast of the United States. *Bulletin of Marine Science*. 20(3): 547-559.
- Bancroft, G.T. and R. Bowman. 2001. White-crowned Pigeon (*Patagioenas leucocephala*). *The Birds of North America Online* (A. Poole, Ed.). Cornell Lab of Ornithology.
- Barton, J.A., B.L. Willis, and K.S. Hutson. 2017. Coral propagation: a review of techniques for ornamental trade and reef restoration. *Reviews in Aquaculture*. 9(3): 238-256.
- Ball, I. R. and H.P. Possingham. 2000. MARXAN (V1. 8.2). Marine Reserve Design Using Spatially Explicit Annealing, a Manual.
- Bennett, J. 2015. Monroe County Visitor Estimates 2008 to 2014. Personal Communication. Monroe County Tourist Development Council, Key West, Florida.
- Bertelsen, R.D. 2013. Characterizing daily movements, nomadic movements, and reproductive migrations of *Panulirus argus* around the Western Sambo Ecological Reserve (Florida, USA) using acoustic telemetry. *Fisheries Research*. 144: 91-102.
- Bertelsen, R.D. and J. Hornbeck. 2009. Using acoustic tagging to determine adult spiny lobster (*Panulirus argus*) movement patterns in the Western Sambo Ecological Reserve (Florida, United States). *New Zealand Journal of Marine and Freshwater Research*. 43(1): 35-46.
- Bertelsen, R.D., M.J. Butler IV, W.F. Herrnkind, and J.H. Hunt. 2009. Regional characterization of hard-bottom nursery habitat for juvenile Caribbean spiny lobster using rapid assessment techniques. *N.Z.J. Mar. Freshw. Res.* 43: 299.
- Bieler, R., C. Granados-Cifuentes, T.A. Rawlings, P. Sierwald, and T.M. Collins. 2017. Non-native molluscan colonizers on deliberately placed shipwrecks in the Florida Keys, with description of a new species of potentially invasive worm-snail (Gastropoda: Vermetidae). *PeerJ*, 5, e3158. doi:10.7717/peerj.3158.
- Bielsa, L.M., W.H. Murdoch, and R.F. Labisky. 1983. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Florida) pink shrimp. Biological Report FWS/OBS-82/11. U.S. Fish and Wildlife Service, Washington, D.C.
- Bishop, R.C, D. Chapman, B.J. Kanninen, J.A. Krosnick, B. Leeworthy, and N.F. Meade. 2011. Total Economic Value for Protecting and Restoring Hawaiian Coral Reef Ecosystems: final Report. Silver Spring, MD: National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Office of Response and Restoration, and the Coral Reef Conservation Program. NOAA Technical Memorandum CRCP16. 406 pp.
- Bishop, R.C, D. Chapman, B.J. Kanninen, J.A. Krosnick, B. Leeworthy, and N.F. Meade. 2010. Total Economic Value for Protecting and Restoring Hawaiian Coral Reef Ecosystems: final Report. Silver Spring, MD: National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Office of Response and Restoration, and the Coral Reef Conservation Program. NOAA Technical Memorandum CRCP16. 406 pp.
- Blake, E.S., C.W. Landsea, and E.J. Gibney. 2011. The deadliest, costliest, and most intense tropical cyclones from 1851 to 2010 (and other frequently requested hurricane facts). NOAA Tech. Memo. NWS NHC-6. 47 pp. www.nhc.noaa.gov/pdf/nws-nhc-6.pdf.
- Bohnsack, J. A., Harper, D. E., McClellan, D. B., Kellison, G. T., & Marine, N. (2009). Coral reef fish response to FKNMS management zones: the first ten years (1997–2007). *Prog Rep Florida Keys Natl Mar Sanctuary*, 1-29.

- Borremans, N.T. 1990. The Paleoindian Historical Context. In, Florida's Archaeological Contexts, C. Payne and J.T. Milanich, eds. Florida's Historic Preservation Plan [Archaeological Contexts]. Report prepared for the Florida Division of Historical Resources, Tallahassee.
- Bresette, M., B. Witherington, R. Herren, D. Bagley, J. Gorham, S. Traxler, C. Crady, and R. Hardy. 2010. Size-class partitioning and herding in a foraging group of green turtles *Chelonia mydas*. *Endangered Species Research*. 9: 105-116.
- Briceno, H. 2021. Preliminary Assessment of Surface Water Clarity Changes in Key West During the Covid-19 Anthro pause. Florida International University.
<http://serc.fiu.edu/wqmnetwork/Reports/FKNMS/KEY%20WEST%20TURBIDITY%20Report.pdf>
- Broward County. 2019. Port Everglades Waterborne Commerce Chart for the Ten Fiscal Years 2018 through 2009. <http://www.porteverglades.net/about-us/statistics/>.
https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/porteverglades/Waterborne_Commerce_Chart_2018_updated_Feb_7_2019_24383738-f5ca-448f-a9ae-f4af78107f16.pdf.
- Bruckner, A.W. 2000. "New Threat to Coral Reefs: Trade in Coral Organisms." *Issues in Science and Technology*. 17(1). <https://issues.org/bruckner/#.XRDjyv2ZXLc.link>.
- Bruckner, A. 2012. Factors contributing to the regional decline of *Montastraea annularis* (complex). Yellowlees, D. and Hughes, T. P. (Ed). *Proceedings of the 12th International Coral Reef Symposium*. James Cook University, Cairns, Australia.
- Bryan, D.R., J. Luo, J.S. Ault, D.B. McClellan, S.G. Smith, D. Snodgrass, and M.F. Larkin. 2015. Transport and connectivity modeling of larval permit from an observed spawning aggregation in the Dry Tortugas, Florida. *Environmental Biology of Fishes*. 98(11): 2263-2276.
- Bureau of Ocean Energy Management. 2012. BOEM/FERC Guidelines on Regulation of Marine and Hydrokinetic Energy Projects on the OCS. Accessed 17 July 2019. <https://www.boem.gov/BOEM-Newsroom/Press-Releases/2012/BOEM-FERC-staff-guidelines-pdf.aspx>.
- Burger, J., M. Gochfeld, and L.J. Niles. 1995. Ecotourism and birds in coastal New Jersey: contrasting responses of birds, tourists, and managers. *Environmental Conservation*. 18: 56-65.
- Burke, L., K. Reyntar, M. Spalding, and A. Perry. 2011. *Reefs at risk*. World Resources Institute, Washington, D.C. 124 pp.
- Butler IV, M.J., J.H. Hunt, W.F. Herrnkind, M.J. Childress, R. Bertelsen, W. Sharp, T. Matthews, J.M. Field, and H.G. Marshall. 1995. Cascading disturbances in Florida Bay, USA: cyanobacteria blooms, sponge mortality, and implications for juvenile spiny lobsters *Panulirus argus*. *Mar. Ecol. Prog. Ser.* 129: 119-125.
- Butler, C.B. and T.R. Matthews. 2015. Effects of ghost fishing lobster traps in the Florida Keys. *ICES Journal of Marine Science*. 72(suppl_1): i185-i198.
- Butler, J., M.J. Butler IV, and H. Gaff. 2017. Snap, crackle, and pop: Acoustic-based model estimation of snapping shrimp populations in healthy and degraded hard-bottom habitats. *Ecological Indicators*. 77: 377-385.
- Butler, J., W. C. Sharp, J. H. Hunt, and M. J. Butler IV. 2021. Setting the foundation for renewal: restoring sponge communities aids the ecological recovery of Florida Bay. *Ecosphere* 12(12):e03876. 10.1002/ecs2.3876
- Cairns, S.D. 2000. A revision of the shallow-water Azooxanthellate Scleractinia of the western Atlantic. *Revisión de los corales azooxantelados (Scleractinia) de las aguas someras del Atlántico occidental*. *Studies*. 75: 1-231.

- California Department of Fish and Wildlife. 2008. The First Five Years of Monitoring the Channel Islands Marine Protected Area Network – February 7-8, 2008.
<https://www.wildlife.ca.gov/Conservation/Marine/MPAs/Planning-Process-Historical-Information/Channel-Islands-MPAs-Monitoring>.
- Calixto-Albarran, I. and J.L. Osorno. 2000. The diet of the Magnificent Frigatebird during chick rearing. *Condor*. 102: 569-576.
- Calle, L., D. Gawlik, Z. Xie, and B. Johnson. 2012. Feasibility of evaluating the impacts of sea level rise on foraging habitat of the little blue heron in the Great White Heron National Wildlife Refuge. Final report for USFWS Grant Agreement 40181AG098.
- Cangialosi, J.P., A.S. Latto, and R. Berg. 2018. Hurricane Irma. National Hurricane Center Tropical Cyclone Report. https://www.nhc.noaa.gov/data/tcr/AL112017_Irma.pdf.
- Carney, K.M. and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. *Waterbirds*. 22: 68-79.
- Carr, R.S. 1987. An Archaeological, Historical and Architectural Survey of the Middle Keys, Monroe County, Florida. The Archaeological and Historical Conservancy, Inc., Miami, Florida. Ms. No. 1514, on file, Florida Division of Historic Resources, Tallahassee.
- Carr, R.S. and P. Fay. 1990. An Archaeological Survey of the Lower Keys, Monroe County, Florida. The Archaeological and Historical Conservancy, Inc., Miami, Florida.
- Carr, R. S. and I. Rodriguez. 1988. An Assessment of the Archaeological and Historic Resources of the Florida Keys, Monroe Keys. The Archaeological and Historical Conservancy, Inc., Miami, Florida.
- Carter, J., G.J. Marrow, and V. Pryor. 1994. Aspects of the ecology and reproduction of Nassau grouper, *Epinephelus striatus*, off the coast of Belize, Central America. *Proceedings of the Gulf and Caribbean Fisheries Institute*. 43: 65-111.
- Carter, R.W.G., P.A. Hesp, and K.F. Nordstrom. 1990. Erosional processes in coastal dunes. In: *Coastal Dunes: Form and Process*. 219-250. Edited by K.F. Nordstrom, N.P. Psuty and R.W.G. Carter. John Wiley, Chichester.
- Causey, B.D. 2008. Coral reefs of the U.S. Caribbean; the history of massive coral bleaching and other perturbations in the Florida Keys. In: C. Wilkinson and D. Souter (eds.). *Status of Caribbean coral reefs after bleaching and hurricanes in 2005*. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Queensland, Australia. 152 pp.
- Cavazos, K.E. and M.G. Bhat. 2020. Impact of risk perception on household willingness-to-pay to restock the threatened staghorn coral, *Ocean & Coastal Management*, Volume 193.
- Center for Economic and Management Research (CEMR). 1995. Economic Impact of Commercial Fisheries in the Florida Keys: Case Study – Florida Keys National Marine Sanctuary Draft Management Plan. Report under contract to the Monroe County Commercial Fishermen, Inc. The Center for Economic and Management Research, University of South Florida: Tampa, Florida.
- Cherkiss, M.S., S.S. Románach, and F.J. Mazzotti. 2011. The American Crocodile in Biscayne Bay, Florida. *Estuaries and Coasts*. 34: 529-535.
- Chiappone, M., L.M. Rutten, S.L. Miller, and D.W. Swanson. 2007. Large-scale distributional patterns of the encrusting and excavating sponge *Cliona delitrix* (Pang) on Florida Keys coral substrates. In: *Porifera Research - Biodiversity, Innovation, Sustainability*. M.R. Custodio, G. Lobo-Hajdu, E. Hajdu, G. Muricy (eds), Museu Nacional, Rio de Janeiro. 255-263.

