Strategy for Stewardship

Tortugas Ecological Reserve

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Ocean Service

Office of National Marine Sanctuaries

Final Supplemental Environmental Impact Statement/ Final Supplemental Management Plan

Florida Keys National Marine Sanctuary

Final Supplemental Environmental Impact Statement/ Final Supplemental Management Plan

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An ecological reserve in the Tortugas will preserve the richness of species and health of fish stocks in the Tortugas and throughout the Florida Keys, helping to ensure the stability of commercial and recreational fisheries. The reserve will protect important spawning areas for snapper and grouper, as well as valuable deep water habitat for other commercial species. Restrictions on vessel discharge and anchoring will protect water quality and habitat complexity. The reserve’s geographical isolation will help scientists distinguish between natural and human-caused changes to the coral reef environment.

Protecting Ocean Wilderness

Creating an ecological reserve in the Tortugas will protect some of the most productive and unique marine resources of the Sanctuary. Because of its remote location 70 miles west of Key West and more than 140 miles from mainland Florida, the Tortugas region has the best water quality in or near the Sanctuary. Healthy baitfish populations support thriving seabird communities, including sooty and noddy terns, masked boobies and the only roosting population of magnificent frigate birds in the continental U.S. Due to its location at the juncture of several major ocean currents, the Tortugas has a high potential for exporting the larvae of fish, lobster, and other marine organisms downstream to the Keys and the east coast of Florida. The U.S. Fish and Wildlife Service has stressed the importance of this area to the well-being of the Key West and Great White Heron National Wildlife Refuges.

The Tortugas reefs also boast the healthiest coral in the region. In the area known as “Sherwood Forest,” coral cover often exceeds 30%, compared to an average of 10% elsewhere in the Florida Keys. The well-developed reef forms a false bottom, interspersed with gorgonian-forests, sponges, and black corals. Scientists examining one bizarre, mushroom-shaped coral**,** characteristic of Sherwood Forest**,** found it to be approximately 400 years old. Other areas contain high relief pinnacles that protrude like mountains upward from the seafloor, providing ideal habitat for a diverse array of fish. Organisms rarely seen elsewhere in the Keys, such as crinoids (feather stars) and black corals, occur on Tortugas' reefs. Some species such as the red-tailed triggerfish only occur in the Tortugas.

Threats to the Tortugas' resources exist and are on the increase. Commercial and recreational fishing pressure has reduced the average size of black grouper in the Tortugas from 22.5 lbs. to 9 lbs. The FKNMS regulations prohibit freighters from anchoring on the lush reefs of Tortugas Bank, but other parts of the region are still threatened by damage from anchors weighing up to several tons. Visitation to the Dry Tortugas National Park indicates a dramatic upward trend, from 18,000 visitors in 1984 to 72,000 in 1998. Continued pressures on this remote area are likely to intensify with improved navigational technology and faster boats.

No-Take Areas in the Florida Keys National Marine Sanctuary

The 2,800 square nautical mile FKNMS was established in 1990 by the Florida Keys National Marine Sanctuary and Protection Act (FKNMSSPA) to ensure the sustainability of the marine environment by balancing resource protection with compatible resource use. In that Act, Congress directed the Secretary of Commerce to consider temporal and geographic zoning to ensure the protection of Sanctuary resources. Like zoning on land, marine zoning designates different areas for different uses. "No-take" areas, which are closed to the taking of marine life, are one type of marine zone.

While no-take areas are a relatively new concept in the United States, resource managers worldwide have used them successfully to protect species diversity, replenish fish populations, and provide opportunities for education and research. Reserves provide protection to species not covered by traditional commercial and recreational fishing regulations. They protect habitat and food that fish and other creatures need to survive.

In 1997, the Sanctuary implemented a groundbreaking marine zoning plan featuring a network of 23 no-take areas classified as ecological reserves, sanctuary preservation areas and special use areas. These areas protect much of the critical shallow reef habitat. Figure 1 of the FSEIS shows the 23 existing no-take areas along with the existing 27 Wildlife Management Areas. While an ecological reserve was proposed to be established at that time for the Tortugas region, it was not established because of public comments indicating that the proposed boundaries did not include the most significant coral reef resources and would cause serious economic harm to commercial fishermen. Instead, the Sanctuary's final management plan called for a collaborative initiative bringing together all stakeholders to determine the area of the Tortugas that needed zoning protection and the degree of protection needed.

The Collaborative Process

To develop a Preferred Alternative, a 25-member Working Group was established composed of commercial and recreational fishers, divers, conservationists, scientists, concerned citizens, and government agencies. The Working Group used the best available information to develop a range of alternatives and recommend a Preferred Alternative to the State of Florida and to the Sanctuary Advisory Council (SAC). The Working Group used an "ecosystem approach," recommending alternatives based on natural resources rather than jurisdictional boundaries.

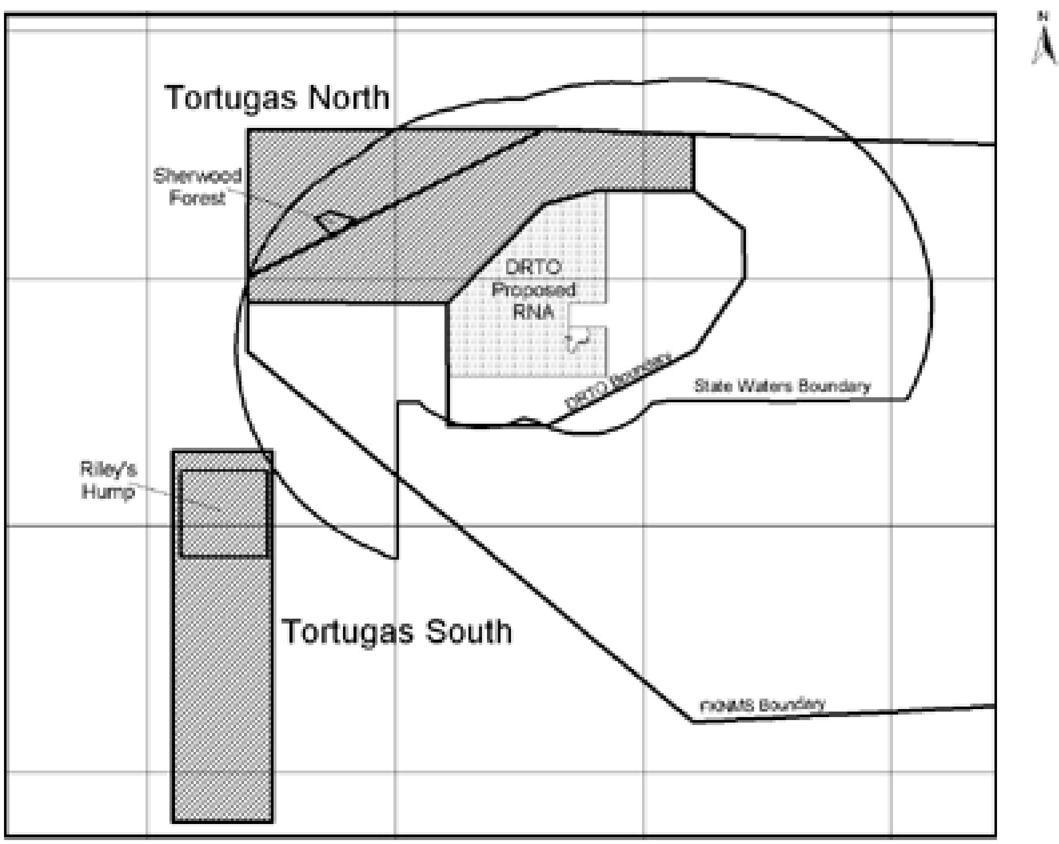
The Working Group gathered ecological and socio-economic information through two public meetings, and a site characterization document, and the firsthand experiences of commercial and recreational fishermen and others. A series of public scoping meetings was held throughout South Florida in the fall of 1998 to gather input. In May 1999, the Working Group reached a consensus on proposed boundaries and regulations for the Reserve. In June 1999, the Sanctuary Advisory Council unanimously approved the Working Group's proposal.

The Tortugas Ecological Reserve Proposal Contained in the DSEIS issued in May 2000

The Preferred Alternative for the establishment of an ecological reserve in the Tortugas region, contained in the Draft Supplemental Environmental Impact Statement (DSEIS), consists of a boundary component (Boundary Alternative III) and a regulatory component (Regulatory Alternative C). The boundary component would expand the boundary of the Sanctuary by approximately 96 square nautical miles (nm) to include two significant coral reef areas known as Sherwood Forest and Riley's Hump and establish an ecological reserve (the Tortugas Ecological Reserve) of approximately 151 square nm in two separate areas. The first area would include and surround Sherwood Forest, and would encompass approximately 91 square nm. This area would be called Tortugas North. The second area would include and surround Riley's Hump and would encompass approximately 60 square nm. This area would be called Tortugas South.

The Preferred Alternative would expand the boundary of the Sanctuary in its northwestern corner by approximately 36 square nm to include Sherwood Forest and would expand the boundary in the south by adding a noncontiguous area of approximately 60 square nm to include Riley's Hump. The Tortugas North section would incorporate approximately 55 square nm of the existing Sanctuary.

The regulatory component would apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South; would prohibit anchoring in Tortugas North and South; would control access to Tortugas North and South for other than continuous transit or for law enforcement purposes via a simple, no cost permit; would require call-in for entering and leaving Tortugas North and South; and would prohibit vessels longer than 100 ft LOA from using a mooring buoy.



The Tortugas Ecological Reserve Proposal Contained in the FSEIS

The Preferred Alternative for the establishment of an ecological reserve in the Tortugas region, contained in the Final Supplemental Environmental Impact Statement (FSEIS), is the same as that for the Preferred Alternative in the DSEIS except that the regulatory component is Alternative D instead of Alternative C. The difference between Regulatory Alternatives C and D is that Regulatory Alternative D would prohibit access in Tortugas South except for continuous transit, law enforcement, or for scientific research or educational purposes pursuant to a sanctuary permit. Under Alternative C, which is less restrictive, access to Tortugas South, except for continuous transit and law enforcement purposes would require a simple, no-cost permit and would require call-in for entering and leaving.

The Gulf of Mexico Fishery Management Council (GMFMC), at its July 10-13, 2000, meeting, took final action on its Generic Amendment Addressing the Establishment of Tortugas Marine Reserves, which would create the Council's own 60 square nautical mile marine reserve in the same location as Tortugas South and in the 13 square nautical mile portion of Tortugas North that is within the Council's jurisdiction. The GMFMC has proposed a prohibition on any fishing (consumptive activity) or anchoring by fishing vessels. The Council also requested that NOS prohibit anchoring by all vessels in the reserve and that NOS prohibit all diving in the areas of Tortugas North and Tortugas South that are subject to Council jurisdiction.

The GMFMC expressed concern that non-consumptive diving would make the no-take prohibitions difficult to enforce, particularly with regard to diving for lobsters and spearfishing. The Council believes that eliminating all diving activities would greatly simplify enforcement.

In addition, the GMFMC stated that non-consumptive diving can impact and damage bottom habitat through the inadvertent contact with coral or by stirring up sand and silt on the bottom. The Council also expressed concern about the biological impact of diving on the behavior of reef fish populations. Tortugas South is a known spawning area for many fish including red snapper, yellow tail snapper, mutton snapper, mangrove snapper, snowy grouper, black grouper, red grouper, red hind, and rock hind. The Council believes that the potential for diver impact on fish spawning would be eliminated by the closure.

In addition, other commentors expressed concern over the effects of non-consumptive diving on sensitive coral reef resources.

Based on the comments received, the Preferred Alternative in the FSEIS has been revised from the Preferred Alternative in the DSEIS to prohibit all diving in Tortugas South except for research or educational purposes pursuant to a Sanctuary permit. Non-consumptive diving would still be allowed in Tortugas North. The resources of Tortugas

North are not as sensitive to diver impacts as those in Tortugas South and permitting non-consumptive diving in Tortugas North with careful monitoring of the impacts of such diving would provide exceptional resource appreciation and public education benefits. Also, prohibiting diving in Tortugas South would provide a reference for assessing the impact of diving activities in Tortugas North.

Socio-economic impacts, determined by analyzing the costs and benefits of no-take regulations on various industries, indicate moderate impacts on fishermen, mostly lobster and handline fishermen, and some recreational charter operators, and minimal or small impacts on recreational fishermen, commercial shippers, and treasure salvors. The potential for benefits to non-consumptive users and the scientific community is high due to the educational and research value of an ecological reserve. Positive effects to surrounding areas through long-term fisheries replenishment are also likely.

The FSEIS Preferred Alternative would adequately protect the nationally significant coral reef resources of the Tortugas region and fulfill the objectives of the FKNMSPA and the National Marine Sanctuaries Act (NMSA). The Preferred Alternative is of sufficient size and imposes adequate protection measures to achieve the goals and objectives of the FKNMSPA and the NMSA while not unduly impacting user groups.

Commenting on the Proposal

NOAA encouraged the public to comment on the alternatives contained in the DSEIS. Comments were accepted until July 31, 2000. NOAA held a series of public hearings throughout South Florida to accept comments on the DSEIS in conjunction with the National Park Service/Dry Tortugas National Park, Florida Fish and Wildlife Conservation Commission, and the Gulf of Mexico Fishery Management Council.

More than 4,000 comments were received on the DSEIS/SMP and the proposed implementing regulations for the proposed Tortugas Ecological Reserve. Almost 3000 of the comments were form letters expressing general support for the creation of the Tortugas Ecological Reserve. Two-hundred and forty-five persons commented by signing a petition. The responses to comments received on the DSEIS are contained in Appendix H.

ABSTRACT

The National Ocean Service of the National Oceanic and Atmospheric Administration, working in cooperation with the State of Florida, the Gulf of Mexico Fishery Management Council, and the National Marine Fisheries Service, proposes to establish a 151 square nautical mile “no-take” ecological reserve to protect the critical coral reef ecosystem of the Tortugas, a remote area in the western part of the Florida Keys National Marine Sanctuary. The reserve would consist of two sections, Tortugas North and Tortugas South, and would require an expansion of the Sanctuary boundary to protect important coral reef resources in the areas of Sherwood Forest and Riley’s Hump. This action is necessary to comprehensively protect some of the healthiest and most diverse coral reefs in the Florida Keys. Without the protection that will be provided by the proposed no-take and no-anchoring regulations, this deep water coral reef community would continue to be degraded by activities such as anchoring and fishing. Degradation of this special part of the ecosystem jeopardizes its integrity in addition to the ability of Americans to experience and learn from a relatively healthy coral reef ecosystem.

In 1997, the Sanctuary implemented a groundbreaking marine zoning plan featuring a network of 23 no-take areas classified as ecological reserves, sanctuary preservation areas and special use areas. These areas protect much of the critical shallow reef habitat. Figure 1 shows the 23 existing no-take areas along with the existing 27 Wildlife Management Areas. While an ecological reserve was proposed to be established at that time for the Tortugas region, it was not established because of public comments indicating that the proposed boundaries did not include the most significant coral reef resources and would cause serious economic harm to commercial fishermen. Instead, the Sanctuary’s final management plan called for a collaborative initiative bringing together all stakeholders to determine the area of the Tortugas that needed zoning protection and the degree of protection needed. This Final Supplemental Environmental Impact Statement/Final Supplemental Management Plan (FSEIS/SMP) has been prepared for the proposed Tortugas Ecological Reserve and supplements the Final Environmental Impact Statement/Final Management Plan (FEIS/MP) for the FKNMS accordingly. Much of the discussion of the Sanctuary, its resources, and its goals in this document references the FEIS/MP.

- Part I of this FSEIS/SMP establishes the need for and purpose of this action.
- Part II discusses the history of zoning in the FKNMS and how ecological reserves can be used to help achieve the objectives of the Sanctuary.
- Part III describes the area and environment that are the subject of the proposed reserve.
- Part IV examines the alternatives, including the Preferred Alternative.
- Part V describes the environmental and socio-economic consequences of each alternative.
- Part VI presents the selection of preferred boundary and regulatory alternative for the proposed ecological reserve.
- Part VII provides a draft supplemental management plan for the ecological reserve.
- Appendices provide supporting information.

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PART I: NEED FOR AND PURPOSE OF THE ACTION

The National Ocean Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA), working in cooperation with the State of Florida, the Gulf of Mexico Fishery Management Council (GMFMC), and the National Marine Fisheries Service (NMFS), proposes to establish a 151 square nm “no-take” ecological reserve to protect the critical coral reef ecosystem of the Tortugas, a remote area in the western part of the Florida Keys National Marine Sanctuary (FKNMS or Sanctuary). The reserve would consist of two sections, Tortugas North and Tortugas South, and would require an expansion of the Sanctuary boundary to protect important coral reef resources in the areas of Sherwood Forest and Riley’s Hump.

An ecological reserve in the Tortugas would preserve the richness of species and health of fish stocks in the Tortugas and throughout the Florida Keys, helping to ensure the stability of commercial and recreational fisheries. The reserve would protect important spawning areas for snapper and grouper, as well as valuable deep water habitat for other commercial species. Restrictions on vessel discharge and anchoring would protect water quality and habitat complexity. The proposed reserve’s geographical isolation would help scientists distinguish between natural and human-caused changes to the coral reef environment.

The purpose of this reserve would be to protect nationally significant coral reef resources and to protect an area that serves as a source of biodiversity for the rest of the Sanctuary as well as the southwest shelf of Florida. Establishment of the proposed reserve would include expansion of the Sanctuary boundary to ensure sensitive coral habitats lying outside the existing boundary of the Sanctuary are protected.

The FKNMS, which was designated by the Florida Keys National Marine Sanctuary and Protection Act (FKNMSPA, Pub. L. 101-605) on November 16, 1990, consists of approximately 2800 square nm (9500 square kilometers) of coastal and oceanic waters, and the submerged lands thereunder, surrounding the Florida Keys and the Tortugas. These waters contain the marine equivalent of tropical rain forests in that they support high levels of biological diversity, are fragile and easily susceptible to damage from human activities, and possess high value to human beings if properly conserved. These environments support a vibrant tourist-based economy worth over $1.2 billion per year. The final management plan (MP) for the Sanctuary was implemented by regulations that became effective on July 1, 1997. The Sanctuary's purpose is to ensure sustainable use of the Keys' marine environment by protecting Sanctuary resources while allowing uses compatible with resource protection.

The FKNMS currently contains a network of 23 no-take zones, one of which is an ecological reserve (Western Sambo Ecological Reserve). This proposal would establish a second ecological reserve to protect the nationally significant coral reef resources of the Tortugas area. This proposal is being made to further the objectives of the National Marine Sanctuaries Act (NMSA) (16 U.S.C. §§ 1431 *et seq.*) and the FKNMSPA and to meet the objectives of Executive Order 13089, Coral Reef Protection (June 11, 1998).

Since 1991, NOAA has been concerned about the need to better protect the Tortugas area. This need is documented in the Draft and Final Environmental Impact Statement (EIS)/Management Plans for the Sanctuary (DOC 1995 and 1996). In the Draft Environmental Impact Statement and Draft Management Plan (DEIS/MP), NOAA proposed a boundary for a 110 square nm Replenishment Reserve (Ecological Reserve) in the Tortugas to protect significant coral resources while minimizing or avoiding adverse impacts to users. Public comment indicated that the then-proposed boundary would not protect the most significant coral reef resources and identified serious adverse economic impacts from the then-proposed boundary and then-proposed no-take regulations. Consequently, NOAA did not establish the reserve and did not issue regulations to protect it other than the general Sanctuary-wide regulations. Instead, the Final Management Plan for the Sanctuary committed to undertaking a process in coordination with the National Park Service (NPS), which is presently revising its management plan for the Dry Tortugas National Park (DRTO), to determine which area of the Tortugas region outside of the DRTO needed marine zoning protection and to what degree.

NOAA stated that it and the NPS would use the information gathered as part of the public review of the draft MP and hold workshops with users, agency representatives, environmental organizations, and the public. NOAA stated that it and the NPS would publish another proposed boundary for the Tortugas Reserve for public comment (DOC 1996, Vol. I, p. 261).

The Sanctuary Advisory Council (SAC) in February 1998 established an *ad hoc* Working Group (WG), composed of stakeholders and government representatives including the NPS, to recommend a boundary for the reserve. After meeting five times over the course of a year, the WG came to full consensus on recommending a preferred boundary to the SAC that, in turn, recommended the same preferred boundary to NOAA and the State of Florida. The WG recommended the application of the existing ecological reserve regulations to the preferred boundary.

The Tortugas is located in the westernmost portion of the FKNMS approximately 70 miles west of Key West. It contains the healthiest coral reefs found in the Sanctuary. Coral pinnacles as high as forty feet with the highest coral cover (>30%) found in the Keys jut up from the ocean floor. These coral formations are bathed by some of the clearest and cleanest waters found in the Florida Keys. This occurs where the tropical waters of the Caribbean mingle with the more temperate waters of the Gulf of Mexico. The Tortugas is in a very strategic position oceanographically that makes it an ideal location for an ecological reserve. It is both a source (where marine life is produced) and a sink (where marine life settles) for a range of diverse marine organisms.

Despite the Tortugas' beauty and productivity, it has been exploited for decades, greatly diminishing its potential as a source of larval recruits to the downstream portion of the Florida Keys and to itself. Fish and lobster populations have been heavily fished thus threatening the integrity and natural dynamics of the ecosystem. Anchoring by freighters is destroying large areas of coral reef habitat that provide the foundation for economically important fisheries.

Visitation to the Tortugas region has increased dramatically over the past 10 years. In the DRTO, visitation increased 300% over the 14-year period between 1984 and 1998. The population of South Florida is projected to increase from the current 6.3 million people to over 12 million by 2050. With continued technological innovations such as global positioning systems (GPS), electronic fish finders, and better and faster vessels, this increase in population will translate to more pressure on the resources in the Tortugas.

By designating this area an ecological reserve, NOAA hopes to create a seascape of promise—a place where the ecosystem's full potential can be realized and a place that humans can experience, learn from and respect. This goal is consistent with Executive Order 13089 on Coral Reef Protection and the U.S. Coral Reef Task Force recommendations.

This FSEIS/SMP supplements the FEIS/MP for the Sanctuary. Further, because this proposed reserve includes a Sanctuary boundary expansion, this FSEIS/SMP is developed pursuant to section 304(a)(2) of the NMSA, 16 U.S.C. 1434(a)(2), consistent with, and in fulfillment of, the requirements of the National Environmental Policy Act (NEPA) of 1969.

Relationship to other planning efforts for the Tortugas

There are four other planning efforts underway in conjunction with the effort described in this document to ensure comprehensive protection of the unique resources of the Tortugas region.

The NPS is revising the General Management Plan for the DRTO. The NPS proposal includes a Preferred Alternative to create a Research/Natural Area (RNA) within the Park. The proposed boundary and regulations for the RNA are compatible with NOAA's proposed ecological reserve. The boundary for the proposed RNA is depicted in the maps contained in this document for the purpose of providing the public a comprehensive view of what is proposed for the region.

Under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), the Gulf of Mexico Fishery Management Council (GMFMC) has primary federal responsibility and expertise for the development of fishery management plans (FMPs) throughout the Gulf of Mexico. The GMFMC has developed an amendment for addressing Essential Fish Habitat requirements for the various Gulf of Mexico Fishery Management Plans (GMFMPs) which cover the area of the proposed Tortugas Ecological Reserve. The GMFMPs are implemented by regulations promulgated by the National Marine Fisheries Service (NMFS) (50 CFR 622). At the GMFMC's meeting on November 9, 1999, the NOS and NMFS requested that the GMFMC take steps to prohibit fishing, consistent with the purpose of the proposed ecological reserve. The GMFMC accepted this request and at its July 10-13, 2000 meeting, adopted the Generic Amendment for Addressing Essential Fish Habitat Requirements for Fishery Management Plans of the Gulf of Mexico. That amendment to the GMFMPs is consistent with the no-take Tortugas Ecological Reserve proposed by NOAA and NOAA’s regulations for ecological reserves in the FKNMS, at 15 CFR 922.164(d).

NMFS intends to issue regulations consistent with the no-take status of the Tortugas Ecological Reserve for the species covered by the GMFMPs and for Atlantic tunas, Swordfish, sharks, and Atlantic billfishes.

The State of Florida is drafting regulations to prohibit fishing in those portions of Tortugas North that lie within State waters. Sanctuary regulations implementing the reserve would not become effective in State waters until approved by the State of Florida.

Combined with the establishment of the proposed ecological reserve, these actions would result in comprehensive protection for the nationally significant coral reef habitats from shallow to deep water extending from the Park into Sanctuary and GMFMC waters.

PART II: ECOLOGICAL RESERVES AS A MANAGEMENT TOOL

An ecological reserve is a type of no-take area that has been used in the Florida Keys National Marine Sanctuary since 1997. The term “ecological reserve” is used interchangeably with “no-take zones” in this document to refer to special areas of the ocean set aside from consumptive activities. Both terms are synonymous with "marine reserves" used internationally to describe these special management areas.

No-take areas or marine reserves are increasing in popularity as tools for marine conservation and fisheries management (PDT 1990, Roberts *et al*. 1995). In the face of extreme uncertainty about the dynamics of fisheries or ecosystems even after more than 20 years of intensive management and modeling, no-take areas offer a more simplified approach for the conservation and sustainable use of marine resources (Lauck *et al.* 1998).

No-take areas are important for establishing reference or control sites from which to gauge the effect of human impacts on the ecosystem. Until 1997 there were no undisturbed sites in the Florida Keys where researchers could compare the functioning of a natural system versus a disturbed system. It is easier to effectively manage human activities when the cumulative and cascading effects of those activities can be compared to reference areas where human activities are restricted.

Appendix G of this FSEIS/SMP is a reproduction of a peer-reviewed paper on no-take reserve networks that appeared in the November 1999 issue of the American Fisheries Society's journal *Fisheries.* It summarizes the rationale and benefits of no-take areas and is reproduced here because of its relevancy to NOAA's proposal and the no-take zones in the FKNMS. The authors make a strong case for the need for no-take areas as a precautionary strategy to complement traditional fishery management practices. "Clearly, improved management approaches are required to sustain fisheries and effectively protect U.S. marine ecosystems and the goods and services they provide." (Murray *et al.* 1999). In describing increasing human threats to marine ecosystems, the authors point out that whereas plants and herbivores are generally exploited on land, top predators are generally exploited in the ocean. The removal of top predators has cascading effects on the entire ecosystem. They argue for well-designed no-take networks that take advantage of the ocean currents that move organisms and materials great distances and that "sites providing sources of larvae and eggs need to be connected hydrographically to recipient sites to ensure the maintenance of local populations" (Murray *et al.* 1999).

Because of the large size of the proposed Tortugas Ecological Reserve, it presents an unprecedented and unique opportunity in the U.S. to study the effects of this reserve, not only on the changes to *in situ* biodiversity and ecosystem functioning, but also on the effects on surrounding fishery resources through spillover of adult biomass and replenishment through larval dispersal. Other potential research opportunities are:

- Connectivity (energy transfer) and establishment of corridors between the reserve components (North and South).
- Test of the S.L.O.S.S. (Single Large Or Several Small) theory using the entire zone network in the FKNMS.
- Ecology of fish spawning aggregations.
- Benefit Cost Analysis of traditional fishery management versus marine reserves.
- Impacts of shrimp trawling on benthic communities.
- Effects on deep water (>100m) benthic and fish communities.

History and performance of no-take areas in the FKNMS

The consideration of temporal and geographic zoning to ensure protection of Sanctuary resources is mandated under Section 7(a)(2) of the FKNMSPA. No-take zoning has been used in the FKNMS since 1997 when the Nation's first network of no-take areas was implemented after a six-year planning process. Indeed, a form of marine zoning was used in the Florida Keys as early as 1935 when the Fort Jefferson National Monument was designated in the Dry Tortugas. Other forms of marine zoning in the Keys followed, including the creation of John Pennekamp Coral Reef State Park (1960), the Key Largo National Marine Sanctuary (1975) and the Looe Key National Marine Sanctuary (1981). However, all of these areas allowed some form of consumptive activities which altered their ecosystems over time.

The following are the goals and objectives for the zoning plan in the FKNMS (see zoning action plan, FEIS/MP, Vol. I, beginning on p. 255).

Goals

The goal of the zoning plan in the Final Management Plan is to protect areas representing diverse Sanctuary habitats and areas important for maintaining natural resources (*e.g.*, fishes, invertebrates) and ecosystem functions while facilitating activities compatible with resource protection. Zoning is critical to achieving the Sanctuary's primary goal of resource protection.

Objectives

To achieve these goals, the following objectives must be accomplished:

- reduce stresses from human activities by establishing areas that restrict access to especially sensitive wildlife populations and habitats;
- protect biological diversity and the quality of resources by protecting large, contiguous diverse habitats that are intended to provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic protection of marine life and to protect and preserve all habitats and species;
- minimize conflicting uses;
- protect Sanctuary resources and separate conflicting uses by establishing a number of non-consumptive zones in areas that are experiencing conflict between consumptive and non-consumptive uses and in areas that are experiencing significant population or habitat declines;
- eliminate injury to critical/sensitive habitats;
- disperse concentrated harvests of marine organisms;
- prevent heavy concentrations of uses that degrade Sanctuary resources;
- provide undisturbed monitoring sites for research activities by setting areas aside for scientific research, monitoring, and restoration; and
- provide control sites to help determine the effects of human activities on resources.

To meet these goals and objectives the following three types of marine zones were established: Ecological Reserves, Sanctuary Preservation Areas (SPA) and Special-use Areas (see Figure 1 for a map of the 23 existing no-take zones and the 27 Wildlife Management Areas located in the Sanctuary). SPAs are small no-take or restricted areas that protect specific, critical habitats such as patch reefs or bank reefs such as Looe Key. Special-use Areas are small areas set aside for scientific research and educational purposes, recovery or restoration of Sanctuary resources, monitoring, to prevent use or user conflicts, to facilitate access and use, or to promote public use and understanding of

Sanctuary resources. ERs and SPAs have the same no-take regulations. This proposal would create the Tortugas Ecological Reserve as the Sanctuary's second Ecological Reserve.

The following is the definition of ecological reserves from the FEIS/MP:

> These areas are designed to encompass large, contiguous diverse habitats. They are intended to provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic protection of marine life and to protect and preserve all habitats and species particularly those not protected by fishery management regulations. These reserves are intended to protect areas that represent the full range of diversity of resources and habitats found throughout the Sanctuary. The intent is to meet these objectives by limiting consumptive activities, while continuing to allow activities that are compatible with resource protection. This will provide the opportunity for these areas to evolve in a natural state, with a minimum of human influence. These zones will protect a limited number of areas that provide important habitat for sustaining natural resources such as fish and invertebrates.

The existing Western Sambo Ecological Reserve is 9 square nm (3000 hectares) and extends from the mean low water mark on land out to the 60 foot isobath (see map at http://www.fknms.nos.noaa.gov/research_monitoring/map.html). It is approximately 2 miles at its widest point and 6.8 miles long and encompasses a wide range of habitats including nearshore hardbottom, patch reefs, mud bottom, seagrass beds, mid-channel patch reefs, and offshore coral reefs.

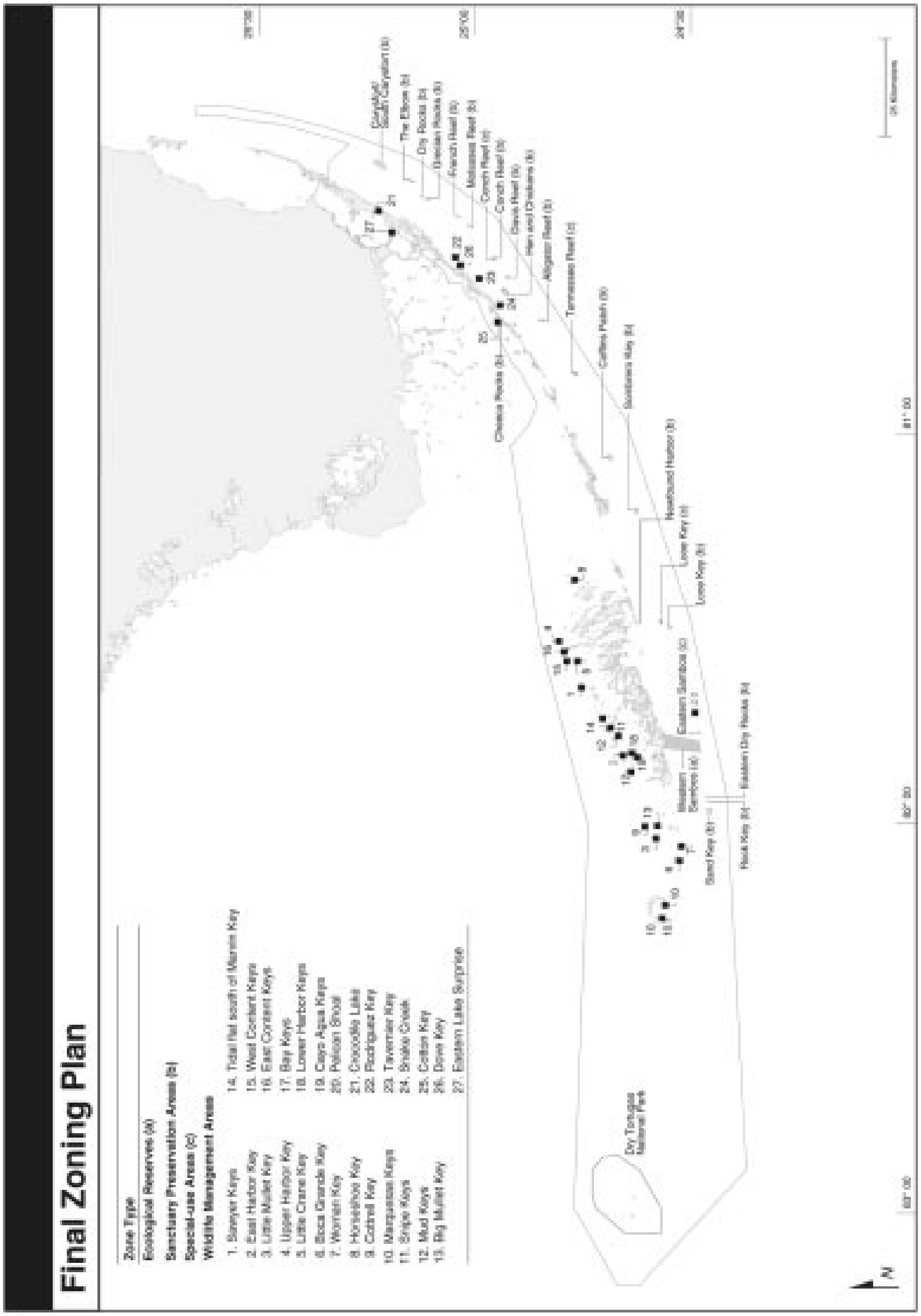
The no-take zone network in the FKNMS is the only one of its kind in the U.S. (Murray *et al.* 1999). The proposed Tortugas Ecological Reserve would be the second ecological reserve and the 24th no-take zone in the network. Given the general eastward flowing direction of the currents in the Keys, the Tortugas reserve would serve a critical role in the network by supplying larvae and biomass to downstream zones and other areas.

The objectives of the proposed Tortugas Ecological Reserve are:

- Protect ecosystem integrity.
- Protect a wide range of contiguous habitats through deep water.
- Maximize connectivity among habitats.

- Protect unique coral formations and areas of high coral cover, including Sherwood Forest.
- Provide adequate buffer areas.
- Sustain ecological and evolutionary processes.
- Protect against short and long-term environmental perturbations.
- Encompass an area that is large enough and sufficiently protected that, when combined with existing protections, maintains the Tortugas region's contribution to the Florida Keys ecosystem.
- Protect biodiversity, including the maintenance or restoration of viable populations of native species.
- Protect the full range of species.
- Protect natural spawning, nursery, and permanent residence areas, including Riley's Hump.
- Protect and enhance commercially and recreationally important fish species.
- Protect species with specific habitat requirements.
- Protect endangered, threatened, rare, or imperiled species.
- Protect areas with physical oceanographic characteristics that will enhance larval dispersal.
- Protect areas of high coral and fish diversity.
- Protect areas of high productivity.
- Protect foraging areas for seabirds and endangered sea turtle populations.
- Protect areas of high endemism.
- Enhance scientific understanding of marine ecosystems.
- Provide a reference area to monitor the effects of both consumptive and non-consumptive activities on ecosystem structure and processes.
- Provide a reference area to discriminate between human-caused and natural changes in the Florida Keys marine ecosystem.
- Facilitate human uses to the extent consistent with the other objectives.
- Minimize adverse socio-economic impacts to the extent consistent with the other objectives.
- Facilitate enforcement and compliance.

Figure 1. Existing zone network in the Florida Keys National Marine Sanctuary.



When the zoning plan became effective in July 1997, NOAA implemented a five-year zone monitoring program to determine the effect of the zones on biodiversity and human activities. This program uses a combination of academic and government scientists as well as volunteers to look at the changes in ecosystem structure (abundance and size) and function (processes such as fish grazing rates) that result from the cessation of consumptive activities. The goal of the program is to present federal and state resource managers a Zone Performance Report in 2002 that describes what effect these zones are having on biodiversity and human activities so that they may make an informed decision on the future of zoning in the FKNMS. After monitoring the zones for one year (1997-98), scientists found that the abundance of some exploited fish species and abundance and average size of spiny lobster (*Panulirus argus*) increased significantly in the zones when compared to corresponding reference sites. An online version of this report is available at http://www.fknms.nos.noaa.gov/research_monitoring/zpr98.html. The fact that these animal populations responded so quickly to the cessation of fishing is suggestive of the intense exploitation pressure they were under.

The FKNMS is the final downstream component of the South Florida Ecosystem Restoration project, a Congressionally-authorized project composed of nearly 200 environmental restoration, growth management, agricultural, and urban revitalization projects, programs, and initiatives that are designed to make South Florida more sustainable in the future. As the final downstream component, the monitoring of status and trends of Sanctuary resources both in disturbed and undisturbed areas is critical to elucidating the causes of ecosystem change and to measuring the success of the multi-billion dollar South Florida ecosystem restoration project. The proposed Tortugas Ecological Reserve is part of this restoration effort and would serve as a critical reference site for distinguishing between natural versus human-caused changes to the ecosystem.