- City of Key West. 2015. Annual Report - Port and Marine Services, Port Operations. p. 28.
https://www.cityofkeywest-fl.gov/egov/documents/1452706268_38532.pdf.
- Clavero, M. and E. García-Berthou. 2005. Invasive species are a leading cause of animal extinctions. *Trends in Ecology and Evolution*. 20: 110.
- Cochard R., S.L. Ranamukhaarachchi, G.P. Shivakoti, O.V. Shipin, P.J. Edwards, and K.T. Seeland. 2008. The 2004 tsunami in Aceh and Southern Thailand: A review on coastal ecosystems, wave hazards and vulnerability. *Perspectives in Plant Ecology Evolution and Systematics*. 10: 3-40.
- Collado-Vides, Ligia., C. Avila, S. Blair, F. Leliaert, D. Rodriguez, T. Thyberg, S. Schneider, J. Rojas, P. Sweeney, C. Drury, and D. Lirman. 2013. A persistent bloom of *Anadyomene* J.V. Lamouroux (*Anadyomenaceae*, *Chlorophyta*) in Biscayne Bay, Florida. *Aquatic Botany*. 111: 95-103.
- Collado-Vides, L., V.G. Caccia, J.N. Boyer, and J.W. Fourqurean. 2007. Tropical seagrass-associated macroalgae distributions and trends relative to water quality. *Estuarine, Coastal and Shelf Science* 73: 680–694. [https:// doi. org/ 10. 1016/j. ecss. 2007. 03. 009](https://doi.org/10.1016/j.ecss.2007.03.009).
- Council on Environmental Quality. 1997. The 1997 Report of the Council on Environmental Quality. Executive Office of the President (U.S.). <https://ceq.doe.gov/docs/ceq-reports/ceq-annual-report-1997.pdf>.
- Cowen, R.K., C.B. Paris, and A. Srinivasan. 2006. Scaling of connectivity in marine populations. *Science*. 311(5760): 522-527.
- Cox, C. and J.H. Hunt. 2005. Change in size and abundance of Caribbean spiny lobsters *Panulirus argus* in a marine reserve in the Florida Keys National Marine Sanctuary, USA. *Mar Ecol-Prog Ser*. 294: 227-239. 10.3354/meps294227.
- Cross, V., D.C. Twichell, R.B. Halley, K.T. Ciembronowicz, B.D. Jarrett, E.S. Hammar-Klose, A.C. Hine, S.D. Locker, and D.F. Naar. 2005. GIS compilation of data collected from the Pulley Ridge deep coral reef region (No. 2005-1089). U.S. Geological Survey.
- Cury, P.M., I.L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R.J.M. Crawford, R.W. Furness, J.A. Mills, E.J. Murphy, H. Österblom, M. Paleczny, J.F. Platt, J.P. Roux, L. Shannon, and W.J. Sydeman. 2011. Global Seabird Response to Forage Fish Depletion - One-Third for the Birds. *Sciences*. 23 December 2011: 1703-1706.
- De'ath, G., J.M. Lough, and K.E. Fabricius. 2009. Declining Coral Calcification on the Great Barrier Reef. *Science*. 323: 116-119.
- Drew, C.A. and D.B. Eggleston. 2008. Juvenile fish densities in Florida Keys mangroves correlate with landscape characteristics. *Mar. Ecol-Prog. Ser*. 362: 233-243.
- Drewitt, A. 1999. Disturbance effects of aircraft on birds. English Nature Birds Network Information Note.
- Duffy, D. 1986. Foraging at Patches: Interactions between Common and Roseate Terns. *Ornis Scandinavica* (Scandinavian Journal of Ornithology). 17(1): 47-52.
- Eakin, C.M., G. Liu, A.M. Gomez, J.L. De la Couri, S.F. Heron, W.J. Skirving, E.F. Geiger, B.L. Marsh, K.V. Tirak, and A.E. Strong. 2018. Unprecedented three years of global coral bleaching 2014–17. Sidebar 3.1. [in State of the Climate in 2017]. *Bulletin of the American Meteorological Society*. 99(8): S74–S75.
- Emmel, T.C. and J.C. Daniels. 2003. Status survey and monitoring of the rare Miami blue butterfly (*Hemiargus thomasi bethunebakeri*) in south Florida 2002-2003 Preliminary Progress Report No. 3 to the U.S. Fish and Wildlife Service on March 31, 2003. McGuire Center for Lepidoptera Research, University of Florida, Gainesville.

- English, D.B.K., W. Kriesel, V.R. Leeworthy, and P.C. Wiley. 1996. Economic Contribution of Recreating Visitors to the Florida Keys/Key West. U.S. Forest Service, Athens, GA, University of Georgia, Athens, GA and National Oceanic and Atmospheric Administration, Rockville, Maryland. November 1996. pp. 22. <http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/visecon9596.pdf>.
- Enos, P. 1977. Holocene sediment accumulations of the South Florida shelf margin. In: P. Enos and R.D. Perkins (eds.). Quaternary Sedimentation in South Florida; Geological Society of America Memoir 147. Boulder, Colorado. 1-130.
- Escalante de Fontaneda, Hernando. "Memoir of the things, the shore, and the Indians of Florida, to describe which, none of the many persons who have coasted that country knows how to describe it" [ca. 1575]. Transl. Buckingham Smith. Washington, 1854. <https://earlyfloridalit.net/fontaneda-memoir/>
- Escalante Fontaneda, Hernando D'. Memoir of Hernando d'Escalante Fontaneda ! on the country and ancient Indian tribes of Florida. New York, 1875. Pdf. <https://www.loc.gov/item/11007011/>.
- Essington, T.E., P.E. Moriarty, H.E. Froehlich, E.E.Hodgson, L.E. Koehn, K.L. Oken, M.C. Siple, and C.C. Stawitz. 2015. Fishing amplifies forage fish population collapses. Proceedings of the National Academy of Sciences May 2015. 112(21): 6648-6652. DOI:10.1073/pnas.1422020112.
- Evans, J.M. and C. Bergh. 2016. Sea Level Rise Vulnerability Assessment for Monroe County, Florida. Technical Appendix in Support of the GreenKeys! Sustainability and Climate Action Plan. Key Largo: Monroe County Sustainability Program.
- Faber, J., B.van Huttum, and F. Kleissen. 2019. The impacts of EGCS wastewater discharges on port water and sediment. Delft, CE Delft. <https://cruising.org/-/media/research-updates/research/ce-delft-the-impacts-of-egcs-wastewater-discharges-on-port-water-and-sediment-28-oct-2019.ashx>
- Farmer, N.A., W.D. Heyman, M. Karnauskas, S. Kobara, T.I. Smart, J.C. Ballenger, M.J.M. Reichert, D.M. Wyanski, M.S. Tishler, K.C. Lindeman, S.K. Lowerre-Barbieri, T.S. Switzer, J.J. Solomon, K. McCain, M. Marhefka, and G.R.Sedberry. 2017. Timing and locations of reef fish spawning off the southeastern United States. PloS one. 12(3): e0172968. doi:10.1371/journal.pone.0172968.
- Feeley, M.W., D. Morley, A. Acosta, P. Barbera, J. Hunt, T.S. Switzer, and M. Burton. 2018. Spawning migration movements of Mutton Snapper in Tortugas, Florida: Spatial dynamics within a marine reserve network. Fisheries Research. (204): 209-233. doi: 10.1016/j.fishres.2018.02.020.
- Feeley, M.W., D. Morley, A. Acosta, T.S. Switzer, and H.L. Pratt. 2012. Regional connectivity of fishes within the Tortugas region of Florida. Implementing the Dry Tortugas National Park Research Natural Area Science Plan: The 5-Year Report 2012. Tallahassee, Florida: South Florida Natural Resources Center, Everglades and Dry Tortugas National Parks, Homestead, FL, and the Florida Fish and Wildlife Conservation Commission. 18-23.
- Fenner, D. and K. Banks. 2004. Orange cup coral *Tubastraea coccinea* invades Florida and the Flower Garden Banks, northwestern Gulf of Mexico. Coral Reefs. 23(4): 505-507.
- Flaherty, K.E., R.E. Matheson Jr., R.H. McMichael Jr., and W.B. Perry. 2013. The Influence of Freshwater on Nekton Community Structure in Hydrologically Distinct Basins in Northeastern Florida Bay, Florida, USA. Estuaries and Coasts. 36.5: 918-939.
- Flynn, R.L. 2015. "Boat Anchoring Contributes to Coral Reef Degradation in the British Virgin Islands." Open Access Master's Theses Paper. 539 pp. <https://digitalcommons.uri.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1541&context=theses>.

- Florida Department of Environmental Protection. 2019. Coral Disease Response Effort Summary - Florida Reef Tract Coral Disease Outbreak. Accessed 26 June, 2019.
<https://floridadep.gov/sites/default/files/FRT-Coral-Disease-Overview.pdf>.
- Florida Department of Environmental Protection, Division of Recreation and Parks. 2016. Inventory of Recreation Areas and Facilities. Online database accessed 12 March, 2016.
<http://webapps.dep.state.fl.us/DrpOrpcr/outdoorRecreationInventory.do?selectedPage=InventoryQueryTable>. (updated page: <http://prodenv.dep.state.fl.us/DrpOrpcr/outdoorRecreationInventory.do>).
- Florida Fish and Wildlife Conservation Commission (2021). Trip ticket report landings [Unpublished data set].
- Florida Fish and Wildlife Conservation Commission/Fish and Wildlife Research Institute. 2019. Presentation given to FKNMS Advisory Council on April 16, 2019. Presentation is available at: <https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/docs/20190416-fish-aggregations.pdf>.
- Florida Fish and Wildlife Conservation Commission/Fish and Wildlife Research Institute. 2015. Presentation given to FKNMS Advisory Council on August 18, 2015. Presentation is available at: <https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/archive/sac/othermaterials/20150818tortugas.pdf>.
- Florida Fish and Wildlife Conservation Commission/Fish and Wildlife Research Institute. 2013. Presentation given to FKNMS Advisory Council Ecosystem Protection working group on May 23, 2013. Presentation is available at: <https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/archive/review/documents/20130523epfishaggregation.pdf>.
- Florida Marine Research Institute , 2000. Benthic Habitats of the Florida Keys. Aqua Docs. Available at https://aquadocs.org/bitstream/handle/1834/18090/TR4_c.pdf?sequence=1&isAllowed=y
- Florida Natural Areas Inventory. 2010. Guide to the natural communities of Florida: 2010 edition. Florida Natural Areas Inventory, Tallahassee, Florida.
- Florida Oceans and Coastal Council. 2009. The effects of climate change on Florida's ocean and coastal resources. Tallahassee, Florida. 34 pp.
- Folk, M.L., W.D. Klimstra, and C.R. Kruer. 1991. Habitat Evaluation: National Key Deer Range. Report to the Florida Game and Fresh Water Fish Commission Nongame Wildlife Program; Tallahassee, Florida. 837 pp.
- Fong P and VJ Paul 2011. Coral Reef Algae in Z. Dubinsky and N. Stambler (eds) Coral Reefs: An Ecosystem in Transition. DOI 10.1007/978-94-007-0114-4_17
- Forys, E.A. and S.R. Humphrey. 1999. Use of population viability analysis to evaluate management options for the endangered Lower Keys marsh rabbit. *Journal of Wildlife Management*. 63: 251-260.
- Fourqurean, J.W., J.N. Boyer, M.J. Durako, L.N. Hefty, and B.J. Peterson. 2003. Forecasting Response of Seagrass Distributions to Changing Water Quality Using Monitoring Data. *Ecological Applications*. 13(2): 474-489.
- Fourqurean, J.W., Robblee, M.B. 1999 Florida Bay: A history of recent ecological changes.
<https://doi.org/10.2307/1353203>
- Freeman, M. 1993. The Measurement of Environmental and Resource Values: Theory and Methods. Resources for the Future: Washington, D.C.

- Furman, B.T. and K.L. Heck. 2008. Effects of nutrient enrichment and grazers on coral reefs: an experimental assessment. *Mar. Ecol. Prog. Ser.* 363: 89-101.
- Gandy, R.L., C. Crawford, and C. Crowley. Stone Crab Fishery-Independent Monitoring Program Annual Report, 2010. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute (FWC/FWRI) Publication Number IHR 2010-004 FWC/FWRI, St. Petersburg, Florida, USA.
- Gawlik, D.E. 2002. The Effects of Prey Availability on the Numerical Response of Wading Birds. *Ecological Monographs*. 72: 329-346.
- Gerhart, S.D. and Bert, T.M. 2008. Life-history aspects of stone crabs (genus *Menippe*): size at maturity, growth, and age. *Journal of Crustacean Biology*. 28: 252-261.
- Ginsburg, R.N. and E.A. Shinn. 1964. Distribution of the reef-building community in Florida and the Bahamas. *Bull. Mar. Assoc. Petrol. Geol.* 48: 527.
- Gintert, B. E., Manzello, D. P., Enochs, I. C., Kolodziej, G., Carlton, R. D., Gleason, A. C. R., & Gracias, N. (2018). Marked annual coral bleaching resilience of an inshore patch reef in the Florida Keys: A nugget of hope, aberrance, or last man standing? *Coral Reefs*, 37(2), 533–547.
<https://doi.org/10.1007/s00338-018-1678-x>
- Glynn, P.W., S.B. Colley, J.L. Maté, J. Cortés, H.M. Guzman, R.L. Bailey, J.S. Feingold, and I.C. Enochs. 2008. Reproductive ecology of the azooxanthellate coral *Tubastraea coccinea* in the Equatorial Eastern Pacific: Part V. *Dendrophylliidae*. *Marine Biology*. 153(4): 529-544.
- Goggin, J.M. 1944. Archaeological Investigations on the Upper Florida Keys. *Tequesta*. 4: 13-35.
- John M. Goggin. *Tequesta*, 1. FL: *Tequesta*. 1950. Indians and History of the Matecumbe Region. (tDAR id: 115906)
- Goreau, T.J., J. Cervino, M. Goreau, R. Hayes, M. Hayes, L. Richardson, G. Smith, K. DeMeyer, I. Nagelkerken, J. Garzón-Ferreira, D. Gil, G. Garrison, E.H. Williams, L. Bunkley-Williams, C. Quirolo, K. Patterson, J. Porter, and K. Porter. 1998. Rapid spread of Caribbean coral reef diseases. *Rev. Biol. Trop.* 46: 157-171. Electronic document available from:
<http://www.globalcoral.org/Rapid%20Spread%20of%20Diseases%20in%20Caribbean%20Coral%20Reefs.pdf>.
- Gorham, J.C., D.R. Clark, M.J. Bresette, D.A. Bagley, C.L. Keske, S.L. Traxler, B.E. Witherington, B.M. Shamblin, and C.J. Nairn. 2014. Characterization of a Subtropical Hawksbill Sea Turtle (*Eretmochelys imbricata*) Assemblage Utilizing Shallow Water Natural and Artificial Habitats in the Florida Keys. *PLoS ONE*. 9(12): e114171.
- Gravinese, P.M., I.C. Enochs, D.P. Manzello, and R. van Woesik. 2018. Warming and pCO₂ effects on Florida stone crab larvae. *Estuarine, Coastal and Shelf Science*. 204: 193-201.
- Green, S.J. and I.M. Côté. 2009. Record densities of Indo-Pacific lionfish on Bahamian coral reefs. *Coral Reefs*. 28: 107.
- Green, M.C. 2006. Status report and survey recommendations on the Reddish Egret (*Egretta rufescens*). Unpublished report, U.S. Department of the Interior, Fish and Wildlife Service, Atlanta, Georgia.
- Griffin, J.W., M.L. Fryman, and J.J. Miller. 1979. Cultural Resource Reconnaissance of the National Key Deer Wildlife Refuge. Cultural Resource Management, Inc., Tallahassee, Florida.
- Grubb, T.G. and R.M. King. 1991. Assessing human disturbance of breeding bald eagles with Classification Tree Models. *Journal of Wildlife Management*. 55(3): 500-511.

- Grubb, T.G. and W.W. Bowerman. 1997. Variations in breeding bald eagle responses to jets, light planes and helicopters. *Journal of Raptor Research*. 31(3): 213-222.
- Gulf of Mexico Fishery Management Council. 2018. Coral Habitat Areas Considered for Habitat Area of Particular Concern Designation in the Gulf of Mexico, Final Amendment 9 to the Fishery Management Plan for the Coral and Coral Reefs of the Gulf of Mexico, U.S. Waters, Including Final Environmental Impact Statement. http://gulfcouncil.org/wp-content/uploads/Final-Coral-9-DEIS-20181005_508C.pdf.
- Gulf of Mexico Fishery Management Council. 2017. Final Regulatory Amendment 4 to the Fishery Management Plan for Spiny Lobster in the Gulf of Mexico and the South Atlantic. Technical report.
- Halas, J.F. 1988. An inventory of shipwrecks, grounding, and cultural marine resources within the Key Largo National Marine Sanctuary Region: Preliminary Report. NOAA Technical Memorandum NOA MEMD # NA87AA-H-CZ007, Key Largo National Marine Sanctuary.
- Hall, M.O., B.T. Furman, M. Merello, and M.J. Durako. 2016. Recurrence of *Thalassia testudinum* seagrass die-off in Florida Bay, USA: initial observations. *Marine Ecology Progress Series*. 560: 243-249.
- Halley, R, G.P. Dennis, D. Weaver, and F. Coleman. 2005. Characterization of Pulley Ridge Coral and Fish Fauna. Technical Report to the Gulf of Mexico Fisheries Management Council, Tampa, Florida. 72 pp.
- Hanson, C.F. 1980. Water resources of Big Pine Key, Monroe County, Florida. U.S. Geological Survey Open File Report 80-447. 36 pp. Water Fish Commission Final Report NG88-015.
- Harter S.L., H. Moe, J.K. Reed, and A.W. David. 2017. Fish assemblages associated with red grouper pits at Pulley Ridge, a mesophotic reef in the Gulf of Mexico. *Fish Bull.* 115(3): 419-432.
- Henry, E. and N. Haddad. 2013. Miami Blue Butterfly Monitoring, Interim Report January 2012-May 2013. FWS internal report.
- Hepner, M.E. 2017. Reef Fish Biodiversity in the Florida Keys National Marine Sanctuary. Master's Thesis - University of South Florida.
- Hester, M. 2011. Long-term monitoring of sea level rise – Permanent monitoring stations. Unpublished report submitted to USFWS.
- Heyman, W.D. and B. Kjerfve. 2008. Characterization of transient multi-species reef fish spawning aggregations at Gladden Spit, Belize. *Bulletin of Marine Science*. 83(3): 531-551.
- Higgs, N.D., J. Newton, and M.J. Attrill. 2016. Caribbean spiny lobster fishery is underpinned by trophic subsidies from chemosynthetic primary production. *Current Biology*. 26(24): 3393-3398.
- Hine, A.C., R.B. Halley, S.D. Locker, B.D. Jarrett, W.C. Jaap, D.J. Mallinson, K.T. Ciembronowicz, N.B. Ogden, B.T. Donahue, and D.F. Naar. 2008. Coral reefs, present and past, on the West Florida Shelf and Platform margin. In: Riegl, B.M. and R.E. Dodge (eds.). *Coral reefs of the USA*. Springer Science + Business Media B.V. 127-173.
- Hoegh-Guldberg, O., P.J. Mumby, A.J. Hooten, R.S. Steneck, P. Greenfield, E. Gomez, C.D. Harvell, P.F. Sale, A.J. Edwards, K. Caldeira, N. Knowlton, C.M. Eakin, R. Iglesias-Prieto, N. Muthiga, R.H. Bradbury, A. Dubi, and M.E. Hatzioiols. 2007. Coral Reefs Under Rapid Climate Change and Ocean Acidification. *Science*. 318: 1737-1742.
- Hoffmeister, J.E. 1974. *Land from the sea: The Geologic Story of South Florida*. Coral Gables, FL: The University of Miami Press. 143 pp.

- Holiman, S. 2014. The use of five-year averages as baselines in assessing the economic impacts of regulations. Personal Communication via e-mail April 7, 2014. NOAA Fisheries, Southeast Region Headquarters: St. Petersburg, Florida.
- Holmes, C.W. 1981. Later tertiary-quaternary geology of the southwestern Florida shelf and slope. Supplement to Transaction, Gulf Coast Association of Geological Societies. 1: 460.
- Hu, C., K.E. Hackett, M.K. Callahan, S. Andrefouet, J.L. Wheaton, J.W. Porter, and F.E. Muller-Karger. 2003. The 2002 ocean color anomaly in the Florida Bight: A cause of local coral reef decline? *Geophys. Res. Lett.* 30(3): 1151.
- Ingle, R.M., B. Eldred, H. Jones, and R.F. Hutton. 1959. A Preliminary Analysis of Tortugas Shrimp Sampling Data 1957-58. *Tech. Ser. Florida State Bd. Conserv.* 32: 1-45.
- Insights, Inc. (2021). *2020 TDC visitor profile survey: County-wide annual summary by quarter, January–December 2019/2020*. <https://www.monroecounty-fl.gov/DocumentCenter/View/28944/2020-TDC-VPS-County-Wide-ANNUAL-Summary-FINAL-03242021?bidId=>
- Insights, Inc. 2016. 2016 TDC Visitor Profile Survey: County-wide ANNUAL Summary by Quarter, January – December 2015/2016.
- Intergovernmental Panel on Climate Change. 2014. Fifth Assessment Synthesis Report (AR5) - Climate Change 2014 Synthesis Report. <https://www.ipcc.ch/report/ar5/syr/>.
- Intergovernmental Panel on Climate Change. 2007. Climate Change 2007 – The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge University Press.
- Intergovernmental Panel on Climate Change. 2001. Climate change 2001. Cambridge University Press, New York.
- Invasive Lionfish Control Ad-Hoc Committee of the Aquatic Nuisance Species Task Force. 2015. National Invasive Lionfish Prevention and Management Plan. http://www.anstaskforce.gov/Meetings/2014_May/NILPMP_5_2014_Final_Draft.pdf.
- Inwater Research Group. 2008. Sea Turtle Distribution and Abundance in the Key West National Wildlife Refuge and Waters of the Marquesas Keys. Final Report December 2008. Submitted to the U.S. Fish and Wildlife Service. Grant Agreement #401815g177.
- Jaap, W.C. 1979. Observation on *zooxanthellae* expulsion at Middle Sambo Reef, Florida Keys, *Bull Mar. Sci.* 29: 414-422.
- Jaap, W.C. 1984. The Ecology of the South Florida Coral Reefs: A Community Profile. Florida Department of Natural Resources. St. Petersburg, FL. <https://tampabay.wateratlas.usf.edu/upload/documents/EcologySouthFLCoralReefsCommProfile.pdf>
- Jaap, W.C. and R. Halley. 2008. Pulley Ridge. In: Ritchie, K.B. and B.D. Keller (eds.). A scientific forum on the Gulf of Mexico: The Islands in the Stream concept. Silver Spring, MD: NOAA National Marine Sanctuary Program. Marine Sanctuaries Conservation Series NMSP-08-04. 45-46.
- Jaap, W.C. and P. Hallock. 1990. Coastal and nearshore communities: Coral reefs. In: N. Phillips and K. Larson, eds. Synthesis of available biological, geological, chemical, socioeconomic, and cultural resource information for the South Florida area. Continental Shelf Associates, Inc. Contract no. 14-12-0001-30417. 657 pp.

- Jaap, W.C. and J. Morelock. 1998. Two-year monitoring report: Soto's Reef restoration project, George Town Grand Cayman Island, British West Indies. *Lithophyte Research and Marine Research Associates*.
- Jarrett, B.D., A.C. Hine, R.B. Halley, D.F. Naar, S.D. Locker, A.C. Neumann, D. Twichell, C. Hu, B.T. Donahua, W.C. Jaap, D. Palandro, and K. Ciembronowicz. 2005. Strange bedfellows – a deep-water hermatypic coral reef superimposed on a drowned barrier island; southern Pulley Ridge, SW Florida platform margin. *Marine Geology*. 214: 295-307.
- Jeffrey, C.F.G., V.R. Leeworthy, M.E. Monaco, G. Piniak, and M. Fonseca (eds.). 2012. An Integrated Biogeographic Assessment of Reef Fish Populations and Fisheries in Dry Tortugas: Effects of No-take Reserves. NOAA Technical Memorandum NOS NCCOS 111. Prepared by the NCCOS Center for Coastal Monitoring and Assessment Biogeography Branch. Silver Spring, MD. 147 pp.
http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/tortugasassessmentreport_final.pdf.
- Johns, G.M., V.R. Leeworthy, F.W. Bell, and M.A. Bonn. 2003. Socioeconomic study of reefs in Southeast Florida. Hazen and Sawyer in association with Florida State University and the National Oceanic and Atmospheric Administration. 349 pp. Electronic document available from:
<http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/sereef2000.pdf>.
- Johns, G.M., V.R. Leeworthy, F.W. Bell, and M.A. Bonn. 2001. Socioeconomic Study of Reefs in Southeast Florida, Final Report for Broward County, Palm Beach County, Miami-Dade County, Monroe County, Florida Fish and Wildlife Conservation Commission, and National Oceanic and Atmospheric Administration.
<https://www.broward.org/NaturalResources/BeachAndMarine/Documents/SocioEconomicStudyFinalReport.pdf>.
- Johnston, M.A., S.R. Gittings, and J.A. Morris, Jr. 2015. NOAA National Marine Sanctuaries Lionfish Response Plan (2015-2018): Responding, Controlling, and Adapting to an Active Marine Invasion. Marine Sanctuaries Conservation Series ONMS-15-01.
- Kasper, K.B. 2007. Hurricane Wilma in the Florida Keys. U.S. Dept. of Commerce/NOAA/NWS. 20 pp.
- Keller, B.D. and S. Donahue (eds). 2006. 2002 - 03 Florida Keys National Marine Sanctuary science report: an ecosystem report card after five years of marine zoning. Marine Sanctuaries Conservation Series NMSP-06-12. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring, MD. 358 pp.
- Kenworthy, W.J., M.S. Fonseca, P.E. Whitfield, and K.K. Hammerstrom. 2002. Analysis of seagrass recovery in experimental excavations and propeller-scar disturbances in the Florida Keys National Marine Sanctuary. *Journal of Coastal Research*. 75-85.
- Key West Chamber of Commerce, 2018. Economy Trends of Key West and Monroe County.
http://www.keywestchamber.org/uploads/4/6/5/2/46520599/demographics_and_economy_as_of_06-2018.pdf.
- Kirkham, I.R. and I.C.T. Nisbet. 1987. Feeding techniques and field identification of Arctic, Common, and Roseate terns. *Brit. Birds*. 80: 41-47.
- Kotrikla, A.M., A. Zavantias, M. Kaloupi. 2021. Waste generation and management onboard a cruise ship: A case study. *Ocean and Coastal Management*. 212: 105850.
- Krause, Johannes & Lopes, Christian & Wilson, Sara & Boyer, Joseph & Briceño, Henry & Fourqurean, James. (2022). Status and Trajectories of Soft-Bottom Benthic Communities of the South Florida