PART III: DESCRIPTION OF THE AFFECTED ENVIRONMENT AND RESOURCE ASSESSMENT REPORT

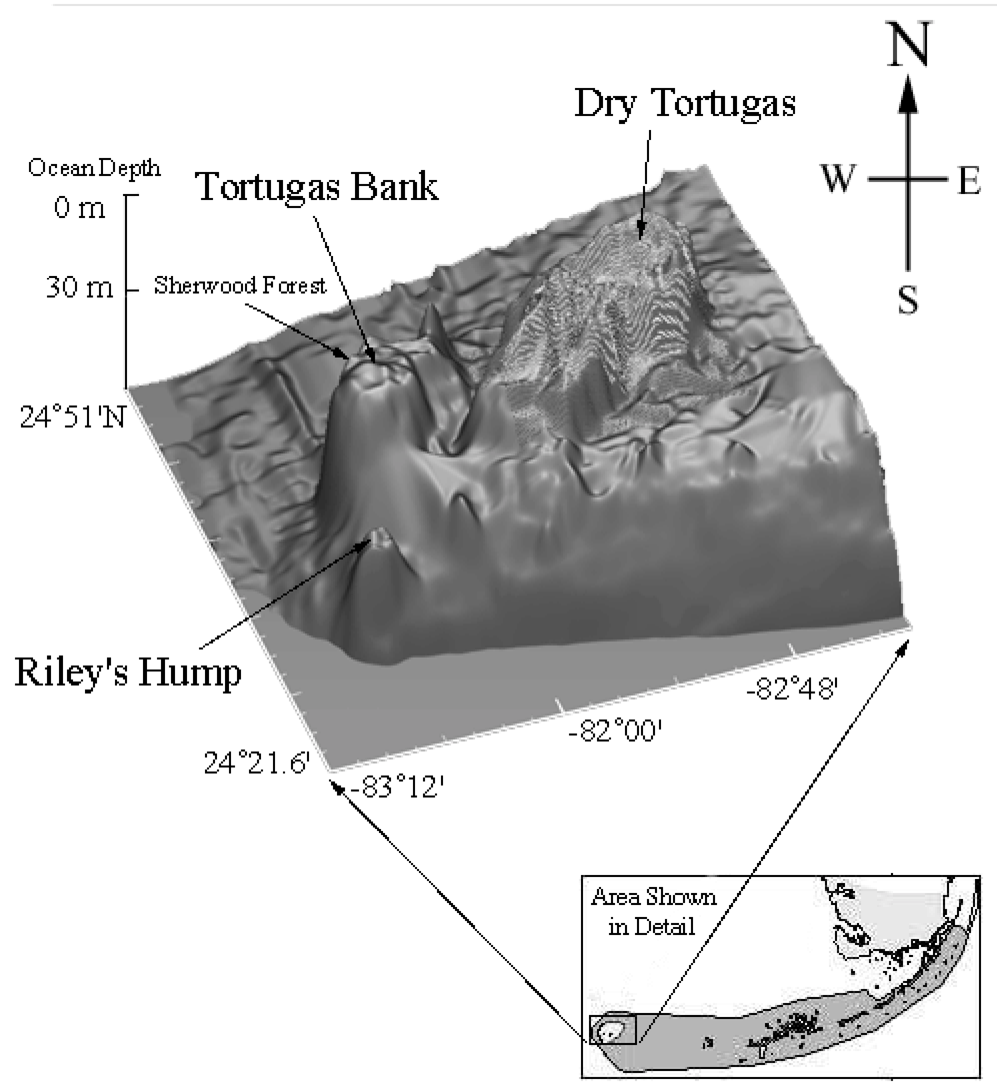
Introduction

The following section supplements the description of the affected environment of the FKNMS found in the FEIS/MP (Volume II, Section 2) with a particular focus on the Tortugas Region.

"The Tortugas, Florida, probably surpasses any other situation in the tropical Atlantic, in the richness of its marine fauna and in natural advantages for the study of tropical life . . . ." (Mayer 1903). This observation written ninety-seven years ago by one of the nation's preeminent marine biologists of the time, Alfred Goldsborough Mayer, still holds true, and is even more relevant today with the degradation of coral reef ecosystems in the Keys and around the world. The relatively clear waters and healthy coral reef resources of the region have not changed much since the days of Mayer's Tortugas Marine Lab (1904-1939) and Louis and Alexander Agassiz's Tortugas explorations in the mid- to late 1800's.

The Tortugas region refers to an approximately 480 square nm area of open ocean containing several carbonate banks, one of which is emergent with 7 small, sandy islands (Figure 2). The Tortugas is remote – located approximately 70 miles west of Key West and over 140 miles from mainland Florida. Its coral reef, hardbottom, and seagrass communities are bathed by the clearest and cleanest waters in the Florida Keys archipelago (R. Jones, pers. comm.). The area's rich biodiversity is fueled by the confluence of strong ocean currents emanating from the Gulf of Mexico and Caribbean Sea. Some of the deeper water portions of the Tortugas are afforded some protection by the FKNMS while the shallower areas and the associated islands are afforded some protection by the DRTO, which is not part of the FKNMS. The DRTO was established in 1992.

Figure 2. Map showing an exaggerated, three-dimensional rendering of the ocean floor with the location of the Dry Tortugas, Tortugas Bank, and Riley's Hump (courtesy of J. Ault, Univ. of Miami).



This section also meets the requirements of section 303(b)(3) of the NMSA which requires that the Secretary of Commerce report on any resource uses in the area under consideration that are subject to the primary jurisdiction of the Department of the Interior and report on any past, present, or proposed future disposal or discharge of materials in the vicinity of the proposed area. The area under consideration for the proposed ecological reserve is not within the jurisdiction of the Department of the Interior. However, the U.S. Fish and Wildlife Service of the Department of Interior (USFWS) commented that the Tortugas area is an important spawning site and source reef for the fish communities found in the Key West and Great White Heron National Wildlife Refuges and the avian species of the Refuges feed upon these fish. USFWS advised NOAA that protection in the Tortugas region will translate into benefits to the trust resources of the USFWS and the National Wildlife Refuge System. These Refuges are well outside the area of the subject action. In consulting with the Departments of Defense and Energy and the Environmental Protection Agency on the proposed boundary expansion, NOAA was not informed of any past, present, or proposed future discharge or disposal of materials.

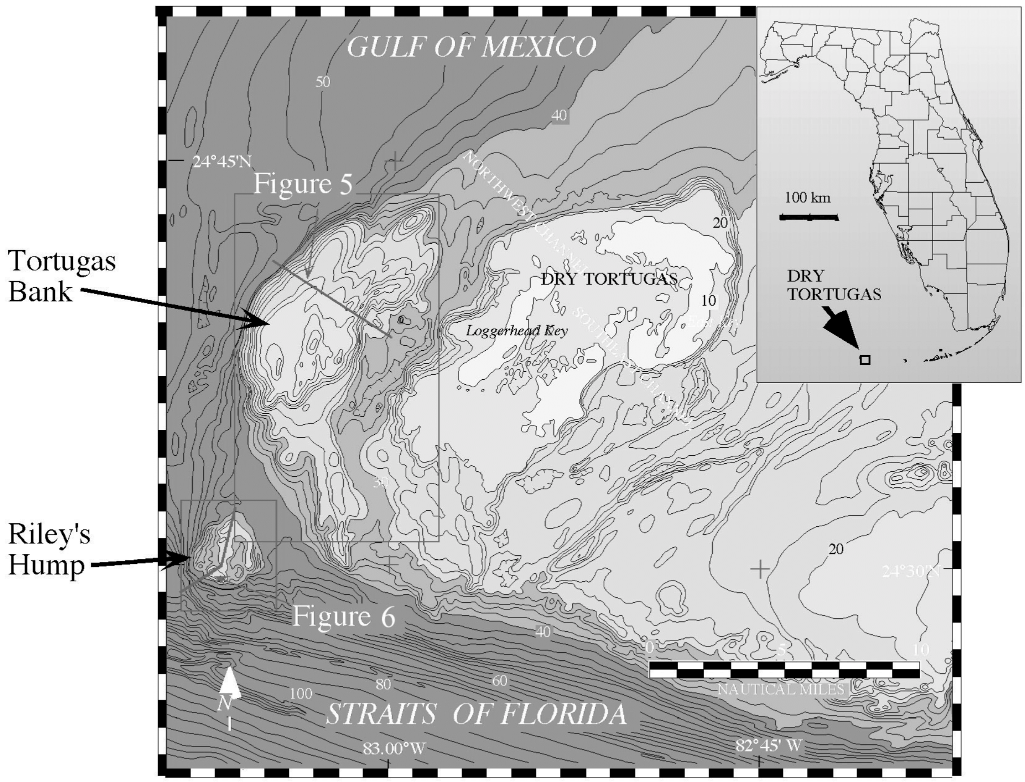
The following sections describe the physical, ecological and human use characteristics of the Tortugas region. Even though the DRTO is not part of the Sanctuary, it is included in the descriptions because it is surrounded by the FKNMS, is an inseparable part of the overall ecosystem, and is in area of the Tortugas about which the most is known. The DRTO is relevant to this proposal because it contains similar biodiversity as the proposed reserve and contains shallow water habitat that is critical to the life histories of many of the species that inhabit the proposed reserve.

A number of people contributed to the following section. Dr. David Mallinson of the University of South Florida contributed the material on geology. Dr. Tom Lee of the University of Miami contributed the material on physical oceanography. Walt Jaap (Florida Marine Research Institute), Jennifer Wheaton (Florida Marine Research Institute), G. P. Schmahl (NOAA), Dione Swanson (National Undersea Research Center), and Dr. Jim Fourqurean (Florida International University) contributed to the description of benthic communities. Drs. Jerry Ault (Univ. of Miami), Jim Bohnsack (NMFS), Tom Schmidt (NPS), and Ken Lindeman (Univ. of Miami) contributed to the description of fish and fisheries. Dr. Bob Leeworthy (NOAA), Peter Wiley (NOAA), Manoj Shivlani (Univ. of Miami) and Tom Murray (Virginia Institute of Marine Science) contributed to the description of human activities.

Geology

The Tortugas comprises a series of carbonate banks situated on the southwest Florida continental margin (Figure 3). The banks define a roughly circular pattern and were described as an atoll by Vaughan (1914). The shallow rim of the atoll is discontinuous and consists of Holocene (<10,000 years old) corals and several sandy islands including Loggerhead Key, Bush Key and Garden Key. These banks occupy a transitional zone between the south and east facing rimmed margin (to the east) and the west facing ramp margin (to the north) of the Florida Carbonate Platform.

Figure 3. Map showing the location of the Dry Tortugas, Tortugas Bank, and Riley's Hump. Also shown are the locations of the seismic profiles illustrated in Figures 4 and 5. Contours are in meters below sea level (map courtesy of Dr. Dave Mallinson, Univ. of South Florida).



The Holocene reefs which comprise the Dry Tortugas, approximately 14 meters (46 feet) thick, are composed of massive head corals such as *Montastrea sp.*, and are situated upon a topographic high of the Key Largo Limestone (~135 thousand years old during a period of warm water) (Figure 4) (Shinn *et al.* 1977). The reefs surrounding the study area represent windward reef margins in regards to their orientation relative to the dominant wind and wave energies (Hine and Mullins 1983). Tidal energy is also important in the study area with exchange occurring between the southwest Florida Shelf (Gulf of Mexico waters) to the north, and the Florida Straits to the south (Shinn *et al.* 1977). Two additional significant carbonate banks are situated in close proximity to the Dry Tortugas. These include Tortugas Bank and Riley's Hump.

Figure 4. Sea-level record based on direct indicators (coral reefs) and proxy indicators (δ^{18} O curves). Reefs of the Tortugas area may preserve a record of 5th order sea-level fluctuations (intermediate-stands) occurring between stage 5e and stage 1.

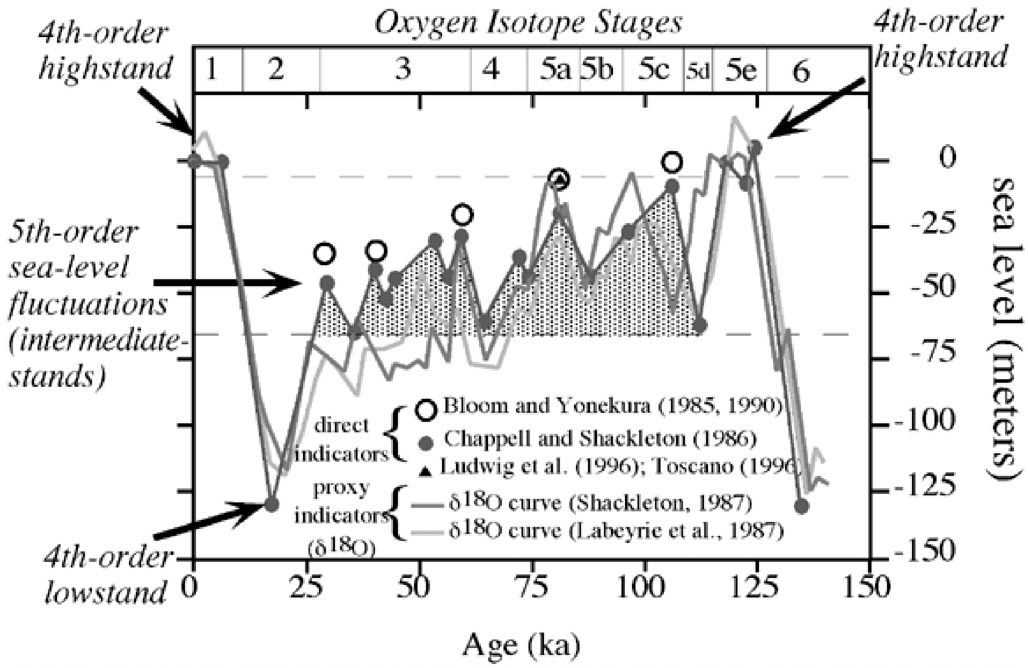


Figure 5. High resolution seismic profile across Tortugas Bank (see Figure 2 for the location). Raw data are shown at the top and an interpretation is presented below that. The acoustic signature and the morphology of this bank suggest that it is a relict coral reef. The present lack of significant coral growth on the structure, and the depth suggest that it may have formed during stage 5a (see sea-level curve inset), contemporary with the outlier reefs to the east. Several sequences are identified in the subsurface of the surrounding area and it is predicted that similar sequences occur in the reef framework.

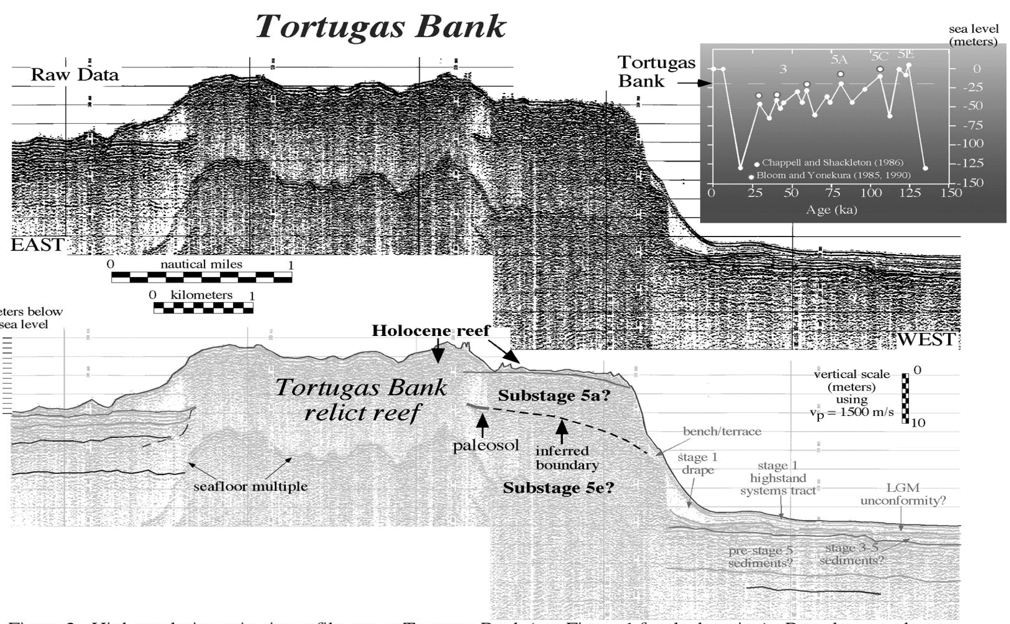


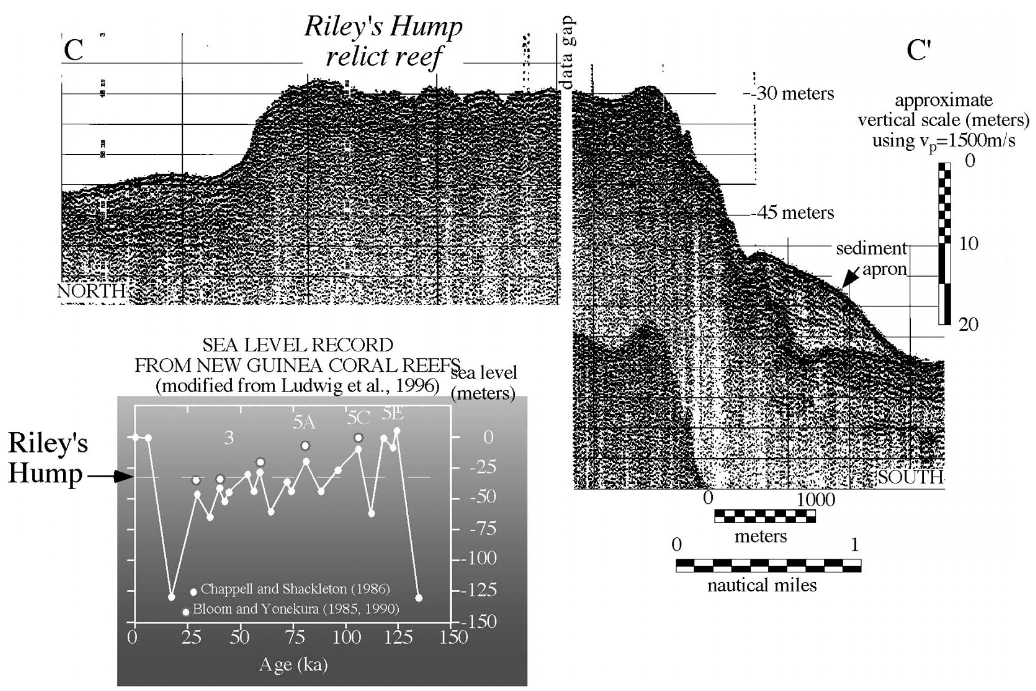
Figure 3. High resolution seismic profile across Tortugas Bank (see Figure 1 for the location). Raw data are shown at the top and an interpretation is presented below that. The acoustic signature and the morphology of this bank suggest that it is a relict coral-reef. The present lack of significant coral growth on the structure, and the depth suggest that it may have formed during stage 5a (see sea-level curve inset), contemporary with the outlier reefs to the east. Several sequences are identified in the subsurface of the surrounding area and we predict that similar sequences occur in the reef framework.

Tortugas Bank crests at approximately 20 meters, and is located directly west of the Dry Tortugas reefs (Figures 2 and 4). A northeast-southwest trending channel, ~34 meters deep and 5 km wide, separates Tortugas Bank from the Dry Tortugas reefs. Tortugas Bank has a 30 meter escarpment on the west side and a 15 meter face on the east side. Sediment aprons drape the flanks of the bank and small patch reefs occur on the top of the bank. Recent geological investigations by the University of South Florida Department of Marine Science show that Tortugas Bank consists of reef framework formed during multiple sea-level fluctuations. Uranium-series and radiocarbon dates of core material are pending. Seismic data and core data initially suggest that the bank consists dominantly of Stage 5a reef framework sediments, overlying highly altered Stage 5e reef sediments. This would indicate that Tortugas Bank was formed at the same time as the outlier reefs seaward of the Keys reef tract (Lidz *et al.* 1991; Ludwig *et al.* 1996).

Riley's Hump is a carbonate bank cresting at ~30 meters directly south-southwest of Tortugas Bank (Figures 2 and 6). The southern face of the bank exhibits a 20

meter escarpment situated at the shelf/slope break. Thick sedimentary deposits fill a trough separating Riley's Hump from Tortugas Bank to the north. Based on the position of Riley's Hump, we postulate that it may be equivalent in age to the Florida Middle Ground, possibly stage 3.

Figure 6. Seismic profile across Riley's Hump (see Figure 2 for location). The acoustic signature and morphology suggest that this structure is a relict coral reef. The depth suggests that it may have formed during stage 3 (see sea-level curve inset), perhaps contemporary with the Florida Middle Ground carbonate banks.



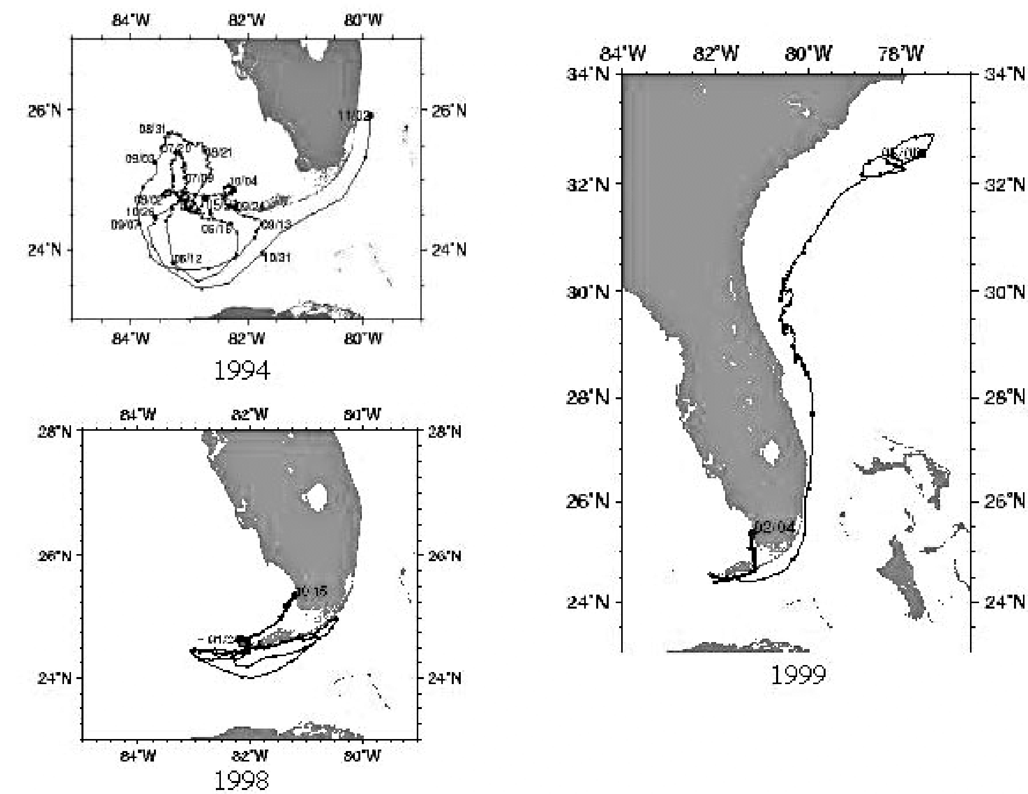
Physical oceanography and recruitment pathways

This section describes a variety of oceanographic characteristics of the Tortugas region using a synthesis of results from the literature, as well as recent and ongoing studies. Particular emphasis is placed on the influence of physical processes on larval recruitment from local and remote sources. The results presented are based primarily on the following recent and ongoing studies of the University of Miami: the South East Florida and Caribbean Recruitment study (SEFCAR); the South Florida Oil Spill Research Center study (SFOSRC); and the Florida Bay Circulation and Exchange Project of the South Florida Ecosystem Restoration Prediction and Modeling Program

(SFERPM) study. Results of a completed Minerals Management Service study of the physical oceanography of the Florida Current by Science Applications International Corporation were also of considerable use for describing the offshore conditions. For a more detailed description of the physical oceanography of the Tortugas region see Lee, *et al.* 1999.

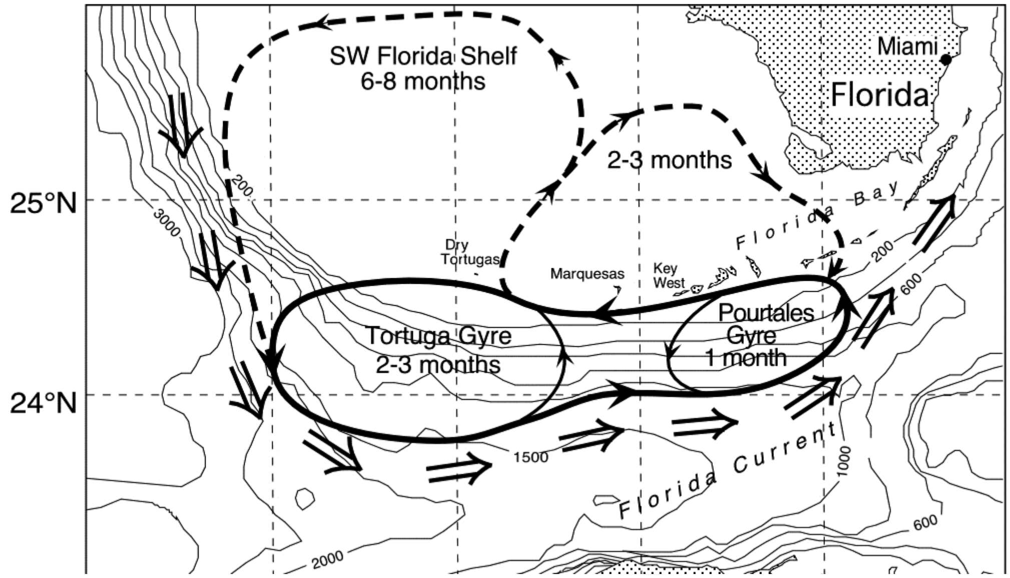
The findings show clearly that the Tortugas region is unique in its location and the extent to which oceanographic processes impact the area. But even more importantly, the Tortugas plays a dynamic role in supporting marine ecosystems throughout south Florida and the Florida Keys (Figure 7). Larvae that are spawned from adult populations in the Tortugas can be spread throughout the Keys and south and southwest Florida by a persistent system of currents and eddies that provide pathways necessary for successful recruitment (settlement) of both local and foreign spawned recruits (juveniles) with larval stages ranging from hours for some coral species up to one year for spiny lobster. In addition the upwelling and convergence of the current systems provide the necessary food supplies in concentrated frontal regions to support larval growth.

Figure 7. Examples of the tracks of several current drifters tracked by satellite showing the connectivity of the Tortugas region with the Southwest shelf of Florida and the South Atlantic region (courtesy of T. Lee/Univ. of Miami).



The Tortugas is located at the transition between the Gulf of Mexico and the Atlantic. As such, it is strongly impacted by two major current systems, the Loop Current in the eastern Gulf of Mexico and the Florida Current in the Straits of Florida, as well as by the system of eddies that form and travel along the boundary of these currents. Of particular importance to the marine communities of the Tortugas and Florida Keys is the formation of a large counter-clockwise rotating gyre (large eddy) that forms just south of the Tortugas where the Loop Current turns abruptly into the Straits of Florida (Figure 8). This gyre can persist for several months before it is forced downstream along the Keys decreasing in size and increasing in forward speed until its demise in the middle Keys. This gyre serves as a retention mechanism for local recruits, and as a pathway to inshore habitats for foreign recruits. It may also serve as a potential food provider through plankton production and concentration.

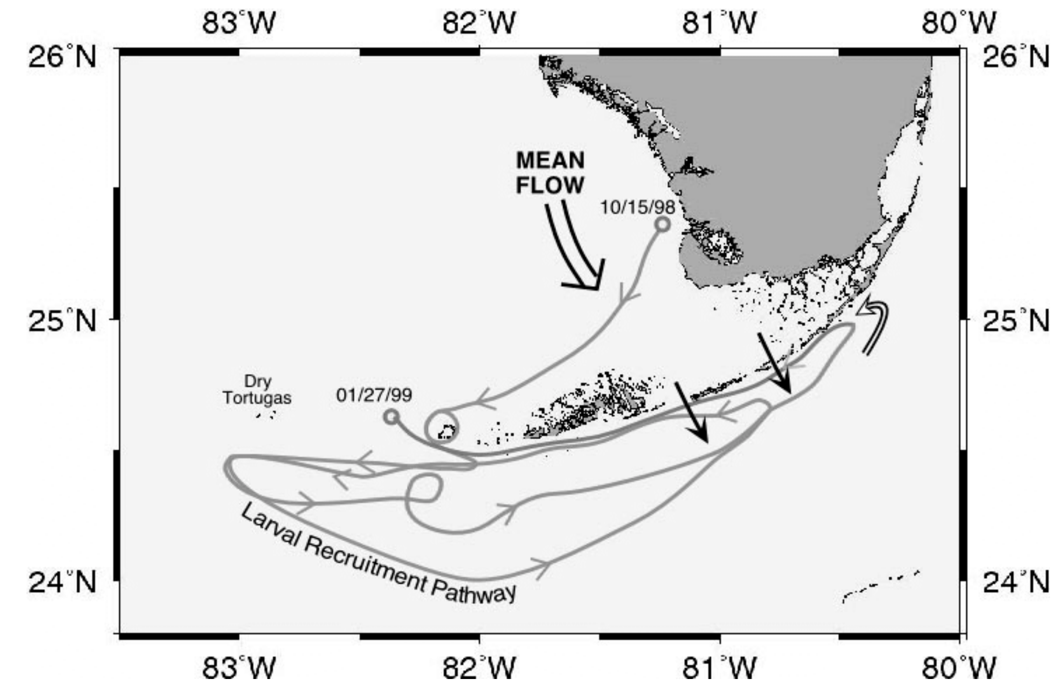
Figure 8. Schematic of potential recruitment pathways for various larvae spawned locally in the Tortugas and Florida Keys (courtesy of T. Lee/Univ. of Miami).



The Tortugas is also located adjacent to two coastal current systems, including the wind–driven currents of both the Florida Keys coastal zone and the west Florida shelf. Persistent westward winds over the Keys create a downwelling system that drives a westward coastal countercurrent which runs primarily along the lower Keys and out to the Tortugas. The countercurrent provides a return route to the Tortugas and its gyre–dominated circulation, and onshore surface Ekman transport (a process whereby wind-driven upwelling bottom water is transported ~45° to the left of the actual wind direction in the northern hemisphere) provides a mechanism for larval entry into coastal habitats. Circulation on the west Florida shelf is strongly influenced by wind forcing, but there also appears to be a significant southward mean flow, possibly due to the Loop Current. The effect of these currents on the Tortugas is to provide a larval return mechanism to the Florida Bay nursery grounds during periods of southeast winds, as well as a transport mechanism for low-salinity shelf waters from the north when the mean southward flow is strong.

The combination of downstream transport in the Florida Current, onshore Ekman transport along the downwelling coast, upstream flow in the coastal countercurrent and recirculation in the Tortugas gyre forms a recirculating recruitment pathway stretching from the Dry Tortugas to the middle Keys which enhances larval retention and recruitment into the Keys coastal waters of larvae spawned locally or foreign larvae from remote upstream areas of the Gulf of Mexico and Caribbean Sea. Convergence between the Florida Current front and coastal gyres provide a mechanism to concentrate foreign and local larvae, as well as their planktonic food supply. Onshore Ekman transport and horizontal mixing from frontal instabilities enhance export from the oceanic waters into the coastal zone. A wind- and gyre-driven coastal countercurrent provides a return leg to aid larval retention in local waters. Seasonal cycles of the winds, countercurrent and Florida Current favor recruitment to the coastal waters during the fall when the countercurrent can extend the length of the Keys from the Dry Tortugas to Key Largo, onshore Ekman transport is maximum and downstream flow in the Florida Current is minimum. The mix and variability of the different processes forming the recruitment conveyor provide ample opportunity for local recruitment of species with larval stages ranging from days to several months. For species with longer larval stages, such as the spiny lobster *Panulirus argus*, which has a 6 to 12 month larval period, a local recruitment pathway exists that utilizes retention in the Tortugas gyre and southwest Florida shelf and return via the Loop Current and the Keys conveyor system. Return from the southwest Florida shelf could also occur through western Florida Bay and the Keys coastal countercurrent, due to a net southeastward flow recently observed connecting the Gulf of Mexico to the Atlantic through the Keys (Figure 9).

Figure 9. Satellite drifter track #23113 demonstrating complexity of currents in the Florida Keys. After its release off Shark River Slough on 10/15/98, the drifter moved southwest past the Marquesas and into the countercurrent where it was transported west to the Tortugas. The drifter then got caught in the Tortugas gyre and was transported rapidly to the east where it was entrained back into the countercurrent around Long Key. After being transported all the way back to the Tortugas the drifter once again got caught in the Tortugas gyre and was carried to the Tavernier area and was again entrained in the countercurrent which carried it to the Marquesas where the batteries ran out on 1/27/99 after 3.5 months of operation. This recirculating pattern of nearsurface currents is a common occurrence in the lower and western Keys and provides a conveyor system with many opportunities for larval recruitment into the Keys from both local and remote sources and may help to explain the high species diversity and large abundance in the region. (Graphic courtesy of T. Lee, Univ. of Miami).



Benthic Habitats

The following is a description of both the benthic (seafloor) habitats found within the DRTO and the deeper water habitats found in Sanctuary waters to the west of the Park boundary.

Dry Tortugas National Park (DRTO)

The Dry Tortugas was discovered by Ponce de Leon in 1513. The area was very much a graveyard of ships (Murphy 1993). The sailing instructions in the eighteenth century warned mariners to be cautious in traversing the area (Gauld 1796). Natural history expeditions to the area in the nineteenth century include Louis and Alexander Agassiz and Louis Pourtales. The greatest contribution in documenting marine benthic resources during this era is a map of submerged habitats published by Alexander Agassiz (1882). In 1904, the Carnegie Institution established a marine laboratory on Loggerhead Key, Dry Tortugas (Mayer 1903). Under Alfred G. Mayer's direction, the Tortugas laboratory was a leading research facility studying the biology, geology, and the environmental conditions of the Dry Tortugas and adjacent area (Davenport 1926; Colin 1980). The Carnegie Institution, Washington, D.C., has published a complete set of the publications resulting from the research at the Tortugas Laboratory. Seminal coral reef work includes: Vaughan (1911, 1914, 1915, 1916); Mayer (1914 and 1918); and Wells (1932). Subsequent publications on Tortugas coral reefs include Shinn *et al.* (1977), Thompson and Schmidt (1977), Davis (1979 and 1982), Halley (1979), Dustan (1985), Jaap *et al.* (1989), Jaap and Sargent (1993). See Schmidt and Pikula (1997) for an annotated bibliography of scientific studies within the DRTO.

An excellent history of the Dry Tortugas island dynamics and status is found in Robertson (1964). As an example, Robertson reported that Bird Key was a major island with a large rookery of terns (documented by Audubon in 1832). Severe hurricanes in 1910 and 1919 destroyed the vegetation (eight foot high bay cedar) and were followed by chronic erosion of the island. By 1929 the Audubon warden abandoned his house on Bird Key and moved to Garden Key.

Current research at Dry Tortugas benefits from the historical data base, relative isolation, and from the fact that the Dry Tortugas has been a National Park with a history of protecting natural resources. Within DRTO, commercial fishing is prohibited and recreational fishing is limited to hook and line fishing for fin-fish (Florida Fishing Regulations apply). Lobster, conch, and other benthic resources have been totally protected within the park boundaries since 1992.

The physiography/bathymetry of the Dry Tortugas is complex and dynamic. The DRTO is an elliptical area with a northeast to southwest axis. The approximate dimensions are 11 nm NE to SW and 5.5 to 6 nm SE to NW (Figure 1). Depth outside the ellipse is 18 m (60 ft) or greater. The park boundaries are delineated by buoys (listed on the charts as: A, C, E, H, I, J, K, L, N, O). The park includes approximately 101 square miles (26,183 hectares), less than one percent of which is terrestrial (Davis 1982). This ellipsoid area has three major components: a crescent-shaped shoal on the east that includes East and Middle Keys; a shoal that extends from Iowa Rock in a southwestern trend for approximately 4 nm and includes Bush, Garden, and Long Keys; and a western shoal including Loggerhead Key and extending northeast to southwest approximately 5.4 nm. A relatively deep basin (12 to 20 m (40 to 67 ft)) occupies the central portion of the ellipse. Three channels to the outside-deeper waters (Southeast, Southwest, and Northwest) converge in the basin. Smaller shoal-water banks (emergent or semi-emergent at low tides) and reefs are found throughout the basin (including Hospital Key, Middle Ground, White Shoal, and Texas Rock).

A recent collaborative effort by the Florida Marine Research Institute (FMRI) and NOAA (FMRI 1998) provides a recent estimate of benthic habitats in the Dry Tortugas, and adjacent areas outside the park boundaries (Table 1).

Table 1. Estimates of benthic habitat coverage in the Tortugas. (FMRI and NOAA).

Habitat	Acres	Hectares	Percent
Total Reef	23,370	9,440	27.46
Patch Reefs	1,760	710	2.07
Bank Reefs	21,610	8,730	25.39
Hard bottom	40	20	0.06
Seagrass	10,960	4,430	12.88
Unmapped	50,710	20,490	59.60
Total	85,080	34,380	100

Algal Communities

Algal communities are the most ephemeral of the benthic communities. Davis (1982) reported that the distribution of algae was restricted to rocks or rubble in areas of high wave energy, such as the reef flats. The conspicuous genera include: *Laurencia, Dictyota*, *Sargassum, Cladophora,* and *Padina*. In deeper areas there are often abundant algae that are attached to the hard substrate or sedimentary deposits. Common genera include: *Halimeda, Avrainvillea, Penicillus, Lobophora, Udotea*. Crustose coralline algae (*Rhodophyceae*) form thin crusts typically attached to the limestone. These algae proliferate in shallow areas with high wave energy (Humm 1984) or in more protected areas exposed to intensive urchin grazing.

The benthic algae and seagrasses function as primary producers contributing biomass and oxygen to the system. The algae and seagrasses are consumed by invertebrate and vertebrate herbivores ranging from microscopic crustaceans to large sea turtles. Some animal species, such as the damselfish, lay their eggs in the algae. The life cycles of the algae are very rapid compared to sponges, corals and fish. The marine algae at Dry Tortugas include at least 377 species (Taylor 1928). Taylor found 50 species of algae within a few yards off the northwest beach of Loggerhead Key. Work to describe the marine algae at Dry Tortugas continues: Ballantine and Aponte (1995) and Ballantine (1996) described eight new species near Pulaski Shoal (northeastern DRTO). In addition to biomass and oxygen, algae such as *Halimeda* contribute significant amounts of carbonate sediments to the system.

Seagrasses

Seagrass beds are one of the most common benthic habitats in the Dry Tortugas and are found in water as deep as 30 m (100 ft) whenever there is sufficient light and unconsolidated sediment to support their root systems. Five species of seagrass have been recorded from the Dry Tortugas (Table 2).

Table 2. Seagrasses in the Dry Tortugas National Park.

Turtle grass	*Thalassia testudinum* (Banks ex Koënig)
Manatee grass	*Syringodium filiforme* (Kützing)
Shoal grass	*Halodule wrightii* (Ascherson)
Paddle grass	*Halophila decipiens* (Ostenfeld)
Star grass	*Halophila engelmannii* (Ascherson)

Seagrasses are valued for their role as nursery grounds, foraging habitat, shelter, sediment stabilization, energy attenuation, and primary production (Zieman 1982). As primary producers, energy fixed by seagrasses predominantly reaches higher trophic levels through the detritus pathway - seagrass blades die and are colonized by bacteria and fungi before being consumed by other organisms. Few animal species graze directly on living seagrass blades, but of those that do, some are quite conspicuous. Green sea turtles (*Chelonia mydas*) feed almost exclusively on seagrass, and the Dry Tortugas is an important refuge for this endangered species. In 1998, 165 green turtle nesting attempts (and 78 actual nests) were recorded in DRTO (Reardon 1998). Many other valued animals are dependent on seagrass beds during part of their life cycle, including pink shrimp (*Penaeus duorarum*), spiny lobster (*Panulirus argus*) and queen conch (*Strombus gigas*). Many predatory fishes of the reef also forage in seagrass beds and many herbivorous fishes that find shelter on coral reefs during the day feed in seagrass beds at night. Vast schools of grunts and snappers migrate off of daytime resting areas around reefs to feed at night in the seagrass beds (Robblee and Zieman 1984).

The distribution of seagrass beds is determined by exposure to air, penetration of light in the water column, availability of nutrients, suitable sandy or muddy sediments, and levels of disturbance (Zieman 1982). The Dry Tortugas lie at the western end of a nearly continuous shallow-water seagrass bed that covers over 14,000 km^2 (Fourqurean *et al.*, in press). As water quality in the park is sufficient to support seagrass growth on the bottom, the primary factor limiting the distribution of seagrasses within DRTO is the presence of suitable unconsolidated substratum. The maximum depth for *T. testudinum* is 18 m (59 ft) and a mean depth of 3 m (10 ft) from 898 randomly-sampled sites in south Florida (Fourqurean *et al.* in press). These findings indicate that deeper waters in Dry Tortugas are generally clear enough to support growth of seagrass beds.

In shallow water, *Thalassia testudinum* forms dense seagrass meadows. As depth increases, other species can coexist with *T. testudinum*. For example, as one swims down the slope of the bank north of Loggerhead Key, a dense *Thalassia* bed grades into a mixed *Thalassia*- *Syringodium* bed, then *Thalassia* drops out, and *Halodule* becomes common with the *Syringodium*. Deeper still, *Syringodium* drops out, and *Halophila engelmannii* and *Halophila decipiens* occur interspersed with *Halodule*. At 23 m (75 ft), the dominant seagrass is *Halophila decipiens*. The seagrass beds of DRTO are relatively diverse compared to other beds in south Florida. It is not uncommon to find three or four seagrass species growing in close association; and 5 species have been found in the same 0.25 m^2 area.

Sponges

The sponge (Porifera) fauna at Dry Tortugas was studied by deLaubenfels during the Carnegie Laboratory period. He described 76 species including five dredged from 1,047 m. Schmahl (1984) reported 85 sponge species within DRTO. Sponges create ecological space (niches) and are thus an important asset to the area. The numbers of species and the broad range of habitat that sponges occupy gives testament to their importance. Sponges are a source of shelter, habitat, and food for many marine organisms. They also play an important role in filtering a large volume of seawater. In the context of reefs and carbonate rock, sponges can be an important structural buttress holding the reef together. Carbonate producing sponges provide structure and demosponges provide an interstitial fabric which holds the materials together. The boring sponges are destructive to the reef, however, because they excavate coral limestone skeletons. Over time the weakened skeletons may break loose from the reef platform.

Coral Habitats

The term coral reef is a broad category used to define many habitats where massive corals are conspicuous. In other cases, the existing community is a mixture of smaller corals, octocorals, and sponges, but the underlying foundation was built in the recent past by massive corals.

The major reef types at Dry Tortugas include bank reefs, patch reefs, and thickets of staghorn coral. The once abundant elkhorn coral (*Acropora palmata*) assemblages (44 hectares by Agassiz's estimate in 1882) have virtually disappeared from the area (Davis 1982, Jaap and Sargent 1993). Since Davis published his map, some of the staghorn (*Acropora cervicornis*, *A. prolifera*) coral populations have declined due to hypothermal stress (Roberts *et al.*, 1982) and a virulent disease (Peters *et al.* 1983).

Reefs are constructed principally by the massive scleractinian (stony) coral species and acroporids. Most of the corals that are found associated with reefs in the western Atlantic and Caribbean occur at Dry Tortugas (Jaap, *et al.*, 1989).

The following is a list of fire corals and stony corals reported from Dry Tortugas based on literature and field observations (Table 3).

Table 3. Taxonomic list of fire and stony corals in the Dry Tortugas.

Phylum Cnidaria
Class Hydrozoa, (Owen, 1843)
- Order Milleporina (Hickson, 1901)
  - Family Milleporidae (Fleming, 1828)
    - *Millepora alcicornis* (Linn, 1758)
    - *Millepora complanata* (Lamarck, 1816)

Class Anthozoa (Ehrenberg, 1834)
- Order Scleractinia (Bourne, 1900)
  - Family Astrocoeniidae (Koby, 1890)
    - *Stephanocenia michelinii* (Milne, Edwards and Haime, 1848)
  - Family Pocillopridae (Gray, 1842)
    - *Madracis decactis* (Lyman, 1859)
    - *Madracis pharensis* (Heller, 1868)
    - *Madracis mirabilis* (sensu Wells 1973)
    - *Madracis formosa* (Wells, 1973)

Family Acroporidae (Verrill 1902)
Acropora cervicornis (Lamarck, 1816)
Acropora palmata (Lamarck, 1816)
Acropora prolifera (Lamarck, 1816)
Family Agariciidae (Gray, 1847)
Agaricia agaricites (Linn , 1758)
Forma *agaricites* (Linn , 1758)
Forma *purpurea* (LeSeuer, 1821)
Forma *humilis* (Verrill, 1901)
Forma *carinata* (Wells, 1973)
*Agaricia lamarck*i (Milne, Edwards and Haime, 1851)
Agaricia fragilis (Dana, 1846)
Leptoseris cucullata (Ellis and Solander, 1786)
Family Siderastreidae (Vaughan and Wells, 1943)
Siderastrea radians (Pallas, 1766)
Siderastrea siderea (Ellis and Solander, 1786)

Family Poritidae (Gray, 1842)
Porites astreoides (Lamarck, 1816)
Porites branneri (Rathbun, 1887)
Porites porites (Pallas, 1766)
Forma *porites* (Pallas, 1766)
Forma *clavaria* (Lamarck, 1816)
Forma *furcata* (Lamarck, 1816)
Forma *divaricata* (LeSueur ,1821)
Family Faviidae (Gregory, 1900)
Favia fragum (Esper, 1795)
Favia gravida (Verrill, 1868)
Diploria labyrithiformis (Linn, 1758)
Diploria clivosa (Ellis and Solander, 1786)
Diploria strigosa (Dana, 1846)
Manicina areolata (Linn , 1758)
Forma *areolata* (Linn , 1758)
Forma *mayori* (Wells, 1936)
Colpophyllia natans (Houttuyn, 1772)
Cladocora arbuscula (LeSueur, 1821)
Montastraea annularis (Ellis and Solander, 1786)
Forma *annularis* (Ellis and Solander, 1786)
Forma *faveolata* (Ellis and Solander, 1786)
Forma *franksi* (Gregory, 1895)
Montastraea cavernosa (Linn , 1767)
Solenastrea hyades (Dana, 1846)
Solenastrea bournoni (Milne, Edwards and Haime, 1849)

Family Rhizangiidae (D'Orbigny, 1851)
Astrangia soliteria (LeSueur, 1817)
Astrangia poculata (Milne, Edwards and Haime, 1848)
Phyllangia americana (Milne and Edwards, 1850)
Family Oculinidae (Gray, 1847)
Oculina diffusa (Lamarck, 1816)
Oculina robusta (Pourtales, 1871)
Family Meandrinidae
Meandrina meandrites (Linn, 1758)
Forma *meandrites* (Linn ,1758)
Forma *danai* (Milne, Edwards and Haime, 1848)
Dichocoenia stokesii (Milne, Edwards and Haime, 1848)
Dendrogyra cylindrus (Ehrenberg, 1834)
Family Mussidae (Ortmann, 1890)
Mussa angulosa (Pallas, 1766)
Scolymia lacera (Pallas, 1766)
Scolymia cubensis (Milne, Edwards and Haime, 1849)
Isophyllia sinuosa (Ellis and Solander, 1786)
Isophyllastrea rigida (Dana, 1846)
Mycetophyllia lamarckiana (Milne, Edwards and Haime, 1849)
Mycetophyllia danaana (Milne, Edwards and Haime, 1849)
Mycetophyllia ferox (Wells, 1973)
Mycetophyllia aliciae (Wells, 1973)
Family Caryophylliidae
Eusmilia fastigiata (Pallas, 1766)

Bank Reefs

The bank reef habitat occurs in an arc along the northeastern to southern margins of DRTO. This habitat includes spur and groove structures and large isolated formations with up to three meters of relief. Bird Key Reef in the southern portion of the park is a good example of this reef type. The reef is estimated to be 5,883 years old (Shinn *et al.* 1977). Three species of coral (*Montastraea annularis*, *M. cavernosa*, and *Siderastrea siderea*) were the principal frame work builders on this reef. Coral diversity, cover, and habitat complexity increased with depth. Coral cover (as determined by linear measurement) was highest in depths between 9 and 13 m. Octocorals exhibited their greatest species richness in depths less than 8 m. Thirty-three species of stony corals were inventoried at Bird Key Reef in 1975-1976.

The topographic complexity of the reef structure provides excellent refuge for both sessile and mobile organisms. Sponges, octocorals, and stony corals are conspicuous on the structures. The grooves between the structures contain sediments that are important as refuges for polycheates and crustaceans that are hidden in the sediments during the daylight hours, but are found in the waters above the reef at night.

Patch Reefs

Patch reefs are isolated accumulations of massive corals that are often surrounded by seagrass and sediments. At DRTO, patch reefs lie inside the bank reef formations in the northeast to southeast, to the south and east of Loggerhead Key, and to the west of Garden Key. The highest concentration of patch reefs is a large area southwest of Loggerhead Key (on the charts as Loggerhead Reef). These formations are isolated or in loose clusters. Well-developed patch reefs have massive colonies of *Montastraea annularis* that are several meters in diameter. A good example of this type of formation is the area due west of Loggerhead Key, commonly referred to as, "Little Africa." Isolated patch reefs off the edge of Loggerhead Key, in 15 m depths, have a circular to irregular outline and come to within 8 m of the surface. The surrounding area is seagrass, rubble and sediments. The massive corals are typically eroded around the bases with small to moderate openings that lead to the interior of the reef. These galleries provide refuge for invertebrates such as lobsters and crabs and dead areas on the massive corals are often occupied by algae (*Halimeda* and *Dictyota*), sponges, octocorals, and other stony corals (*Porites porites, Mycetophyllia spp*).

Staghorn Coral Reefs

Staghorn reefs are constructed by two species of staghorn corals (*Acropora cervicornis* and *Acropora prolifera*) that are able to rapidly monopolize a large area. Their success is partially the result of broken fragments surviving and growing into new colonies. These species have the highest growth rate of any scleractinian corals in Florida. Vaughan (1916) reported 4 cm per year, Shinn (1966) reported a rate of 10.9 cm a year and Jaap (1974) reported a growth rate of 11.5 cm per year. The large thickets of staghorn coral up to two meters high have virtually no other coral species associated with them. In the period prior to January 1977, staghorn reefs were the most commonly occurring reef in Dry Tortugas. In an area west of Loggerhead Key, huge fields of staghorn coral were typical (Davis 1977). Davis (1982) estimated staghorn reefs comprised 478 hectares of the seafloor (55.3 percent of all reef habitat). The staghorn reef community is very susceptible to perturbation from meteorological phenomena, however, and the passage of a winter cold front in January of 1977 eliminated up to 95 percent of the extant staghorn reefs (Walker 1981, Davis 1982, Porter *et al.* 1982, Roberts *et al.* 1982). The *M/V Mavro Vetranic* ship grounding near Pulaski Shoal (Tilmant *et al.* 1989) exposed a deep cross section of reef strata composed of alternating layers of staghorn corals and star and brain corals showing that, over centuries, staghorn coral reefs have been dynamic: proliferating and waning in time and space.

In 1989, Jaap *et al.* installed permanent monitoring sites east and west of Loggerhead Key. These areas had extensive staghorn coral thickets in 1975-77. As reported above, these thickets were severely impacted by hypothermic stress during the January 1977 cold front passage. These areas were sampled by a quadrat census from 1989-1991 and recorded that recovery of staghorn corals was not occurring west of Loggerhead Key. There was evidence of recruitment and growth at White Shoal (east of Loggerhead Key), particularly on the north end. Jaap *et al.* have subsequently returned to these sites (between 1991 and 1997) and examined them qualitatively. The area west of Loggerhead Key is still characterized as staghorn coral rubble covered with *Dictyota, Lobophora,* and *Halimeda* algae. The White Shoal area has extensive thickets of *Acropora cervicornis* that occupy the northeastern portions of the bank. Other areas within the DRTO have moderately large staghorn coral reefs.

Elkhorn Coral Reefs

The extant elkorn (*Acropora palmata*) assemblage at Dry Tortugas is located in front of Garden Key. It is a remnant population that survived Hurricane Georges (October 1998) and occupies approximately 800 m^2. This formerly abundant coral now is at risk of local extinction.

Octocoral Dominated Hardbottom

This was the habitat type that Davis (1982) identified as major bottom type. He reported 3,965 hectares of octocoral covered hardbottom within DRTO (4.08 percent of the seafloor in the park). The most conspicuous characteristics of the octocoral hardbottom are the abundant sea whips, sea plumes, sea fans, and the rather flat topography. Octocoral species density at a monitoring station at Pulaski Shoal was 15.50Å3.50 and 92.60Å31.74 colonies per m^2. The area is like a jungle with the bottom virtually obscured by the octocoral canopy. The octocoral hardgrounds have a rich diversity in species. The following is a list of species that are reported from Dry Tortugas. These data are based on the literature and Jennifer Wheaton's field notes (Table 4).

Table 4. Taxonomic list of octocorals observed from Dry Tortugas.

Phylum Cnidaria
Subclass Octocorallia (Haeckel, 1866)
Order Alcyonacea (Lamouroux, 1816)
Family Briareidae (Gray, 1840)
Briareum asbestinium (Pallas, 1766)
Family Anthothelidae
Iciligorgia schrammi (Duchassaing, 1870)
Erythropodium caribaeorum (Duchassaing and Michelotti, 1860)
Family Plexauridae (Gray, 1859)
Plexaura homomalla (Esper,1792)
Plexaura flexuosa (Lamouroux, 1821)
Eunicea succinea (Pallas,1766)
Eunicea calyculata (Ellis and Solander, 1786)
Eunicea laxispica (Lamarck, 1815)
Eunicea mammosa (Lamouroux, 1816)
Eunicea fusca (Duchassaing and Michelotti , 1860)
Eunicea lanciniata (Duchassaing and Michelotti, 1860)
Eunicea tourneforti (Milne, Edwards and Haime, 1857)
Eunicea knighti (Bayer, 1961)
Plexaurella dichotoma (Esper, 1791)
Plexaurella grisea (Kunze, 1916)
Plexaurella fusifera (Kunze, 1916)
Muricea elongata (Lamouroux, 1821)
Muricea laxa (Verrill, 1864)
Muricea atlantica (Kenthal, 1919)
Pseudoplexaura porosa (Houttuyn, 1772)
Pseudoplexaura flagellosa (Houttuyn, 1772)
Pseudoplexaura crucis (Bayer, 1961)
Family Gorgoniidae (Lamouroux, 1812)
Pseudopterogorgia acerosa (Pallas, 1766)
Pseudopterogorgia americana (Gmelin ,1791) (Figure 9)
Pseudopterogorgia bipinnata (Verril, 1864)
Gorgonia ventalina (Linn, 1758)
Pterogorgia anceps (Pallas, 1766)
*Pterogorgia citrin*a (Esper 1792)
Pterogorgia guadalupensis (Duchassaing and Michelin, 1846)

Sedimentary Habitats

The largest component of the Dry Tortugas sea floor is composed of sediments (silt, sand, gravel). Davis (1982) estimated that sediments were contributing 10,892 hectares (47.80%) of the benthic habitat in DRTO. If seagrasses are included (because seagrasses grow in sediments), the sediment benthic contribution in DRTO is 78 percent.

Research on Dry Tortugas sedimentary habitats is very limited. Sedimentary habitats provide niches for virtually every marine phyla and thus the biodiversity of these habitats is relatively high. Because organisms are living (for the most part) under the surface of the sediments, there is a misconception that this area is barren of life (Cahoon *et al.* 1990, Snelgrove 1999). Bacteria, diatoms, protozoa, mollusks, crustaceans, echinoderms, polycheates, gobies, and blennies are examples of higher order taxonomic categories that are found in the sediments. The sediments also function as a forage area for larger predators (Cox *et al.* 1996) and serve as a pool of geo-chemical material (calcium carbonate).

Benthic habitats outside of the DRTO

Deep Coral Banks

To the west of the DRTO in the area proposed for the ecological reserve are several deep water coral banks. In contrast to the DRTO, these deep reefs have not been well studied or mapped. Water depths surrounding the banks are 20 to 24 m (66 to 78 ft), the shallowest portions of these banks being 11 to 15 m (36 to 48 ft) deep. Diving observations reveal a complex karst-like limestone with abundant attached reef organisms (sponges, corals, octocorals).

Tortugas Bank

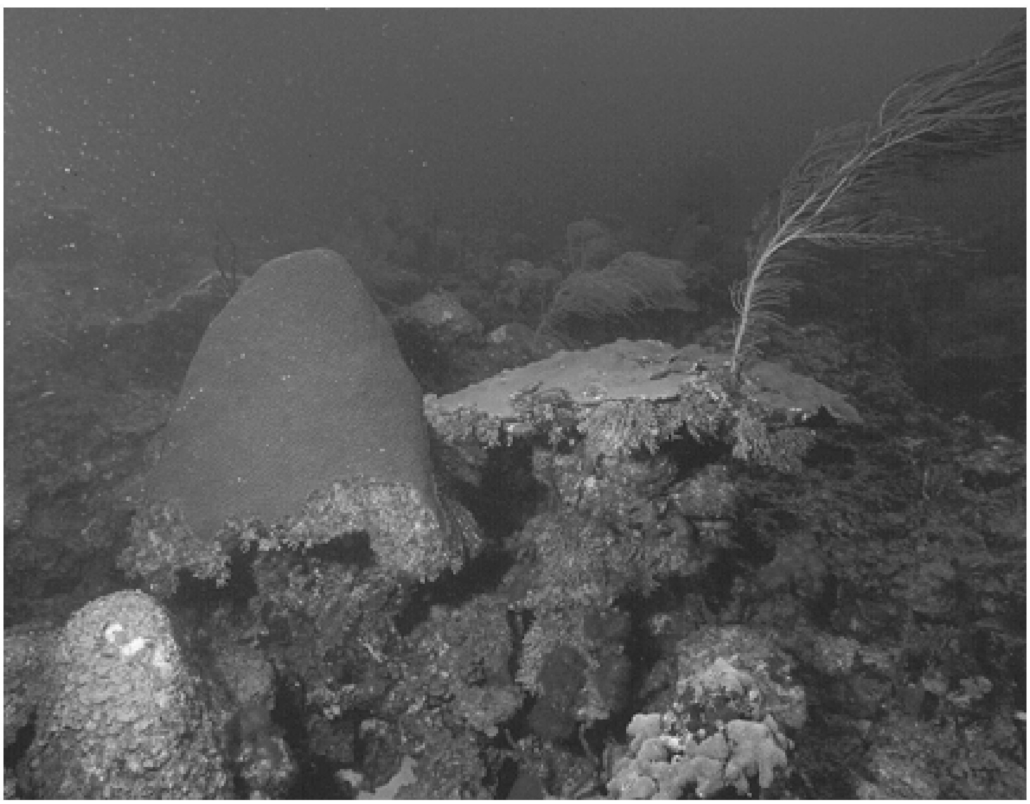
Tortugas Bank is approximately 7 nm west of Loggerhead Key; 8 Fathom Rock is located north of Tortugas Bank and approximately 5.5 nm WNW of Loggerhead Key; and Little Bank is north of 8 Fathom Rock and approximately 6.6 nm NW of Loggerhead Key. The central, western, northern, and southern portions of Tortugas Bank are characterized by low-relief hard-bottom with patches of sand and rubble at 7-23 m depth. The substratum is dominated by brown algae and gorgonians.

The southern terminus of the bank is characterized by deep sandy plains with patches of hard-bottom at 25-27 m depth. Corals found on the banks appear light starved. As depth increases, corals respond by maximizing their surface area, building pancake-like structures rather than the mounds or hemispheres characteristic of shallow water.

Sherwood Forest

Along the western flank of Tortugas Bank is an ancient coral forest exhibiting high coral cover. Coral abundance exceeds 30% bottom cover in many areas compared to an average coral cover of 10% in the rest of the Florida Keys (see Table 1). The area was dubbed "Sherwood Forest" because of the bizarre mushroom shaped coral heads that are an adaptation to the low light conditions (Figure 10). Robert Ginsburg and Phil Kramer at the University of Miami sectioned one coral mushroom head from Sherwood Forest in 1999 estimated it to be approximately 400 years old, and determined that it was a composite of two coral species (R. Ginsburg, pers. comm.). The coral reef is so well-developed it forms a veneer over the true bottom approximately 3 feet below the coral reef. This veneer is riddled with holes and caves providing ideal habitat for a high diversity of fish. Soft corals, gorgonian-forests, sponges, and black corals are also present. In other areas, such as Black Coral Rock, large relief structures protrude like mountains upward from the seafloor.

Figure 10. Typical coral formations found in Sherwood Forest; note the mushroom and plate-like formations which are adaptations to the low light conditions found on these deep reefs.



The black corals (*Antipathies spp.*) which are uncommon in Florida Keys reefs, are attached along wall faces. Black corals are a branching type of coral that have a yellow to red outer tissue layer with a solid black matrix skeleton. The skeleton has value in the manufacture of jewelry and in many areas collection pressure has made black corals rare. Black corals are listed in the Rare and Endangered Biota of Florida (Deyrup and Franz, 1994) as being extirpated (meaning no longer found in Florida). This is inaccurate: they are rare, but do occur in isolated places. They favor deep reef environments with moderate to strong currents. Black corals are listed as totally protected under the Convention on International Trade in Endangered Species (CITES). Moderate to strong currents are common on Tortugas Banks and may be one of the reasons that black corals are moderately abundant in the area. Reef corals are abundant on the deep banks and are a principal faunal and major constructional component of the reef structures. The most common corals are the *Montastraea* complex with other common genera being *Siderastrea*, *Colpophyllia*, and *Agaricia*. *Halimeda* is common and occupies the areas between the corals.

Riley's Hump

Riley’s Hump is located approximately 10 nm southwest of DRTO just outside State waters. This deep reef terrace (22-27 m in depth) is dominated by algae interspersed with coral. It is not known for spectacular coral formations, but for its richness of fish and other marine life. A small population of sargassum, or red-tailed triggerfish (*Xanthichthys ringen*s) is among the unique species found in the area. Large pelagic fish (tunas, jacks, and sharks) are common in the area as well as dolphins. Evidence suggests that this low profile reef is an aggregation or spawning site for snapper-grouper species, including gray, cubera, mutton, dog, red and yellowtail snapper, black grouper and ocean triggerfish. Under the FMP for reef fish developed by the GMFMC, Riley’s Hump is closed two months of the year to protect mutton snapper while they spawn. The deeper water habitats to the south of Riley's contain important habitat for red and goldeye snapper, tilefish, golden crab and snowy grouper. Large freighters, now prohibited from anchoring on Tortugas Bank, use Riley’s as a secure place to anchor between port visits. The several ton anchors and chains of these freighters are devastating this fragile coral reef habitat (see section below on commercial shipping). Riley's Hump lies outside the existing boundary of the FKNMS, and thus cannot be protected by the Sanctuary without a boundary modification.

Table 5. Percent cover of various benthic habitats in the Tortugas region (data courtesy of D. Swanson, Univ. of North Carolina at Wilmington).

Region	No. sites	Algal cover (%)			Sponge cover (%)			Coral cover (%)		
		Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
DRTO	10	49.1	14.4	23.0-77.5	4.5	2.9	0.3-19.5	7.6	16.0	7.3-52.8
Tortugas Bank	9	54.4	8.3	41.3-63.0	5.3	3.1	0.8-8.8	8.7	13.6	0.5-32.8
Sherwood Forest	2	67.4	5.1	63.8-71.0	5.7	0.5	5.3-6.0	19.8	8.1	14.0-25.5

Essential Fish Habitat

Essential fish habitat (EFH) is defined in the Magnuson-Stevens Fishery Conservation and Management Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. This definition is codified in NMFS' Regulations at 50 CFR 600.100. The Magnuson-Stevens Act requires the fishery management councils to describe and identify EFH, including the identification of adverse impacts from both fishing and non-fishing activities on EFH and the identification of actions required to conserve and enhance EFH. Both the South Atlantic and Gulf of Mexico Fishery Management Councils have identified hermatypic coral reefs, hardbottom, seagrass, and areas within the FKNMS as EFH and Habitat Areas of Particular Concern. The proposed Tortugas Ecological Reserve is located in an area identified as EFH in the 1998 amendment to the fishery management plans prepared by the GMFMC. The proposed reserve is also located in an area identified as EFH for adult and juvenile pink shrimp; postlarval, juvenile, and adult black and red grouper; and gray, yellowtail, mutton, and lane snappers. The SAFMC has identified spawning areas as EFH-Habitat Areas of Particular Concern (SAFMC 1998).

Fish Communities and Fisheries

This section summarizes the major findings of a report entitled, "Site characterization for the Tortugas region: Fisheries and essential habitats" by Schmidt *et al.* 1999. The report synthesized the pertinent literature and data to determine the extent and current status of key resources in the Tortugas region relevant to the condition of the broader fish communities and fisheries of the Florida Keys. The report was commissioned by the National Park Service and the FKNMS as background and baseline information for designing and evaluating the ecological reserve and assessing management needs for the DRTO. For the full report see Schmidt *et al.* 1999.

Reef Fish Biogeography, Trophic Structure, and Species Diversity

The geographic description of fishes varies over time. The distribution of each fish species being partly a product of regional oceanography, coastal geomorphology, habitat availability, and natural disturbance. The Tortugas is a region of convergence for a wide variety of tropical, subtropical, and temperate fish species. Tortugas reef fish constitute a highly diverse fauna of over 400 fish species packed into a relatively small area represented by the Tortugas region according to a long-term study by Longley and Hildebrand (1940). Many of these species are rare and some are endemic to the region such as the red-tailed triggerfish (*Xanthichthys ringens*). Researchers counted 53 species of fish on one dive in 1999 (Bohnsack, pers. comm.).

The demersal fishes of the Tortugas region can be classified into four basic types based on habitat descriptions and species distribution as discussed by Longhurst and Pauly (1987). The four categories are: (1) sciaenid assemblages (drums, croakers, groupers), (2) lutjanid assemblages (snappers), (3) active, large-eyed species adapted to clear water/high illumination (grunts, mojarra), and (4) highly evolved genera specific to reefs (*e.g.* triggerfishes, boxfishes, pufferfishes). Sciaenid assemblages occur from warm temperate turbid waters to tropical areas in the western Atlantic. Although the tropical *Sciaenid* assemblages have not been reported in Florida, the subtropical sciaenid assemblage does occur in the Florida/Tortugas area and is represented by families/species from the northern Gulf of Mexico to Cape Hatteras (Longhurst and Pauly 1987) including sciaenidae (drums/croakers), Serranidae (groupers), Clupeidae (herrings), Mullidae (goatfishes), and Gerreidae (mojarra). The lutjanid assemblage inhabits rock, coral, and coral sand habitats from Florida to Brazil and includes species from the families Lutjanidae (snapper), Serranidae (grouper), Balistidae (triggerfishes), and Haemulidae (grunts). These species are found primarily offshore from the Tortugas region northward to west central Florida. In addition to the species specific to reefs (*e.g.*, triggerfishes, trunkfishes) the Florida Keys/Tortugas Region is considered a faunal transitional zone based on the presence of one or more demersal assemblages (Schomer & Drew 1982). Starck (1968) described assemblages of fish as either insular (reef-associated species from abiotically stable environments) or continental as represented by species found over muddy bottoms or turbid waters. The merging of temperate and tropical species is also apparent in other taxa (*e.g.*, invertebrates and benthic algae) as reported in Chiappone and Sluka (1996). This unique convergence of abiotic and biotic factors provides for diverse and variable fish communities relative to the more tropical (Caribbean) and more temperate (*e.g.*, northern Gulf of Mexico) environments in the western Atlantic.

Table 6 below describes the various trophic classifications for reef fish indicating the general type of prey items they consume. Many reef fish are herbivorous bottom feeders on plants and animals and some feed mostly during the night to avoid predation.

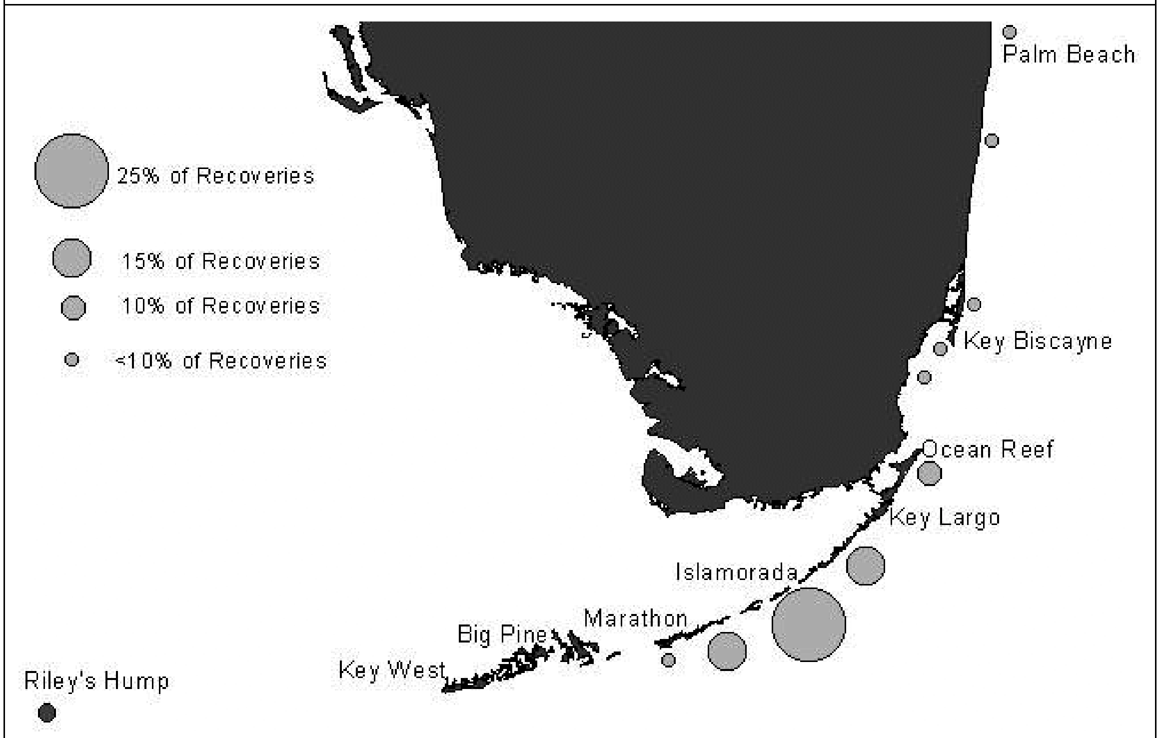
Table 6. Trophic classifications of fish in the Tortugas.

Trophic classification	Prey
Herbivores	Algae, seagrasses
Planktivores	Plankton in water column
Benthic invertivores	Invertebrates on the bottom
Benthic carnivores	Invertebrates and fish on the bottom
Pelagic carnivores	Invertebrates and fish in the water column
Corallivores	Corals
Omnivores	Everything
Detritus feeders	Dead or decaying matter

Reproduction, larval transport, and recruitment

Recruitment is defined as the addition of newborn to a stock each year. In the tropics, recruitment can occur over most of the year (Ault 1988; Ault and Fox 1990). Spawning aggregations often bring together specific conditions of biological cycles, physical oceanography and habitat. A number of spawning aggregation sites have been identified in the Tortugas region. These areas concentrate fish during the spawning season and serve as the source points for larvae that then drift advectively and then behaviorally until they become competent to metamorphose and settle to take on a benthic existence. A suite of different species occupies different spawning sites at different times. For example the snapper species, gray (*Lutjanus griseus)*, cubera *(Lutjanus cyanopterus)*, mutton *(Lutjanus analis)*, yellowtail *(Ocyurus chrysurus)*, and dog *(Lutjanus jocu)*, are all thought to use the Riley's Hump area as a spawning site (Domeier *et al.* 1996, Lindeman *et al.* in press). It is critical to protect the integrity of the spawning sites and spawners during the reproductive periods of the year, and to protect the habitats critical to the survivorship of settling juveniles.

Figure 11. Map showing the recovery locations of drifter bottles. 1000 drifters (small vials) were released on Riley's Hump on the full moon in May 1999 to coincide with the release of mutton snapper larvae. The drifters began washing ashore in the middle Florida Keys around three weeks after their release which approximates the planktonic larval duration for mutton snapper (Lutjanus analis) (Graphic courtesy of Dr. Michael Domeier, Pfleger Institute of Environmental Research. For more information see http://www.pier.org/MuttonSnapper.html).



Most tropical marine reef fishes of the Florida Keys and the Tortugas region have pelagic larvae that are dispersed by currents driven by winds, tides and bathymetry. Recruitment of juveniles into a particular habitat or environment (*e.g.*, the inshore coastal bays, nearshore barrier islands or the coral reef tract) of this region is dependent upon the nature of the water flow. Evidence of larval settlement of important reef fish species within DRTO clearly exists (Lindeman *et al.* in press). Interestingly, new evidence from physical oceanographers suggests gyre formations and diametric current reversals occur seasonally which facilitate the transport and retention of larvae to suitable settling areas (Figures 8 and 11). Migrations across the continental shelf are often necessary to connect settlement areas to spawning sites. Indeed, several spawning sites in the Tortugas region have been identified by commercial fishermen and others (Lindeman *et al.* in press). Thus the probability of successful recruitment is a function of the size of the parent stock, the number of gravid (egg-bearing) fish spawning at a particular location, and the physical environment prevalent during the period of spawning and transport. In general, the biophysical processes involved in recruitment and survivorship of the larvae and juveniles are often the most poorly understood portion of the life history of reef fishes.

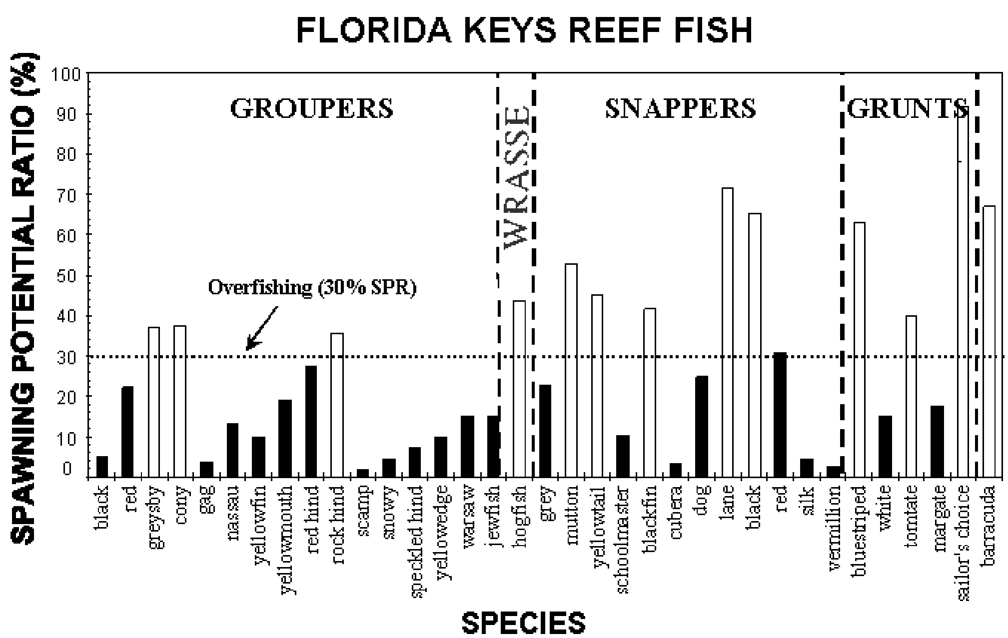
Relatively few studies of reef fishes in the Florida Keys have examined the recruitment and post-settlement of fish larvae near the Tortugas Region. Recent studies by Cha *et al.* (1994) and Limouzy-Paris *et al.* (1994) have examined the distribution and biodiversity of reef fish larvae from the Upper Florida Keys to Cosgrove Reef near the eastern boundary of Tortugas Ecological Reserve Study Area (TERSA) (Marquesas Keys). Of the 68 families of reef fishes compiled by Starck (1968) at Alligator Reef in the Middle Keys, larvae of 43 families were collected in plankton tows from May 31 to June 5, 1989 (Limouzy-Paris *et al.* 1994). Of these 43 families, the nine most common ones (most frequently occurring among stations, and in the top 10% in terms of abundance) were Paralichthyidae (flounders), Scombridae (mackerel/tunas), Gobiidae (gobies), Bregmacerotidae (codlets) Myctophidae (lanternfishes), Serranidae (seabasses), Carangidae (jacks), and Bothidae (lefteye flounders).

Status of Fishes and Fisheries

Compared to the rest of the Florida Keys, the Tortugas region appears to have more and larger fish of the key predatory species (*e.g.*, groupers, snappers, hogfish, grunts). However, throughout the Florida Keys including the Tortugas there appears to be a serious “serial overfishing” problem in which the largest, most desirable, and vulnerable species (*e.g.* Nassau grouper) are depleted first, followed by smaller, less desirable species.

Using two independent data sources on reef fish: fishery-independent diver observations and fishery-dependent charter fishing catches, Ault *et al.* (1998) showed that 13 of 16 groupers (*Epinephelus*), 7 of 12 snappers (Lutjanidae), and 2 of 5 grunts (Haemulidae) were below the 30% spawning potential ratio (SPR) federal standard (Figure 12). Some stocks appear to have been chronically overfished since the late 1970's. The Florida Keys reef fishery exhibits classic “serial overfishing.”

Figure 12. Status of the snapper-grouper complex in the Florida Keys (from Ault et al. 1998).



Black grouper was used as an example of the effects of overfishing on the fisheries resources of the Tortugas region and the Florida Keys. The net conclusion of these analyses relevant to fishermen is that the average size of black grouper caught in 1999 was 40% its historical level (*i.e.*, average of 22.5 lbs. circa 1930 versus 9 lbs. today) (Schmidt *et al.* 1999). In terms of the stability and resiliency of the black grouper population, the spawning stock biomass is estimated to now be at 5% of what it once was (Schmidt *et al.* 1999). The current rate of fishing mortality on the black grouper stock is now greater than four times the level that would be expected to produce maximum sustainable yield (Schmidt *et al.* 1999). This situation is similar for a broad segment of the economically and ecologically important reef fish stocks in the Florida Keys.

Highly Migratory Fish Species

Table 7 provides a list of migratory fish species that are very likely to be found in the Tortugas region (Ed Little, pers. comm.). Very little is known about distribution and abundance of highly migratory species in the Tortugas region, or about the region's importance to these species. However, one study discovered that the Tortugas region likely serves as a spawning ground for a variety of migratory species such as bluefin tuna.

In an analysis of the regurgitated food of sooty terns (*Sterna fuscata*) and brown noddies (*Anous stolidus*), Potthoff and Richards (1970) found 40 juvenile bluefin tuna (*Thunnus thynnus*) and other juvenile scomberids such as blackfin tuna (*Thunnus atlanticus*), bullet mackerel (*Auxis* spp.), little tuna (*Euthynnus alletteratus*), and skipjack tuna (*Katsuwonus pelamis*). Migratory species in the Tortugas region are managed under three FMPs: the FMP for Atlantic Tunas, Swordfish, and Sharks and the Atlantic Billfish FMP developed and adopted by the Secretary of Commerce through NMFS and the FMP for Coastal Migratory Pelagic Resources developed and adopted jointly by the GMFMC and South Atlantic Fishery Management Council (SAFMC). A FMP for dolphin and wahoo is under development by the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils.

Table 7. Migratory pelagic fish species likely to be found in the Tortugas region.