- Seascape Revealed by 25 Years of Seagrass and Water Quality Monitoring. *Estuaries and Coasts*. 46. 10.1007/s12237-022-01158-7.
- Kruer, C. 2017. Florida Keys Shallow Water Boating Impact Analysis and Trends Assessment - Mapping Summary Report. <https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/docs/2017-florida-keys-boat-impacts-summary-with-maps.pdf>.
- Kruczynski, W.L. and P.J. Fletcher, (eds.). 2012. Tropical connections: South Florida's marine environment. IAN Press, University of Maryland Center for Environmental Science, Cambridge MD. 492 pp.
- Kuffner I.B., L.J. Walters, M.A. Becerro, V.J. Paul, R. Ritson-Williams, and K. Beach. 2006. Inhibition of coral recruitment by macroalgae and cyanobacteria. *Mar Ecol Prog Ser*. 323: 107–117.
- LaFever, D.H., R.R. Lopez, R.A. Feagin, and N.J. Silvy. 2007. Predicting the impacts of future sea-level rise on an endangered lagomorph. *Environmental Management*. 40: 430–437.
- Lages, B.G., B.G. Fleury, A.C. Pinto, and J.C. Creed. 2010. Chemical defenses against generalist fish predators and fouling organisms in two invasive ahermatypic corals in the genus *Tubastraea*. *Marine Ecology*. 31(3): 473-482.
- Langevin, C.D., M.T. Stewart, and C.M. Beaudoin. 1998. Effects of sea water canals on fresh water resources: An example from Big Pine Key, Florida. *Ground Water*. 36(3): 503–513.
- Lapointe, B. E. 2019. Chasing Nutrients and Algal Blooms in Gulf and Caribbean Waters: A Personal Story. *Gulf and Caribbean Research* 30 (1): xvi-xxx. Retrieved from <https://aquila.usm.edu/gcr/vol30/iss1/12> DOI: <https://doi.org/10.18785/gcr.3001.10>
- Lee, T.N., M.E. Clarke, E. Williams, A.F. Szmant, and T. Berger. 1994. Evolution of the Tortugas gyre and its influence on recruitment in the Florida Keys. *Bull. Mar. Sci*. 54(3): 21-646.
- Lee, T.N. and E. Williams. 1999. Mean Distribution and Seasonal Variability of Coastal Currents and Temperature in the Florida Keys with Implications for Larval Recruitment. *Bull. of Mar. Science*. 64(1): 35-56.
- Leeworthy, V.R. 2010. Visitor Study: Selected Comparisons 1995-06 and 2007-08. National Oceanic and Atmospheric Administration, National Ocean Service, Office of National Marine Sanctuaries, Silver Spring, Maryland. July 2010. 17 pp. http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/comparisons_9596_0708.pdf.
- Leeworthy, V.R. and M. Bowker. 1997. Nonmarket Economic User Values of the Florida Keys/Key West. National Oceanic and Atmospheric Administration, National Ocean Service, Strategic Environmental Assessments Division & USDA Forest Service. Rockville, Maryland. October 1997. 48 pp. https://www.srs.fs.usda.gov/pubs/ja/ja_leeworthy001.pdf.
- Leeworthy, V.R. and R. Ehler. 2010. Economic Contribution of Recreating Visitors to the Florida Keys/Key West 2007-08. National Oceanic and Atmospheric Administration, National Ocean Service, Office of National Marine Sanctuaries, Silver Spring, Maryland. July 2010. 19 pp. <http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/economic08.pdf>.
- Leeworthy, V.R., D.K. Loomis, and S.K. Paterson. 2010. Visitor Profiles: Florida Keys/Key West 2007-08. National Oceanic and Atmospheric Administration, National Ocean Service, Office of National Marine Sanctuaries, Silver Spring, Maryland. June 2010. 196 pp. http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/full_visitor_08.pdf.
- Leeworthy, V.R. and F.C. Morris. 2010. A Socioeconomic Analysis of the Recreation Activities of Monroe County Residents in the Florida Keys/Key West 2008. National Oceanic and Atmospheric

- Administration, National Ocean Service, Office of National Marine Sanctuaries, Silver Spring, Maryland. September 2010. 61 pp.
http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/floridakeysres_report.pdf.
- Leeworthy, V., D. Schwarzmann, and R. Shea. 2019. Florida Keys National Marine Sanctuary: Supporting Analysis for the Restoration Blueprint. Conservation Science Series ONMS-19-07. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, Maryland. 284 pp.
- Leeworthy, V.R. and P.C. Wiley. 2000. Proposed Tortugas 2000 Ecological Reserve, Final Socioeconomic Impact Analysis of Alternatives. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects, Silver Spring, Maryland. October 2000. 157 pp.
<http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/tortugasinitassess.pdf>.
- Leeworthy, V.R. and P.C. Wiley. 1996. Visitor Profiles: Florida Keys/Key West. National Oceanic and Atmospheric Administration, National Ocean Service, Strategic Environmental Assessments Division, Rockville, Maryland. November 1996. 159 pp.
<http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/visprof9596.pdf>.
- Leichter, J.L., H.L. Stewart, and S.L. Miller. 2003. Episodic nutrient transport to Florida coral reefs. *Limnology and Oceanography*. 48(4): 1394-1407.
- Levitan, D.R. 1988. Algal-urching biomass responses following mass mortality of *Diadema antillarum* Phillipi at St. Johns, U.S. Virgin Islands. *J. Exp. Mar. Bio Eco.* 119: 167-178.
- Levy, J.M., M. Chiappone, and K.M. Sullivan. 1996. Invertebrate infauna and epifauna of the Florida Keys and Florida Bay. Volume 5: Site characterization for the Florida Keys National Marine Sanctuary. The Preserver, Zenda. 166 pp.
- Leynes, J.B. and D. Cullison. 1998. Biscayne National Park Historic Resource Study. National Park Service, Southeast Region, Atlanta, Georgia.
- Liddle, M.J. and P. Greig-Smith. 1975. A survey of tracks and paths in a sand dune ecosystem, I/II. *Soils. J. appl. Ecol.* 12: 909-930.
- Lindeman, K.C., R. Pugliese, G.T. Waugh, and J.S. Ault. 2000. Developmental Patterns within a Multispecies Reef Fishery: Management Applications for Essential Fish Habitats and Protected Areas. *Bulletin of Marine Science*. 66(3): 929-956.
- Lirman, D., S. Schopmeyer, D. Manzello, L.J. Gramer, W.F. Precht, F. Muller-Karger, K. Banks, B. Barnes, E. Bartels, A. Bourque, J. Byrne, S. Donahue, J. Duquesnel, L. Fisher, D. Gilliam, J. Hendee, M. Johnson, K. Maxwell, E. McDevitt, J. Monty, D. Rueda, R. Ruzicka, and S. Thanner. 2011. Severe 2010 cold-water event caused unprecedented mortality to corals of the florida reef tract and reversed previous survivorship patterns. *PLoS One* 6:e23047. <https://doi.org/10.1371/journal.pone.0023047>.
- Lirman, D. and Biber, P. Seasonal Dynamics of Macroalgal Communities of the Northern Florida Reef Tract. *Botanica Marina*, vol. 43, no. 4, 2000, pp. 305-314. <https://doi.org/10.1515/BOT.2000.033>
- Locker, S.D., R.A. Armstrong, T.A. Battista, J.J. Rooney, C. Sherman, and D.G. Zawada. 2010. Geomorphology of mesophotic coral ecosystems: current perspectives on morphology, distribution, and mapping strategies. *Coral Reefs* (2010). 29: 329-345.
- Longley, W.H. and S.F. Hildebrand. 1941. Systematic catalogue of the fishes of Tortugas, Florida. *Carneg. Inst. Wash. Publ.* 535(34): 1-331.
- Lopez, R.R., N.J. Silvy, R.F. Labisky, and P.A. Frank. 2003. Hurricane impacts on Key deer in the Florida Keys. *Journal of Wildlife Management*. 67: 280-288.

- Lott, C.A. 2006. A new raptor migration monitoring site in the Florida Keys: counts from 1999-2004. J. Raptor Research. 40: 200-209.
- Lugo, A.E. and S.C. Snedaker. 1974. The Ecology of Mangroves. Annual Review of Ecological Systems. 5: 39-64.
- Maliao, R.J., R.G. Turingan, and J. Lin. 2008. Phase-shift in coral reef communities in the Florida Keys National Marine Sanctuary (FKNMS), USA. Marine Biology. 154: 841-853.
- Manzello, D. P., Enochs, I. C., Kolodziej, G., Carlton, R., & Valentino, L. (2018). Resilience in carbonate production despite three coral bleaching events in 5 years on an inshore patch reef in the Florida Keys. Marine Biology, 165, 99. <https://doi.org/10.1007/s00227-018-3354-7>
- Manzello, D.P. 2015. Rapid Recent Warming of Coral Reef in the Florida Keys. Nature.com, Scientific Reports. 5: 16762.
- Marquardt, W.H. 1992. Culture and Environment in the Domain of the Calusa. Monograph No. 1. Institute of Archaeology and Paleoenvironmental Studies, University of Florida, Gainesville.
- Matthews, T. 2016. Recreational Fishing Effort for Spiny Lobster in the Florida Keys National Marine Sanctuary 2009 – 2013. Personal Communications, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute (FWRI), Marathon, Florida.
- Mathewson, R.D., III. 1992. A Preliminary Assessment of Archaeological Sites in Hardwood Hammocks in the Middle and Upper Florida Keys (Draft). Archaeological – Historical Survey Resource Management Group, Islamorada, Florida.
- Mazzotti, F. 1983. The ecology of the American crocodile in Florida. Ph.D., Pennsylvania State University, State College, Pennsylvania.
- Mazzotti, F.J., M. Cherkiss, G. Cook, and E. McKercher. 2003. Status and conservation of the American crocodile in Florida: Recovering an endangered species while restoring an endangered ecosystem. University of Florida, Ft. Lauderdale Research and Education Center, Davie, Florida, USA.
- McDaniel, C.J., L.B. Crowder, and J.A. Piddy. 2000. Spatial dynamics of sea turtle abundance and shrimping intensity in the US Gulf of Mexico. Conservation Ecology. 4: 15.
- McDonnell, M.J. 1981. Trampling effects on coastal dune vegetation in the Parker River National Refuge. Biol. Conserv. 21: 289-301.
- Mcguire, H.L. 2001. Evaluating the Taxonomic Status of the Great White Heron (*Ardea Herodias Occidentalis*) Using Morphological, Behavioral and Genetic Evidence. LSU Historical Dissertations and Theses. 423 pp.
- McKenzie, T.P. and J.R. Nicolas. 1988. Cetaceans, sea turtles, and pinnipeds of the Mid-Atlantic Water Management Unit. In Characterization of the Middle Atlantic Water Management Unit of the Northeast Regional Action Plan. A. L. Pacheco, ed. NOAA Technical Memorandum NMFS/ NEC-56. National Marine Fisheries Service, Woods Hole. 263-304.
- McManus J.W., J.F. Polsenberg. 2004 Coral–algal phase shifts on coral reefs: Ecological and environmental aspects. Progress in Oceanography, 60 (2-4) 263-279.
- McMurray, S.E., J.E. Blum, and J.R. Pawlik. 2008. Redwood of the reef: growth and age of the giant barrel sponge *Xestospongia muta* in the Florida Keys. Marine Biology. 155: 159-171.
- Meeder, J.F. and R.W. Parkinson. 2018. SE Saline Everglades Transgressive Sedimentation in Response to Historic Acceleration in Sea-Level Rise: A Viable Marker for the Base of the Anthropocene?. Journal of Coastal Research. 34(2): 490-497.