Group	***Species***	***Scientific name***
Swordfish	Swordfish	*Xiphias gladius*
Atlantic Billfishes	Sailfish	*Istiophorus platypterus*
	White marlin	*Terapturus albidus*
	Blue marlin	*Makaira nigricans*
	Longbill spearfish	*Terapturus pfluegeri*
Atlantic Tunas	Atlantic bluefin	*Thunnus thynnus*
	Atlantic bigeye	*Thunnus obesus*
	Atlantic yellowfin	*Thunnus albacares*
	Albacore	*Thunnus alalunga*
	Skipjack	*Katsuwonus pelamis*
	Little tunny	*Euthynnus alletteratus*
Ocean Pelagics	Wahoo	*Acanthocybium solandri*
	Dolphin	*Coryphaena hippurus*
	Bonito	*Sarda sarda*
Mackerels	King	*Scomberomorus cavalla*
	Spanish	*Scomberomorus maculatus*
	Cero	*Scomberomorus regalis*
Cobia	Cobia	*Rachycentron canadum*

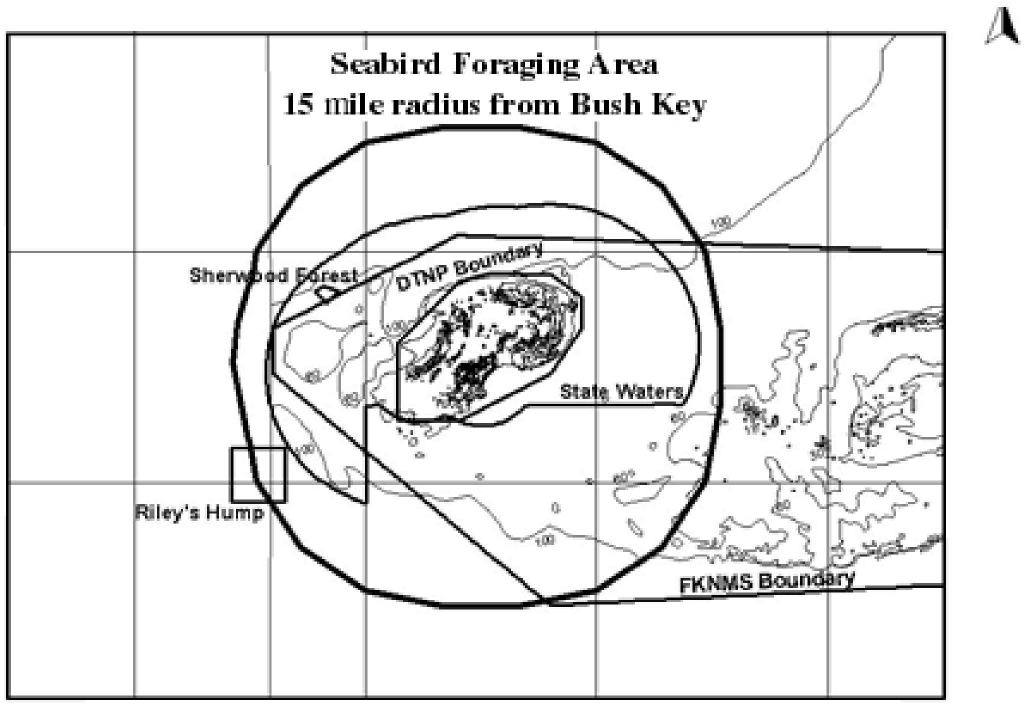
Atlantic Sharks		
Large Coastal Species		
Basking Sharks	Basking shark	*Cetorhinus maximus*
Hammerheads	Great hammerhead	*Sphyrna mokarran*
	Scalloped hammerhead	*Sphyrna lewini*
	Smooth hammerhead	*Sphyrna zygaena*
Mackerel Sharks	White shark	*Carcharadon carcharius*
Nurse Sharks	Nurse shark	*Ginglymostoma cirratum*
Requiem sharks	Bignose shark	*Carcharhinus altimus*
	Blacktip shark	*Carcharhinus limbatus*
	Bull shark	*Carcharhinus leucas*
	Caribbean Reef shark	*Carcharhinus perezi*
	Dusky shark	*Carcharhinus obscurus*
	Galapagos shark	*Carcharhinus galapagensis*
	Lemon shark	*Negaprion brevirostris*
	Narrowtooth shark	*Carcharhinus brachyurus*
	Night shark	*Carcharhinus signatus*
	Sandbar shark	*Carcharhinus plumbeus*
	Silky shark	*Carcharhinus falciformis*
	Spinner shark	*Carcharhinus brevipinna*
	Tiger shark	*Galeocerdo cuvieri*
Sand Tiger sharks	Bigeye sandtiger shark	*Odontaspis noronhai*
	Sand Tiger shark	*Odontaspis taurus*
Whale Sharks	Whale shark	*Rhinocodon typus*

Small Coastal Species		
Angel sharks	Atlantic angel shark	*Squatina dumerili*
Hammerhead sharks	Bonnethead shark	*Sphyrna tiburo*
Requiem sharks	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*
	Blacknose shark	*Carcharhinus acronotus*
	Caribbean sharpnose shark	*Rhizoprionodon porosus*
	Finetooth shark	*Carcharhinus isodon*
	Smalltail shark	*Carcharhinus porosus*
Pelagic Species		
Cow sharks	Bigeye sixgill shark	*Hexanchus vitulus*
	Sevengill shark	*Heptranchias perlo*
Mackerel sharks	Longfin mako	*Isurus paucus*
	Porbeagle shark	*Lamna nasus*
	Shortfin mako	*Isurus oxyrinchus*
Requiem sharks	Blue shark	*Prionace glauca*
	Oceanic whitetip shark	*Carcharhinus longimanus*
Thresher sharks	Bigeye thresher shark	*Alopias superciliosus*
	Thresher shark	*Alopias vulpinus*

Seabirds

The islands of the Tortugas are the only breeding ground in the continental U.S. for magnificent frigate birds (*Fregata magnificines*), sooty terns (*Sterna fuscata*), brown noddies (*Anous stolidus*), and masked boobies (*Sula dactylatra*). These seabirds rely on the clear waters of the area to see and prey on fast moving baitfish. The foraging range of the sooty tern is approximately 15 miles from Bush Key (Potterhoff and Richards 1970) (Figure 13). This sooty tern colony is the most productive in the Caribbean region (Wayne Hoffman, pers. comm.).

Figure 13. Foraging range of the sooty tern (Sterna fuscata) .



Marine reptiles and mammals

Sea Turtles

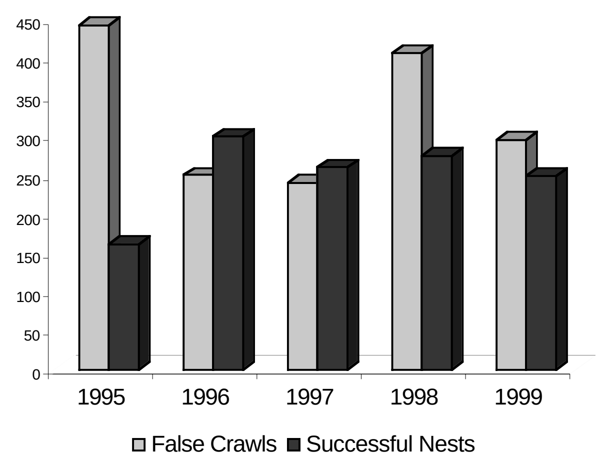
Table 8 lists the five species of marine turtles found in the Tortugas region. The Tortugas is the most productive nesting area for the green and loggerhead turtles in the entire Florida Keys. All of these species were once much more abundant, but now all are listed under the Endangered Species Act as either endangered or threatened. By the late 1800's there was a full-scale turtle fishery in Key West where one cannery was canning 200 quarts of turtle meat a day (Lott *et al.* 1996). Prior to this era of exploitation, turtles served a critical ecological role in grazing on seagrass and converting it into labile nutrients. Jackson (1997) estimated that the green turtle population in the Caribbean basin before the industrial revolution was around 660 million; now the population is in the tens of thousands. One green turtle eats roughly the same amount of turtlegrass as 500 large *Diadema* (sea urchins). The turtle is able to break down the grass into basic nutrients and distribute these over a wide area for reuse by the ecosystem (Jackson 1997). Whereas once the green turtle played a major role in structuring the Florida Keys ecosystem, both sea turtles and *Diadema* are now effectively ecologically extinct.

Table 8. Sea turtles found in the Tortugas region.

Common name	Scientific name
green	*Chelonia mydas*
loggerhead	*Caretta caretta*
Kemp's ridley	*Lepidochelys kempii*
hawksbill	*Eretmochelys imbricata*
leatherback	*Dermochelys coriacea*

The DRTO contains the largest remaining loggerhead and green turtle rookery in the Florida Keys. The Park has surveyed turtle nests and nesting activities from April through October since 1995 (Figure 14).

Figure 14. Green (Chelonia mydas) and loggerhead (Caretta caretta) turtle nesting activity in the DRTO (Data courtesy of R. Brock, NPS).



Dolphins and whales

Because of the remoteness of this region, very little is known about the dolphin and whale species that visit the area. The most common dolphins found in the area are: bottlenose dolphins (*Tursiops truncatus*), spotted dolphins (*Stenella frontalis*), offshore spotted dolphins (*Stenella attenuata*), and Risso's dolphins (*Grampus griseus*) (Laura Engleby, pers. comm.). Bottlenose dolphins are undoubtedly the most common cetacean in the area. Given the depths in the proposed Tortugas South reserve, it is likely that some of the deeper diving whales (sperm, right, and minke) can be found there. See Lott (1997) for a list of cetaceans found in the Florida Keys and environs.

Submerged Cultural Resources

While very little is known about the submerged cultural resources (SCRs) in the deeper waters surrounding the Dry Tortugas, a great deal is known about the SCRs in the DRTO. Over the past two decades the Submerged Cultural Resources Unit of the National Park Service has extensively inventoried the SCRs of the Park. For a description of the SCRs in the DRTO, please visit their web site at http://www.nps.gov/drto/scru. There is currently one Sanctuary survey and inventory permit (allows for finding and mapping SCRs) for SCRs outside the Park. This is on Tortugas Bank and is within Sanctuary waters.

Human Activities

Resource agency jurisdictions

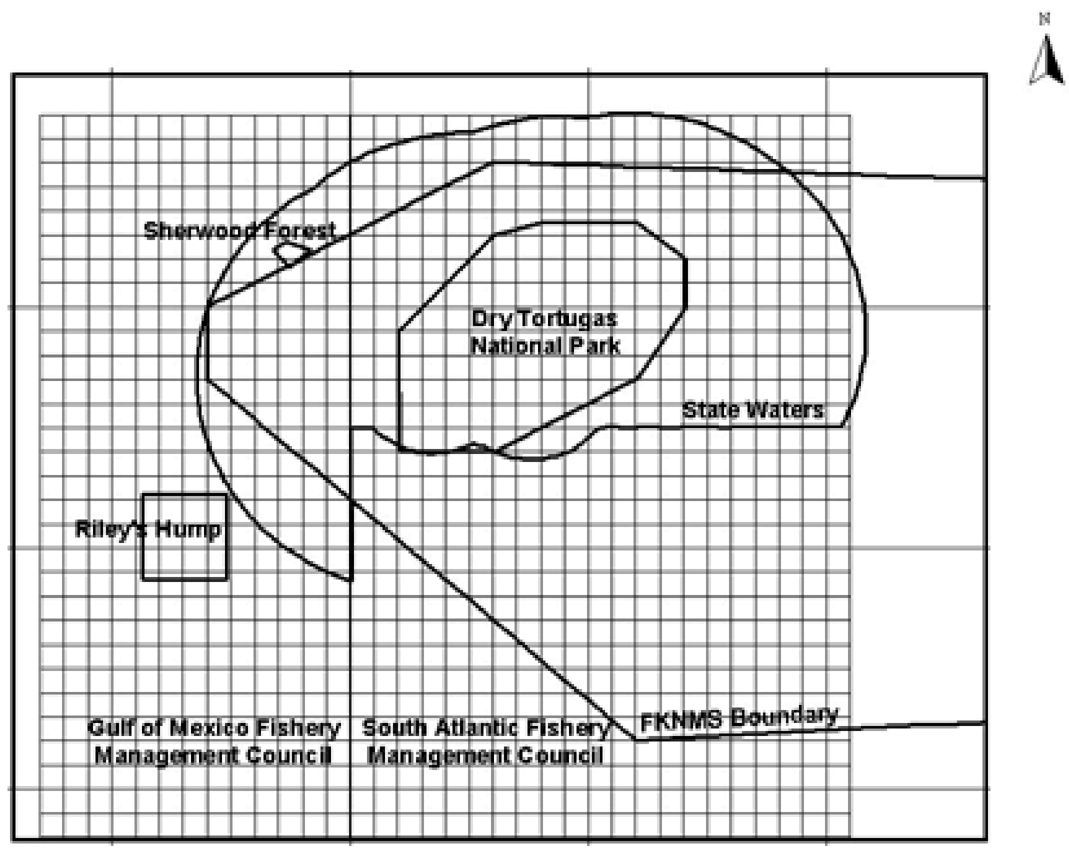
The jurisdictions of several resource management agencies converge in the Tortugas region; six of which would be affected by the proposed reserve. Referring to Figure 15 below, Table 9 lists the six resource management agencies and their responsibilities in the Tortugas region.

Table 9. Resource management agencies with jurisdiction in the Tortugas.

Agency/Responsibility
Department of Commerce/National Oceanic and Atmospheric Administration 1. National Ocean Service/Florida Keys National Marine Sanctuary – Responsible for managing and protecting natural and cultural resources within the Sanctuary. 2. National Marine Fisheries Service – Responsible for approving and implementing Gulf of Mexico Fishery Management Council FMPs for fishery resources in the Exclusive Economic Zone (EEZ) of the Gulf of Mexico, for preparing and implementing FMPs for Atlantic highly migratory species, and for protecting marine mammals and threatened and endangered species. 3. Gulf of Mexico Fishery Management Council – Responsible for preparing FMPs for fishery resources in the EEZ of the Gulf of Mexico, and for recommending fishery regulations for the Sanctuary.
Department of the Interior/National Park Service/Dry Tortugas National Park 4. Responsible for protecting and interpreting the DRTO – A pristine subtropical terrestrial and marine ecosystem, including an intact coral reef ecosystem.
State of Florida 5. Department of Environmental Protection – Co-trustee with NOAA for the management of Sanctuary resources. 6. Fish and Wildlife Conservation Commission – Responsible for managing fish and wildlife resources within state waters.

This proposed action does not directly affect the jurisdiction of the South Atlantic Fishery Management Council (SAFMC); however, the SAFMC does have jurisdiction in a portion of the Tortugas region, has an interest in the effects of the reserve, and has been consulted extensively by the FKNMS throughout the process of establishing the proposed reserve.

Figure 15. Tortugas Ecological Reserve Study Area (TERSA) showing resource agency jurisdictions and two coral banks: Sherwood Forest and Riley's Hump. The square demarcating Rileys Hump is currently closed to fishing in May and June in order to protect a mutton snapper spawning aggregation. The grid area represents the study area for the proposed reserve and was used as a framework for collecting and organizing data and designing the proposed reserve (each grid cell represents one minute by one minute of latitude or approximately one square nautical mile).



Human Uses

Recreational charter and commercial activities in the Tortugas region (excluding the DRTO) were characterized and mapped during 1998 so that the potential economic impacts of a reserve could be analyzed. Private recreational activities were not mapped. Every effort was made to contact fishing clubs in the region. During the public comment period, data on private boat usage was acquired and has been analyzed (see Figures 16 through 19).

The location and intensity of recreational charter and commercial fishing activities were determined by interviews in which the interviewee was asked to draw on a gridded map, similar to the one in Figure 15 above, where he or she fishes and dives and at what intensity. Intensity was recorded as person-days for recreational charter activities and pounds of fish caught for commercial fishing activities. The entire population of recreational charter vessel operators (12) that operate outside of the DRTO was interviewed. A sample of the commercial fishing population that fishes the Tortugas region was interviewed (90). The population of commercial fishermen (105-110) was determined by holders of saltwater-product licenses for Florida Marine Research Institute Areas 2.0 and 2.9 that fall within the study area. Figures 16-23 are the result of this data collection effort. See Part V for a detailed analysis of the economic impacts of the proposed action.

Recreational Diving and Fishing

Figure 16. Recreational charter fishing activity in the Tortugas region in 1998.

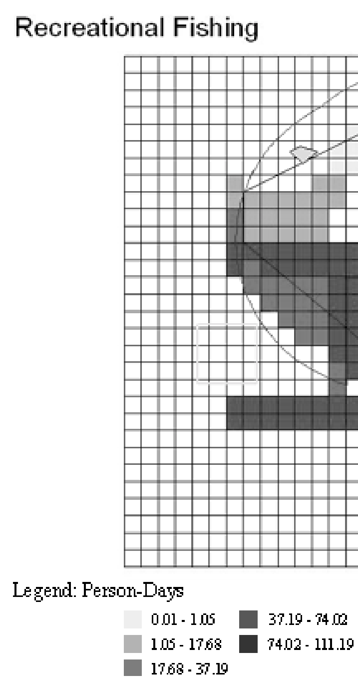


Figure 17. Recreational charter diving (non-consumptive) activity in the Tortugas region in 1998.

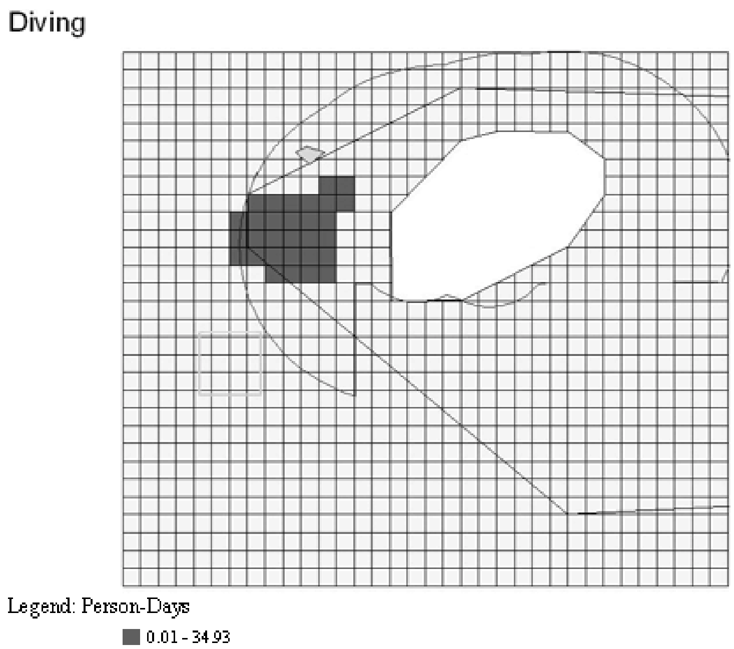


Figure 18. Recreational charter diving for lobster activity in the Tortugas region in 1998.

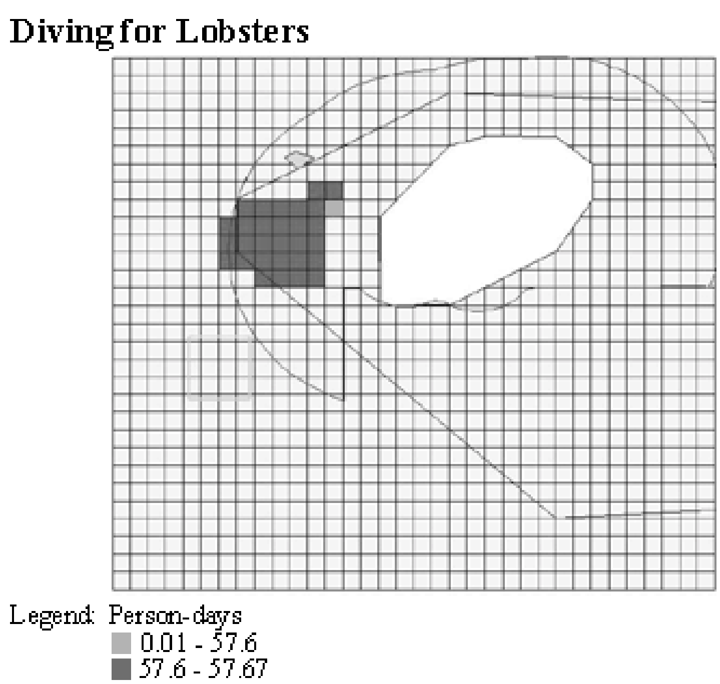
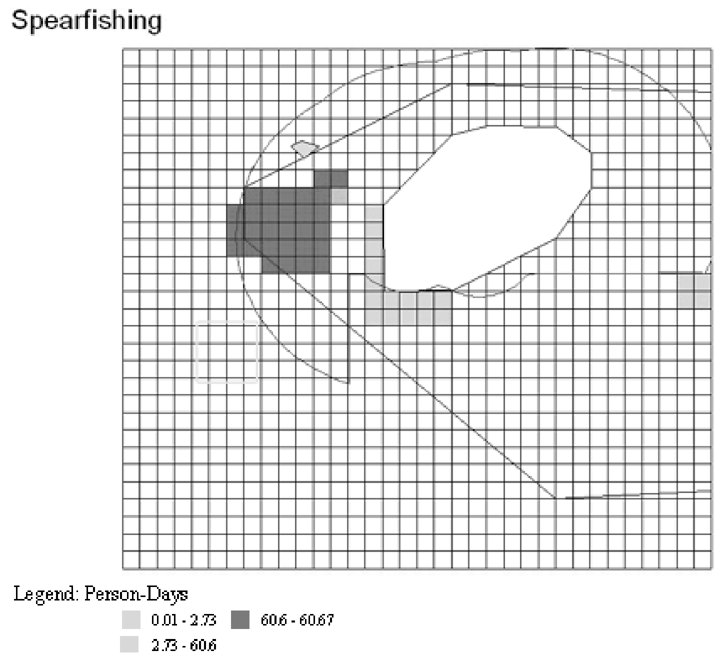


Figure 19. Recreational charter spearfishing activity in the Tortugas region in 1998.



Commercial Fisheries

Commercial fisheries of southern Florida and the Tortugas region have been described previously by Bannerot (1990), Bohnsack *et al.* (1994), and Chiappone and Sluka (1996). Analyses of commercial and recreational sector fisheries operations within the FKNMS, including the Tortugas area, were described by Bohnsack *et al.* (1994). The Tortugas region supports productive and profitable fisheries. For example, of the fish caught in the Florida Keys in 1997, the Tortugas catch (FMRI areas 2.0 and 2.9) accounted for 26% of the reef fish, 17% of spiny lobster, and 60% of pink shrimp (Leeworthy, pers. comm.).

Reef Fish

Reef fish refers to the snapper-grouper complex comprised of approximately 56 species (Figure 20). The primary means of catching reef fish are by hook-and-line, longline, and fish traps (pots). Hook-and-line fishermen are fairly effective at targeting snapper and grouper, particularly, yellowtail snapper. However, longlines and fish traps are much more indiscriminate gear types producing significant bycatch. Because of chronic problems with regulating fish trapping and lost fish traps, this gear was prohibited from State waters in 1980 and South Atlantic Fishery Management Council waters in 1990 which effectively made fish traps illegal in the Sanctuary. The GMFMC is considering phasing out fish traps from the Tortugas region in 2001. Consequently, they are still legal in the area proposed for the Tortugas South reserve.

Pink Shrimp

The Tortugas region has been the principal fishing grounds for pink shrimp, and represents one the most valuable commercial fisheries in Florida waters. Pink shrimp appear to favor sediments composed of hard- and sand-bottoms in waters between 9 and 44 m deep. The main commercial gear is double-winged trawls. Most shrimp are caught south and north of the DRTO (Figure 22). The fishery was developed in the early 1950's, and the pink shrimp fishery has grown to average annual landings of around 10 million pounds. Area closures have been the primary measures used for managing the pink shrimp population off south Florida and the Tortugas grounds. The Tortugas Shrimp Sanctuary (not to be confused with the Florida Keys National Marine Sanctuary) north of the Marquesas Keys was established in the 1960's to protect juveniles. Pink shrimp spawn year round, and juveniles settle inshore in the low salinity environments of coastal bays, tending to get larger (and mature) as they move farther from shore (Ault *et al.* 1998).

Spiny Lobster

The spiny lobster fishery is extremely productive in the Tortugas region. The main fishing method is by trapping although some diving does occur. Commercial fishing for lobster in the DRTO ended in 1935 and recreational fishing ended in 1971. Most of the lobster is landed on the south side of the DRTO (Figure 23). However, in the winter when the winds pick up, fishermen tend to move their traps to the east or west (Tortugas Bank).

In a study of lobster spawning potential throughout the Keys, Bertelsen and Hunt (1999) found some stark differences between fished and unfished populations. Lobster sizes ranged from 17 mm carapace length (CL) from a back reef area in the Upper Keys to 184 mm CL from a back reef area in the DRTO. Egg mass sizes ranged from 1.95 million eggs found in the DRTO to 0.03 million eggs found west of Key West. The average egg mass size in the DRTO was 800,000 eggs whereas it was 300,000 for the rest of the Keys (Bertelsen and Hunt 1999).

King mackerel

King mackerel is a seasonal species caught primarily in the Lower and Middle Keys. It is a multiple gear species, in that net fishermen and hook-and-line fishermen target the fish. Also, both commercial and charter fishermen target the species. In the Tortugas the catch is limited to certain hot spots which may be an artifact of the dumping of shrimp trawl bycatch such as in the area northeast of the DRTO (Figure 21).

Figure 20. Commercial handline fishing (reef fish) activity in the Tortugas region in 1998.

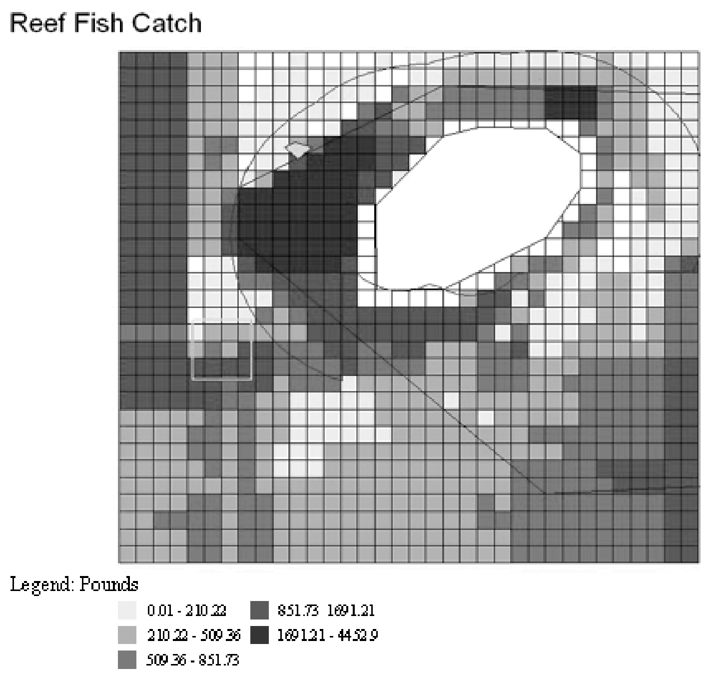


*Figure 21. Commercial handline fishing (*King mackerel*) activity in the Tortugas region in 1998*

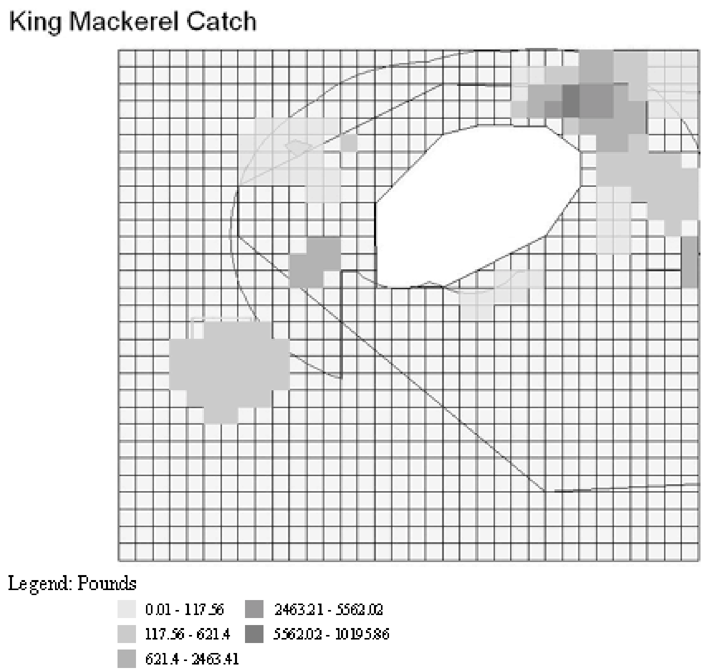


Figure 22. Commercial shrimp trawling activity in the Tortugas region in 1998

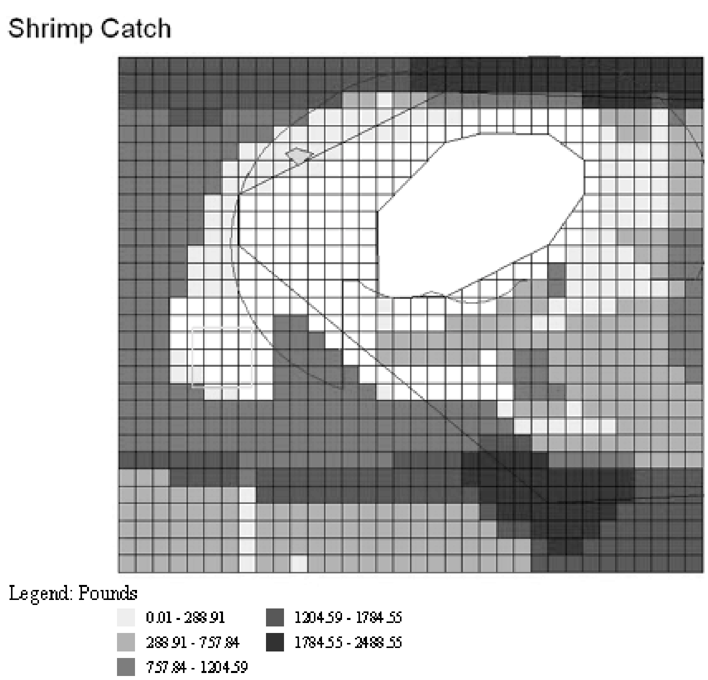
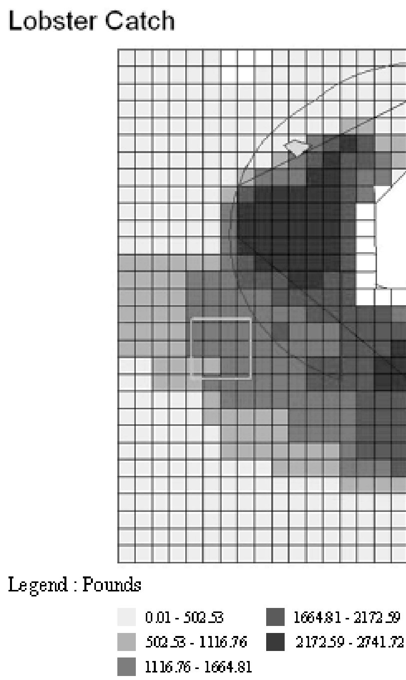


Figure 23. Commercial lobster trapping activity in the Tortugas region in 1998



Tourism

Tourism is generally confined to the DRTO. Recently, visitor utilization has increased dramatically at the Park as a result of scheduled tour boats from Key West and Ft. Myers and seaplane tours from Key West. In 1998, an estimated 72,000 people visited the park. This number is a three hundred percent increase since 1984 (NPS 1998). The resources and infrastructure at DRTO are not able to sustain a growth rate of this magnitude while at the same time maintaining the resources and providing visitors with a memorable experience. The number of live-aboard sailboats and yachts visiting Dry Tortugas has also increased in the last decade. It serves as a popular layover site for vessels going to and from Cuba and Mexico. The Tortugas is a refuge for migratory birds and is an internationally renowned birdwatching destination that annually draws over 500 people for three-day trips, with several thousand people coming on single day trips.

Commercial Shipping

The Straits of Florida have historically been the access route for all vessels entering the Gulf of Mexico from the north and east and, consequently, the area is one of the most heavily trafficked in the world. It is estimated that 40 percent of the world's commerce passes within 1.5 days' sailing time of Key West (U.S. Dept. of the Navy, 1990).

According to the Navy, over the past several years approximately 1,000-1,200 commercial ships from over 60 different countries have annually transited the area of the Florida Keys National Marine Sanctuary. Most of this traffic is composed of cargo ships (300+), tankers (300+) and bulk carriers (300+). However, there are also some 30-40 passenger ships, 8-16 tugboats, 7-12 research vessels, and several service, fishing, training, and miscellaneous vessels annually transiting this area.

Area to be Avoided

In 1990, the FKNMSPA declared an "Area to be Avoided" (ATBA) off-limits to tankers and other vessels 50 meters or greater in length in response to the region's many historical groundings. Large vessels are prohibited from operating in the ATBA located along the Florida Reef Tract, four separate portions of which account for 96 square nm of waters within and adjacent to the Sanctuary. One of the ATBAs provides a two mile wide buffer around the DRTO (Figure 25).

Anchoring

Many commercial ships going west to ports in Mexico and along the Gulf of Mexico anchor outside the ATBA in the region from Rebecca Shoal to Riley's Hump until a port has been selected for the ship's next cargo pick-up. The length of stay for ships awaiting their next cargo ranges from one day to several months. According to NOAA records, 17 ships were reported to have anchored on Tortugas Banks, Rebecca Shoal, and Riley's Hump from August 1997 to November 1999. Nearly all of these ships were foreign flagged vessels from Greece, Liberia, Panama, Russia, Monrovia, Malta, and Saudi Arabia. The 6-10 ton anchors of these ships cause extreme damage to corals and other habitats (Figure 24). In addition, the chain warp composed of 100 pound chain links causes extreme damage to natural resources as it drags across the bottom. In response to the damage to coral caused by this anchoring, NOAA issued a final rule on August 17, 1998, prohibiting anchoring by vessels 50 meters or greater in registered length on Tortugas Bank (15 C.F.R. 922.164(g); 63 FR 43870-43873) (Figure 25). It appears that the vessels that in the past anchored on Tortugas Bank now anchor in the Riley's Hump and Rebecca Shoal areas. These areas also contain coral reef habitat. Riley's Hump is not within the existing boundary of the Sanctuary.

Figure 24. Underwater photo of the anchor of the merchant vessel Lika taken by Sanctuary biologists while the vessel was anchored on Tortugas Bank on 9/30/97. Large fragments of coral are visible below and ahead of the pictured diver.

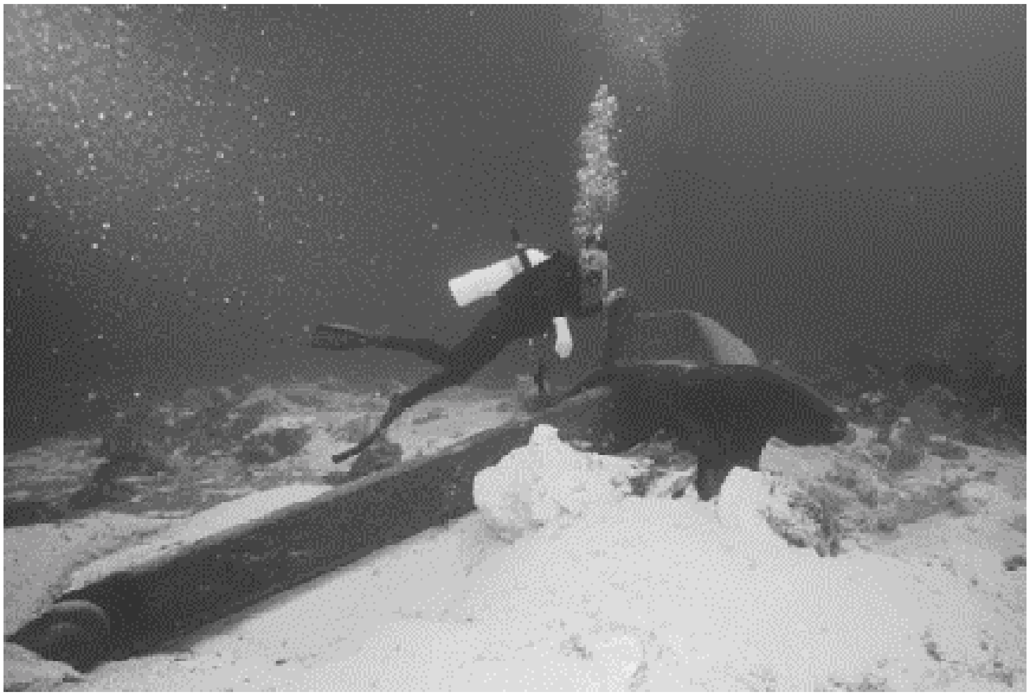
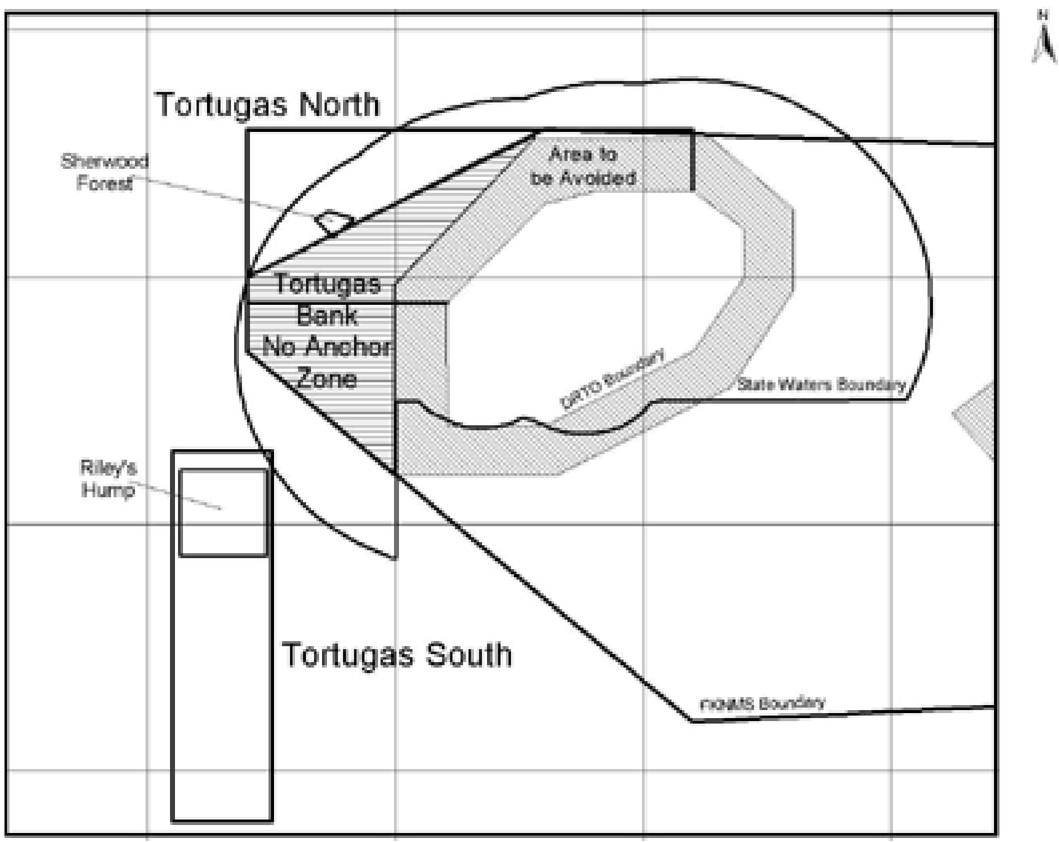


Figure 25. Graphic depicting location of Area To Be Avoided buffer surrounding the DRTO and the Tortugas Bank No Anchor Area implemented on Aug. 7, 1998 (15 C.F.R. 922.164(g)). The proposed boundary of the Tortugas Ecological Reserve (North and South), a proposed no-anchor area, is also shown.