- Meyer, K.D. and G. Kent. 2011. The decline of the Great White Heron in Florida: explanations and recommendations for recovery of this small and highly vulnerable population. In: Final report 07156 to Florida Fish and Wildlife Conservation Commission.
- Meyer, K.D. and G.M. Kent. 2011. Satellite tracking of Reddish Egrets in southern Florida: foraging behavior, activity ranges, seasonal movements, and survival. Final Report for Grant Agreement 401819G524. U. S. Fish and Wildlife Service, Atlanta, Georgia.
- Meyer, K. and T. Wilmers. 2006. Foraging habitats, wintering residency, survival, and philopatry of adult white-crowned pigeons (*Patagioenas leucocephala*) in the lower Florida Keys. Unpublished report.
- Meyer, K.D., G.M. Zimmerman, P.J. Mahoney, S. Beyeler, and T.J. Wilmers. 2008. Enduring effect of hurricanes and additive human threats for five avian species of greatest conservation need in the Florida Keys. Final report submitted to Florida Fish and Wildlife Conservation Commission for Grant Agreement 06014.
- Meyerriecks, A. 1957. Field observations pertaining to the systematic status of the Great White Heron in the Florida Keys. *The Auk*. 74: 469-478.
- Miami-Dade County. 2019. Port Miami Port Guide 2018 - 2019. 8 pp.
<https://www.miamidade.gov/portmiami/library/stats-brochure-2019.pdf>.
- Miami-Dade County. 2018. Port Miami 2018 Comprehensive Annual Financial Report. 72 pp.
<https://www.miamidade.gov/portmiami/library/comprehensive-annual-financial-report-2018.PDF>.
- Mikkelsen, P.M. and R. Bieler. 2007. Seashells of Southern Florida: Living Marine Mollusks of the Florida Keys and Adjacent Regions. Bivalves. Princeton University Press: Princeton, New Jersey.
- Miller J, Waara R, Muller E, Rogers C (2006) Coral bleaching and disease combine to cause extensive mortality on reefs in the US Virgin Islands . *Coral Reefs* 25:418
- Minerals Management Service. 1990. Synthesis of available biological, geological, chemical, socio-economic, and cultural resources information for the South Florida area. N. Phillips and K. Larson, eds. OCS Study MMS 90-0019. Prepared by Continental Shelf Associates, Inc. Washington D.C., U.S. Government Printing Office. 657 pp. plus appendices.
- Mitchell, N.C. 1996. Silver rice rat status. Draft final report to Florida Game and Fish.
- Milazzo, M., I. Anastasi, and T.J. Willis. 2006. Recreational fish feeding affects coastal fish behavior and increases frequency of predation on damselfish *Chromis chromis* nests. *Marine Ecology Progress Series*. 2006(310): 165–172. Electronic document available from <http://www.int-res.com/articles/meps2006/310/m310p165.pdf>.
- Mires, C. 2014. The value of Maritime Archaeological Heritage: An Exploratory Study of the Cultural Capital of Shipwrecks in the Graveyard of the Atlantic. A Dissertation In partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Coastal Resources Management, East Carolina University. April 2014. 22 pp.
- Monroe County Growth Management Division. 2011. Technical Document. Available on-line at:
<http://keyscompplan.com/facts-information-resources/comprehensive-plan-documents/>.
- Monroe County Board of County Commissioners. 1986. Florida Keys comprehensive plan: Volume I. Background data element. Approved by the Department of Community Affairs and the Administration Commission of the State of Florida. Key West, Florida. 583 pp.

- Monroe County. 2003. Habitat Conservation Plan for the Florida Key Deer (*Odocoileus virginianus clavium*) and other Protected Species on Big Pine Key and No Name Key, Monroe County, Florida. Submitted to South Florida Ecological Services Field Office, U.S. Fish and Wildlife Service.
- Monroe County Emergency Management (MCEM), 2012: Comprehensive Emergency Preparedness – Part III. Concept of Operations. 46 pp.
- Monroe County. 2011. Year 2030 Comprehensive Plan, Technical Document. Accessed 27 June, 2019. <https://www.monroecounty-fl.gov/DocumentCenter/View/4606/2030-MC-Comp-Plan-revision-3?bidId=>.
- Monroe County. 2017. Tourist Development Council (TDC). International Visitation Estimates 2015.
- Morais, Juliano & Cardoso, Aiara & Santos, Bráulio. (2022). A global synthesis of the current knowledge on the taxonomic and geographic distribution of major coral diseases. *Environmental Advances*. 8. 100231. 10.1016/j.envadv.2022.100231.
- Morris, Jr., J.A. and P.E. Whitfield. 2009. Biology, ecology, control and management of the invasive Indo-Pacific Lionfish: an updated integrated assessment. NOAA Technical Memorandum NOS NCCOS. 99: 57.
- Muller EM, Sartor C, Alcaraz NI, van Woesik R. 2020. Spatial epidemiology of the stony-coral-tissue-loss disease in Florida. *Front Mar Sci*. 7:163.
- Multer, H.G. 1977. Field guides to some carbonate rock environments. Dubuque, IA: Kendall/Hunt Publishing Co. 415 pp.
- Nalvikin, D.V. 1969. Hurricanes, Storms, and Tornadoes. Academy of Sciences of USSR, Translated from Russian (1982), NOAA, U.S. Department of Commerce, Washington, D.C.
- National Air and Space Administration. 2017. Global climate change: vital signs of the planet. <https://climate.nasa.gov>. Accessed August 15, 2017.
- NOAA. 2018a. Coral Ecosystem Connectivity from Pulley Ridge to the Florida Keys, 2011-2018. <https://coastalscience.noaa.gov/project/coral-ecosystem-connectivity-gulf-florida-keys/>. Accessed 1 July 2019.
- NOAA. 2018b. Programmatic Environmental Assessment of Field Operations in the Southeast and Gulf of Mexico National Marine Sanctuaries. Office of National Marine Sanctuaries. <https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/docs/20180807-pea-of-field-opsse-gom-nms.pdf>.
- NOAA. 2018c. US Coral Reef Monitoring Data Summary 2018. NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP. 31: 224.
- NOAA. 2017. Policy and Procedures for Compliance with the National Environmental Policy Act and Related Authorities. Companion Manual for NOAA Administrative Order 216-6A. <https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-01132017.pdf>.
- NOAA. 2019. The Status of Stocks 2019: Quarterly Report to Congress. Prepared by the National Marine Fisheries Service, Silver Spring, Maryland. source data can be found here: <https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates>.
- NOAA. 2015. Recover Outline: Pillar Coral, Rough Cactus Coral, Lobed Star Coral, Mountainous Star Coral, Boulder Star Coral. National Marine Fisheries Service. http://www.nmfs.noaa.gov/pr/species/invertebrates/coral/recovery_outline_5_caribbean_corals.pdf.

- NOAA. 2015. Recovery Plan for Elkhorn (*Acropora palmata*) and Staghorn (*A. cervicornis*) Corals. Prepared by the Acropora Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.
- NOAA. 2011. Florida Keys National Marine Sanctuary Condition Report. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring MD. 105 pp.
- NOAA. 2009. NOAA Coral Reef Conservation Program Goals & Objectives 2010-2015. Silver Spring, MD: NOAA.
- NOAA. 2007. Florida Keys National Marine Sanctuary Revised Management Plan. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Marine Sanctuary Program. Silver Spring, Maryland. 382 pp. Electronic document available from: <http://floridakeys.noaa.gov/management/welcome.html>.
- NOAA. 2006. Endangered and Threatened Species: Final Listing Determinations for Elkhorn Coral and Staghorn Coral. National Marine Fisheries Service 71 FR 26852.
- NOAA. 1997. Florida Keys National Marine Sanctuary Management Plan. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. National Marine Sanctuaries Program. Silver Spring, MD. Electronic document available from: <http://floridakeys.noaa.gov/management/welcome.html>.
- NOAA. 1989. National Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*) in the Waters of the United States of America. National Marine Fisheries Service, Washington, D.C. 5-20.
- Neely KL, Lewis CL, Lunz KS, Kabay L. 2021. Rapid population decline of the pillar coral *Dendrogyra cylindrus* along the Florida Reef Tract. *Front Mar Sci.* 8:656515.
- Nemeth, R.S. 2012. Ecosystem aspects of species that aggregate to spawn. In Reef fish spawning aggregations: biology, research and management. Springer, Dordrecht. 21-55.
- Nicholls, J.L. 1989. Distribution and other ecological aspects of Piping Plovers (*Charadrius melodus*) wintering along the Atlantic Gulf coasts of the United States. M.S. thesis, Auburn Univ., Alabama.
- Nickerson, N. H. and F.R. Thibodeau. 1983. Barefoot and shod trampling of dunes on Province Lands, Cape Cod, Massachusetts. *Biol. Conserv.* 27: 277-87.
- Niles, L. 2009. Red knots wintering on the Florida Gulf Coast 2005–2009. Unpublished final report (Report on Red Knot Surveys in Florida 2008–2009). Neotropical Migrant Bird Conservation Act. Project #3556, Agreement #NJ-N31.
- Nisbet, I.C.T. 1981. Biological characteristics of the Roseate Terns *Sterna dougallii*. U.S. Fish and Wildlife Service Office of Endangered Species, Newton Corner, Massachusetts. Purchase order 50181-0840-9. 112 pp.
- Nuttle, W.K. and P.J. Fletcher (eds.). 2013. Integrated conceptual ecosystem model development for the Southwest Florida Shelf coastal marine ecosystem. NOAA Technical Memorandum, OAR-AOML-102 and NOS-NCCOS-162. Miami, Florida. 108 pp.
- Ocean Acidification Reference User Group. 2009. Ocean Acidification: The Facts. A special introductory guide for policy advisers and decision makers. D. d'A. Laffoley, and J.M. Baxter (eds). European Project on Ocean Acidification (EPOCA). 12 pp.
- Ogden J.C., J.D. Baldwin, O.L. Bass, J.A. Browder, M.I. Cook, P.C. Frederick, P.E. Frezza, R.A. Galvez, A.B. Hodgson, K.D. Meyer, and L.D. Oberhofer. 2014. Waterbirds as indicators of ecosystem health in