Preferred Routes

Offshore of the Florida Keys lies the eastward flowing Gulf Stream. The mean center line of the Gulf Stream lies 65 nm south of the Dry Tortugas, and 45 nm south of Key West. Farther along the Keys, the centerline moves closer to land until it is within 20 nm of Fowey Rocks (near Miami). The northern edge of the Gulf Stream is considerably closer to land however, and is generally within 15 to 20 nm of Key West.

Ships traveling west along the Keys must stay outside of the ATBA, which is approximately 4.5 nm offshore of the coral reef tract or along the approximate 600 foot depth contour. Once past Key West, ships with destinations west of the Mississippi River to Mexico will go around the Dry Tortugas before turning north for their destinations. Ships with destinations east of the Mississippi River will travel through Rebecca Channel which separates the Dry Tortugas from the rest of the Keys (not in the ATBA) and head north. Ships traveling east usually stay in the Gulf Stream to make use of its 2.5 knot current in the vicinity of Key West.

Inside the reef, a counter current runs to the west until approximately Rebecca Channel. The current through Rebecca Channel is generally to the south. Therefore, yachts traveling to Mexico will usually travel along the Intracoastal Waterway in this counter current between the reef and land.

Pollutant Discharges

According to a report by the Department of Commerce (1985), petroleum hydrocarbon discharges from ships within 50 nm of the TERSA were greater than 50,000 gallons per year. Petroleum hydrocarbons discharged from ships under normal operating conditions in the Gulf of Mexico represented an estimated 2.5 million gallons for the year 1979. In comparison, the average amount of oil spilled 12 or more miles from shore in American waters for the years 1976-1980 was 80,000 gallons/year (U.S. DOT 1983). Operational discharges are an important source of chronic discharges into the Gulf of Mexico, contributing up to 30 times more oil than accidental spills (DOC 1985).

PART IV: ALTERNATIVES INCLUDING THE PREFERRED

Introduction to the Development of Boundary and Regulatory Alternatives

Since 1991, NOAA has been concerned about the need to better protect the Tortugas area. This need is documented in the Draft and Final Environmental Impact Statement (EIS)/Management Plans for the Sanctuary (DOC 1995, 1996). In the DEIS/MP, NOAA proposed a boundary for a 110 square nm Replenishment Reserve (Ecological Reserve) in the Tortugas area to protect significant coral resources while minimizing or avoiding adverse impacts to users. Public comment indicated that the then-proposed boundary would not protect the most significant coral reef resources and identified serious adverse economic impacts on commercial fishers from the then-proposed boundary and then-proposed no-take regulations. Accepting these comments, NOAA postponed establishing a reserve and went back to the drawing board by convening an *ad hoc* 25 member WG of the SAC, composed of key stakeholder representatives, eight SAC members, and government agency representatives with resource management authority in the Tortugas area to recommend a "Preferred Boundary Alternative" for the reserve.

One of the key stakeholders in the WG process was the NPS because of its stewardship of the DRTO, which is surrounded by but jurisdictionally separate from the FKNMS. The NPS's involvement in the design of the reserve was critical because of the important shallow water coral reef resources found within the Park and the connectivity of those resources with surrounding Sanctuary waters. Coordination with the NPS was further motivated by the fact that the Park is revising its general management plan concurrent with the design of the ecological reserve and is considering making part of the Park a no-take area.

The following is a description of the WG process.

Chronology of the Process

The process to develop the proposed ecological reserve can be described in three phases. The design phase (Phase I) took place from April 1998 to June 1999 and culminated with the SAC's recommendation and NOAA's acceptance of a preferred boundary. Phase II has been the development of the SEIS/MP and solicitation of public comments on them. Phase III is the completion of the Final Supplemental Environmental

Impact Statement/Final Supplemental Management Plan (FSEIS/SMP), including responding to public comments.

At the core of this planning process was the 25-member WG composed of stakeholder representatives, eight SAC members, and government agency representatives with resource management authority in the Tortugas area (see Appendix D for membership list). The WG's charge was as follows:

> Using the best available information, the Tortugas 2000 Working Group will collaborate in seeking to reach agreement on a recommendation to the State of Florida and the Sanctuary Advisory Council regarding a preferred alternative for an ecological reserve in the Tortugas area. The Working Group will develop criteria for evaluating a range of alternatives regarding location, size, and regulations that are consistent with the objectives for "Ecological Reserves" that were defined in the Florida Keys National Marine Sanctuary's Final Management Plan.

Over a 13 month period, the WG met five times in Key West (Table 10) and built up a knowledge base on the Tortugas region using scientific information provided by Sanctuary staff and experts, personal knowledge, knowledge passed on by their constituents, and anecdotal information (Table 11). To inform the WG of the resources and human uses of the area, two forums were held; one on ecological aspects of the region and one on socio-economic uses. Scientists and knowledgeable local residents were invited to present their information to the WG (see http://www.fknms.nos.noaa.gov/tortugas for agenda and summaries of forums). All of the WG meetings were facilitated to ensure timely discussion of relevant issues and help build consensus.

Table 10. Working Group Meetings.

Date	**Purpose**
April 1998 (2 days)	Ecological Forum and setting ground rules for group process
June 1998 (1 day)	Socio-economic Forum
February 1999 (2 days)	Criteria development
April 1999 (2 days)	Boundary alternative development
May 1999 (1 day)	Selection of Preferred Alternative

Table 11. Information provided to Working Group.

Date	Information provided
May 1998	Summary of April meeting
June 1998	Tortugas web site available online
July 1998	Summary of June meeting
September 1998	Summaries of Ecological and socio-economic fora
January 1999	Resource binder containing ecological site characterization, newspaper articles, and other relevant information
March 1999	Summary of the February meeting
April 1999	Site characterization maps of ecology and uses with overlays for drafting alternative
May 1999	12 draft alternatives developed at April meeting

The Tortugas 2000 web site (www.fknms.nos.noaa.gov/tortugas) was a critical tool for disseminating information and was constantly updated as the process evolved and products were produced.

Site Characterization and Geographic Information Systems

The NOS and NPS commissioned an ecological site characterization document composed of three chapters. Chapter One covered physical oceanography and recruitment and was completed by Dr. Tom Lee of the University of Miami. Chapter Two dealt with fish and fisheries and was completed by Dr. Jerry Ault of the University of Miami and colleagues Dr. Jim Bohnsack of NMFS and Dr. Tom Schmidt of Everglades National Park. Chapter Three was on benthic communities and was completed by Walt Jaap and Jennifer Wheaton of the Florida Marine Research Institute. The information contained in these analyses was used to inform the WG of the resources and uniqueness of the Tortugas region and the data were used to create geographic information system (GIS) maps of the resources.

In addition to the ecological information, socio-economic data were gathered from the commercial and recreational users of the area. This was an unprecedented data collection effort spearheaded by Dr. Vernon R. (Bob) Leeworthy of NOAA. His contractors first determined that approximately 105-110 commercial fishermen used the area. They then collected information on catch, costs, and trips from 90 of the fishermen. These 90 fishermen caught over 90% of the total harvest from the Tortugas. The entire population of recreational charter users was interviewed and data on trips and costs were obtained. Through the help of the Florida Marine Research Institute, the commercial and recreational data were input into a GIS format and maps were produced showing intensity of use.

A critical aspect of this GIS data was the creation of maps at a consistent scale using the same grid cell framework so comparisons could be made between maps. The study area was partitioned into one minute by one minute (approximately one square nautical mile) grid cells which facilitated the collection and analysis of data and the creation of boundary alternatives.

Building Consensus

In February 1999, the WG developed criteria for the ecological reserve that addressed ecological and socio-economic concerns (Table 12).

Table 12. Ecological Reserve criteria developed at the February 1999 WG meeting.

Criteria	Objective
Biodiversity and habitat	Try to choose an area that would contain the greatest level of biological diversity and widest range of contiguous habitats.
Fisheries sustainability	Try to choose an area that would provide the greatest benefit in protecting and enhancing commercially and recreationally important fish species, especially those that are rare, threatened, or depleted.
• Spawning areas	Try to choose an area that would include significant fish spawning aggregation sites.
• Full life cycles	Try to choose an area that would encompass all the habitats required to support the full life cycle of commercially and recreationally important fish.
Sufficient size	Try to choose a boundary that would encompass an area that is large enough to meet the criteria listed above and to achieve the potential benefits and goals of an ecological reserve.
Allowable activities	Try to allow only those activities in the Ecological Reserve that would be compatible with achieving its goals.
Socio-economic impacts	Try to choose an area and craft recommendations that would serve to minimize adverse socio-economic impacts on established users of resources in the area.
Reference area/monitoring	Try to choose an area that would serve as a reference or control area to facilitate the monitoring of anthropogenic impacts and to evaluate the consequences of establishing the Ecological Reserve.
Enforcement/compliance	Try to choose a boundary and craft regulations that would facilitate enforcement and encourage compliance.

On April 7, 1999, a packet of GIS maps was sent to the WG. Each WG member was instructed to overlay the grid cell transparency on each map and develop his or her own map of critical concerns. From this map, each member could formulate a draft alternative and bring it to the April meeting.

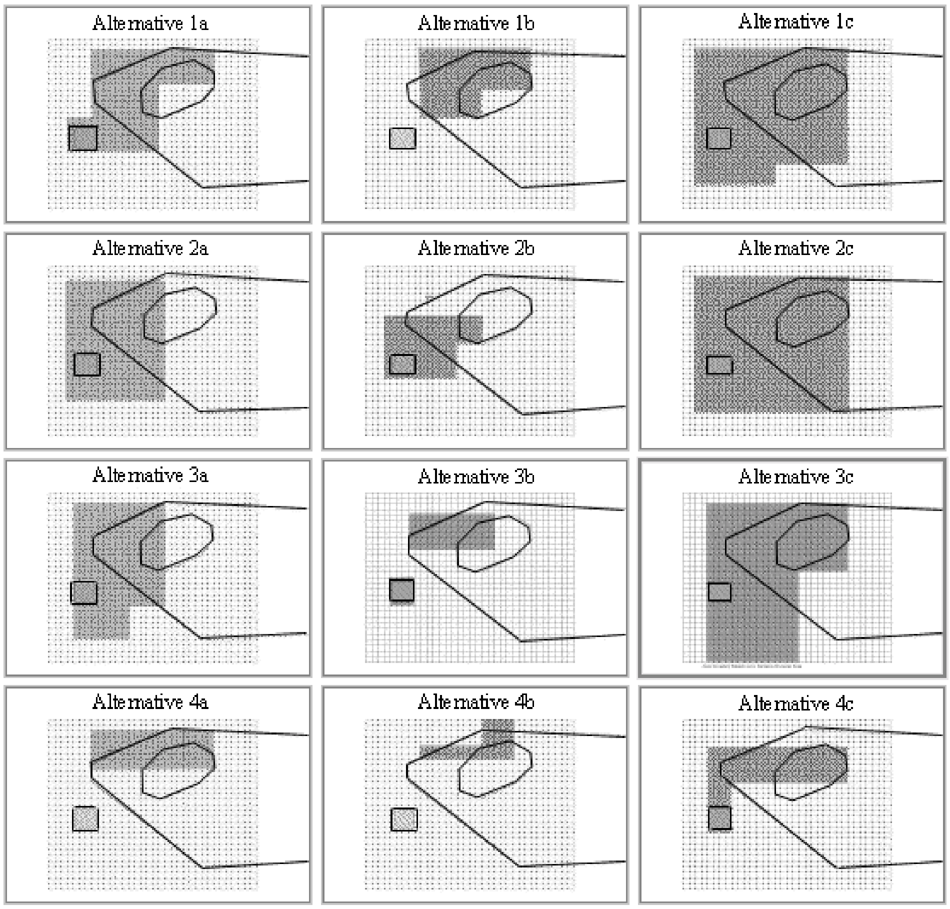
At the April 22-23, 1999 meeting, the criteria were ranked and 12 potential alternatives were drafted. Sanctuary staff presented some “strawman” alternatives that addressed single criteria for the purpose of jump starting the discussions of alternatives. In order to develop a range of alternatives, the criteria were first prioritized by the entire WG. The facilitator then broke up the WG into two groups: those that were conservation-oriented and those that were use-oriented. The groups reprioritized the criteria according to their interests resulting in a less protective profile and a more protective profile. This exercise produced a matrix of three criteria weighting profiles (Table 13) that were used to develop the draft alternatives. In order to draw alternatives, the WG was broken up into four groups of varied perspectives (to facilitate an early development of consensus).

Table 13. Criteria weighting profiles developed at the April 1999 WG meeting.

Criteria Weighting Profile "A" Mid-range Consensus	**Criteria Weighting Profile "B" Less Protective**	**Criteria Weighting Profile "C" More Protective**
Biodiversity and Habitat 27%	Fisheries Sustainability 25%	Sufficient Size 50%
Fisheries Sustainability 26%	Socio-economic Impacts 25%	Fisheries Sustainability 20%
Enforcement & Compliance 17%	Enforcement & Compliance 20%	Biodiversity and Habitat 15%
Sufficient Size 16%	Biodiversity and Habitat 15%	Reference Area and Monitoring 5%
Socio-economic Impacts 9%	Reference Area and Monitoring 10%	Enforcement & Compliance 5%
Reference Area and Monitoring 5%	Sufficient Size 5%	Socio-economic Impacts 5%
Total 100%	Total 100%	Total 100%

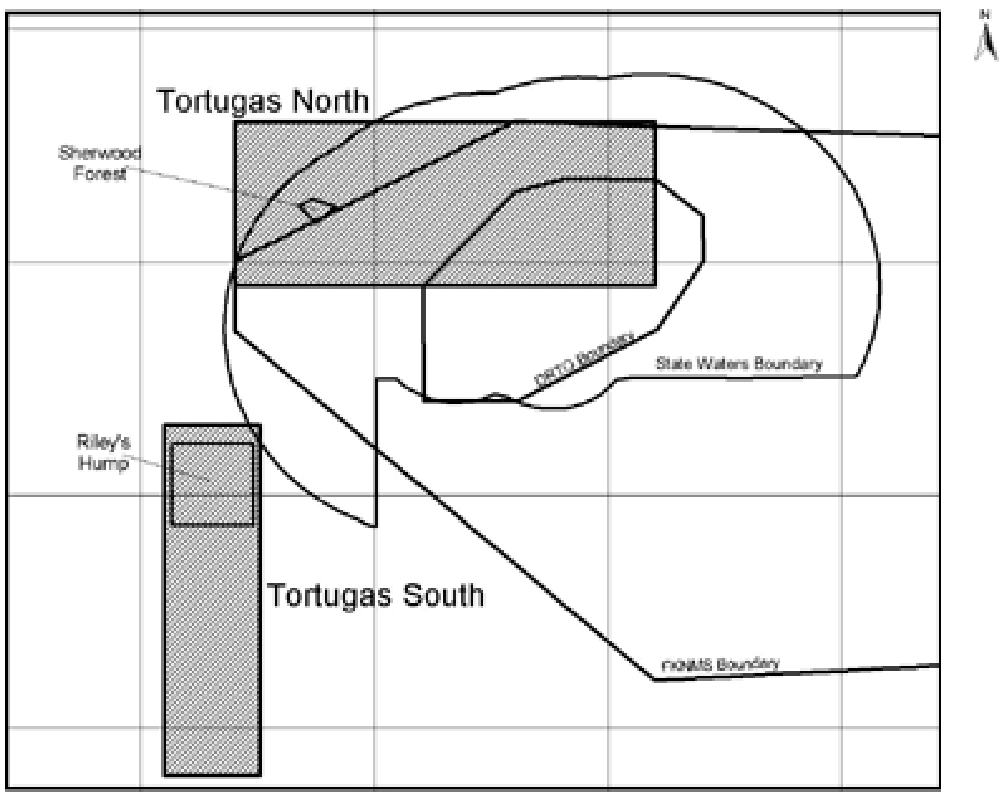
These groups, convened around roundtables, were presented with large, blank grid maps with corresponding transparent overlays. They also had workbooks showing maps of resources and uses. Each group was instructed to develop one alternative for each criteria profile. Observers who were not WG members were allowed to provide input into the drawing of the maps. Twelve draft alternatives were produced representing a range of protection (Figure 26).

Figure 26. Potential boundary alternatives developed at the April 1999 WG meeting.



At the May 22, 1999, meeting, the WG chose two (1a and 4a, Figure 26) of the 12 alternatives to focus on and from those two alternatives a compromise arose that was presented by members of the WG (Figure 27). After considerable deliberation this compromise was ultimately endorsed by the WG through consensus as the Recommended Preferred Alternative.

Figure 27. Preferred alternative recommended at the May 1999 WG meeting.



The rationale presented by the WG for this compromise alternative was as follows:

- Protects a range of contiguous habitats including shallow areas in the DRTO.
- Sufficient size to protect biological diversity and achieve fisheries sustainability criterion.
- Protects several known spawning sites and provides connectivity with other habitats.
- Includes Riley's Hump and a buffer area.
- Includes Sherwood Forest and its unique coral formations.
- Protects important habitat to the west and north of Tortugas Bank.

- Protects deep water habitat and species, such as snowy grouper, tilefish, golden crab, and red snapper.
- Facilitates enforcement with simple boundaries.
- Leaves open significant fishing grounds for lobster and reef fish such as the southern half of Tortugas Bank, which is an important fishing area in the winter.
- Leaves open fishing areas for King mackerel.
- Includes long-term monitoring sites in DRTO.
- Leaves open southern half of Tortugas Bank to be used as a reference site for gauging impacts of fishing on the ecosystem.

Sanctuary Advisory Council Recommendation

On June 15, 1999, a presentation on the WG's process and recommended Preferred Alternative was given to the SAC. Following a lengthy and thorough deliberation the SAC voted unanimously to adopt the recommendation of the WG and forward it to NOAA and the State of Florida. The SAC passed the following motion with unanimous consent:

> The Sanctuary Advisory Council recognizes the hard work and extensive deliberations of the Working Group, a diverse group of stakeholders, in arriving at an unprecedented consensus recommendation for an ecological reserve that both protects biodiversity and minimizes impacts to users. The FKNMS SAC adopts the attached recommendation of the Tortugas 2000 Working Group Alternative as the Preferred Alternative for the T2000 Ecological Reserve.

Development of Boundary Alternatives by National Ocean Service Staff

In developing the boundary alternatives presented in this document, Sanctuary staff took into consideration the deliberations of the WG, the recommendation of the SAC, the requirements of the FKNMSPA, NMSA and NEPA, and the NPS's proposed Research/Natural Area alternative. NOS staff have developed five boundary alternatives for analysis which represent a broad range of areas for protection (Figures 28-31). The basis for these alternatives is the SAC's recommended Preferred Boundary Alternative

(III) as well as the two alternatives (1a and 4a) that the WG chose to focus on at their final meeting. Alternatives 1a and 4a were modified in order to create a broad range of options for consideration and are presented here as Boundary Alternatives II and IV.

To aid the reader in the analysis of this proposal, NOAA notes here that Boundary Alternative III is its Preferred Alternative. The basis for that selection appears in Part V, below. Table 14 below compares the boundary alternatives by physical attributes.

Table 14. Comparison of boundary alternatives by physical attributes.

Attribute	**Boundary Alternatives**				
	I (no action)	**II**	**III**	**IV**	**V**
Size[1] (square nm) - Total - Tortugas North - Tortugas South	0	55 55 0	151 91 60	175 115 60	189 144.5 44.5
State waters (square nm)	0	55	77.2	101.2	102.1
State waters outside of FKNMS jurisdiction (square nm)	0	0	22.2	46.2	47.1
Federal waters in Gulf Council jurisdiction (square nm) - Tortugas North - Tortugas South	 0 0	 0 0	 13.8 60	 13.8 60	 42.4 44.5
FKNMS Boundary Expansion (new area in square nm)	N	N	Y (96)	Y (120)	Y (134)
% of total FKNMS area as no-take	0.5	2.5	5.9	6.8	7.4
Sherwood Forest included	N	N	Y	Y	Y
Riley's Hump included	N	N	Y	Y	Y
Percent of known spawning areas included (n=8)	13%	13%	63%	88%	88%
Percent of known habitats protected[2]					
- Hardbottom	NA	60	76	100	100
- High relief reef	NA	85	85	100	100
- Low relief reef	NA	54	76	100	100
- Pinnacle reef	NA	100	100	100	100
- Sand bottom	NA	68	88	100	100
Volume to edge ratio	NA	1.4	2.7	2.9	3.0
Enforcement burden rank[3]	NA	1	2	3	4

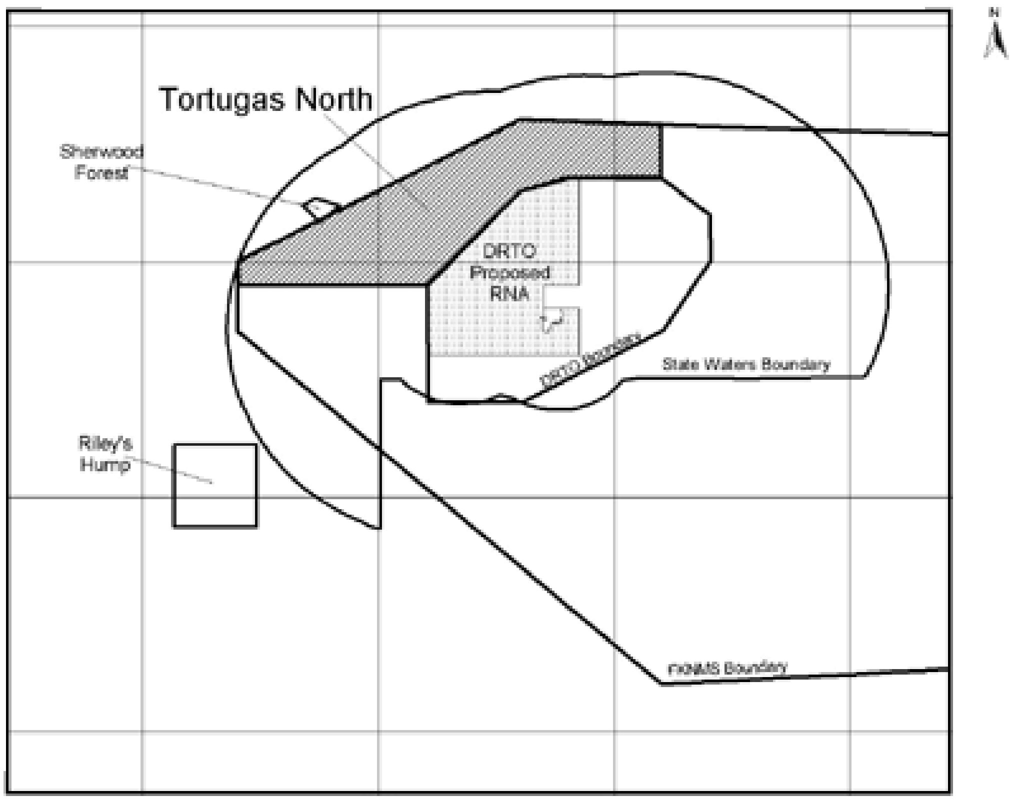
1- does not include area within the DRTO

2- based on habitats mapped by side scan sonar which comprise an estimated 50% of the critical habitat area

3- based on volume/edge ratio, 1=easier, 4=harder

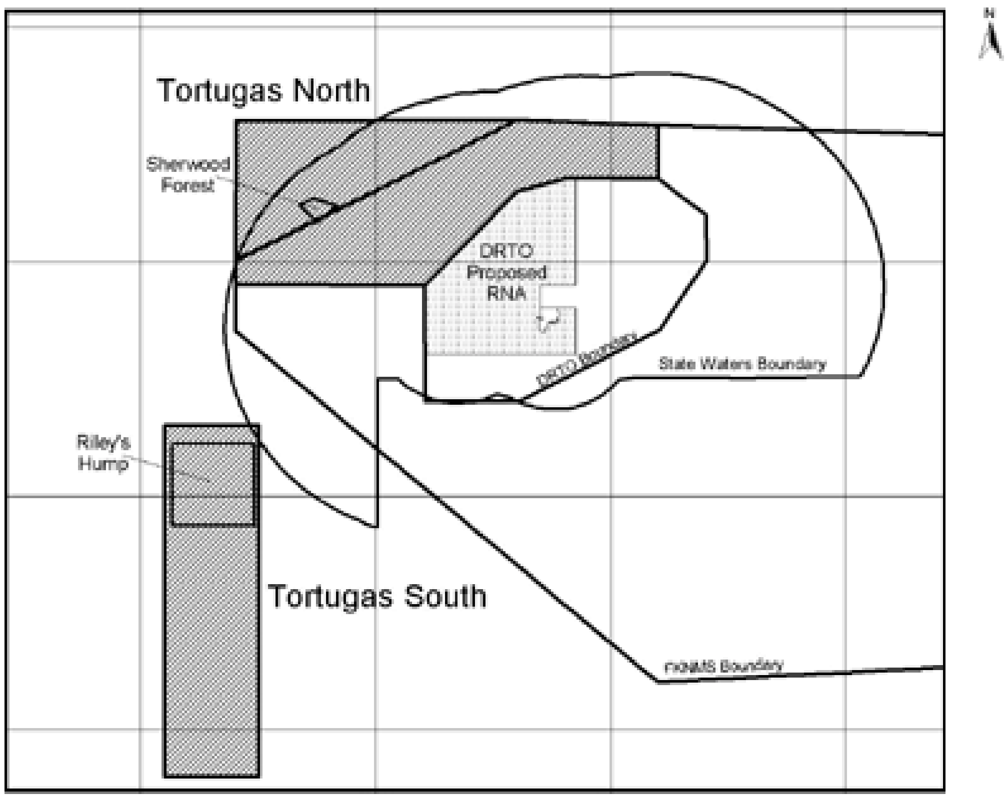
<u>Boundary Alternative I</u>. This alternative would be taking no-action, that is, not expanding the Sanctuary boundary and not establishing a Tortugas Ecological Reserve.

Figure 28. Boundary Alternative II.



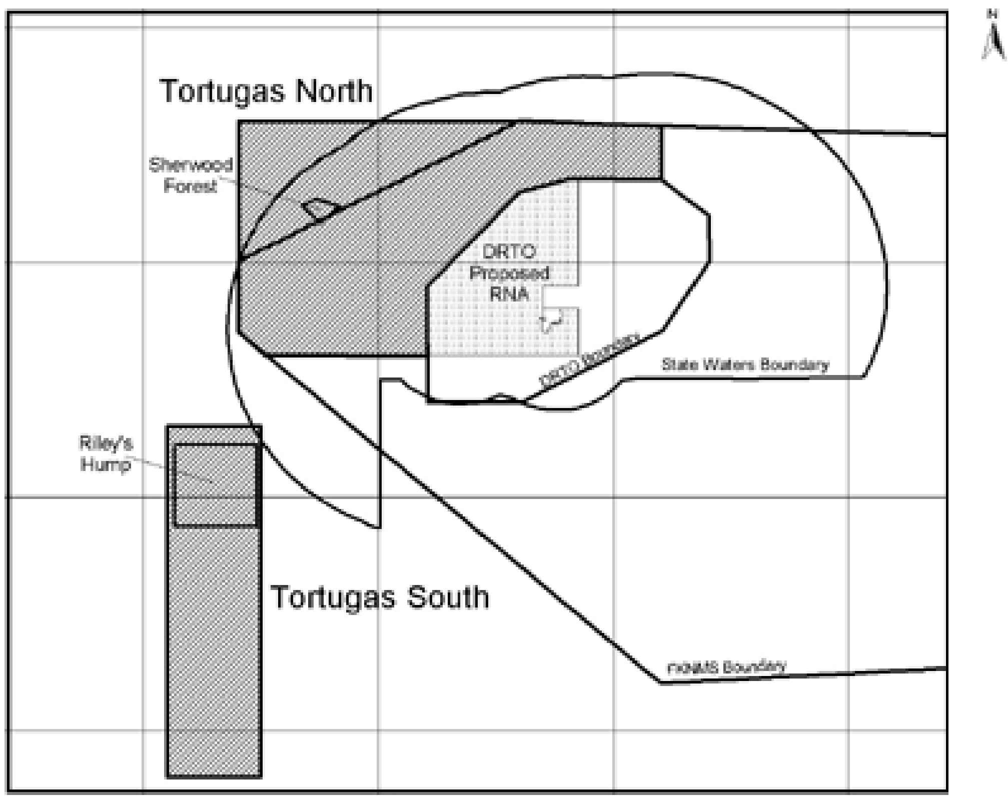
<u>Boundary Alternative II</u>. This alternative limits the reserve to the existing Sanctuary boundary for a total area of approximately 55 square nm (Figure 28). Areas within the SAC's recommended reserve boundary that are not protected by this alternative would have to be protected by the relevant management agency. This alternative includes a portion of Sherwood Forest and the coral pinnacles north of Tortugas Bank; it does not include Riley's Hump. It includes some coral and hardbottom habitat north of the DRTO.

Figure 29. Boundary Alternative III (Preferred Boundary Alternative).



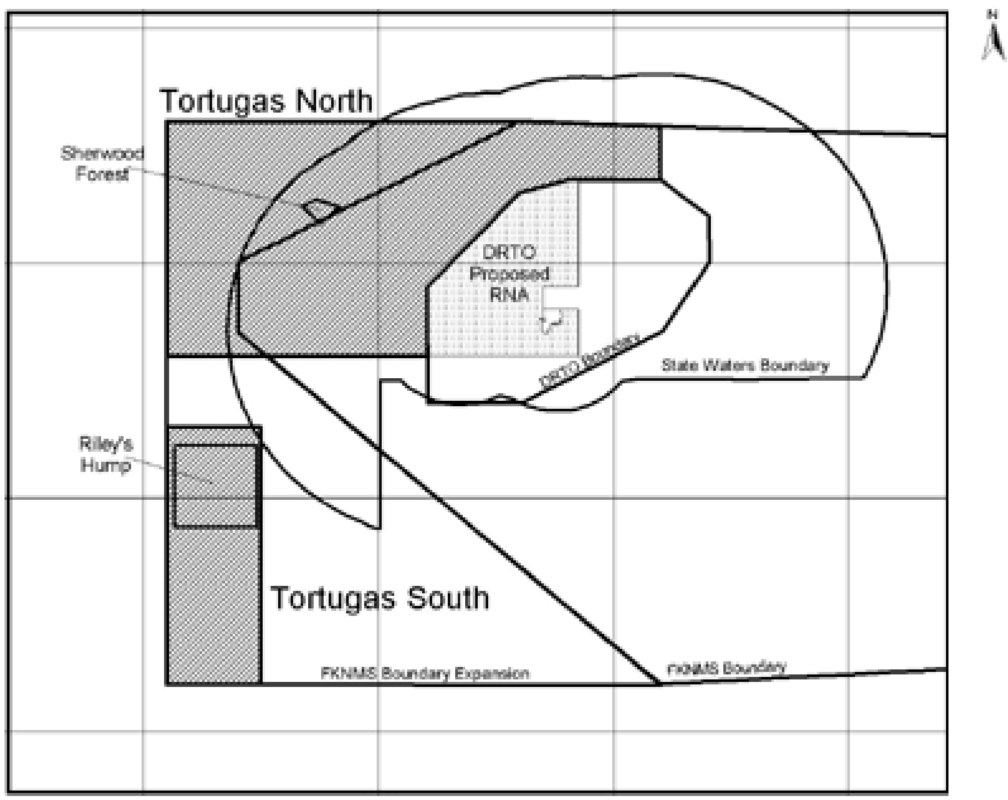
Boundary Alternative III (Preferred Boundary Alternative). This alternative would expand the boundary of the Sanctuary and its westernmost corner by approximately 36 square nm to include Sherwood Forest (Figure 29). In addition, this alternative would expand the boundary by adding a non-contiguous area of approximately 60 square nm to include Riley's Hump. The proposed Reserve would also incorporate approximately 55 square nm of the existing Sanctuary in its northern section, for a total area of approximately 151 square nm. The area of the proposed Reserve surrounding Sherwood Forest would be called Tortugas North and encompass approximately 91 square nm; the area surrounding Riley's Hump would be called Tortugas South and encompass approximately 60 square nm. This alternative would involve four different management jurisdictions: FKNMS, State of Florida, GMFMC, and NMFS, all of which are in the process of taking steps to protect the areas within their respective jurisdictions. This alternative represents the WG's recommendation adopted by the SAC and recommended to NOAA and the State of Florida.

Figure 30. Boundary Alternative IV.



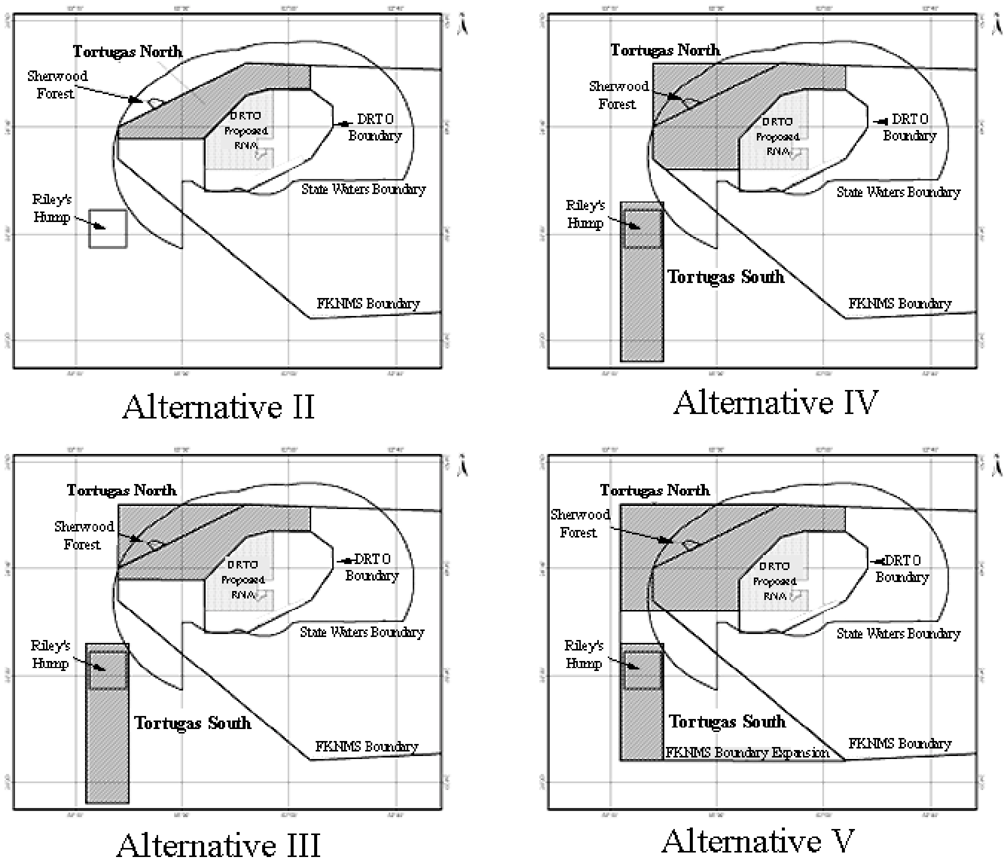
Boundary Alternative IV. This alternative would increase the area of Tortugas North over that in Alternative III by an additional 23 square nm to make it conterminous with the DRTO's proposed Research/Natural Area for a total area of approximately 175 square nm (Figure 30). It would involve the same boundary expansion as in Alternative III. The Tortugas South area would be the same as in Alternative III.

Figure 31. Boundary Alternative V showing proposed ecological reserve and boundary expansion..



<u>Boundary Alternative V</u>. This alternative involves a Sanctuary boundary expansion to the west by 3 square nm over Alternatives III and IV to make the boundary extend as far west as the western boundary of Tortugas South. Tortugas North would be expanded to over Alternatives III and IV to include this boundary expansion. The area of Tortugas North would be approximately 145 square nm (Figure 31). The area of Tortugas South would be approximately 45 square nm, by reducing its southern extent over alternatives III and IV. Under Alternative V the overall area of the Reserve would be approximately 190 square nm.

Figure 32. Side-by-side comparison of all four boundary alternatives.

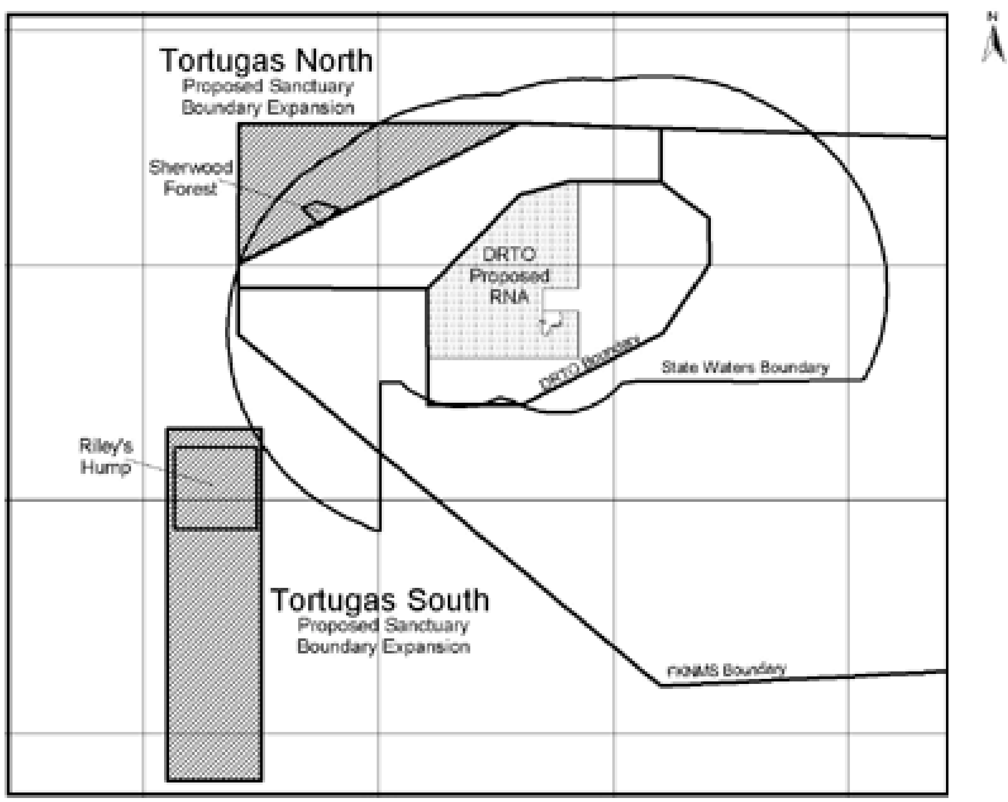


Boundary Expansion

Boundary Alternatives III, IV, and V would require expansions of the existing Sanctuary boundary (Figure 33 for Alternatives III and IV and Figure 31 for Alternative V). The existing boundary in the western portion of the Sanctuary established by Congress in the FKNMSPA, was based on bathymetry as there was little information available at the time on the significant ecological features related to the coral reef resources in the far western extent of the Florida Keys. Over the last decade, scientists and managers have learned and documented a considerable amount about the existence of extensive and unique coral reef resources that are located outside the current boundary of the Sanctuary.

Consistent with Executive Order 13089, Coral Reef Protection, and consistent with comprehensively protecting the nationally significant coral reef resources that were unknown to the agency and to Congress at the time the Sanctuary was designated, the boundary of the Sanctuary would need to be expanded to protect these resources. Boundary Alternative III is the Preferred Boundary Alternative.