- the coastal marine habitats of Southern Florida: 2. Conceptual ecological models. *Ecol. Indic.* 44: 128-147.
- Ogden, J.C. 1978. Status and nesting biology of the American crocodile, *Crocodylus acutus*, (*Reptilia, Crocodylidae*) in Florida. *Journal of Herpetology*. 12(2):183-196.
- Ogurcak, D.E. 2015. The effect of disturbance and freshwater availability on Lower Florida Keys' coastal forest ecology. Dissertation, Florida International University, Miami, Florida, USA.
- Olden, J.D., N.L. Poff, M.R. Douglas, M.E. Douglas, and K.D. Fausch. 2004. Ecological and evolutionary consequences of biotic homogenization. *Trends in Ecology and Evolution*. 19: 18–24.
- Owre, O.T. 1990. Coastal and marine birds. In: N. Phillips and K. Larson, eds. Synthesis of available biological, geological, chemical, socio-economical, and cultural resources information for the South Florida Area. Continental Shelf Associates, Inc. Contract no. 14-12-0001-30417. 657 pp.
- Parga, M.L. 2012. Hooks and sea turtles: a veterinarian's perspective. *Bulletin of Marine Science*. 88: 731-741.
- Paul, R.T. 1991. Status report – *Egretta rufescens* (Gmelin) Reddish Egret. U.S. Fish and Wildlife Service, Houston, TX. 73 pp.
- Perry, N.D., et. al. 2005. Distribution of Silver Rice Rats (*Oryzomys palustris natator*) in the Lower Florida Keys. Final Report from Texas Agricultural and Mechanical University, College Station, Texas. Cooperative Agreement No. 1448-40181-01-G-230. U.S. Fish and Wildlife Service, Vero Beach, Florida.
- M. Peters¹, D. Palandro², P. Hallock¹, E. Shinn 2008. Assessing the distribution of patch reef morphologies in the Lower Florida Keys, USA, using IKONOS satellite imagery. Proceedings of the 11th International Coral Reef Symposium, Ft. Lauderdale, Florida, 7-11 July 2008 Session number 17
- Phillips, N.W., D.A. Gettleson, and K.D. Spring. 1990. Benthic biological studies of the Southwest Florida shelf American Zoologist. 30(1990): 65-75.
- Porter, J.W., V. Kosmynin, K.L. Patterson, K.G. Porter, W.C. Jaap, J.L. Wheaton, K. Hackett, M. Lybolt, C.P. Tsokos, G. Yanev, D.M. Marcinek, J. Dotten, D. Eaken, M. Patterson, O.W. Meier, M. Brill, and P. Dustan. 2002. Detection of coral reef change by the Florida Keys coral reef monitoring project. In: Porter J.W. and K.G. Porter (eds) The Everglades, Florida Bay, and coral reefs of the Florida Keys: an ecosystem sourcebook. CRC Press, Boca Raton, Florida. 749-769.
- Porter, JW, SK Lewis and KG Porter 1999 The effect of multiple stressors on the Florida Keys coral reef ecosystem: a landscape hypothesis and a physiological test. *Limnol. Oceanogr.* 44: 941-949.
- Precht, W.F., B.E. Gintert, M.L. Robbart, R. Fura, and R. van Woesik. 2016. Unprecedented Disease-Related Coral Mortality in Southeastern Florida. *Scientific Reports*. 6: 31374. 2016/08/10/online. <https://doi.org/10.1038/srep31374>.
- Radabaugh, K.R., R.P. Moyer, and A.R. Chappel, et al. *Estuaries and Coasts*. 2019. <https://doi.org/10.1007/s12237-019-00564-8>.
- Randall, A., and J.R Stoll. 1983. Existence Value in a total Valuation Framework. In *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*. Robert D. Rowe and Lauraine G. Chestnut (eds.) Westview Press. Boulder, Colorado.
- Raven, J. A. (2017). The possible roles of algae in restricting the increase in atmospheric CO₂ and global temperature. *Eur. J. Phycol.* 52, 506–522. doi: 10.1080/09670262.2017.1362593
- Reed J.K., S. Farrington, A. David, S. Harter, S.A. Pomponi, M. C. Diaz, J.D. Voss, K.D. Spring, A.C. Hine, V.H. Kourafalou, R.H. Smith, A.C. Vaz, C.B. Paris, and M.D. Hanisak. 2019. Pulley Ridge, Gulf of

- Mexico, USA. In: Loya Y, Puglise KA, Bridge TCL (eds) Mesophotic coral ecosystems. Springer, New York. 57-69.
- Reed J.K., S. Farrington, A. David, S. Harter, H. Moe, L. Horn, G. Taylor, J. White, J. Voss, S. Pomponi, and D. Hanisak. 2017. Characterization of mesophotic coral/sponge habitats and fish assemblages in the regions of Pulley Ridge and Tortugas from ROV dives during R/V Walton Smith cruises of 2012 to 2015. NOAA CIOERT Cruise Report. Submitted to NOAA-NOS-NCCOS, NOAA Office of Ocean Exploration and Research. Harbor Branch Oceanographic Institute Technical Report. 178: 76.
- Reed, J. 2016. Mesophotic coral ecosystems examined: Pulley Ridge, Gulf of Mexico, USA. In Baker, E.K., K.A. Puglise, P.T. Harris (Eds.). Mesophotic coral ecosystems - A lifeboat for coral reefs? pp. 23-25. The United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal, www.unep.org, www.grida.no.
- Reed, J., S. Farrington, S. Harter, H. Moe, D. Hanisak, and A. David. 2015. Characterization of the mesophotic benthic habitat and fish assemblages from ROV dives on Pulley Ridge and Tortugas during 2014 R/V Walton Smith Cruise. NOAA Cooperative Institute for Ocean Exploration, Research and Technology. Report to NOAA-NOS-NCCOS. HBOI Technical Report. 157: 133.
- Reed, J., S. Farrington, H. Moe, S. Harter, D. Hanisak, and A. David. 2014. Characterization of the mesophotic benthic habitat and fish assemblages from ROV Dives on Pulley Ridge and Tortugas during 2012 and 2013 R/V Walton Smith Cruises. NOAA Cooperative Institute for Ocean Exploration, Research and Technology. Report to NOAA-NOS-NCCOS. HBOI Technical Report. 147: 51.
- Reef Environmental Education Foundation. 2012. Monitoring of the Artificial Reef General Hoyt S. Vandenberg 2011 and 2012, Final Report. Submitted to Florida Fish and Wildlife Conservation Commission Artificial Reef Program. https://www.reef.org/sites/default/files/Vandenberg2012finalreportv4_pt1_append.pdf.
- Reef Environmental Education Foundation. 2007. Fish Monitoring on the Spiegel Grove Artificial Reef April 2002 – August 2007 Final Report. https://www.reef.org/sites/default/files/monitoring/SpiegelGrove_5year_report.pdf.
- Reef Relief Founders. Mangroves: Why they are needed, what threatens them. Available at: <http://reefrelieffounders.com/mangroves.html> (page accessed on 29 June, 2017).
- Rhyne, A., R. Rotjan, A. Bruckner, and M. Tlustý. 2009. Crawling to collapse: ecologically unsound ornamental invertebrate fisheries. PLoS One. 4(12): e8413.
- Riul, P., C.H. Targino, L.A.C. Júnior, J.C. Creed, P.A. Horta, and G.C. Costa. 2013. Invasive potential of the coral *Tubastraea coccinea* in the southwest Atlantic. Marine Ecology Progress Series. 480: 73-81.
- Robblee, M.B., T.R. Barber, P.R. Carlson, M.J. Durako, J.W. Fourqurean, L.K. Muehlstein, D. Porter, L.A. Yarbro, R.T. Zieman, and J.C. Zieman. 1991. Mass mortality of the seagrass *Thalassia testudinum* in Florida Bay (USA). Marine Ecology Progress Series 1991. 71: 297-299.
- Rockland, D.B. 1988. The Economic Impact of the Sport and Commercial Fisheries of the Florida Keys. Report prepared for the Everglades Protection Association, Florida Conservation Association, and The Monroe County Industrial Development Authority. Sports Fishing Institute: Washington, D.C.
- Rockport Analytics (2021). *Key West International Airport (EYW) visitor analysis*. <https://www.monroecounty-fl.gov/DocumentCenter/View/28945/Key-West-International-Airport-Visitation-Analysis?bidId>
- Rodgers, J.A., Jr. and H.T. Smith. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbance in Florida. Wildlife Society Bulletin. 25: 139-145.

- Rodgers, J.A., Jr. and H.T. Smith. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. *Conservation Biology*. 9: 89-99.
- Ross, M., J. O'Brien, and L. Flynn. 1994. Sea-level rise and the reduction of pine forests in the Florida Keys. *Ecological Applications*. 4(1): 144-156.
- Ross, M., J. O'Brien, R. Ford, K. Zhang, and A. Morkill. 2009. Disturbance and the rising tide: the challenge of biodiversity management on low-island ecosystems. *Frontiers in Ecology and the Environment*. 7: 471-478.
- Rowell, T.J., R.S. Nemeth, M.T. Schärer, R.S. Appeldoorn. 2015. Fish sound production and acoustic telemetry reveal behaviors and spatial patterns associated with spawning aggregations of two Caribbean groupers. *Marine Ecology Progress Series*: 518: 239-254.
- Rudnick, D.T., P.B. Ortner, J.A. Browder, and S.M. Davis. 2005. A conceptual ecological model of Florida Bay. *Wetlands*. 25(4): 870-883.
- Ruppel, C.D., T.C. Weber, E.R. Staatterman, S.J. Labak, and P.E. Hart. 2022. Categorizing Active Marine Mammal Acoustic Sources Based on Their Potential to Affect Marine Mammals. *Journal of Marine Science and Engineering*, 10, 1278.
- Ruttenberg, B.I., P.J. Schofield, J.L. Akins, A. Acosta, M.W. Feeley, J. Blondeau, S.G. Smith, and J.S. Ault. 2012. Rapid invasion of Indo-Pacific lionfishes (*Pterois volitans* and *Pterois miles*) in the Florida Keys, USA: evidence from multiple pre-and postinvasion data sets. *Bull. Mar. Sci.* 88: 1051-1059.
- Ruzicka, R., M.A. Colella, J.W. Porter, J.M. Morrison, J.A. Kidney, V. Brinkhuis, K.S. Lunz, K.A. Macaulay, L.A. Bartlett, M.A. Meyers, and J. Colee. 2013. Temporal changes in benthic assemblages on Florida Keys reefs 11 years after the 1997/1998 El Niño. *Mar Ecol Prog Ser*. 489: 125-141.
- Saarinen, E. and J. Daniels. 2006. Miami Blue butterfly larvae (*Lepidoptera: Lycaenidae*) and ants (*Hymenoptera: Formicidae*): New information on the symbionts of an endangered taxon. *Florida Entomologist*. 89(1): 69-74.
- Saarinen, E. 2009. Population genetics of the endangered Miami blue butterfly *Cyclargus thomasi bethunebakeri*: Implications for conservation. Dissertation, University of Florida.
- Sale, P.F. 2006. *Coral Reef Fishes: Dynamics and Diversity in a Complex System*. Academic Press. Burlington, Massachusetts. 149-170.
- Saloman, C.H., D.M. Allen, and T.J. Costello. 1968. Distribution of three species of shrimp (genus *Penaeus*) in waters contiguous to southern Florida. *Bulletin of Marine Science*. 18(2): 343-350.
- Samonte, G., Schwarzmann, D., Dongarra, L., Boarman, C., & Shea, R. (2022). *Florida Keys National Marine Sanctuary community profile* [Manuscript in preparation]. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries.
- Schmidt, T.W., J.S. Ault, J.A. Bohnsack, J. Luo, S.G. Smith, D.E. Harper, G.A. Meester, and N. Zurcher. 1999. Site characterization for the Dry Tortugas region: fisheries and essential habitats. Report to the Florida Keys National Marine Sanctuary and National Park Service.
- M. Jesse Schneider, Traci Ardren, Brad Bertelli, Philippa Jorissen & Sam J. Purkis (2022): The Spanish wells: Freshwater lenses and the Florida Keys, *The Journal of Island and Coastal Archaeology*, DOI: 10.1080/15564894.2021.2021332. To link to this article: <https://doi.org/10.1080/15564894.2021.2021332>
- Schofield, P.J. 2010. Update on geographic spread of invasive lionfishes (*Pterois volitans* [Linnaeus 1758] and *P. miles* [Bennett 1828]) in the Western North Atlantic Ocean, Caribbean Sea and Gulf of Mexico.

- Aquat. Invasions 5, S117–S122 pp. Starck, W.A. 1968. A list of fishes of alligator reef, Florida with comments on the nature of the Florida reef fish fauna. Undersea Biology. 1: 4-40.
- Schofield, P.J. 2009. Field Guide to Nonindigenous Marine Fishes of Florida. NOAA Technical Memorandum NOS NCCOS 92. 120 pp.
- Schofield, P.J., J.A. Morris, and L. Akins. 2009. Geographic extent and chronology of the invasion of non-native lionfish (*Pterois volitans* [Linnaeus 1758] and *P. miles* [Bennett 1828]) in the Western North Atlantic and Caribbean Sea. Aquat. Invasions. 4: 473-479.
- Schomer, N.S. and R.D. Drew. 1982. An ecological characterization of the Lower Everglades, Florida Bay, and the Florida Keys. Washington, D.C.: U.S. Fish and Wildlife Service, Office of Biological Services. 246 pp.
- Schutz, C. 2016. Visitor Volume and Spending for Monroe County, Florida: Year-End 2015 Visitor Volume and Spending. D.K. Shifflet & Associates, Ltd. McLean, Virginia. June 2016.
- Schwarzmann et al. 2022. Florida Keys National Marine Sanctuary Restoration Blueprint: Updated Socioeconomic Supporting Documentation for the 2019 Draft Environmental Impact Statement and 2022 Proposed Rule.
- Science and Conservation of Fish Aggregations (SCRFA). 2013. <https://www.scrfa.org/>.
- Shamblin, B.M., A.B. Bolten, F.A. Abreu-Grobois, K.A. Bjorndal, L. Cardona, C. Carreras, M. Clusa, C. Monzón-Argüello, C.J. Nairn, J.T. Nielsen, R. Nel, L.S. Soares, K.R. Stewart, S. T. Vilaça, O. Türkozan, C. Yilmaz, and P.H. Dutton. 2014. Geographic Patterns of Genetic Variation in a Broadly Distributed Marine Vertebrate: New Insights into Loggerhead Turtle Stock Structure from Expanded Mitochondrial DNA Sequences. PLoS ONE. 9(1): e85956.
- Sharp, W. and N. Sheridan. 2019. Trend Analysis of Marine Life Landings 2005-2017. Report to the Florida Fish and Wildlife Conservation Commission's Division of Marine Fisheries Management.
- Shearer, T.L. 2009. Population Analysis of an Introduced Coral Species, *Tubastraea coccinea*, in Florida. In: Pollock NW, eds. Diving for Science 2009. Proceedings of the American Academy of Underwater Sciences 28th Symposium. Dauphin Island, Alabama. AAUS. 2009.
- Sheets, B. and J. Williams. 2001: Hurricane Watch: *Forecasting the Deadliest Storms on Earth*. Random House, Inc. 331 pp.
- Sherley, R.B., H. Winker, R. Altwegg, C.D. van der Lingen, S.C. Votier, and R.J.M. Crawford. 2015. Bottom-up effects of a no-take zone on endangered penguin demographics. Biol. Lett. 2015 11 20150237; DOI: 10.1098/rsbl.2015.0237.
- Shin, E.A., B.H. Lidz, J.L. Kindinger, J.H. Hudson, and R.B. Halley. 1989. A Field Guide: Reefs of Florida and the Dry Tortugas, A Field Trip to the Modern Carbonate Environments of the Florida Keys and the Dry Tortugas, International Geological Congress. IGC Field Trip T1 76. American Geophysical Union, Washington D.C. 54 pp.
- Shivlani, M. 2014. "The Impacts of Fisheries Management on the Performance and Resiliency of the Commercial Fishing Industry and Fishing Communities in the Florida Keys (Monroe County, Florida) from 1950-2010" FIU Electronic Theses and Dissertations. Paper 1234. <http://digitalcommons.fiu.edu/etd/1234>.
- Shivlani, M., V.R. Leeworthy, T.J. Murray, D.O. Suman, and F. Tonioli. 2008. Knowledge, Attitudes and Perceptions of Management Strategies and Regulations of the Florida Keys National Marine Sanctuary by Commercial Fishers, Dive Operators, and Environmental Group Members: A Baseline Characterization and 10-year Comparison. Marine Sanctuaries Conservation Series ONMS-o8-o6. U.S.

- Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD. 170 pp.
- Smith, S.G., J.S. Ault, J.A. Bohnsack, D.E. Harper, J. Luo, and D.B. McClellan. 2011. Multispecies survey design for assessing reef-fish stocks, spatially explicit management performance, and ecosystem condition. *Fisheries Research*. 109(2011): 25-41.
- Smith, S.H. 2016. Recreational Fishing Effort, 2009-2010 Annual Averages for the Florida Keys National Marine Sanctuary by Species, Gear type and Mode of Access. Personal Communications, University of Miami, Rosenstiel School for Marine and Atmospheric Science (RSMAS).
- Smith, K.M., Payton, T.G., Sims, R.J. et al. Impacts of consecutive bleaching events and local algal abundance on transplanted coral colonies in the Florida Keys. *Coral Reefs* 38, 851–861 (2019).
<https://doi.org/10.1007/s00338-019-01823-7>
- Snodgrass, D. and C.W. Harnden. 2009. Composition of fish species on ocean-side beach habitats in the Florida Keys. *Fl Sci*. 72: 153–170.
- Sobel, J. 1996. "Marine reserves: Necessary tools for biodiversity conservation?", *Canadian Museum of Nature*. 1996: 8-18.
- Socioeconomic Research and Monitoring Program, Florida Keys National Marine Sanctuary.
<http://sanctuaries.noaa.gov/science/socioeconomic/>.
- South Florida Reef Visual Census. 2016. https://grunt.sefsc.noaa.gov/rvc_analysis20/.
- South Florida Water Management District, Interdepartmental Climate Change Group, 2009. Climate Change and Water Management in South Florida, swfmd.gov.
- Sponaugle S. and R.K. Cowen. 2019. Coral ecosystem connectivity between Pulley Ridge and the Florida Keys. In: Loya Y, Puglise KA, Bridge TCL (eds) *Mesophotic coral ecosystems*. Springer, New York. pp. 897-907.
- Spurgeon, J.P.G. 1992. The Economic Valuation of Coral Reefs. *Marine Pollution Bulletin*. 24(11): 529-536.
- Starck, W.A. 1968. A list of fishes of Alligator Reef, Florida with comments on the nature of the Florida reef fish fauna. *Undersea Biology*. 1(1): 4-40.
- Starck WA, Estapé CJ, Morgan Estapé A. (2017) The fishes of Alligator Reef and environs in the Florida Keys: a half-century update. *Journal of the Ocean Science Foundation* 7: 74–117.
10.5281/zenodo.851651
- Stefanski, S. and J.P. Shimshack. 2016. Valuing Marine Biodiversity in the Gulf of Mexico: Evidence from the Proposed Boundary Expansion of the Flower Garden Banks National Marine Sanctuary. *Marine Resource Economics*, 31: 2.
- Stevely, J.M., D.E. Sweat, T.M. Bert, C. Sim-Smit., and M. Kelly. 2011. Sponge mortality at marathon and long key, Florida: patterns of species response and population recovery. *Proc. 63rd Gulf Caribb. Fish. Inst.* pp. 384-400.
- Stevenson, H.M. and B.H. Anderson. 1994. *The birdlife of Florida*. University of Florida, Gainesville, Florida, USA.
- Storlazzi, C.D., B.G. Reguero, A.D. Cole, E. Lowe, J.B. Shope, A.E. Gibbs, B.A. Nickel, R.T. McCall, A.R. van Dongeren, and M.W. Beck. 2019, Rigorously valuing the role of U.S. coral reefs in coastal hazard risk reduction: U.S. Geological Survey Open-File Report 2019–1027. 42 pp.
<https://doi.org/10.3133/ofr20191027>.

- Sully S., MK DONovan, G. Hodgson and R van Woesik 2022 Nature Communications
<https://doi.org/10.1038/s41467-019-09238-2>
- Szmant, A.M. and A. Forrester. 1996. Water column and sediment nitrogen and phosphorus distribution patterns in the Florida Keys, USA. *Coral Reefs*. 15: 21-41.
- Szmant, A.M. and M.W. Miller. 2006. Settlement preferences and post-settlement mortality of laboratory cultured and settled larvae of the Caribbean hermatypic corals *Montastraea faveolata* and *Acropora palmata* in the Florida Keys, USA. *Proc 10th Int Coral Reef Symp*. 1: 43-49.
- Teuchies, J., Cox, T.J.S., Van Itterbeeck, K. *et al.* The impact of scrubber discharge on the water quality in estuaries and ports. *Environ Sci Eur* 32, 103 (2020). <https://doi.org/10.1186/s12302-020-00380-z>
- T.J. Murray & Associates. 2006. Tortugas 2000 - A post mortem: Evaluation of actual versus projected socioeconomic impacts of the Dry Tortugas Ecological Reserve. Report completed in accordance of MARFIN Grant NAO4NMF4330079.
- Thorbjarnarson, J.B., S. Manolis, and C. Stevenson. 2010. American crocodile, *Crocodylus acutus*. Crocodiles: Status Survey and Conservation Action Plan. 46-53.
- Toth, L.T., Kuffner, I.B., Stathakopoulos, A., Precht, W.F., Aronson, R.B., and Shinn, E.A., 2018, A 3000-year lag between the geological and ecological collapse of Florida's coral reefs: *Global Change Biology*, v.24 i.11, p. 5471-5483, doi: 10.1111/gcb.14389.
- Toth LT, Courtney TA, Colella MA, Kupfner Johnson SA, Ruzicka RR. The past, present, and future of coral reef growth in the Florida Keys. *Glob Chang Biol*. 2022 Sep;28(17):5294-5309. doi: 10.1111/gcb.16295. Epub 2022 Jul 5. PMID: 35789026; PMCID: PMC9542952.
- Trager, M. and J. Daniels. 2011. Size effects on mating and egg production in the Miami blue butterfly. *Journal of Insect Behavior*, DOI 10.1007/s10905-010-9234-8.
- Trager, M. and J. Daniels. 2009. Ant tending of Miami blue butterfly larvae (*Lepidoptera: Lycaenidae*): Partner diversity and effects on larval performance. *Florida Entomologist*. 92: 474-482.
- TRC Environmental Corporation. 2012. Inventory and analysis of archaeological site occurrence on the Atlantic outer continental shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-008. 324 pp.
- Uhrin, A.V., W.J. Kenworthy, and M.S. Fonseca. 2011. Understanding uncertainty in seagrass injury recovery: an information-theoretic approach. *Ecological Applications*. 21(4): 1365-1379.
- Uhrin, A.V. and J.G. Holmquist. 2003. Effects of propeller scarring on macrofaunal use of the seagrass *Thalassia testudinum*. *Marine Ecology Progress Series*. 250: 61-70.
- Uhrin, A., T. Matthews, and C. Lewis. 2014. Lobster trap debris in the Florida Keys National Marine Sanctuary: distribution, abundance, density, and patterns of accumulation. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*. 6: 20-32.
- U.S. Army Corps of Engineers and U.S. Department of the Interior. 2015. Comprehensive Everglades Restoration Plan Central and Southern Florida Project. Report to Congress.
<https://www.saj.usace.army.mil/Portals/44/docs/Environmental/Report%20to%20Congress/2015CE RPReportCongressDRAFT.pdf>.
- U.S. Coral Reef Task Force (USCRTF), 1999. Coastal Uses Working Group Summary Report.
<https://www.coralreef.gov/coastal/CUWG.pdf>.

- U.S. Census Bureau. (2021a). *American Community Survey demographic and housing estimates* [Data set]. U.S. Department of Commerce.
<https://data.census.gov/cedsci/table?q=&text=DP05&tid=ACSDP1Y2019.DP05>
- U.S. Census Bureau. (2021b). *Transportation and warehousing: Summary statistics for the U.S., states, and selected geographies: 2017* [Data set].
<https://data.census.gov/cedsci/table?q=ec1748BASIC&g=0400000US12&n=48-49%3AN0300.48%3AN0400.48%3AN0500.48%3AN0600.48&hidePreview=true&tid=ECNBASIC2017.EC1748BASIC&vintage=2017>
- U.S. Census Bureau (2013). *American Community Survey commuting products*.
<https://www.census.gov/newsroom/press-kits/2013/commuting.html>
- U.S. Department of Commerce, Bureau of the Census. <http://www.census.gov>.
- U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.
<http://www.bea.gov/regional/downloadzip.cfm>.
- U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index. <http://data.bls.gov/cgi-bin/surveymost>.
- U.S. Department of Labor, Bureau of Labor Statistics, Unemployment.
<http://www.bls.gov/data/#unemployment>.
- U.S. Environmental Protection Agency. 2008. Cruise Ship Discharge Report. USEPA Office of Water, Washington D.C. Access this study on the following USEPA webpage: https://www.epa.gov/vessels-marinas-and-ports/cruise-ship-discharges-and-studies#access_reports.
- U.S. Environmental Protection Agency. 2011. Exhaust Gas Scrubber Washwater Effluent. USEPA Office of Wastewater Management, Washington D.C., EPA-800-R-11-006
- U.S. Environmental Protection Agency. 2013. Florida Keys National Marine Sanctuary Water Quality Protection Program Report to Congress. USEPA Region 4, Atlanta, Georgia.
http://ocean.floridamarine.org/FKNMS_WQPP/docs/wqpp/WQPP_Biennial_Report_to_Congress_2013.pdf.
- U.S. Fish and Wildlife Service. 2017. Letter from R. Hinzman, Field Supervisor South Florida Ecological Services Office, FWS to A. Williamson, Project Managers, NRC. Subject: Biological Opinion for Combined License for Turkey Point Nuclear Plant, Units 6 and 7. June 23, 2017. ADAMS Accession No. ML17177A673.
- U.S. Fish and Wildlife Service. 2015. Status of the species, red knot (*Calidris canutus rufa*). November 2015. https://www.fws.gov/verobeach/StatusoftheSpecies/20151104_SOS_RedKnot.pdf (accessed September 12, 2018).
- U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; Listing of the Miami blue butterfly as endangered throughout its range; Listing of the cassius blue, ceraunus blue, and nickerbean blue butterflies as threatened due to similarity of appearance to the Miami blue butterfly in coastal south and central Florida. Federal Register. 77: 20948-20986.
- U.S. Fish and Wildlife Service. 2009. Lower Florida Keys National Wildlife Refuges: Comprehensive Conservation Plan. 344 pp.
- U.S. Fish and Wildlife Service. 2007. Wood stork (*Mycteria americana*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, FL. September 21, 2007. https://ecos.fws.gov/docs/five_year_review/doc1115.pdf (accessed September 12, 2018).