Figure 33. Proposed Sanctuary boundary expansion (denoted in dark gray on map) for Boundary Alternatives III and IV.



Development and Description of Regulatory Alternatives

Four alternatives for regulating human activities within the reserve were developed (Table 15). The regulatory alternatives are independent of the boundary alternatives (*i.e.,* regulatory alternatives can be paired with various boundary alternatives).

The foundations for these alternatives are the current Sanctuary-wide regulations (15 C.F.R. 922 Subpart P, in particular, 922.163) and the additional regulations applicable to ecological reserves (15 C.F.R. 922.164(d)). In summary, the Sanctuary-wide regulations prohibit mineral and hydrocarbon exploration; removal of, injury to, or possession of coral or live rock; alteration of, or construction on, the seabed; discharge or deposit of materials or other matter; operation of vessels in a manner that endangers life, marine resources, or property; diving and snorkeling without flying a divers down flag; releasing exotic species; damaging or removing markers; moving, removing, injuring, or possessing Sanctuary historical resources; taking or possessing protected wildlife; possessing or using explosives or electrical charges; harvesting or possessing marine life species not in accordance with the Florida Administrative Code; and interfering with law enforcement authorities.

In summary, the ecological reserve regulations prohibit the take or disturbance of any dead or living material; fishing; discharge or deposit of any material except cooling water or engine exhaust; anchoring when a mooring buoy is available or on living or dead coral; and touching living or dead coral. Transit by vessels is allowed as long as all fishing gear is stowed away. All of the alternatives begin with this foundation. Currently, there is one ecological reserve in the Sanctuary (Western Sambo Ecological Reserve).

Other regulatory alternatives considered but rejected were taking no action, or making the entire proposed ecological reserve a no access, research/education-only area. The no action alternative was rejected because it would not provide sufficient protection to coral reef resources from anchoring and other consumptive activities. Making the entire reserve a no access, research/education-only area appears to unnecessarily restrict non-consumptive activities that could provide unique resource appreciation and education opportunities to the public.

Table15. Comparison of Regulatory Alternatives

Comparison of Regulatory Alternatives	**Regulatory Alternative**							
	A		**B**		**C**		**D** (Pref. Alt.)	
	TN	TS	TN	TS	TN	TS	TN	TS
Regulation								
Existing Sanctuary-wide Regulations	Y	Y	Y	Y	Y	Y	Y	Y
Existing Ecological Reserve Regulations (Includes No Fishing)	Y	Y	Y	Y	Y	Y	Y	Y
No Mooring by Ships >100’	N	N	Y	N	Y	Y	Y	Y
Access by Permit Only	N	N	Y	N	Y	Y	Y	Y
No Anchoring	N	N	Y	N	Y	Y	Y	Y
Access for Research/Education Only	N	N	N	N	N	N	N	Y
TN = Tortugas North								
TS = Tortugas South								

Regulatory Alternative A

- Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South.

Regulations:

- Tortugas North. Apply existing Sanctuary-wide and existing ecological reserve regulations.
- Tortugas South. Apply existing Sanctuary-wide and existing ecological reserve regulations.

Objective: To minimize human disturbance in order to restore and maintain ecological integrity including a full assemblage of fishes, coral, and other benthic invertebrates.

Regulatory Alternative B

- Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Alternative A).
- Prohibit anchoring in, prohibit mooring by vessels more than 100 ft in length overall (LOA), and control access to Tortugas South for other than continuous transit or for law enforcement purposes via permit and require permitted vessels to call-in prior to entering and when leaving.

Regulations:

- Tortugas North. Same as in Alternative A above.
- Tortugas South. Same as in Alternative A above. In addition, prohibit anchoring, prohibit mooring by vessels more than 100 ft LOA, require a permit to enter the reserve for other than continuous transit or for law enforcement purposes, and require permitted vessels to call-in prior to entering and when leaving.
- Description of access permit: Permit would be free, no paperwork would be required, and Sanctuary staff would be available year-round to handle requests.

Application: Applicant must call the Key West or Marathon Sanctuary office to request a permit and would have to radio the Sanctuary staff person at Fort Jefferson (DRTO) prior to entering and upon leaving the reserve.

Required Information:

1. Names, addresses, and telephone numbers of owner, captain, and applicant.
2. Vessel name and home port.
3. USCG documentation number, state license, or boat registration number.
4. Length of vessel and primary propulsion type (i.e., motor or sail).
5. Number of divers.
6. Requested effective date and duration of permit.

Permit duration: For the time the vessel is in the area, not to exceed two weeks.

Restrictions: Vessels longer than 100 ft LOA cannot use the mooring buoys. Advance reservations can be made no more than one month in advance.

Special Conditions: Doubling-up on mooring buoys would be permissible, leave and return privileges (dive during day, stay at the park overnight) would be allowed within the time period covered by the permit.

Call-in requirement: Permit holders must notify FKNMS staff at DRTO by radio no less than 30 minutes and no more than six hours before entering the reserve and upon leaving.

Objective: To minimize human disturbance in order to restore and maintain ecological integrity including a full assemblage of fishes, coral, and other benthic invertebrates and to create a reference area for studying human impacts on the ecosystem. This alternative would better protect Tortugas South by prohibiting anchoring and by controlling access (except for continuous transit) by a new type of permit. Prohibiting anchoring would better protect the coral reef resources in Tortugas South because the high cover of coral and the deep water depths make it difficult to anchor without damaging coral. The prohibition on mooring by vessels more than 100 ft LOA would protect the buoys from being ripped off their moorings by vessels exceeding the buoys' mooring capacity. Making Tortugas South a controlled access area would enhance its utility as a reference site for research and would facilitate enforcement of the regulations by giving advance notice to enforcement officers of the presence of a user vessel in this remote area.

Regulatory Alternative C

- Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Alternative A).
- Prohibit anchoring in, prohibit mooring by vessels more than 100 ft LOA, and control access to Tortugas North and South, except for continuous transit or for law enforcement purposes, and require permitted vessels to call-in when entering and leaving (as described in Alternative B).

Regulations:

- Tortugas North. Same as for Tortugas South in Alternative B above.
- Tortugas South. Same as for Tortugas South in Alternative B above.

Objective: To minimize human disturbance in order to restore and maintain ecological integrity including a full assemblage of fishes, coral, and other benthic invertebrates and to create a reference area for studying human impacts on the ecosystem. Over Regulatory Alternative B, this alternative provides increased protection to Tortugas North by prohibiting anchoring and by controlling access (except for continuous transit) by access permit. Prohibiting anchoring would better protect the coral reef resources in Tortugas North because of the difficulty of anchoring without damaging coral due to the high cover of coral and the deep water depths. Anchoring by vessels 50 m or greater in length is already prohibited in approximately 19% of Tortugas North. The prohibition on mooring by vessels more than 100 ft LOA would protect the buoys from being ripped off their moorings by vessels exceeding the buoys' mooring capacity. Making Tortugas North a controlled access area would enhance its utility as a reference site for researching and would facilitate enforcement of the regulations by giving advance notice to enforcement officers of the presence of a user vessel in this remote area. The existing ATBA already prohibits vessels 50m or greater from accessing approximately 23% of Tortugas North.

Regulatory Alternative D (Preferred Regulatory Alternative).

- Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Alternative A).
- Prohibit anchoring in, prohibit mooring by vessels more than 100 ft LOA, and control access to Tortugas North, other than for continuous transit or for law enforcement purposes, via permit and require permitted vessels to call-in prior to entering and when leaving (as described in Alternative B).
- Prohibit anchoring in, prohibit mooring by vessels more than 100 ft LOA, and restrict access to Tortugas South, other than for continuous transit or for law enforcement purposes, to research or educational purposes. A sanctuary permit would be required for all research and educational purposes.

Regulations:

- Tortugas North. Same as in Alternative C above.
- Tortugas South. Except for continuous transit, law enforcement, or for scientific research or educational purposes pursuant to a sanctuary permit (see 15 CFR 922.166(a)), access to Tortugas South would be prohibited.

Objective: To minimize human disturbance in order to restore and maintain ecological integrity including a full assemblage of fishes, coral, and other benthic invertebrates and to create a reference area for studying human impacts on the ecosystem. Tortugas North would have the same protections as outlined in Regulatory Alternative C above. This alternative provides increased protection to Tortugas South over Alternative C by making it a research/education-only area. Making Tortugas South a research/education-only area would greatly enhance its utility as a reference site for researching and monitoring the effects of human activities on the functioning of a coral reef ecosystem. This alternative would also protect sensitive resources in Tortugas South, such as fish aggregating and spawning areas, from the effects of non-consumptive diving. The prohibition on mooring by vessels more than 100 ft LOA would protect the buoys from being ripped off their moorings by vessels exceeding the buoys' mooring capacity.

Preferred Alternative

The preferred alternative is to implement Boundary Alternative III and Regulatory Alternative D. The Sanctuary Designation Document would be revised and 15 CFR 922.161 would be amended to expand the boundary of the FKNMS to be consistent with Boundary Alternative III. The Sanctuary boundary coordinates would also be revised to make minor revisions in the existing boundary to correct errors, provide clarification, reflect more accurate data and, in the area of Biscayne National Park, to provide a fixed, enforceable boundary. The coordinates would be set forth in the Designation Document and in Appendix I to Part 922. Appendix IV to Part 922 would be revised to make the area within the coordinates for Boundary Alternative III an ecological reserve, to provide clarification, and to remove no longer needed introductory text. (Appendices II, V, VI, and VII would also be revised to correct technical errors, provide clarification, and reflect more accurate data.)

The draft final regulations would revise the ecological reserve regulations at 15 CFR 922.164(d)(1) to prohibit: anchoring in the Tortugas Ecological Reserve; entering Tortugas South (except for continuous transit, law enforcement purposes, or, pursuant to a sanctuary permit, for scientific research or educational purposes); entering Tortugas North without a valid access permit (except for continuous transit or law enforcement purposes); entering or leaving Tortugas North without calling in; and tying a vessel greater than 100 ft (30.45 meters) LOA to a mooring buoy in the Tortugas Ecological Reserve or tying more than one vessel (other than vessels carried on board a vessel), if the combined lengths would exceed 100 ft (30.45 meters) LOA, to a mooring buoy or to a vessel tied to a mooring buoy in the ecological reserve. The length restriction is intended to prevent a buoy from being ripped off its mooring.

Because all anchoring will be prohibited in the northern portion of the Tortugas Bank no-anchoring zone established by 15 CFR 922.164(g), the regulations would revise the zone to be consistent. The existing zone is an area within the Sanctuary boundary where vessels 50 m or greater in LOA are prohibited from anchoring. The northern portion of the zone overlaps the proposed ecological reserve.

The regulations would add a new section to provide for permits for access to the Tortugas North. Access to Tortugas South will be restricted to continuous transit, law enforcement purposes, or, pursuant to a sanctuary permit, to scientific research or educational purposes. Except for continuous transit or for law enforcement, a person will only be allowed to enter Tortugas North with a valid access permit. Access permits will not require written applications or the payment of any fee. Access permits will have to be requested at least 72 hours but no longer than one month before the date the permit would be effective. Permits can be requested via telephone or radio by contacting the Sanctuary office in Key West or Marathon. A permit applicant will be required to provide, as applicable, the following information: vessel name; the names, addresses, and telephone number of the owner, operator and applicant; USCG documentation, state license, or registration number; home port; length of vessel and propulsion type (*i.e.*, motor or sail); number of divers; and the requested effective date and duration of permit (two weeks, maximum). The Sanctuary Superintendent will issue a permit to the owner or to the owner's representative for the vessel when all applicable information has been provided. FKNMS would provide a permit number to the applicant and confirm the effective date and duration period of the permit. Written confirmation of permit issuance will be provided upon request. Permit holders will be required to notify FKNMS staff at the Dry Tortugas National Park office by telephone or radio no less than 30 minutes and no more than six hours, before entering and upon leaving the Tortugas Ecological

Reserve. Permit holders could leave and return to the ecological reserve during the time their permit is effective.

Finally, the regulations would add a new definition to 15 CFR 922.162, to define "length overall (LOA) or length of a vessel."

See Appendix C for the draft final regulations.

PART V: ENVIRONMENTAL AND SOCIO-ECONOMIC CONSEQUENCES OF BOUNDARY AND REGULATORY ALTERNATIVES

Environmental Consequences

This section compares the differences in environmental impacts among the boundary and regulatory alternatives being considered for the proposed ecological reserve.

Boundary Alternative I is the no-action or status quo alternative. Some protection to coral and bottom formations is already provided in part of the area by the existing anchoring prohibition that applies to vessels 50m or greater in registered length. The existing ATBA also provides some protection to part of the area by prohibiting access by tank vessels and by vessels 50m or greater in registered length. This alternative assumes that no action would be taken and that the current trajectory of uses and concomitant threats to the area would continue. Anchoring by large vessels on Riley's Hump would continue destroying coral reefs and essential fish habitat. Cumulative impacts from fishing would continue to alter the ecosystem by reducing the number of top level predators which has cascading effects on the trophic structure of the ecosystem often reducing the size of spawning aggregations. Fishing also would continue to degrade the genetic heterogeneity of species making them less resilient to stress. Fishing would continue to skew the size structure of populations toward smaller individuals that produce significantly fewer gametes (eggs) than large adults, which compromises the ability of populations to sustain themselves. Cumulative impacts from fishing gear, such as the use of shrimp trawls, lobster traps, fish traps, and grapples for retrieving trap lines, would continue to erode the integrity of the ecosystem by destroying habitat. Juveniles would continue to be lost from the system as bycatch. Under this alternative a nationally significant coral reef community and associated resources such as fish, shellfish and other invertebrates would continue to degrade. The degradation of this critical region impairs the long-term ecological integrity of the Sanctuary.

Boundary Alternative II (Figure 28) limits the reserve area to within the existing Sanctuary boundary. Under Regulatory Alternative A (see Part IV) this alternative would protect part of the northern half of Tortugas Bank including the high profile coral reef areas around Little Bank and Eight Fathom Rock and along the northern edge of the DRTO by making it subject to the existing regulations applicable to ecological reserves (this area is already subject to the existing Sanctuary-wide regulations). However, the majority of the important coral formations and habitat found in Sherwood Forest would not be protected and this alternative would include less of the diverse benthic habitats than Alternatives III, IV, or V. The highly productive Riley's Hump area and the deep water habitats to the south of Riley’s Hump would also not be protected. Protecting part of the northern half of Tortugas Bank would facilitate the study of fishing effects and would allow comparison with areas outside the reserve that are not subject to no-take restrictions. One of the eight known fish spawning areas would be protected by this alternative. Of the known coral reef habitat in the area being considered for the reserve, Boundary Alternative II would protect approximately 80% of it and 60% of the hardbottom area. This alternative would be the easiest to enforce because of its small size and relative proximity to the base of operations in the DRTO. Regulatory Alternatives B and D (see Part IV) are not applicable to this boundary alternative. Under Regulatory Alternative C (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve regulations, anchoring would be prohibited, access for other than continuous transit or for law enforcement purposes would be allowed only by permit, and permitted vessels would be required to call in when entering and leaving. This would provide increased protection to the significant coral reef resources of the area by preventing anchor damage from all vessels and would facilitate enforcement by giving advance notice to enforcement officers of the presence of a user vessel. Within the area of Boundary Alternative II, the prohibition on all forms of take would either stop or greatly reduce the impacts of fishing and fishing gear and the ecological integrity of the area would be restored and preserved. This would maintain the number of top level predators, thereby avoiding cascading effects on the trophic structure of the ecosystem. The genetic heterogeneity of species would also be maintained within the Reserve and it is expected that the size structure of populations would be preserved.

There may be some potential negative impacts on surrounding resources from the displacement of fishing activity from Boundary Alternative II. This impact would be similar under all of the regulatory alternatives since they all displace consumptive users. The impacts would be most prevalent on the southern half of Tortugas Bank that is currently a heavily fished area. Impacts on lobster would be minimal given the State of Florida's trap reduction program. Habitat destruction from gear impacts may increase due to increased fishing effort in adjacent areas. Impacts on fish resources may be greater given their overfished status outside of the reserve. It remains to be seen whether the impact will be mitigated or exacerbated by spillover of adult biomass into adjacent areas such as the southern half of Tortugas Bank.

<u>Boundary Alternative III (Preferred Boundary Alternative) (Figure 29)</u> consists of two components: Tortugas North covering the northern half of Tortugas Bank, including

Sherwood Forest, and Tortugas South covering Riley's Hump and deep water areas to the south.

The Tortugas North component would include Sherwood Forest, an area of high coral cover. Some of the coral formations in Sherwood Forest are estimated to be approximately 400 years old. The thick veneer covering the bottom contains holes and caves that provide ideal habitat for a high diversity of fishes. Soft corals, gorgonian-forests, sponges, and black corals are also present. In addition to Sherwood Forest, Tortugas North would include several deep water coral banks in depths to approximately 24 m. Part of Tortugas Bank would also be included in the Tortugas North component. The bank is characterized by low-relief hard-bottom with patches of sand and rubble at 7-23 m depth. Tortugas North would also include a substantial sand buffer area around the coral community that provides foraging areas for reef inhabitants. The inclusion of diverse habitats such as sand areas and other benthic habitats is essential to preserve the biodiversity of the Tortugas region. Research in the Tortugas region has indicated that benthic primary production provides the base for the food web on this portion of the West Florida Shelf. The surrounding open sand, algae and seagrass communities directly support large numbers and species of fish.

The Tortugas South component of Boundary Alternative III would include a full range of coral reef related-habitats. Tortugas South includes a range of deep water coral reef habitats with biologically diverse marine communities. These habitats include the shallow Riley's Hump area, which is composed of scattered small coral colonies and sand in less than 100 feet of water. Riley’s Hump is a known fish aggregating and spawning site. The area in 200 to 400 foot depths consists of deep reef habitats with numerous soft corals but few stony corals. These varied communities are apparent through the deeper areas of Tortugas South from 250 to 1,800 feet depths. Small seamounts or pinnacles have been identified in regions of Tortugas South from 250 to 550 feet of water, and there is a series of smaller pinnacles that surround a larger seamount. These are part of an east-west running ledge that begins around 250 feet and drops to almost 400 feet in a nearly vertical profile. This is unlike any other coral reef habitat discovered within Sanctuary waters to date.

At 250 feet the surrounding bottom is a mixture of sand and low-profile hard substrate that supports a diverse assemblage of benthic organisms. In 380 feet of water, the bottom of one portion of a ledge is described to have huge, rocky boulders protruding from the surrounding sand bottom. Large numbers and diversity of deep water species have been observed at a depth of 250 feet, including streamer bass, yellowmouth grouper, snowy grouper, scamp, speckled hind, creole fish, bank butterflyfish, amberjack, almaco, and unique sea urchins.

At 1,600 to 1,800 foot depths a limestone ledge exists with unusual deep-dwelling sea life such as lantern fish (myctophids), tilefish, golden crabs, and giant isopods. This deep sand bottom habitat is teeming with unique deep sea species of shrimp, fish, sea cucumbers, anemones, and crabs.

This boundary alternative includes a contiguous expansion of the Sanctuary to encompass the northwest corner of Tortugas North and a non-contiguous boundary expansion to encompass Tortugas South, making both subject to the Sanctuary-wide regulations. Under all of the regulatory alternatives, deep water habitats and their associated species would be protected as no-take areas. Protecting the entire northern half of Tortugas Bank would facilitate the study of fishing effects and would allow comparison with areas outside the reserve that are not subject to no-take restrictions. This alternative would protect 5 of the 8 known fish spawning areas as well as approximately 87% of the known coral reef habitat and 76% of the known hardbottom habitat. Protecting Tortugas South would preserve the important habitats of Riley’s Hump as well as the deep water sand and limestone substrates to the south, where fishing gear impacts have been observed.

The prohibition against all forms of take would apply under all of the regulatory alternatives. In both Tortugas North and Tortugas South the impacts from fishing and from fishing gear would either stop or be greatly reduced and the ecological integrity of the area would be restored and preserved. This would maintain the number of top level predators, thereby avoiding cascading effects on the trophic structure of the ecosystem. The genetic heterogeneity of species would also be maintained within the Reserve and it is expected that the size structure of populations would be preserved.

Under Regulatory Alternative B (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve no-take regulations, anchoring would be prohibited, mooring by vessels greater than 100 ft LOA would be prohibited, access to Tortugas South for other than continuous transit or for law enforcement purposes would be allowed only by permit, and permitted vessels would be required to call in when entering and leaving. This would provide increased protection to the significant coral reef resources of Tortugas South by preventing anchor damage and would facilitate enforcement in Tortugas South, a remote area, by giving advance notice to enforcement officers of the presence of a user vessel. Under Regulatory Alternative C (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve regulations, anchoring would be prohibited, access for other than continuous transit or for law enforcement purposes would be allowed only by permit, and permitted vessels would be required to call in when entering and leaving. This would provide increased protection to the significant coral reef resources of Tortugas North and South by preventing anchor damage and would facilitate enforcement in Tortugas North and South by giving advance notice to enforcement officers of the presence of a user vessel. Under Regulatory Alternative D (Preferred Regulatory Alternative) (see Part IV), one additional protection in Tortugas South would be provided by allowing access, other than for continuous transit or for law enforcement purposes, only for research and educational purposes. Access for research or educational purposes would require a sanctuary permit. This will greatly enhance the utility of Tortugas South as a reference site for researching and monitoring the effects of human activities on the functioning of a coral reef ecosystem.

Boundary Alternative IV (Figure 30) is similar in configuration to Alternative III, but is larger in area. The Tortugas South component would be the same as in Alternative III. Tortugas North would be expanded to the south by an additional 23 square nm to coincide with the DRTO's proposed Research/Natural Area. This would protect the habitats found along the southwest slope of the bank that forms the Dry Tortugas, thereby protecting contiguous habitats from shallow to deep water. It would also encompass all of the productive habitat on Tortugas Bank including a known fish spawning area. As with Alternative III, this alternative would require a contiguous expansion of the Sanctuary boundary to encompass the northwest corner of the Tortugas North and a non-contiguous boundary expansion to encompass Tortugas South. Because this alternative covers all of Tortugas Bank there would be no comparable reference area to assess the impacts of fishing. This alternative would encompass 6 of 8 known fish spawning sites. It is estimated that 100% of the known coral and hardbottom habitat would be protected by this alternative.

The prohibition against all forms of take would apply under all of the regulatory alternatives. In both Tortugas North and Tortugas South the impacts from fishing and from fishing gear would either stop or be greatly reduced and the ecological integrity of the area would be restored and preserved. This would maintain the number of top level predators, thereby avoiding cascading effects on the trophic structure of the ecosystem. The genetic heterogeneity of species would also be maintained within the Reserve and it is expected that the size structure of populations would be preserved.

Under Regulatory Alternative B (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve no-take regulations, anchoring would be prohibited, mooring by vessels greater than 100 ft LOA would be prohibited, access to Tortugas South for other than continuous transit or for law enforcement purposes, would be allowed only by permit and permitted vessels would be required to call in when entering a leaving. This would provide increased protection to the significant coral reef resources of Tortugas South by preventing anchor damage and would facilitate enforcement in Tortugas South, a remote area, by giving advance notice to enforcement officers of the presence of a user vessel. Under Regulatory Alternative C (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve regulations, anchoring would be prohibited, mooring by vessels greater than 100 ft LOA would be prohibited, access to both Tortugas North and South for other than continuous transit or for law enforcement purposes, would be allowed only by permit and permitted vessels would be required to call in when entering a leaving. This would provide increased protection to the significant coral reef resources of Tortugas North and South by preventing anchor damage and would facilitate enforcement in Tortugas North and South by giving advance notice to enforcement officers of the presence of a user vessel. Under Regulatory Alternative D (Preferred Regulatory Alternative) (see Part IV), one additional protection in Tortugas South would be provided by allowing access, other than for continuous transit or for law enforcement, only for research and educational purposes. Access for research or educational purposes would require a sanctuary permit. This will greatly enhance the utility of Tortugas South as a reference site for researching and monitoring the effects of human activities on the functioning of a coral reef ecosystem.

Boundary Alternative V (Figure 31), as in Alternatives III and IV, includes two components: Tortugas North and Tortugas South. However, Tortugas North would be expanded to the west by 28.6 square nm from that in Alternative IV to encompass more deep water habitats and Tortugas South would be reduced in size by 15.5 square nm from that in Alternatives III and IV. While this alternative would require a boundary expansion as would Alternatives III and IV, this alternative would require a much larger boundary expansion and one that was contiguous with the existing boundary, and would make waters outside of the reserve but within the additional Sanctuary area subject to the Sanctuary-wide regulations (15 C.F.R. § 922.163). Because this alternative covers all of Tortugas Bank, there would be no comparable reference area to assess the impacts of fishing. This alternative would encompass 7 out of 8 known fish spawning sites and would protect all of the known coral and hardbottom habitat. The expansion of Tortugas North to the west would mean increased protection for deep water habitats and associated species. The reduction in size of Tortugas South would mean less protection for deep water habitat and associated species in that area.

The prohibition against all forms of take would apply under all of the regulatory alternatives. In both Tortugas North and Tortugas South the impacts from fishing and from fishing gear would either stop or be greatly reduced and the ecological integrity of the area would be restored and preserved. This would maintain the number of top level predators, thereby avoiding cascading effects on the trophic structure of the ecosystem. The genetic heterogeneity of species would also be maintained within the Reserve and it is expected that the size structure of populations would be preserved.

Under Regulatory Alternative B (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve no-take regulations, anchoring would be prohibited, mooring by vessels greater than 100 ft LOA would be prohibited, access to Tortugas South for other than continuous transit or for law enforcement purposes, would be allowed only by permit and permitted vessels would be required to call in when entering a leaving. This would provide increased protection to the significant coral reef resources of Tortugas South by preventing anchor damage and would facilitate enforcement in Tortugas South, a remote area, by giving advance notice to enforcement officers of the presence of a user vessel. Under Regulatory Alternative C (see Part IV), in addition to the Sanctuary-wide regulations and the existing ecological reserve regulations, anchoring would be prohibited, mooring by vessels greater than 100 ft LOA would be prohibited, access to both Tortugas North and South for other than continuous transit or for law enforcement purposes, would be allowed only by permit and permitted vessels would be required to call in when entering a leaving. This would provide increased protection to the significant coral reef resources of Tortugas North and South by preventing anchor damage and would facilitate enforcement in Tortugas North and South by giving advance notice to enforcement officers of the presence of a user vessel. Under Regulatory Alternative D (Preferred Regulatory Alternative) (see Part IV), one additional protection in Tortugas South would be provided by allowing access, other than for continuous transit or for law enforcement, only for research and educational purposes. Access for research or educational purposes would require a sanctuary permit. This will greatly enhance the utility of Tortugas South as a reference site for researching and monitoring the effects of human activities on the functioning of a coral reef ecosystem.

Socio-Economic Consequences of Boundary and Regulatory Alternatives

Background

This section meets the requirements of Executive Order 12866, which requires for this action which has been determined to be significant for purposes of review by the Office of Management and Budget (OMB), a draft text of the regulations to be proposed, a reasonably detailed description of the need for the action, an explanation of how the action will meet that need, and an assessment of the potential costs and benefits, including an explanation of the manner in which the action is consistent with statutory mandates and, to the extent permitted by law, promotes the President's priorities and avoids undue interference with State, local, and tribal governments in the exercise of their governmental functions (referred to as Regulatory Impact Review (RIR)). This section, together with Parts I, IV, VI and Appendix H, of this FSEIS, meets the requirements of the Regulatory Flexibility Act which requires the preparation of a Final Regulatory Flexibility Analysis (FRFA) setting forth: 1) a succinct statement of the need for and objectives of the rule; 2) a summary of the significant issues raised by the public comments in response to the Initial Regulatory Flexibility Analysis (IRFA), a summary of the assessment of the agency of such issues, a statement of any changes made to the proposed rule as a result of such comments; 3) a description of and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available; 4) a description of the projected reporting, record keeping and other compliance requirements of the regulations, including an estimate of the classes of small entities that will be subject to these requirements and the type of professional skills necessary to prepare any required report or record; 5) a description of the steps the agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual policy and legal reasons for selecting the alternative adopted in the final rule and why each of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected. This section provides a comprehensive review of the level and incidence of impact associated with the regulatory actions. The section, also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the significant alternatives that meet the objectives of the FKNMSPA and minimize socio-economic impacts.

The RIR and FRFA presented here are based on a complete socio-economic impact analysis that can be found in Leeworthy and Wiley (2000). Leeworthy and Wiley (2000) is a revision of Leeworthy and Wiley (1999) based on public comments and contains complete descriptions of the data and methods used and contains technical appendices that provide more detailed results than provided in the summary tables included here. The technical appendices also provide how consumer's surpluses were calculated for the commercial fisheries and the geographic information system (GIS) maps that show the distributions of commercial catch and recreation activity in the Tortugas Ecological Reserve Study Area (TERSA).

Species not documented as being commercially or recreationally fished in the Tortugas region are not included in this analysis. Even if some species not here included were taken in small amounts, it would not change the results of this analysis.

Statement of Need

See Part I of this document for a statement of need and why regulatory action is being considered.

Goals, Objectives and Legal Basis

See Part I of this document for the goals and objectives of, and legal basis for this action.

Discussion of all Relevant State and Federal Rules Which May Duplicate, Overlap or Conflict with the Regulations

Under the Magnuson-Stevens Act, the GMFMC has primary federal responsibility and expertise for the development of FMPs throughout the Gulf of Mexico and has developed an Essential Fish Habitat Amendment for the various GMFMPs, which includes the area of the proposed Tortugas Ecological Reserve. The GMFMPs are implemented by regulations promulgated by the NMFS (50 CFR 622). At the GMFMC's meeting on November 9, 1999, the NOS and NMFS requested that the GMFMC take steps to prohibit fishing, consistent with the purpose of the proposed ecological reserve. The GMFMC accepted this request and at its July 10-13, 2000 meeting, adopted a Generic Amendment Addressing the Establishment of Tortugas Marine Reserves. That amendment to the GMFMPs is consistent with the no-take Tortugas Ecological Reserve proposed by NOAA and NOAA's regulations for ecological reserves in the FKNMS, at 15 CFR 922.164(d).

NMFS intends to issue regulations under the Magnuson-Stevens Act consistent with the no-take status of the Tortugas Ecological Reserve for the species covered by the GMFMPs and for Atlantic Atlantic tunas, swordfish, sharks, and billfish. These regulations will duplicate and overlap, but not conflict, with the Sanctuary regulations prohibiting fishing in the Tortugas Ecological Reserve. Regulations issued under the Magnuson-Stevens Act must satisfy the requirements of that Act including the National Standards set forth in that Act. Sanctuary regulations including those governing fishing are issued under the NMSA. While some of the goals and objectives of the two Acts are similar, many of the goals and objectives of the two statutes are quite different.

The State of Florida may implement a no-fishing rule for the areas of Tortugas North within State waters. This rule could duplicate and overlap with the Sanctuary, but not conflict with the Sanctuary no-take rule for the Tortugas Ecological Reserve. The State of Florida is co-manager of the Reserve with NOAA and Sanctuary regulations affecting State waters must have the approval of the State.

Description of the Projected Reporting, Record Keeping and Other Compliance Requirements of the Regulations, Including an Estimate of the Classes of Small Entities that Will be Subject to These Requirements and the Type of Professional Skills Necessary to Prepare Any Required Report or Record

See Part IV for a description of the access permit application and call in requirements. Any entity desiring to enter Tortugas North for other than continuous transit or for law enforcement purposes would be subject to these requirements. It is anticipated that dive charters operators and individuals wishing to dive from a private vessel would be the primary class of small entity subject to this requirement. No special skills would be necessary to comply with the permitting or call in requirements.

Any entity desiring to conduct educational and research activities in Tortugas South would be required to apply for a National Marine Sanctuary General Permit. Each permit applicant would be required to provide a detailed description of the proposed activity, including a timetable for completion of the activity and the equipment, personnel and methodology to be employed; the qualifications and experience of all personnel; a statement of the financial resources available to the applicant to conduct and complete the proposed activity; a statement as to why it is necessary to conduct the activity within the Sanctuary; a statement of the potential impacts of the activity, if any, on Sanctuary resources and qualities; and a statement of the benefit to be derived from the activity; and such other information as the Director may request. Copies of all other required licenses, permits, approvals, or other authorizations must be attached to the application. The application requirements for such a permit are set forth in 15 CFR 922.166(e). There would be additional reporting and record keeping requirements associated with a Sanctuary permit. These are projected to include submitting interim reports on the status of the activity and final reports including relevant research findings.

It is anticipated that marine scientists affiliated with public and private research institutions, universities, and conservation organizations, and associated graduate students or assistants, would be the primary class of small entity subject to this requirement.

The skills necessary for preparing a permit application and subsequent reports are the same as those that are required to prepare research proposals, grant applications, and their associated activity reporting requirements.

Approach to the Analysis

In a standard benefit-cost analysis (BCA), the benefits and costs are identified, and to the extent practical, the benefits and costs are quantified. Benefits and costs in the BCA framework are usually limited to consumer's surpluses and producer's surpluses or economic rents. The approach used here is broader than the BCA approach. Here we do identify and quantify, where possible, consumer's surpluses and economic rents. Generally, we concluded that economic rents did not exist in either the recreation industry or in the commercial fisheries (See Leeworthy and Wiley, 2000). Consumer's surplus and economic rents are generally referred to as non-market economic values and are the appropriate inputs in a BCA. However, BCA is usually focused on economic efficiency arguments where it is assumed that the economy is at full employment and labor and capital are completely mobile. In addition, equity issues are also usually ignored in the calculus of BCA. Our socio-economic impact analysis recognizes the limitations of BCA. A great deal of focus is placed on the market economic impacts as measured by direct revenue, costs and profits of the business firms directly affected by the "no-take" regulations. These impacts are then translated into the secondary or multiplier impacts on the local economy. For the recreational industry, the impact area is defined as Monroe County, Florida and, for the commercial fisheries the impact areas are Monroe County and Lee/Collier counties. For the commercial fisheries, the results presented here are an aggregation of the impacts on both Monroe and Lee/Collier Counties. The market economic impacts include estimates of output/sales, income and employment. The details by impacted area can be found in Leeworthy and Wiley (2000). Although the results are only presented for impacts on Monroe and Lee/Collier Counties, the impacts are based on catch landed in all counties. The results for Monroe and Lee/Collier counties are slightly overstated because they include the amounts landed in other counties, but for the boundary alternatives, these amounts are insignificant.

The approach begins by first analyzing the affects of the “no-take” regulation for each boundary alternative. Analyses are presented for the recreation industry (broken down into consumptive and non-consumptive), the commercial fisheries, commercial shipping, treasure salvors and then other benefits (non-users, scientific and education values). The next step is to analyze other regulations. Other regulations include the no anchoring/required mooring buoy use regulation, access restrictions, and sanctuary-wide regulations (for boundary alternatives that include areas outside current Sanctuary boundary). For most of the sanctuary-wide regulations, there is no additional or incremental impact over the “no-take” regulation.

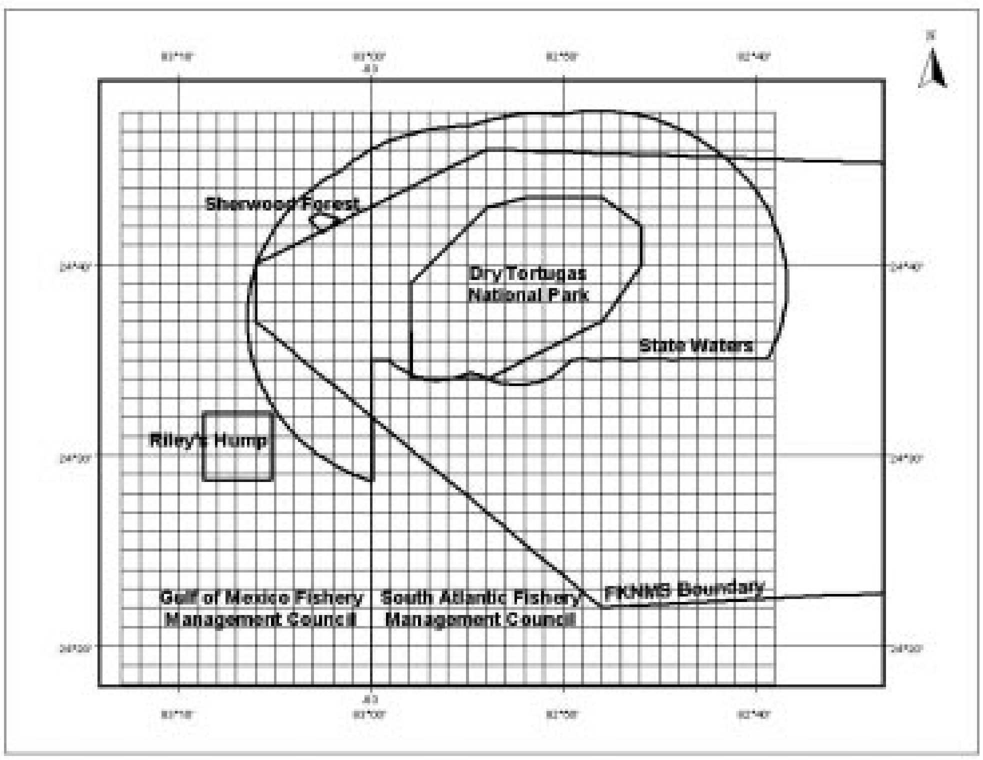
The approach used here proceeds in two basic steps for the recreation industry and the commercial fisheries. First, the impacts are estimated under the assumption that all the activities displaced result in complete loss. This is done by simply adding up all the activities within the geographic area defined by an ecological reserve boundary (*i.e.*, the no-take area) and applying the appropriate economic parameters. In the second step, a qualitative approach is used to assess whether the results from step 1 are likely to occur. Here mitigating factors and offsetting factors are taken into account and an assessment is made as to whether net benefits or costs exist in the short and longer terms. Over the long term, the ecological reserve is expected to generate replenishment effects to the fisheries. In the commercial reef fisheries, there may be some short term losses, however over the longer term, the expectation is that there would be long-term benefits even to commercial reef fishermen and related dependent businesses.

Results are presented in four sections. The first section addresses the recreation industry. Consumptive recreation is separated from non-consumptive recreation since consumptive recreation activities are displaced from the “no-take” areas and may potentially be negatively impacted, while non-consumptive activities would be beneficiaries of the “no-take” area in Tortugas North. The second section addresses the commercial fisheries which would all be displaced from the “no-take” areas and thus potentially negatively impacted. Section three addresses other potential benefits of the “no-take” areas including non-use economic values, scientific values, and education values. Section four addresses the costs of the management action to create the reserve.

This analysis assumes that all entities impacted are small entities within the meaning of the Regulatory Flexibility Act.

Definition of the Study Area. For purposes of the analyses presented in this report, NOS examined a 1,020 square nm area called the Tortugas Ecological Reserve Study Area (TERSA) (Fig. 34). All socio-economic information was collected and organized for the TERSA at a geographical resolution of one square nm. Detailed descriptions of the data are included for the recreation industry and for the commercial fisheries. Four separate boundary alternatives were identified within the TERSA and analyzed using the information collected for the TERSA.

Figure 34. Tortugas Ecological Reserve Study Area.



Boundary Alternatives

For a description of the boundary alternatives see Development of Sanctuary Staff Boundary Alternatives in Part IV.