- U.S. Fish and Wildlife Service. 2006. Crocodile Lake National Wildlife Refuge: Comprehensive Conservation Plan. 127 pp.
- U.S. Fish and Wildlife Service. 1999. South Florida Multi-Species Recovery Plan. Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 1992. Management agreement for the submerged lands within boundaries of the Key West and Great White Heron National Wildlife Refuges. 119 pp.
- U.S. Fish and Wildlife Service. 1989. Roseate tern recovery plan-northeast population. U.S. Fish and Wildlife Service; Newton Corner, Massachusetts.
- U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Act Consultation Handbook, Procedures for Conducting Section 7 Consultations and Conferences. Accessed 19 July, 2019. https://www.fws.gov/endangered/esa-library/pdf/esa_section7_handbook.pdf.
- Valentine, M. V., and M. J. Butler IV. 2019. Sponges structure water column characteristics in a shallow, tropical coastal ecosystem. *Marine Ecology Progress Series* 608:133–147
- Valentine, J.F, K.L. Heck Jr., D. Blackmon, M.E. Goecker, J. Christian, R.M. Kroutil, B.J. Peterson, M.A. Vanderklift, K.D. Kirsh, and M. Beck. 2008. Exploited species impacts on trophic linkages along reef-seagrass interfaces in the Florida Keys. *Ecological Applications*. 18(6): 1501-1515.
- Vermeij, M.J.A. 2006. Early life-history dynamics of Caribbean coral species on artificial substratum: the importance of competition, growth and variation in life-history strategy. *Coral Reefs*. 25: 59–71.
- Viehman, T. S., Grove, J. G., Blondeau, J., Cain, E., Edwards, K. F., Groves, S. H., Krampitz, N., Langwiser, C. Siceloff, L. Swanson, D., Towle, E. K., and Williams, B. (2023). National Coral Reef Monitoring Program, Biological Monitoring Summary – Florida: 2022. NOAA Technical Memorandum NOS CRCP 48. <https://doi.org/10.25923/e6xg-1989>
- Vos, D.K., R.A. Ryder, and W.D. Gaul. 1985. Response of breeding great blue herons to human disturbance in north central Colorado. *Colonial Waterbirds*. 8: 13-22.
- Voss, G.L. 1988. *Coral reefs of Florida*. Sarasota, FL: Pineapple Press. 80 pp.
- Voss, J.D. 2006. Coral disease dynamics and environmental drives in the northern Florida Keys and Lee Stocking Island, Bahamas. ETD Collection for Florida International University. Paper AAI3235620. Electronic document available from: <http://digitalcommons.fiu.edu/dissertations/AAI3235620>.
- Waddell, J.E. 2005. The State of the Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005. NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, Maryland.
- Wagner, D., E. Mielbrecht, and R. van Woesik. 2008. Application of landscape ecology to spatio-temporal variance of water-quality parameters along the Florida Keys reef tract. *Bull Marine Science*. 83(3): 553-569.
- Wallmo, K., Lovell, S., Gregg, K., & Allen, M. (2021a). *Economic impact analysis of recreational fishing on Florida reefs*. NOAA Technical Memorandum CRCP 41. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Coral Reef Conservation Program. <https://repository.library.noaa.gov/view/noaa/31429>
- Wallmo, K., Edwards, P., Steinback, S., Wusinich-Mendez, D., & Allen, M. (2021b). *Economic impact analysis of snorkeling and SCUBA diving on Florida reefs*. NOAA Technical Memorandum CRCP 42. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Coral Reef Conservation Program. <https://repository.library.noaa.gov/view/noaa/30606>

- Walton C.J., N.K. Hayes, and D.S. Gilliam. 2018. Impacts of a Regional, Multi-Year, Multi-Species Coral Disease Outbreak in Southeast Florida. *Front Mar Sci.* e 5. <https://doi.org/10.3389/fmars.2018.00323>.
- Wang, M., C. Hu, B. Barnes, B. Lapointe, and J.P. Montoya. 2019. The great Atlantic Sargassum belt. *Science* 365:83–87. <https://doi.org/10.1126/science.aaw7912>
- Wanless, H.R., and Tagett, M.G., 1989, Origin, growth and evolution of carbonate mudbanks in Florida Bay: *Bulletin of Marine Science*, v. 44, p. 454–489.
- Watts, K.G. 2015-2018. Florida Keys National Wildlife Refuge Complex Wildlife Biologist. personal communications.
- Waycott, M., C.M. Duarte, T.J. Carruthers, R.J. Orth, W.C. Dennison, S. Olyarnik, A. Calladine, J.W. Fourqurean, K.L. Heck Jr, A.R. Hughes, G.A. Kendrick, W.J. Kenworthy, F.T. Short, and S.L. Williams. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences of the United States of America*. 106(30): 12377-12381.
- Weil, E. 2004. Coral reef diseases in the wider Caribbean. *In*: E. Rosenberg and Y. Loya (Eds.). *Coral health and disease*. Springer. 35-68.
- Weisberg, R.H., L. Zheng, and Y. Liu. 2016. West Florida shelf upwelling: Origins and pathways. *Journal of Geophysical Research: Oceans* 121: 5672–5681. <https://doi.org/10.1002/2015JC011384>.
- Weisberg, R.H., Y. Liu, and D.A. Mayer. 2009. West Florida Shelf mean circulation observed with long-term moorings. *Geophysical Research Letters*. 36: L19610.
- Weisbrod, B. 1964. Collective-Consumption Services of Individual-Consumption Goods. *Quarterly Journal of Economics*. 78(Aug. 1964): 471-477.
- Westhof, Lena, S. Koster, and M. Reich. 2016. Occurrence of micropollutants in the wastewater streams of cruise ships. *Emerging Contaminants*. 2 (2016) 178-184
- Wheaton J (1981) Octocorals. *In*: NOAA Technical Report CZ/SP-1. Key Largo Coral Reef National Marine Sanctuary Deep Water Resources Survey. NOAA Office of Coastal Zone Management.
- Wheeler, R. 2004. Southern Florida Sites Associated with the Tequesta and their Ancestors. National Historic Landmark/National Register of Historic Places Theme Study. Florida Division of Historical Resources, Tallahassee, Florida.
- Whitfield, P.E., J.A. Hare, A.W. David, S.L. Harter, R.C. Muñoz, and C.M. Addison. 2007. Abundance estimates of the Indo-Pacific lionfish *Pterois volitans*/miles complex in the Western North Atlantic. *Biological Invasions*. 9: 53-64.
- Widmer, R.J. 1988. *The Evolution of the Calusa: A Nonagricultural Chiefdom on the Southwest Florida Coast*. University of Alabama Press, Tuscaloosa.
- Wightman, M.J. 1990. Geophysical analysis and Dupuit-Ghyben-Herzberg modeling of freshwater lenses on Big Pine Key, Florida. M.S. Thesis, Univ. South Florida, Tampa, Florida. 122 pp.
- Wilkinson, C. 2008. Status of the Coral Reefs of the World: 2008. Townsville, Australia. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre.
- Wilkinson, C. and D. Souter (eds.). 2008. Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005. Townsville, Australia, Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre.

- Williams, D.E., M.W. Miller, A.J. Bright, R.E. Pausch, and A. Valdivia. 2017. Thermal stress exposure, bleaching response, and mortality in the threatened coral *Acropora palmata*. *Marine Pollution Bulletin*. 124(1): 189-197.
- Williams, D.E. and M.W. Miller. 2012. Attributing mortality among drivers of population decline in *Acropora palmata* in the Florida Keys (USA). *Coral Reefs*. 31: 369-382.
- Wilmers, T. 2010. Distribution and population trend of nesting great white herons (*Ardea herodias occidentalis*) in the Florida Keys National Wildlife Refuges, 1986-2009. Internal Summary Report.
- Wilmers, T.J. 2003. Distribution and Population Trends of Nesting Great White Herons (*Ardea herodias occidentalis*) in the Florida Keys National Wildlife Refuges, 1986-2001. Unpublished Report, Florida Keys National Wildlife Refuges, Big Pine Key, Florida.
- Wilmers, T.J and J. Arnett. 2002. A survey of reddish egrets in the lower Florida Keys 1986-2001. Unpublished final report. U.S. Fish and Wildlife Service. Big Pine Key, Florida.
- Winchester, C., S.B. Castleberry, and Mengak, M. T. 2009. Evaluation of factors restricting distribution of the endangered Key Largo woodrat. *Journal of Wildlife Management*. 73(3): 374-379.
- Windhorn, S. and W. Langley. 1974. Yesterday's Florida Keys. Langley Press, Inc. Key West, Florida.
- Windhorn, S. and W. Langley. 1973. Yesterday's Key West. Langley Press, Inc. Key West, Florida.
- Winsberg, M.D. 2003: *Florida Weather (Second Edition)*. University Press of Florida. 218 pp.
- Woodley, C.M., C.A. Downs, A.W. Bruckner, J.W. Porter, and S.B. Galloway. 2016. Diseases of Coral. By. John Wiley & Sons Inc., Hoboken, New Jersey, USA. 582 pp. ISBN: 978-0-8138-2411-6.
- Worth, J.E. 1995. Fontaneda Revisited: Five Descriptions of Sixteenth-Century Florida. *Florida Historical Quarterly*. 73(3): 339-352.
- Yan, T., L.J. Pietrafesa, D.A. Dickey, P.T. Gayes, and S. Bao. 2015. Seasonal prediction of landfalling hurricanes along Eastern Seaboard of the United States. *International Journal of Climatology*. 35(9): 2647-2653.
- Young, J.M., B.G. Yeiser, and J.A. Whittington. 2014. Spatiotemporal dynamics of spawning aggregations of common snook on the east coast of Florida. *Marine Ecology Progress Series*. 505: 227-240.
- Zhang, K, J. Dittmar, M. Ross, and C. Bergh. 2011. Assessment of sea level rise impacts on human population and real property in the Florida Keys. *Climatic Change*. 107:129-146.
- Zhong, H., L.J. Hribar, J.C. Daniels, M.A. Feken, C. Brock, and M.D. Trager. 2009. Aerial ultra low volume application of naled: impact on non-target imperiled butterfly larvae and efficacy against adult mosquitoes. Public Health Entomology Research and Education Center, College of Engineering Sciences, Technology and Agriculture, Florida A&M University, Panama City, Florida.
- Zieman, J.C., J.W. Fourqurean, and T.A. Frankovich. 1999. Seagrass die-off in Florida Bay: long-term trends in abundance and growth of turtle grass, *Thalassia testudinum*. *Estuaries*. 22(2): 460-470.
- Zieman J.C., J.W. Fourqurean and R.I. Iverson. 1989. Distribution, abundance and productivity of seagrass and macroalgae in Florida Bay. *Bulletin of Marine Science*, 44:292-311.



NATIONAL MARINE
SANCTUARIES

AMERICA'S UNDERWATER TREASURES