No-take Regulations

Recreation Industry

Boundary Analysis. The interpretation of the estimates provided in this analysis is critical to understanding the "true" impact of the various alternatives proposed for the Tortugas Ecological Reserve. The estimates from our geographic information system (GIS) analysis for the different boundary alternatives are simply the sum of each measurement within the boundaries for a given alternative. The estimates therefore represent the maximum total potential loss from displacement of the consumptive recreational activities. This analysis ignores possible mitigating factors and the possibility of net benefits that might be derived if the proposed ecological reserve has replenishment effects. Although the extent of the mitigating factors or the potential benefits from replenishment is unknown, this analysis will discuss these as well as other potential benefits of the proposed ecological reserve after the maximum potential losses from displacement of the current consumptive recreational uses are presented and discussed.

There are two types of potential losses identified and quantified in the analysis, non-market economic values and market economic values.

Non-Market Economic Values. There are two types of non-market economic values. The first is consumer's surplus, which is the amount an individual is willing to pay for a good or service over and above what he or she is required to pay for the good or service. It is a net benefit to the consumer and in the context of recreation use of natural resources, where the natural resources go unpriced in markets, this value is often referred to as the net user value of the natural resource. The second type of non-market economic value is one received by producers or owners of the businesses providing goods or services to the users of the natural resources. This is commonly referred to as producer's surplus. The concept is similar to consumer's surplus in that the businesses do not pay a price for the use of natural resources when providing goods or services to users of the resources. However, this concept is a little more complicated because, in "welfare economics", not all producer's surplus is considered a proper indicator in the improvement of welfare. Only that portion of producer's surplus called "economic rent" is appropriate for inclusion. Economic rent is the amount of profit a business receives over and above a normal return on investment (*i.e.*, the amount of return on investment that could be earned by switching to some alternative activity). Again, because businesses that depend on natural resources in the Tortugas do not have to pay for the use of them, there exists the possibility of earning above normal rates of return on investment or "economic rent". This like consumer's surplus, would be additional economic value attributable to the natural resources (*i.e.*, another user value).

Economic rents are different from consumer's surplus in that supply and demand conditions are often likely to lead to dissipation of the economic rents. This is generally true for most open access situations. As new firms enter the industry because of the lure of higher than normal returns on investment, the net effect is to eliminate most if not all of the economic rent. However, given the remoteness of the TERSA, it is likely that all economic rents would not be eliminated. Accounting profits are used as a proxy for economic rents in the analysis. The absolute levels of accounting profits are not a good proxy for economic rents, however, they are used here as an index for assessing the relative impacts across the different boundary alternatives.

The estimates for consumer's surplus were derived by combining estimates of person-days from all the operators in the TERSA with estimates of consumer's surplus per person-day from Leeworthy and Bowker (1997). The estimates were derived separately by season (see Leeworthy and Wiley 2000).

Market Economic Values. Revenues from the charter boat operations that provided service to the consumptive recreational users provide the basis for this portion of the analysis. Total output/sales, income and employment impacts on the Monroe County economy are then derived from these estimates. These impacts include the ripple or multiplier impacts. Total output/sales is equal to business revenue times the total output multiplier of 1.12 from English *et al.* (1996). Income is then derived by taking the total output/sales impact and dividing by the total output-to-income ratio (2.63) from English *et al.* And, total employment was derived by dividing the total income impact by the total income-to-employment ratio ($23,160) from English *et al.*

Boundary Alternative I: No Action

The no-action alternative simply means that the proposed Tortugas Ecological Reserve and corresponding no-take regulations would not take place. The no-action alternative has a simple interpretation in that any costs of imposing the no-take regulations, for any given alternative with no-take regulations, would be the benefits of the no-action alternative. That is, by not adopting the no-take regulations, the costs are avoided. Similarly, any benefits from imposing the no-take regulations, for any given alternative with no-take regulations, would be the costs of the no action alternative. That is, by not adopting the no-take regulations, the costs are the benefits lost by not adopting the no-take regulations. Said another way, the opportunities lost. The impacts of the no-action alternative can only be understood by comparing it to one of the proposed alternatives. Thus the impacts of the no-action alternative can be obtained by reading the impacts from any of the proposed alternatives in reverse (Tables 16-23). Table 17 shows the 1997 baseline conditions.

Table 16. Boundary analysis summary: TERSA – Consumptive recreation.

	Diving for Lobsters	Fishing	Spearfishing	Total
Within FKNMS Boundary				
Person-Days	1,442	12,215	1,569	15,226
Revenue	$ 99,282	$ 579,143	$ 291,898	$ 970,323
Cost	$ 68,372	$ 471,657	$ 149,503	$ 689,532
Profit	$ 30,909	$ 107,497	$ 142,395	$ 280,801
Number of Firms	2	10	3	12 [1]
Consumer Surplus	$ 131,222	$ 996,744	$ 144,034	$ 1,272,000
Outside FKNMS Boundary				
Person-Days	288	4,163	303	4,754
Revenue	$ 19,868	$ 267,597	$ 41,795	$ 329,260
Cost	$ 13,680	$ 217,794	$ 22,926	$ 254,400
Profit	$ 6,188	$ 49,804	$ 18,869	$ 74,861
Number of Firms	2	4	2	5 [1]
Consumer Surplus	$ 26,208	$ 339,619	$ 27,815	$ 393,642
Total				
Person-Days	1,730	16,378	1,872	19,980
Revenue	$ 119,150	$ 846,740	$ 333,693	$ 1,299,583
Cost	$ 82,052	$ 689,451	$ 172,429	$ 943,932
Profit	$ 37,097	$ 157,301	$ 161,264	$ 355,662
Number of Firms	2	10	3	12 [1]
Consumer Surplus	$ 157,430	$ 1,336,363	$ 171,850	$ 1,665,643

1. Number of firms does not add up to the total because individual firms may engage in more than one activity.

Table 17. Boundary Analysis Summary: Alternative II/ Regulatory Alternative D - Consumptive Recreation

Charter/Party Boat Operators	Diving for Lobsters[2]		Fishing[2]		Spearfishing[2]		Total[2]	
Within FKNMS Boundary								
Person-Days	461	(31.97%)	200	(1.64%)	485	(30.91%)	1,146	(7.53%)
Revenue	$ 31,732	(31.96%)	$ 24,691	(4.26%)	$ 66,816	(22.89%)	$ 123,239	(12.70%)
Cost	$ 21,862	(31.98%)	$ 14,496	(3.07%)	$ 36,656	(24.52%)	$ 73,014	(10.59%)
Profit	$ 9,870	(31.93%)	$ 10,195	(9.48%)	$ 30,160	(21.18%)	$ 50,225	(17.89%)
Number of Firms	2	(100.00%)	8	(80.00%)	3	(100.00%)	9	(75.00%) [1]
Consumer Surplus	$ 41,977	(31.99%)	$ 15,859	(1.59%)	$ 44,548	(30.93%)	$ 102,384	(8.05%)
Outside FKNMS Boundary								
Person-Days	-	(0.00%)	-	(0.00%)	-	(0.00%)	-	(0.00%)
Revenue	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)
Cost	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)
Profit	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)
Number of Firms	-	(0.00%)	-	(0.00%)	-	(0.00%)	-	(0.00%) [1]
Consumer Surplus	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)
Total								
Person-Days	461	(26.65%)	200	(1.22%)	485	(25.91%)	1,146	(5.74%)
Revenue	$ 31,732	(26.63%)	$ 24,691	(2.92%)	$ 66,816	(20.02%)	$ 123,239	(9.48%)
Cost	$ 21,862	(26.64%)	$ 14,496	(2.10%)	$ 36,656	(21.26%)	$ 73,014	(7.74%)
Profit	$ 9,870	(26.61%)	$ 10,195	(6.48%)	$ 30,160	(18.70%)	$ 50,225	(14.12%)
Number of Firms	2	(100.00%)	8	(80.00%)	3	(100.00%)	9	(75.00%) [1]
Consumer Surplus	$ 41,977	(26.66%)	$ 15,859	(1.19%)	$ 44,548	(25.92%)	$ 102,384	(6.15%)
Private Boats[3]								
Person-Days	-	n/a	673	(100.00%)	-	n/a	673	(100.00%)
Consumer's surplus	$ -	n/a	$ 53,392	(100.00%)	$ -	n/a	$ 53,392	(100.00%)

1. Number of firms does not add up to the total because individual firms may engage in more than one activity.
2. Percent of TERSA (See Table 15) by activity and total in parentheses.
3. Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus.

Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus. Lacking any information with regard to the distribution of the activity, the assumption was made that all of the activity takes place within the boundary alternative.

Boundary Alternative II

Non-Market Economic Values. This alternative would displace over 26% of the total person-days of diving for lobsters, about 26% of the spearfishing, and just over 2% of the fishing. Across all three consumptive recreational activities just under 6% of the person-days would be displaced (Table 18). This alternative is entirely within the FKNMS boundary. Because of the way in which consumer's surpluses are calculated, they generally mirror the patterns in displaced use. Minor differences would be due to the distributions across activities by season. Only in the case of diving for lobsters are the impacts on person-days and profits equal. For spearfishing, the impacts on profits are lower than the affect on person-days (18.7% versus 25.9%), while for fishing the affect is greater on profits than on person-days (6.5% versus 1.2%). The GIS generated maps show why diving for lobsters and spearfishing are relatively more affected than fishing. The reason is that diving for lobsters and spearfishing are concentrated on Tortugas Bank, while relatively little fishing currently takes place on the Tortugas Bank.

Market Economic Values. Presently, there are 12 charter boats operating within the TERSA, nine of which would be potentially affected by this alternative. Direct business revenue would include potential losses of 26.6% for diving for lobsters, 20% for spearfishing, and 3% for fishing. Across all three consumptive recreational activities, 9.5% of revenue would be potentially affected (Table 18).

Through the ripple or multiplier effects, 11-13% of output/sales, income and employment associated with all the consumptive recreational activities in the TERSA could potentially be lost (Table 22). Although these costs could have an affect on the nine firms operating in the TERSA, the affect would not likely be noticed in the Monroe County economy because the affect would amount to only a fraction of a percent of the total economy supported by recreating visitors to the Florida Keys (Table 23).

Boundary Alternative III (Preferred Boundary Alternative)

Non-Market Economic Values. Because the portion of this alternative that is within the FKNMS boundary is exactly the same as Alternative II, the analysis for these two activities will be exactly the same for the two alternatives. The alternative would displace over 26% of the total person-days of diving for lobsters, about 26% of the spearfishing, and just over 3% of the fishing. Across all three consumptive recreational activities over 7% of the person-days would be displaced (Table 18). For fishing, 40% of the displaced activity would be from within the FKNMS boundary. Consumer's surpluses generally mirror patterns of displaced use. Again, minor differences would be due to the distributions across activities by season. Only in the case of diving for lobsters are the effects on person-days and profits equal. For spearfishing, the effects on profits is lower than the affect on person-days (18.7% versus 25.9%), while for fishing the effect is greater on profits than on person-days (10.2% versus 3.0%).

Table 18. Boundary Analysis Summary: Alternative III/ Regulatory Alternative D - Consumptive Recreation

Charter/Party Boat Operators	Diving for Lobsters[2]		Fishing[2]		Spearfishing[2]		Total[2]		
Within FKNMS Boundary									
Person-Days	461	(31.97%)	200	(1.64%)	485	(30.91%)	1,146	(7.53%)	
Revenue	$ 31,732	(31.96%)	$ 24,691	(4.26%)	$ 66,816	(22.89%)	$ 123,239	(12.70%)	
Cost	$ 21,862	(31.98%)	$ 14,496	(3.07%)	$ 36,656	(24.52%)	$ 73,014	(10.59%)	
Profit	$ 9,870	(31.93%)	$ 10,195	(9.48%)	$ 30,160	(21.18%)	$ 50,225	(17.89%)	
Number of Firms	2	(100.00%)	8	(80.00%)	3	(100.00%)	9	(75.00%)	1
Consumer Surplus	$ 41,976	(31.99%)	$ 15,859	(1.59%)	$ 44,548	(30.93%)	$ 102,383	(8.05%)	
Outside FKNMS Boundary									
Person-Days	-	(0.00%)	297	(7.13%)	-	(0.00%)	297	(6.25%)	
Revenue	$ -	(0.00%)	$ 28,815	(10.77%)	$ -	(0.00%)	$ 28,815	(8.75%)	
Cost	$ -	(0.00%)	$ 23,254	(10.68%)	$ -	(0.00%)	$ 23,254	(9.14%)	
Profit	$ -	(0.00%)	$ 5,561	(11.17%)	$ -	(0.00%)	$ 5,561	(7.43%)	
Number of Firms	-	(0.00%)	2	(50.00%)	-	(0.00%)	2	(40.00%)	1
Consumer Surplus	$ -	(0.00%)	$ 23,570	(6.94%)	$ -	(0.00%)	$ 23,570	(5.99%)	
Total									
Person-Days	461	(26.65%)	497	(3.03%)	485	(25.91%)	1,443	(7.22%)	
Revenue	$ 31,732	(26.63%)	$ 53,506	(6.32%)	$ 66,816	(20.02%)	$ 152,054	(11.70%)	
Cost	$ 21,862	(26.64%)	$ 37,750	(5.48%)	$ 36,656	(21.26%)	$ 96,268	(10.20%)	
Profit	$ 9,870	(26.61%)	$ 15,756	(10.02%)	$ 30,160	(18.70%)	$ 55,786	(15.69%)	
Number of Firms	2	(100.00%)	8	(80.00%)	3	(100.00%)	9	(75.00%)	1
Consumer Surplus	$ 41,976	(26.66%)	$ 39,429	(2.95%)	$ 44,548	(25.92%)	$ 125,953	(7.56%)	
Private Boats[3]									
Person-Days	-	n/a	673	(100.00%)	-	n/a	673	(100.00%)	
Consumer's surplus	$ -	n/a	$ 53,392	(100.00%)	$ -	n/a	$ 53,392	(100.00%)	

1. Number of firms does not add up to the total because individual firms may engage in more than one activity.
2. Percent of TERSA (See Table 15) by activity and total in parentheses.
3. Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus.

Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus. Lacking any information with regard to the distribution of the activity, the assumption was made that all of the activity takes place within the boundary alternative.

4. Private boat usage does not impact commercial recreational fishing operations, therefore the only impacts are the loss of person days and the non-market value (consumer's surplus) of the activity. During the public comment period it was brought to our attention that there was 673 person days of activity taking place in the TERSA. This translates to a maximum potential loss of $53,392 in consumer's surplus.

Market Economic Values. Nine of the twelve charter boats operating within the TERSA would be potentially affected by this alternative. Direct business revenue would include potential losses of 26.6% for diving for lobsters, 20.0% for spearfishing, and 6.3% for fishing. Across all three consumptive recreational activities, 11.7% of revenue would be potentially affected (Table 18).

Through the ripple or multiplier effects, 16-17% of output/sales, income and employment associated with all the consumptive recreational activities in the TERSA could potentially be lost (Table 22). Although these costs could have an affect on the nine firms operating in the TERSA, the affect would not likely be noticed in the Monroe County economy because the it would amount to only a fraction of a percent of the total economy supported by recreating visitors to the Florida Keys (Table 23).

<u>Boundary Alternative IV</u>

Non-Market Economic Values. This alternative would displace over 73% of the total person-days of diving for lobsters, just under 72% of the spearfishing, and over 6% of the fishing. Across all three consumptive recreational activities over 18% of the person-days would be displaced (Table 19). All the diving for lobsters and spearfishing activity displaced would be from within the FKNMS boundary. For fishing, 71% of the displaced activity would be from within the FKNMS boundary. Similarly to the other alternatives, consumer's surpluses mirror the patterns in displaced use because of the way in which they are calculated. Minor differences would be due to the distributions across activities by season. Again, profits are only equal to the affect on person-days for diving for lobsters. For spearfishing, the effects on profits is lower than the affect on person-days (56.2% versus 71.7%), while for fishing the affect is greater on profits than on person-days (17.6% versus 6.3%).

Table 19. Boundary Analysis Summary: Alternative IV/ Regulatory Alternative D - Consumptive Recreation

Charter/Party Boat Operators	Diving for Lobsters[2]		Fishing[2]		Spearfishing[2]		Total[2]	
Within FKNMS Boundary								
Person-Days	1,269	(88.00%)	736	(6.03%)	1,343	(85.60%)	3,348	(21.99%)
Revenue	$ 87,361	(87.99%)	$ 60,261	(10.41%)	$ 196,944	(67.47%)	$ 344,566	(35.51%)
Cost	$ 60,165	(88.00%)	$ 38,093	(8.08%)	$ 106,360	(71.14%)	$ 204,618	(29.67%)
Profit	$ 27,196	(87.99%)	$ 22,168	(20.62%)	$ 90,584	(63.61%)	$ 139,948	(49.84%)
Number of Firms	2	(100.00%)	8	(80.00%)	3	(100.00%)	10	(83.33%) [1]
Consumer Surplus	$115,449	(87.98%)	$ 58,501	(5.87%)	$ 123,271	(85.58%)	$ 297,221	(23.37%)
Outside FKNMS Boundary								
Person-Days	-	(0.00%)	297	(7.13%)	-	(0.00%)	297	(6.25%)
Revenue	$ -	(0.00%)	$ 28,815	(10.77%)	$ -	(0.00%)	$ 28,815	(8.75%)
Cost	$ -	(0.00%)	$ 23,254	(10.68%)	$ -	(0.00%)	$ 23,254	(9.14%)
Profit	$ -	(0.00%)	$ 5,561	(11.17%)	$ -	(0.00%)	$ 5,561	(7.43%)
Number of Firms	-	(0.00%)	2	(50.00%)	-	(0.00%)	2	(40.00%) [1]
Consumer Surplus	$ -	(0.00%)	$ 23,570	(6.94%)	$ -	(0.00%)	$ 23,570	(5.99%)
Total								
Person-Days	1,269	(73.35%)	1,033	(6.31%)	1,343	(71.74%)	3,645	(18.24%)
Revenue	$ 87,361	(73.32%)	$ 89,076	(10.52%)	$ 196,944	(59.02%)	$ 373,381	(28.73%)
Cost	$ 60,165	(73.33%)	$ 61,347	(8.90%)	$ 106,360	(61.68%)	$ 227,872	(24.14%)
Profit	$ 27,196	(73.31%)	$ 27,729	(17.63%)	$ 90,584	(56.17%)	$ 145,509	(40.91%)
Number of Firms	2	(100.00%)	8	(80.00%)	3	(100.00%)	10	(83.33%) [1]
Consumer Surplus	$ 115,449	(73.33%)	$ 82,071	(6.14%)	$ 123,271	(71.73%)	$ 320,791	(19.26%)
Private Boats[3]								
Person-Days	-	n/a	673	(100.00%)	-	n/a	673	(100.00%)
Consumer's surplus	$ -	n/a	$ 53,392	(100.00%)	$ -	n/a	$ 53,392	(100.00%)

1. Number of firms does not add up to the total because individual firms may engage in more than one activity.
2. Percent of TERSA (See Table 15) by activity and total in parentheses.
3. Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus.

Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus. Lacking any information with regard to the distribution of the activity, the assumption was made that all of the activity takes place within the boundary alternative.

Market Economic Values. Ten of the twelve charter boats operating within the TERSA would be potentially affected by this alternative. Direct business revenue would include potential losses of 73.4% for diving for lobsters, 59.0% for spearfishing, and 10.5% for fishing. Across all three consumptive recreational activities, 28.7% of revenue would be potentially affected (Table 19).

Through the ripple or multiplier effects, 38-39% of output/sales, income and employment associated with all the consumptive recreational activities in the TERSA could potentially be lost (Table 22). Although these impacts could have significant affect on the ten firms operating in the TERSA, the affect would not likely be noticed in the Monroe County economy because the affect would amount to only a fraction of a percent of the total economy supported by recreating visitors to the Florida Keys (Table 23).

Boundary Alternative V

Non-Market Economic Values. This alternative would displace over 86% of the total person-days of diving for lobsters, over 84% of the spearfishing, and over 7% of the fishing. Across all three consumptive recreational activities over 21% of the person-days would be displaced (Table 20). For diving for lobsters 85% of the displaced activity would be from within the FKNMS boundary, 59% of the fishing, and 85% of the spearfishing. Because of the way in which consumer's surpluses are calculated, they generally mirror the patterns in displaced use. Minor differences would be due to the distributions across activities by season. Profits are only equal to the affect on person-days for diving for lobsters. For spearfishing, the effects on profits are lower than the affect on person-days (65.5% versus 84.7%), while for fishing the affect is greater on profits than on person-days (21.9% versus 7.6%).

Table 20. Boundary Analysis Summary: Alternative V/ Regulatory Alternative D - Consumptive Recreation

Charter/Party Boat Operators	Diving for Lobsters[2]		Fishing[2]		Spearfishing[2]		Total[2]		
Within FKNMS Boundary									
Person-Days	$ 1,269	(88.00%)	736	(6.03%)	1,343	(85.60%)	3,348	(21.99%)	
Revenue	$ 87,361	(87.99%)	$ 60,261	(10.41%)	$ 196,944	(67.47%)	$ 344,566	(35.51%)	
Cost	$ 60,165	(88.00%)	$ 38,093	(8.08%)	$ 106,360	(71.14%)	$ 204,618	(29.67%)	
Profit	$ 27,196	(87.99%)	$ 22,168	(20.62%)	$ 90,584	(63.61%)	$ 139,948	(49.84%)	
Number of Firms	2	(100.00%)	10	(100.00%)	3	(100.00%)	10	(83.33%)	1
Consumer Surplus	$115,449	(87.98%)	$ 58,501	(5.87%)	$ 123,271	(85.58%)	$ 297,221	(23.37%)	
Outside FKNMS Boundary									
Person-Days	231	(80.21%)	511	(12.27%)	243	(80.20%)	985	(20.72%)	
Revenue	$ 15,894	(80.00%)	$ 48,832	(18.25%)	$ 33,436	(80.00%)	$ 98,162	(29.81%)	
Cost	$ 10,944	(80.00%)	$ 36,495	(16.76%)	$ 18,341	(80.00%)	$ 65,780	(25.86%)	
Profit	$ 4,950	(79.99%)	$ 12,337	(24.77%)	$ 15,095	(80.00%)	$ 32,382	(43.26%)	
Number of Firms	2	(100.00%)	3	(75.00%)	2	(100.00%)	3	(60.00%)	1
Consumer Surplus	$ 20,992	(80.10%)	$ 40,617	(11.96%)	$ 22,277	(80.09%)	$ 83,886	(21.31%)	
Total									
Person-Days	1,500	(86.71%)	1,247	(7.61%)	1,586	(84.72%)	4,333	(21.69%)	
Revenue	$103,255	(86.66%)	$109,093	(12.88%)	$ 230,380	(69.04%)	$ 442,728	(34.07%)	
Cost	$ 71,109	(86.66%)	$ 74,588	(10.82%)	$ 124,701	(72.32%)	$ 270,398	(28.65%)	
Profit	$ 32,146	(86.65%)	$ 34,505	(21.94%)	$ 105,679	(65.53%)	$ 172,330	(48.45%)	
Number of Firms	2	(100.00%)	10	(100.00%)	3	(100.00%)	11	(91.67%)	1
Consumer Surplus	$136,441	(86.67%)	$ 99,118	(7.42%)	$ 145,548	(84.69%)	$ 381,108	(22.88%)	
Private Boats[3]									
Person-Days	-	n/a	673	(100.00%)	-	n/a	673	(100.00%)	
Consumer's surplus	$ -	n/a	$ 53,392	(100.00%)	$ -	n/a	$ 53,392	(100.00%)	

1. Number of firms does not add up to the total because individual firms may engage in more than one activity.
2. Percent of TERSA (See Table 15) by activity and total in parentheses.
3. Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus.

Private boat activity does not involve losses to commercial recreation operators, therefore the only impacts are in loss of person-days of activity and in consumer's surplus. Lacking any information with regard to the distribution of the activity, the assumption was made that all of the activity takes place within the boundary alternative.

Market Economic Values. Eleven of the twelve charter boats operating within the TERSA would be potentially affected by this alternative. Direct business revenue would include potential losses of 86.7% for diving for lobsters, 69.0% for spearfishing, and

12.9% for fishing. Across all three consumptive recreational activities, 34.1% of revenue would be potentially affected (Table 19).

Through the ripple or multiplier effects, 45% of output/sales, income and employment associated with all the consumptive recreational activities in the TERSA could potentially be lost (Table 22). Although these effects could have significant affect on the ten firms operating in the TERSA, the affect would not likely be noticed in the Monroe County economy because the affect would amount to only a fraction of a percent of the total economy supported by recreating visitors to the Florida Keys (Table 23).

Table 21. Calculation of Maximum Potential Market Economic Losses: Consumptive Recreation

	TERSA	Alternative II		III Preferred Alternative		Alternative IV		Alternative V	
Within FKNMS Boundary									
Revenue[1]	$ 970,323	$ 123,239	(12.70%)	$ 123,239	(12.70%)	$ 344,566	(35.51%)	$ 344,566	(35.51%)
Output/Sales[2,5]	$ 1,086,762	$ 138,028	(12.70%)	$ 138,028	(12.70%)	$ 385,914	(35.51%)	$ 385,914	(35.51%)
Income[3,5]	$ 413,217	$ 52,482	(12.70%)	$ 52,482	(12.70%)	$ 146,735	(35.51%)	$ 146,735	(35.51%)
Employment[4,5]	18	2	(12.70%)	2	(12.70%)	6	(35.51%)	6	(35.51%)
Outside FKNMS Boundary									
Revenue[1]	$ 329,260	$ -	(0.00%)	$ 28,815	(8.75%)	$ 28,815	(8.75%)	$ 98,162	(29.81%)
Output/Sales[2,5]	$ 368,771	$ -	(0.00%)	$ 32,273	(8.75%)	$ 32,273	(8.75%)	$ 109,941	(29.81%)
Income[3,5]	$ 140,217	$ -	(0.00%)	$ 12,271	(8.75%)	$ 12,271	(8.75%)	$ 41,803	(29.81%)
Employment[4,5]	6	0	(0.00%)	1	(8.75%)	1	(8.75%)	2	(29.81%)
Total									
Revenue[1]	$ 1,299,583	$ 123,239	(9.48%)	$ 152,054	(11.70%)	$ 373,381	(28.73%)	$ 442,728	(34.07%)
Output/Sales[2,5]	$ 1,455,533	$ 138,028	(9.48%)	$ 170,300	(11.70%)	$ 418,187	(28.73%)	$ 495,855	(34.07%)
Income[3,5]	$ 553,435	$ 52,482	(9.48%)	$ 64,753	(11.70%)	$ 159,006	(28.73%)	$ 188,538	(34.07%)
Employment[4,5]	24	2	(9.48%)	3	(11.70%)	7	(28.73%)	8	(34.07%)

1. Total Revenue from Tables 16-19.
2. Output is derived by multiplying Revenue by a multiplier of 1.12.
3. Income is calculated by dividing total output by the total output to total income ratio for Monroe County (2.63).
4. Employment is calculated by dividing total income by the total income to jobs ratio for Monroe County (23,160).
5. The multiplier, total output to total income ratio, and total income to jobs ratio are taken from English, et. al. 1996

Table 22. Summary of Maximum Total Potential Losses from Displacement: Consumptive Recreation

	TERSA	Alternative II		III Preferred Alternative[1]		Alternative IV		Alternative V	
Market Impacts									
Output/Sales	$ 1,086,762	$ 138,028	(12.70%)	$ 170,300	(15.67%)	$ 418,187	(38.48%)	$ 495,855	(45.63%)
Income	$ 413,217	$ 52,482	(12.70%)	$ 64,753	(15.67%)	$ 159,006	(38.48%)	$ 188,538	(45.63%)
Employment	18	2	(11.21%)	3	(16.81%)	7	(39.23%)	8	(44.84%)
Non-market Impacts									
Consumer's Surplus	$ 1,665,643	$ 102,965	(6.18%)	$ 127,029	(7.63%)	$ 320,791	(19.26%)	$ 381,108	(22.88%)
Producer's Surplus (profit)	$ 355,662	$ 50,225	(14.12%)	$ 55,786	(15.69%)	$ 145,509	(40.91%)	$ 172,330	(48.45%)

1. Percent of TERSA in parentheses.

Table 23. Comparison to the Economic Contribution of Various Visitors to the Florida Keys and Monroe County

	Monroe County	Alternative II	III Preferred Alternative[1]	Alternative IV	Alternative V
Output/Sales	$ 1,548,762,097	0.009%	0.011%	0.027%	0.032%
Income	$ 573,566,049	0.009%	0.011%	0.028%	0.033%
Employment	18,892	0.011%	0.016%	0.037%	0.042%

1. For year June 1997 - May 1998. Represents total impact of spending by recreating visitors (non-residents of Monroe County) on economy of Monroe County. See Leeworthy and Vanasse, 1999.

Addendum to Economic Impact Estimates based on One Commentor's Revised Input

Economic Impact Estimates based on Commentor's Revised Input. In the course of the public comment period, several pieces of correspondence were received from a charter spearfishing operator indicating information and data that differ from that which he provided to us during our initial interview with him conducted on December 10, 1998. We make no judgements about the accuracy of the commentor's revised estimates but we show the implications of incorporating the additional information that was submitted. The following are impact estimates based on the revised information received. These estimates are based on the assumption of a constant rate of profit, where no revised profit is indicated and a constant relationship between revenue and person-days of activity. The first column is *the company's revised estimates*, the second is the revised estimates for *Spearfishing* and the third is the revised estimates for *Total Consumptive Recreational Activities.*

The revised estimates indicate maximum potential impact on spearfishing and total consumptive recreational use based on the commentor's revised estimates (Tables 24-27). It must be noted that these estimates were submitted after the analysis based upon the alternative boundaries, including the Preferred Alternative, was complete.

Table 24. Data from original survey - Revised Assumption: all activity takes place within Preferred Boundary Alternative (based on comments received in June 2000).

	DeMauro	Spearfishing Total	Total Consumptive
Revenue:	$214,000	$245,142	$301,565
Profit:	$124,000	$130,160	$150,225
Person-days of activity	1,650	1,860	3,194
Total Output/Sales Impact:	$239,680	$274,519	$337,713
Total Income Impact:	$91,133	$104,395	$128,423
Total Employment Impact:	4	4	5
Consumer's Surplus	$151,465	$170,743	$284,812

Table 25. Revised Assumption: Revenue $288,000, Profit $144,000 and all activity takes place within Preferred Boundary Alternative (based on comments submitted in June 2000).

	DeMauro	Spearfishing Total	Total Consumptive
Revenue:	$288,000	$319,142	$375,565
Profit:	$144,000	$150,160	$170,225
Person-days of activity	2,221	2,431	3,765
Total Output/Sales Impact:	$322,560	$357,399	$420,593
Total Income Impact:	$122,646	$135,908	$159,936
Total Employment Impact:	5	5	6
Consumer's Surplus	$203,841	$223,119	$337,188

Table 26. Revised Assumption: Revenue $416,000 and all activity takes place within Preferred Boundary Alternative (based on comments submitted in June 2000).

	DeMauro	Spearfishing Total	Total Consumptive
Revenue:	$416,000	$447,142	$503,565
Profit:	$241,047	$247,207	$267,272
Person-days of activity	3,207	3,417	4,751
Total Output/Sales Impact:	$465,920	$500,759	$563,953
Total Income Impact:	$177,156	$190,418	$214,446
Total Employment Impact:	8	8	9
Consumer's Surplus	$294,437	$313,715	$427,784

Table 27. Revised Assumption: Revenue $460,000 and all activity takes place within Preferred Boundary Alternative (based on comments submitted in May 2000).

	DeMauro	Spearfishing Total	Total Consumptive
Revenue:	$460,000	$491,142	$547,565
Profit:	$266,542	$272,702	$292,767
Person-days of activity	3,547	3,757	5,091
Total Output/Sales Impact:	$515,200	$550,039	$613,233
Total Income Impact:	$195,894	$209,156	$233,184
Total Employment Impact:	8	8	9
Consumer's Surplus	$325,579	$344,857	$458,926

Mitigating Factors – Are the Potential Losses Likely?

In the above GIS-based analysis, effects are referred to as "potential losses." The reason is that there are several factors that could mitigate these potential losses and further there is a possibility that there might not be any losses at all. It is quite possible that there might be actual benefits to even the current displaced users. These factors are referred to only in qualitative terms because it is not possible to quantify them. Below two possible mitigating factors, how likely they might mitigate the potential losses from displacement, and further how this might differ for each of the three alternatives are discussed.

Substitution. If displaced users are simply able to relocate their activities, they may be able to fully or partially mitigate their losses. This of course depends on the availability of substitute sites and further depends on the substitute site qualities. Several scenarios are possible. Even when total activity remains constant (*i.e.*, person-days remain the same as they simply go to other sites), if the quality of the site is lower there could be some loss in consumer's surplus. If it costs more to get to the substitute sites, there could still be increases in costs and thus lower profits. If there is not a completely adequate supply of substitute sites, then there could be losses in total activity and in all the non-market and market economic measures referenced in our above analysis of displaced use. The possibilities for substitution vary by alternative.

Long-term benefits from Replenishment Effects. Ecological reserves or marine reserves may have beneficial effects beyond the direct ecological protection for the sites themselves. That is, both the size and number of fish, lobster and other invertebrates both inside and outside the reserves may increase. The following quote from Davis (1998) summarizes what is currently known about the replenishment effect of reserves:

> *[W]e found 31 studies that tested whether protected areas had an effect on the size, reproductive output, diversity, and recruitment of fish in adjacent areas. Fisheries targeted species were two to 25 times more abundant in no-take areas than in surrounding areas for fish, crustaceans, and mollusks on coral and temperate reefs in Australia, New Zealand, the Philippines, Japan, Kenya, South Africa, the Mediterranean Sea, Venezuela, Chile, and the United States (California, Florida and Rhode Island). Mean sizes of fished species protected in no-take zones were 12 to 200 percent larger than those in surrounding areas for all fishes studied and in 75 to 78 percent of the invertebrates. Eighty-six percent of the studies that tested fishery yields found that catches within three kilometers of the marine protected areas were 46 to 50 percent higher than before no-take zones were created. It is clear that fishers all over the world believe no-take zones increase yields because they fish as close to the boundaries as possible.*

The long-term benefits from the reserve could offset any losses from displacement and may also result in long-term benefits and no costs to recreational users that are displaced by the proposed Tortugas Ecological Reserve. Again, this conclusion may still vary by alternative.

Boundary Alternative II

Substitution. Complete mitigation by substituting to alternative sites has a high probability for this alternative because over half of the Tortugas Bank would still be available for all consumptive recreation activities. Given the equal distribution of use for diving for lobsters and spearfishing on the Tortugas Bank, it is not likely that increased costs of relocation would occur or that there would be losses from users forced to go to sites of lower quality. Crowding effects, by pushing all the use currently spread over the whole Tortugas Bank onto half the bank, would also be unlikely given the small absolute amounts of activity. For fishing, only 1% of the activity would be displaced, so for this activity we would also expect there would be no crowding effects and recreational fishermen would not likely suffer any losses.

Long-term Benefits from Replenishment Effects. From Schmidt *et al.* (1999) there are five spawning areas identified in the western portion of the TERSA. On of these spawning areas is in the Alternative II boundary area. As mentioned previously, Alternative II is the portion of the Preferred Alternative that lies within the existing boundary of the Sanctuary. Therefore the long-term benefits to stocks derived from the portion of the Preferred Alternative that lies outside of the FKNMS boundary would not be realized. This alternative is the smallest of the three analyzed here and so the potential long-term benefits to stocks outside the protected area would be smaller than the other alternatives. But by the same token, the displaced activity to be mitigated is also much smaller and thus on net there is a high likelihood that there would be long-term benefits to all the consumptive recreational users in the TERSA.

Boundary Alternative III (Preferred Boundary Alternative)

Substitution. As with Alternative II, complete mitigation by substituting to alternative sites has a high probability for this alternative because of the small proportion of the Tortugas Bank included in the alternative. Given the equal distribution of use for diving for lobsters and spearfishing on the Tortugas Bank, it is not likely that increased costs of relocation would occur or that there would be losses from users forced to go to sites of lower quality. Crowding effects, again, would be unlikely given the small absolute amounts of activity. For fishing, only 3% of the activity would be displaced, so recreational fishermen would not likely suffer any losses.

Long-term Benefits from Replenishment Effects. Again, from Schmidt *et al.* (1999) three of the five spawning sites identified in the western portion of the TERSA are located within the boundary of this alternative. Because this alternative includes areas outside the Sanctuary, the potential long-term benefits to stocks outside the protected area would be comparatively larger than it would be for Alternative II. The mitigating effort required on the part of operators in the boundary alternative would be also be comparatively larger, but as mentioned above, because of the small percentage of the active recreational area included in the alternative, the effect is likely to be very small. Therefore, there is a high likelihood that there would be long-term benefits to all the consumptive recreational users in the TERSA.

Boundary Alternative IV

Substitution. Under this alternative, about 73% of the diving for lobsters and 72% of the spearfishing would be displaced. The potential for substituting to other sites is greatly reduced as compared with alternatives II and III. The reason is that under this alternative all of the Tortugas Bank falls within this boundary alternative. Some substitution is possible, but the probability of crowding effects rises considerably for diving for lobsters and spearfishing.

For fishing, substitution mitigating all the losses is still highly probable since only about 6% of the fishing activity would be displaced. This represents a relatively low amount of activity and given the wide distribution of this activity in the study area, crowding effects are still a low probability under this alternative.

Long-term Benefits from Replenishment Effects. Again, from Schmidt *et al.* (1999) four of the five spawning sites identified in the western portion of the TERSA are located within the boundary of this alternative. For diving for lobsters and spearfishing, it is not clear whether there would be significant benefits offsite given that most of this activity currently takes place on the Tortugas Bank and none of the bank is available for the activity. Not much is currently known about other areas which might benefit from the stock effect and where they could relocate to reap these benefits. Whether those doing the activities displaced could find alternative sites where both the quantity and quality of activity could be maintained or enhanced seems less likely given the extent of displacement.

For fishing, however, the small amount of displacement relative to the entire area plus the wider distribution of fishing activity still makes it highly likely that the long-term benefits of replenishment would more than offset the potential losses from displacement resulting in net benefits to this group.

Boundary Alternative V

Substitution. This alternative displaces about 87% of the diving for lobsters and 85% of the spearfishing. Substitution possibilities for these activities are reduced even more, meaning that losses given in Table 21 are more likely to actually occur.

For fishing, mitigating all the losses through substitution is still highly probable since only about 8% of the fishing activity would be displaced. This again, represents a relatively low amount of activity and given the wide distribution of this activity in the study area, crowding effects are still a low probability under this alternative.

Long-term Benefits from Stock Effects. Again, from Schmidt *et al.* (1999) four of the five spawning sites identified in the western portion of the TERSA are located within the boundary of this alternative. However, because the entire Tortugas Bank would be closed to diving for lobsters and spearfishing and the additionally large area encompassed by the proposed reserve, it is highly unlikely that these two user groups would benefit from the enhanced stocks of lobster and fish. Therefore, under this alternative, the maximum potential losses listed in Table 21 are highly likely to occur.

For fishing, however, the stock effects for the reserve could be substantial. Whether the benefits would be large enough to offset the displacement cannot immediately be determined. But given the past experience with reserves, it is still somewhat likely that the long-term benefits would offset the displacement costs yielding net benefits.

Benefits of the Proposed Tortugas Ecological Reserve to Recreational Users

Recreational Users on Entire Florida Keys Reef Tract. Above we discussed the possibility that consumptive recreational users could possibly benefit if there were long-term offsite impacts. But given the work by Ault *et al.* (1998), Bohnsack and Ault (1996), Bohnsack and McClellan (1998), and Lee *et al.* (1994 and 1999), there is also the possibility that a protected area in the Tortugas could yield beneficial stock effects to a wide variety of species all along the entire Florida Keys reef tract and to species such as sailfish that are primarily offshore species. Even small increases in recreational tourist activities along the entire Florida Keys reef tract could more than offset the total displacements from the most extreme alternative analyzed here. Table 22 shows the total effects for each alternative relative to the total Florida Keys recreational visitor economic contribution. They are only fractions of a percent of the total recreational visitor economic contribution. One-tenth of one percent increase in the total recreational visitor contribution along the entire Florida Keys reef tract would more than offset the maximum potential losses from alternative V (Table 21).

Non-consumptive Users (Divers) in Tortugas. Currently there is one operator that brings divers to the TERSA for non-consumptive diving. There were 1,048 person-days of non-consumptive diving which account for 4.98% of the total recreational activity in the TERSA (excluding the National Park). Of the total non-consumptive diving, 83.3% is currently done within the FKNMS boundary. Table 29 summarizes the information for non-consumptive divers. We expect that this group would be benefited by Tortugas

North. As the site improves in quality, we would expect that the demand for this site would increase and person-days, consumer's surplus, business revenues and profits would all increase. This would be expected to vary by alternative with the more protective alternatives having greater benefits.

Table 28. Non-consumptive Diving

	TERSA	Alternative II		III Preferred Alternative		Alternative IV		Alternative V	
Within FKNMS Boundary									
Person-Days	873	279	(31.96%)	279	(31.96%)	768	(87.97%)	768	(87.97%)
Revenue	$ 95,123	$ 30,439	(32.00%)	$ 30,439	(32.00%)	$ 83,708	(88.00%)	$ 83,708	(88.00%)
Cost	$ 58,157	$ 18,610	(32.00%)	$ 18,610	(32.00%)	$ 51,178	(88.00%)	$ 51,178	(88.00%)
Profit	$ 36,966	$ 11,829	(32.00%)	$ 11,829	(32.00%)	$ 32,530	(88.00%)	$ 32,530	(88.00%)
Number of Firms	1	1	(100.00%)	1	(100.00%)	1	(100.00%)	1	(100.00%)
Consumer Surplus	$ 77,198	$ 24,710	(32.01%)	$ 24,710	(32.01%)	$ 67,954	(88.03%)	$ 67,954	(88.03%)
Outside FKNMS Boundary									
Person-Days	175	-	(0.00%)	-	(0.00%)	-	(0.00%)	140	(80.00%)
Revenue	$ 19,025	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ 15,220	(80.00%)
Cost	$ 11,631	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ 9,305	(80.00%)
Profit	$ 7,393	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ 5,915	(80.01%)
Number of Firms	1	-	(0.00%)	-	(0.00%)	-	(0.00%)	1	(100.00%)
Consumer Surplus	$ 15,475	$ -	(0.00%)	$ -	(0.00%)	$ -	(0.00%)	$ 12,355	(79.84%)
Total									
Person-Days	1,048	279	(26.62%)	279	(26.62%)	768	(73.28%)	908	(86.64%)
Revenue	$ 114,148	$ 30,439	(26.67%)	$ 30,439	(26.67%)	$ 83,708	(73.33%)	$ 98,928	(86.67%)
Cost	$ 69,788	$ 18,610	(26.67%)	$ 18,610	(26.67%)	$ 51,178	(73.33%)	$ 60,483	(86.67%)
Profit	$ 44,359	$ 11,829	(26.67%)	$ 11,829	(26.67%)	$ 32,530	(73.33%)	$ 38,445	(86.67%)
Number of Firms	1	1	(100.00%)	1	(100.00%)	1	(100.00%)	1	(100.00%)
Consumer Surplus	$ 92,673	$ 24,710	(26.66%)	$ 24,710	(26.66%)	$ 67,954	(73.33%)	$ 80,309	(86.66%)

COMMERCIAL FISHERY

Boundary Analysis

Boundary Analysis Methodology. In performing the boundary analysis, for the each alternative, the impact estimates are broken out by "within the FKNMS boundary" and "outside the FKNMS boundary."

Commercial fishing is prohibited in the DRTO so these grid cells are "true" zeroes in the analysis. Before breaking out the impact, the status of each grid cell (*i.e.*, inside or outside of the boundary) had to be determined. Two methods were considered to carry out this task: the "centroid method" and the "intersection method." The centroid method characterizes a grid cell as within a boundary if the center point of the cell is within the boundary. The intersection method characterizes a grid cell as within a boundary if any part of the cell is intersected by the boundary. The centroid method was selected because it was more consistent with how the data were collected (*i.e.*, 1 square nm grid cells was the finest resolution).

The interpretation of the estimates provided in this analysis is critical to understanding the "true" impact of the various alternatives proposed for the Tortugas Ecological Reserve. The estimates from our geographic information system (GIS) analysis for the different boundary alternatives are simply the sum of each measurement within the boundary for a given alternative. The estimates therefore represent the maximum total potential loss from displacement of the commercial fishing activities. This analysis ignores possible mitigating factors and the possibility of net benefits that might be derived if the proposed ecological reserve has replenishment effect. Although the extent of the mitigating factors or the potential benefits from replenishment cannot be quantified, these as well as other potential benefits of the proposed ecological reserve are discussed after presenting and discussing the maximum potential losses from displacement of the current commercial fisheries.

The boundary analysis is driven by the catch summed across grid cells within each boundary alternative. The set of relationships, measures and methods described in Leeworthy and Wiley (1999) are then used to translate catch into estimates of market and non-market economic values potentially affected. These estimates are broken-down by area both inside and outside FKNMS boundary and are done by species. Table 30 shows the results for catch for each alternative. Catch for the total TERSA is also presented to allow assessment of the proportion of the TERSA fishery potentially affected by each alternative.

Table 29. TERSA Catch Potentially Lost from Displacement, 1997

	Species/Species Group (Pounds)/Percent[1]							
Alternative/Area	King Mackerel		Lobster		Reef Fish		Shrimp	
TERSA	**96,346**		**937,952**		**574,642**		**715,500**	
Inside FKNMS	77,285	(80.22%)	568,399	(60.60%)	293,374	(51.05%)	183,262	(25.61%)
Outside FKNMS	19,061	(19.78%)	369,553	(39.40%)	281,268	(48.95%)	532,238	(74.39%)
Alternative II	**4,057**		**56,625**		**74,494**		**7,940**	
Inside FKNMS	4,057	(100.00%)	56,625	(100.00%)	74,494	(100.00%)	7,940	(100.00%)
Outside FKNMS	-	(0.00%)	-	(0.00%)	-	(0.00%)	-	(0.00%)
Preferred Alternative	**13,489**		**108,639**		**116,642**		**58,374**	
Inside FKNMS	4,057	(30.08%)	56,802	(52.29%)	74,494	(63.87%)	7,940	(13.60%)
Outside FKNMS	9,432	(69.92%)	51,837	(47.71%)	42,148	(36.13%)	50,434	(86.40%)
Alternative IV	**14,999**		**153,778**		**161,997**		**58,374**	
Inside FKNMS	5,568	(37.12%)	101,940	(66.29%)	119,849	(73.98%)	7,940	(13.60%)
Outside FKNMS	9,431	(62.88%)	51,838	(33.71%)	42,148	(26.02%)	50,434	(86.40%)
Alternative V	**14,999**		**164,908**		**169,907**		**73,427**	
Inside FKNMS	5,568	(37.12%)	101,940	(61.82%)	119,849	(70.54%)	7,940	(10.81%)
Outside FKNMS	9,431	(62.88%)	62,968	(38.18%)	50,058	(29.46%)	65,487	(89.19%)

1. Percents of catch inside and outside FKNMS in parentheses.

The boundary alternatives are ordered according to size and potential impact. Alternative I is the "No Action" alternative and is the least protective alternative. Alternative III is the "Preferred Alternative". Alternatives IV and V are the largest and "most protective" alternatives. For catch, generally the higher the alternative number the greater the potential affect on catch, except for King mackerel and shrimp. Potential affect on King mackerel catch is the same for both alternatives IV and V and, the potential affect on shrimp catch is the same for the Preferred Alternative (III) and alternative IV.

Both the market and non-market economic values potentially lost from displacement for each alternative, except the "No-action" Alternative (Boundary Alternative I), are summarized in Leeworthy and Wiley (2000), includes greater detail by species/species groups, and for the market economic values, separate estimates for Monroe and Collier/Lee counties. Although the impacts on only Monroe and Collier/Lee counties are presented, the catch impacted that is landed in other counties is included in the analyses. The result is that the impacts in Monroe and Collier/Lee Counties are slightly overstated. However, in the boundary alternative analyses only a small amount of catch is landed in other counties and the amounts are insignificant.

Table 30. Maximum Potential Losses to the Commercial Fisheries from Displacement

		Alternatives			
Area/Measure	Total TERSA	Alternative II	Preferred Alternative	Alternative IV	Alternative V
Total TERSA					
Market[1]					
Harvest Revenue	$ 6,884,992	$ 411,632	$ 843,583	$ 1,126,237	$ 1,224,849
Total Output	$ 14,957,717	$ 865,819	$ 1,817,843	$ 2,400,730	$ 2,621,627
Total Income	$ 9,273,785	$ 536,808	$ 1,127,063	$ 1,488,453	$ 1,625,409
Total Employment	404	23	49	65	71
Non-market					
Consumer's Surplus[2]	$ 7,537,781	$ 473,097	$ 879,973	$ 1,103,808	$ 1,239,587
Producer's Surplus[3]	$ -	$ -	$ -	$ -	$ -
Return to Labor & Capital[4]	$ 1,926,162	$ 106,789	$ 221,968	$ 300,599	$ 326,880
Inside FKNMS					
Market					
Harvest Revenue	$ 3,476,456	$ 411,632	$ 411,632	$ 694,284	$ 694,284
Total Output	$ 7,292,387	$ 865,819	$ 865,819	$ 1,448,700	$ 1,448,700
Total Income	$ 4,521,280	$ 536,808	$ 536,808	$ 898,194	$ 898,194
Total Employment	197	23	23	39	39
Non-market					
Consumer's Surplus	$ 3,890,933	$ 473,097	$ 473,097	$ 696,932	$ 696,932
Producer's Surplus	$ -	$ -	$ -	$ -	$ -
Return to Labor & Capital	$ 1,029,118	$ 106,789	$ 106,789	$ 185,420	$ 185,420
Outside FKNMS					
Market					
Harvest Revenue	$ 3,408,536	$ -	$ 431,951	$ 431,953	$ 530,565
Total Output	$ 7,665,330	$ -	$ 952,024	$ 952,030	$ 1,172,927
Total Income	$ 4,752,505	$ -	$ 590,255	$ 590,259	$ 727,215
Total Employment	207	-	26	26	32
Non-market					
Consumer's Surplus	$ 3,646,848	$ -	$ 406,876	$ 406,876	$ 542,655
Producer's Surplus	$ -	$ -	$ -	$ -	$ -
Return to Labor & Capital	$ 897,044	$ -	$ 115,179	$ 115,179	$ 141,460

1. Market economic measures include impacts on Monroe County and Collier/Lee counties. See Appendix A, Tables A.6 – A.11 in Leeworthy and Wiley (1999) for details by species and counties.
2. Maximum values from each species were used when range of estimates was generated from multiple demand equations. See Appendix B in Leeworthy and Wiley (1999) for detailed calculations by species and alternatives.
3. Producer's surplus or economic rents were assumed to be zero for two reasons. First, all fisheries, except spiny lobsters, are open access fisheries and therefore economic rents would be zero i.e., firms are earning only normal rates of return on investment. Second, even using total return to labor & capital, which overstates return on investment, does not yield rates of return on investment above normal rates of return.
4. Return to Labor & Capital is not a non-market value but would include rent if it existed.

Boundary Alternative I: No Action

The no action alternative simply means that the proposed Tortugas Ecological Reserve would not be established and the corresponding no-take regulations would not be implemented. The no action alternative has a simple interpretation in that any costs of imposing the no-take regulations, for any given alternative with no-take regulations, would be the benefits of the no action alternative. That is, by not adopting the no-take regulations, the costs are avoided. Similarly, any benefits from imposing the no-take regulations, for any given alternative with no-take regulations, would be the costs of the no action alternative. That is, by not adopting the no-take regulations, the costs are the benefits lost by not adopting the no-take regulations. Said another way, the opportunities lost. The effects of the no action alternative can only be understood by comparing it to one of the proposed alternatives. Thus the effects of the no action alternative can be obtained by reading the effects from any of the proposed alternatives in reverse.

Boundary Alternative II

Market Economic Values. This alternative could potentially affect 4.2% of the catch of King mackerel, 6% of the lobster catch, 12.96% of the Reef Fish catch, and 1% of the shrimp catch in the TERSA. This would lead to a reduction in about $411 thousand in harvest revenue or 6% of the TERSA harvest revenue. This reduction in revenue would result in a reduction of 5.8% of total output, income and employment generated by the TERSA fishery. Since this alternative was restricted to reside within FKNMS current boundary, the effects are all inside FKNMS boundary. Although these effects might seem significant to those firms that might potentially be affected, the overall affect on the local economies would be so small they would not be noticed. Harvest revenue potentially impacted was only 0.67% of all harvest revenue of catch landed in Monroe County. In addition, this lost revenue would translate (accounting for the multiplier effects) into only fractions of a percent of the total Monroe County economy; 0.035% of total output, 0.046% of total income and 0.045% of total employment.

Non-market Economic Values. For all species/species groups, this alternative could result in a potential loss of over $473 thousand in consumer’s surplus. This was 6.28% of the consumer’s surplus generated by the entire TERSA. Although producer’s surplus or economic rents are estimated to be zero, about 5.54% of the return to labor and capital of the TERSA fishery is potentially affected by this alternative.

Boundary Alternative III (Preferred Boundary Alternative)

Market Economic Values. This alternative could potentially affect 14% of the catch of King mackerel, 11.58% of the lobster catch, 20.30% of the Reef Fish catch, and 8.16% of the shrimp catch in the TERSA. This would lead to a reduction in about $844 thousand in harvest revenue or 12.26% of the TERSA harvest revenue. This reduction in revenue would result in a reduction of 12.16% of total output, income and employment generated by the TERSA fishery. The impacts are split almost evenly between the areas inside and outside the FKNMS boundary. Although these costs might seem significant to those firms that might potentially be affected, the overall affect on the local economies would be so small they would not be noticed. Harvest revenue potentially affected was only 1.16% of all harvest revenue of catch landed in Monroe County. In addition, this lost revenue would translate (accounting for the multiplier effects) into only fractions of a percent of the total Monroe County economy; 0.0596% of total output, 0.0779% of total income and 0.0785% of total employment.

Non-market Economic Values. For all species/species groups, this alternative could result in a potential loss of about $880 thousand in consumer's surplus. This was 11.7% of the consumer's surplus generated by the entire TERSA. Whereas the market economic values were almost evenly split inside and outside the FKNMS, 53.76% of the consumer's surplus potentially affected is from inside the FKNMS boundary. This is due to the distributions of lobster and reef fish catch where a higher proportion of the potentially affected catch come from inside the FKNMS boundary, whereas the distributions of shrimp and King mackerel come largely from outside the FKNMS boundary.

Although producer's surplus or economic rents are estimated to be zero, about 11.5% of the return to labor and capital of the TERSA fishery is potentially affected by this alternative. The distribution inside versus outside the FKNMS boundary follows that of the market economic values with 48% from catch inside the FKNMS boundary.

Boundary Alternative IV

Market Economic Values. This alternative could potentially affect 15.57% of the catch of King mackerel, 16.4% of the lobster catch, 28.19% of the Reef Fish catch, and 8.16% of the shrimp catch in the TERSA. This would lead to a reduction in about $1.126 million in harvest revenue or 16.45% of the TERSA harvest revenue. This reduction in revenue would result in a reduction of 16.05% of total output, income and employment generated by the TERSA fishery. About 61.65% of the harvest revenue and 60.34% of the output, income and employment impacts would come from catch displaced from within FKNMS boundary. Although the costs might seem significant to those firms that might potentially be affected, the overall impact on the local economies would be so small they would not be noticed. Harvest revenue potentially affected was only 1.82% of all harvest revenue of catch landed in Monroe County. In addition, this lost revenue would translate (accounting for the multiplier effects) into only fractions of a percent of the total Monroe County economy; 0.0968% of total output, 0.127% of total income and 0.1281% of total employment.

Non-market Economic Values. For all species/species groups, this alternative could result in a potential loss of about $1.1 million in consumer's surplus. This was 14.64% of the consumer's surplus generated by the entire TERSA. Approximately 63.14% of the consumer's surplus potentially affected is from catch from inside the FKNMS boundary. This is due to the distributions of lobster and reef fish catch where a higher proportion of the potentially affected catch come from inside the FKNMS boundary, whereas the distributions of shrimp and King mackerel come largely from outside the FKNMS boundary.

Although producer's surplus or economic rents are estimated to be zero, about 15.6% of the return to labor and capital of the TERSA fishery is potentially affected by this alternative. The distribution inside versus outside the FKNMS boundary follows that of the market economic values with 61.68% from catch inside the FKNMS.

Boundary Alternative V

Market Economic Values. This alternative could potentially affect 15.57% of the catch of King mackerel, 17.58% of the lobster catch, 29.57% of the Reef Fish catch, and 10.26% of the shrimp catch in the TERSA. This would lead to a reduction in about $1.224 million in harvest revenue or 17.89% of the TERSA harvest revenue. This reduction in revenue would result in a reduction of 17.5% of total output, income and employment generated by the TERSA fishery. About 56.68% of the harvest revenue and 55.26% of the output, income and employment impacts would come from catch displaced from within the FKNMS boundary. Although the costs might seem significant to those firms that might potentially be affected, the overall impact on the local economies would be so small they would not be noticed. Harvest revenue potentially affected was only 1.98% of all harvest revenue of catch landed in Monroe County. In addition, this lost revenue would translate (accounting for the multiplier effects) into only fractions of a percent of the total Monroe County economy; 0.106% of total output, 0.138% of total income and 0.1399% of total employment.

Non-market Economic Values. For all species/species groups, this alternative could result in a potential loss of about $1.24 million in consumer's surplus. This was 16.4% of the consumer's surplus generated by the entire TERSA. 56.2% of the consumer's surplus potentially affected is from catch from inside the FKNMS boundary. This is due to the distributions of lobster and reef fish catch where a higher proportion of the potentially affected catch come from inside the FKNMS boundary, whereas the distributions of shrimp and King mackerel come largely from outside the FKNMS boundary.

Although producer's surplus or economic rents are estimated to be zero, about 16.97% of the return to labor and capital of the TERSA fishery is potentially affected by this alternative. The distribution inside versus outside the FKNMS boundary follows that of the market economic values with 56.7% from catch inside the FKNMS boundary.

Profiles of Fishermen Potentially Affected

A profile of the approximately 110 fishermen using TERSA based on a sample of 90 was completed with a comparison with other commercial fishermen in Monroe County. The profiles of those potentially affected by each alternative were compared. The profiles are summarized in Table 31. Statistical tests were performed comparing the sample distributions for the groups that fished within each boundary alternative as compared with TERSA fishermen as a whole. Except for the number of fishing operations potentially affected, the only significant differences for all alternatives were in membership in organizations and in fish house usage.

Fishermen potentially affected by Boundary Alternative II were the only group that was significantly different for any other characteristics listed in Table 31. These fishermen had less experience fishing in Monroe County than the general TERSA fishermen, however they were not significantly different with respect to years fishing in the TERSA. Fishermen potentially affected by Boundary Alternative II also earned a significantly lower proportion of their income from fishing than the general TERSA fishermen; however, they earned a significantly higher proportion of their income from fishing within the TERSA than the general TERSA fishermen.

Fishermen potentially affected by Boundary Alternative II were also significantly different from the general TERSA fishermen in the distribution of their primary hauling port. A significantly higher proportion of those potentially affected by this alternative used Key West/Stock Island and Tavenier than the general TERSA fishermen, and they used Big Pine Key, Marathon and Naples/Ft. Myers significantly less than the general TERSA fishermen.

Fifty-one (51) or 57% of the sampled fishing operations could be potentially affected by Boundary Alternative II followed by 64 operations or 71% for Alternative III, and 65 operations or 72% for both Alternatives IV and V. Twenty-four (24) of the 28 or 86% of all the lobster operations could be potentially affected by Boundary Alternative II, while 27 of the 28 lobster operations or 96% are potentially affected by Boundary Alternatives III, IV, and V. Six (6) of the 18 or 33.3% of the shrimp operations are potentially affected by Alternative II, while Alternative III could potentially affect 15 of 18 or 83% of the shrimp operations. Boundary Alternatives IV and V could potentially affect 14 of the 18 or 78% of the shrimp operations. Fifteen (15) of the 16 King mackerel operations could be potentially affected by Boundary Alternative II, while Boundary Alternatives III, IV and V could potentially affect all 16 of the King mackerel operations. Thirty-seven (37) of the 42 or 88% of the reef fish operations could be potentially affected by Alternative II, while 40 or 95% of the reef fish fishing operations could be potentially affected by Alternative III. Boundary Alternatives IV and V could potentially affect all 42 reef fish operations.

Table 31. Profile of TERSA Fishermen Compared to Other Keys Fishermen

	TERSA (%)	Alternative II	Preferred Alternative	Alternative IV	Alternative V
			Age		
18-30	13.3	19.6	15.6	15.4	15.4
31-40	18.9	19.6	18.8	20.0	20.0
41-50	36.7	29.4	34.4	33.8	33.8
51-60	20.0	21.6	21.9	21.5	21.5
Over 60	11.1	9.8	9.4	9.2	9.2
			Years of Fishing in Monroe		
Less than one year	1.1	**2.0**	1.6	1.5	1.5
1-5 years	6.7	**9.8**	7.8	7.7	7.7
6-10 years	12.4	**13.7**	12.5	12.3	12.3
11-20 years	16.9	**19.6**	17.2	18.5	18.5
21 or more years	62.9	**54.9**	60.9	60.0	60.0
			Years of Fishing in TERSA		
1-5 years	10.1	9.8	10.9	10.8	10.8
6-10 years	25.8	25.5	20.3	21.5	21.5
11-20 years	16.9	17.6	17.2	18.5	18.5
21 or more years	47.2	47.1	51.6	49.2	49.2
			Race/Ethnicity		
Anglo-American	76.7	74.5	78.1	78.5	78.5
Hispanic	21.1	25.5	20.3	20.0	20.0
African-American	2.2	0.0	1.6	1.5	1.5
			Membership in Organizations		
Conch Coalition	7.0	**3.9**	**3.1**	**3.1**	**3.1**
OFF	12.0	**9.8**	**7.8**	**7.7**	**7.7**
MCCF	38.0	**23.5**	**21.9**	**21.5**	**21.5**
Environmental	2.0	**3.9**	**4.7**	**4.6**	**4.6**
Chambers of Commerce	303.0	**2.0**	**4.7**	**4.6**	**4.6**

Table 31. Continued

	TERSA (%)	Alternative II	Preferred Alternative	Alternative IV	Alternative V
			Occupation		
Full-time Commercial Fishing	87.8	84.3	85.9	86.2	86.2
Part-time Commercial Fishing	1.1	2.0	1.6	1.5	1.5
Charter Boat (sell some catch)	11.1	13.7	12.5	12.3	12.3
			Income		
Percent Income from Fishing	89.1	**84.3**	87.3	87.5	87.5
Percent Income from Fishing in TERSA	44.7	**51.2**	46.8	45.9	45.9
			Family Members Supported		
1 (Myself)	19.3	17.0	15.5	16.9	16.9
2	28.9	27.7	29.3	27.1	27.1
3	22.9	29.8	27.6	28.8	28.8
4 or more	28.9	25.5	27.6	27.2	27.2
			Primary Hauling Port		
Key West/Stock Island	74.4	**82.4**	75.0	72.3	72.3
Big Pine Key	4.4	**3.9**	4.7	4.6	4.6
Marathon	3.3	**0.0**	0.0	1.5	1.5
Tavernier	2.2	**3.9**	3.1	3.1	3.1
Naples/Ft. Myers	15.6	**9.8**	17.2	18.5	18.5
Fish House Usage (% Yes)	41.1	**35.3**	**35.9**	**36.9**	**36.9**
Number in Sample	90	51	64	65	65
Lobster Operations	28	24	27	27	27
Shrimp Operations	18	6	15	14	14
King Mackerel Operations	16	15	16	16	16
Reef Fish Operations	42	37	40	42	42

1. Numbers in bold identify statistically significant differences compared to total TERSA.
Kolgromov-Smirnoff two-sample test at 5 percent level of significance.

Other Potential Costs and Mitigating Factors – Are the Potential Losses Likely?

In the above GIS-based analysis, the effects are referred to as "potential losses" or "maximum potential losses". There is the possibility that there could be an additional cost not discussed but which cannot be quantified, that is, crowding and the resulting conflicts among users forced to compete in a smaller area. There are also several factors that could mitigate all the potential losses and further there is a possibility that there might not be any losses at all. It is quite possible that there might be actual net benefits to even the current displaced users. Below the issue of crowding costs and the mitigating factors and potential for beneficial outcomes are discussed in qualitative terms because it is not possible for us to quantify them. Two mitigating factors, how likely they might mitigate the potential losses from displacement, and how this might differ for each of the alternatives are discussed.

Crowding. As shown above, each of the alternatives would result in a certain amount of displacement. Displacement of commercial fishing activity is a certainty under all boundary alternatives, except Alternative I, the No-action Alternative. If this displacement results in the activity being transferred to other sites, there is a potential for crowding effects. Crowding effects could raise the costs of fishing, both private costs to each fishing operation and social costs in resolving conflicts.

Crowding conflicts were one of the issues mentioned when the State of Florida created the lobster trap certificate program which was designed to reduce the number of lobster traps. If fishing stocks outside the protected area are already fished to their limits (*i.e.*, limits of sustainable harvests), then displacement could also lead to adverse stock effects and a lower level of catch from all commercial fisheries. Crowding effects would represent a potential costs not accounted for in our above GIS-based analysis and the potential for the existence of crowding effects would vary by alternative. Whether crowding effects are experienced would depend on the status of the fisheries outside the proposed protected area, the extent of displacement, the current knowledge and fishing patterns of the displaced fishermen, and other potential regulations. The trap reduction program is an example where crowding effects could be mitigated by making room for the displaced traps.

Relocation. If displaced commercial fishermen are simply able to relocate their fishing effort and they are able to partially or completely replace their lost catch by fishing elsewhere, then there might be less or no affect. However, the possibility exists that displacement, even if it does not result in lower overall catch, may result in higher costs. This would result in lower profits to fishing operations. Whether fishermen are able to relocate to other fishing sites and replace lost catch or avoid cost increases would depend, like with the issue of crowding, on the status of the fisheries outside the proposed protected area, the extent of the displacement, the current knowledge and fishing patterns of the displaced fishermen, and other potential regulations.

Long-term benefits from Replenishment Effects. Ecological reserves or marine reserves may have beneficial effects beyond the direct ecological protection from the sites themselves. That is, both the size and number of fish, lobster, and other invertebrates both inside and outside the reserves may increase *i.e.*, the replenishment effect. The following quote from Davis 1998 summarizes what is currently known about the replenishment effect of reserves:

> *[W]e found 31 studies that tested whether protected areas had an effect on the size, reproductive output, diversity, and recruitment of fish in adjacent areas. Fisheries targeted species were two to 25 times more abundant in no-take areas than in surrounding areas for fish, crustaceans, and mollusks on coral and temperate reefs in Australia, New Zealand, the Philippines, Japan, Kenya, South Africa, the Mediterranean Sea,*

> *Venezuela, Chile, and the United States (California, Florida and Rhode Island). Mean sizes of fished species protected in no-take zones were 12 to 200 percent larger than those in surrounding areas for all fishes studied and in 75 to 78 percent of the invertebrates. Eighty-six percent of the studies that tested fishery yields found that catches within three kilometers of the marine protected areas were 46 to 50% higher than before no-take zones were created. It is clear that fishers all over the world believe no-take zones increase yields because they fish as close to the boundary as possible.*

The long-term benefits from the reserve could offset any losses from displacement and may also result in long-term benefits and no costs (net benefits) to commercial fishermen that would be displaced by a proposed reserve. Again, this conclusion may vary by alternative.

<u>Boundary Alternative II</u>

Crowding and Relocation. For the lobster fishery, it appears that the lobster trap reduction program could fully mitigate the potential for crowding costs. This boundary alternative would displace 2,228 traps. A ten percent reduction in traps in the TERSA would provide space for 3,690 traps. Further, lobster fishermen in the TERSA only catch 68% of their lobsters from the TERSA. Thus, lobster fishermen are knowledgeable about fishing in other areas of the Keys where they might move their displaced traps. Thus, under this boundary alternative their would be no crowding costs for lobsters and they would be able to replace catch from other areas. Thus, for lobsters, the potential economic losses identified in Table 29 are not likely to occur under alternative II.

Crowding is not an issue for King mackerel because they are a pelagic species and thus move around and catching them elsewhere is highly likely without interfering with other fishermen. Shrimp fishermen currently only catch ten percent of their total shrimp catch from the TERSA. Displacement of shrimp catch under Boundary Alternative II would only be about one percent of their TERSA catch and less than one percent of their total shrimp catch. It would seem highly likely that there would be no crowding costs from displacement and given the small amounts of catch affected, it is highly likely that shrimp fishermen would be able to replace lost catch from other sites. However, some shrimp fishermen have said that they cannot replace lost catch from other sites. Thus, for King mackerel, the potential economic losses identified in Table 29 are not likely to occur under Boundary Alternative II, but for shrimp the economic losses could range from zero to the maximum potential losses reported in Table 29.

Reef Fish fishermen comprise the largest group of TERSA fishermen. Under Boundary Alternative II, 37 of the sampled 42 fishermen would be affected. Reef fishermen are knowledgeable of other fishing locations outside the TERSA. In 1997, they caught 52% of their reef fish from areas in the Keys outside the TERSA. However, stocks of reef fish in the TERSA and throughout the Keys appear to be overfished. Alternative II displaces about 13% of the reef fish catch in the TERSA. Given the status of reef fish stocks, the losses identified in Table 29 are likely to occur in the short-term until the benefits of replenishment could off-set these losses in the longer-term.

Replenishment. No replenishment benefits to King mackerel or shrimp are expected. For lobsters and reef fish, replenishment benefits are expected. Davis (1998) provided an estimate that invertebrates and reef fish at other marine reserves had shown increases in yields of 46-50% within three kilometers of the protected areas. Also, from Schmidt *et al.* (1999) they identified 5 spawning areas in the western portion of the TERSA. Only one of the five spawning areas are located within the Alternative II boundary and would be protected, and to thus support the replenishment effect. For lobsters, we expect their to be long-term net benefits under Boundary Alternative II to the commercial fishery of the TERSA. For reef fish, it is not clear whether the full 13% lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses expected to be less than the 13% reductions that are the basis for the losses calculated and presented in Table 29.

<u>Boundary Alternative III (Preferred Boundary Alternative)</u>

Crowding and Relocation. For the lobster fishery, there is some potential for crowding costs. This boundary alternative would displace 4,346 traps. A ten percent reduction in traps in the TERSA would provide space for 3,690 traps. However, if the remaining 656 traps are relocated to zones 1-3 in the Keys, there would be more than adequate space given the 10% reduction in traps that took place in Monroe County between 1997-98 and 1998-99 (475,094 to 428, 411). See FMRI, 1998. Lobster fishermen in the TERSA only catch 68% of their lobsters from the TERSA. Thus, lobster fishermen are knowledgeable about fishing in other areas of the Keys where they might move their displaced traps. Thus, under this alternative their would be no crowding costs for lobsters and we expect they would be able to replace catch from other areas. Thus, for lobsters, the potential economic losses identified in Table 29 are not likely to occur under this alternative.

Crowding is not an issue for King mackerel because they are a pelagic species and thus move around and catching them elsewhere is highly likely without interfering with other fishermen. Shrimp fishermen currently only catch ten percent of their total shrimp catch from the TERSA. Displacement of shrimp catch under Boundary Alternative III (Preferred Boundary Alternative) would only be about eight percent of their TERSA catch and less than one percent of their total shrimp catch. It would seem highly likely that there would be no crowding costs from displacement and given the small amounts of catch affected, it is highly likely that shrimp fishermen would be able to replace lost catch from other sites. However, some shrimp fishermen have said that they cannot replace lost catch from other sites. Thus, for King mackerel, the potential economic losses identified in Table 29 are not likely to occur under Boundary Alternative III, but for shrimp the economic losses could range from zero to the maximum potential losses reported in Table 29.

Reef Fish fishermen comprise the largest group of TERSA fishermen. Under Boundary Alternative III (Preferred Boundary Alternative), 40 of the sampled 42 fishermen would be affected. Reef fishermen are knowledgeable of other fishing locations outside the TERSA. In 1997, they caught 52% of their reef fish from areas in the Keys outside the TERSA. However, stocks of reef fish in the TERSA and throughout the Keys appear to be overfished. Boundary Alternative III (Preferred Boundary Alternative) displaces 20% of the reef fish catch in the TERSA. Given the status of reef fish stocks, the losses identified in Table 29 are likely to occur in the short-term until the benefits of replenishment could off-set these losses in the longer-term.

Replenishment. No replenishment benefits to King mackerel or shrimp are expected. For lobsters and reef fish, replenishment benefits are expected. Davis (1998) reports increases in yields of invertebrates and reef fish of 46-50% within three kilometers of the protected areas at other marine reserves. Also, Schmidt *et al.* (1999) identified 5 spawning areas in the western portion of the TERSA. Three of the five spawning areas are located within the alternative III boundary and would be protected, thus bolstering the replenishment effect. For lobsters, long-term net benefits would be expected under Boundary Alternative III (Preferred Boundary Alternative). For reef fish, it is not clear whether the full 20% lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses expected to be less than the 20% reductions that are the basis for the losses calculated and presented in Table 29.

Boundary Alternative IV

Crowding and Relocation. For the lobster fishery, there is some potential for crowding costs. We estimate that this boundary alternative would displace 6,050 traps. A ten percent reduction in traps in the TERSA would provide space for 3,690 traps. However, if the remaining 2,360 traps are relocated to zones 1-3 in the Keys, there would be more than adequate space given the 10% reduction in traps that took place in Monroe County between 1997-98 and 1998-99 (475,094 to 428, 411). See FMRI, 1998. Lobster fishermen in the TERSA only catch 68% of their lobsters from the TERSA. Thus, lobster fishermen are knowledgeable about fishing in other areas of the Keys where they might move their displaced traps. Thus, under this alternative there would be no crowding costs for lobsters and fishermen would be able to replace catch from other areas. Thus, for lobsters, the potential economic losses identified in Table 29 are not likely to occur under Boundary Alternative IV.

Crowding is not an issue for King mackerel because they are a pelagic species and thus move around and catching them elsewhere is highly likely without interfering with other fishermen. Shrimp fishermen currently only catch ten percent of their total shrimp catch from the TERSA. Displacement of shrimp catch under Boundary Alternative IV would only be about eight percent of their TERSA catch and less than one percent of their total shrimp catch. It would seem highly likely that there would be no crowding costs from displacement and given the small amounts of catch affected, it is highly likely that shrimp fishermen would be able to replace lost catch from other sites. However, some shrimp fishermen have said that they cannot replace lost catch from other sites. Thus, for King mackerel, the potential economic losses identified in Table 29 are not likely to occur under Boundary Alternative IV, but for shrimp the economic losses could range from zero to the maximum potential losses reported in Table 29.

Reef fish fishermen comprise the largest group of TERSA fishermen. Under Boundary Alternative IV, all 42 of the sampled fishermen would be affected. Reef fishermen are knowledgeable of other fishing locations outside the TERSA. In 1997, they caught 52% of their reef fish from areas in the Keys outside the TERSA. However, stocks of reef fish in the TERSA and throughout the Keys appear to be overfished. Boundary Alternative IV displaces 28% of the reef fish catch in the TERSA. Given the status of reef fish stocks, the losses identified in Table 29 are likely to occur in the short-term until the benefits of replenishment could off-set these losses in the longer-term.

Replenishment. No replenishment benefits to King mackerel or shrimp are expected. For lobsters and reef fish, replenishment benefits are expected. Davis (1998) reports increases in yields of invertebrates and reef fish of 46-50% within three kilometers of the protected areas at other marine reserves. Also, Schmidt *et al*. (1999) identified 5 spawning areas in the western portion of the TERSA. Four of the five spawning areas are located within the Alternative IV boundary and would be protected, thus bolstering the replenishment effect. For lobsters, we expect their to be long-term net benefits under alternative IV to the commercial fishery of the TERSA. For reef fish, it is not clear whether the full 28% lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses expected to be less than the 28% reductions that are the basis for the losses calculated and presented in Table 29.

Boundary Alternative V

Crowding and Relocation. For the lobster fishery, there is some potential for crowding costs. This boundary alternative would displace 6,487 traps. A ten percent reduction in traps in the TERSA would provide space for 3,690 traps. However, if the remaining 2,797 traps are relocated to zones 1-3 in the Keys, there would be more than adequate space given the 10% reduction in traps that took place in Monroe County between 1997-98 and 1998-99 (475,094 to 428, 411). See FMRI, 1998. Lobster fishermen in the TERSA only catch 68% of their lobsters from the TERSA and they are knowledgeable about fishing in other areas of the Keys where they might move their displaced traps. Thus, under this boundary alternative there would be no crowding costs for lobsters and fishermen would be able to replace catch from other areas. Therefore, for lobsters, the potential economic losses identified in Table 29 are not likely to occur under Boundary Alternative V.

Crowding is not an issue for King mackerel because they are a pelagic species and thus move around and catching them elsewhere is highly likely without interfering with other fishermen. Shrimp fishermen currently only catch ten percent of their total shrimp catch from the TERSA. Displacement of shrimp catch under Boundary Alternative V would only be about ten percent of their TERSA catch and about one percent of their total shrimp catch. It would seem highly likely that there would be no crowding costs from displacement and given the small amounts of catch affected, it is highly likely that shrimp fishermen would be able to replace lost catch from other sites. However, some shrimp fishermen have said that they cannot replace lost catch from other sites. Thus, for King mackerel, the potential economic losses identified in Table 29 are not likely to occur under Boundary Alternative V, but for shrimp the economic losses could range from zero to the maximum potential losses reported in Table 29.

Reef fish fishermen comprise the largest group of TERSA fishermen. Of the 90 TERSA fishermen sampled, 42 were reef fish fishermen. Under Boundary Alternative V, all 42 would be affected. Reef fishermen are knowledgeable of other fishing locations outside the TERSA. In 1997, they caught 52% of their reef fish from areas in the Keys outside the TERSA. However, stocks of reef fish in the TERSA and throughout the Keys appear to be overfished. Boundary Alternative V displaces 29% of the reef fish catch in the TERSA. Given the status of reef fish stocks, the losses identified in Table 29 are likely to occur in the short-term until the benefits of replenishment could off-set these losses in the longer-term.

Replenishment. No replenishment benefits to King mackerel or shrimp are expected. For lobsters and reef fish, replenishment benefits are expected. Davis (1998) reports increases in yields of invertebrates and reef fish of 46-50% within three kilometers of the protected areas at other marine reserves. Also, Schmidt *et al*. (1999) identified 8 spawning areas in the western portion of the TERSA. Severn of the eight spawning areas are located within the Alternative V boundary and would be protected, thus bolstering the replenishment effect. For lobsters, long-term net benefits under Alternative V are expected. For reef fish, it is not clear whether the full 29% lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses expected to be less than the 29% reductions that are the basis for the losses calculated and presented in Table 29.

COMMERCIAL SHIPPING

No effect for any of the alternatives.

TREASURE SALVORS

No expected effect for any of the alternatives. One permit for inventorying submerged cultural resources in Sanctuary waters was issued for the Tortugas area of the Sanctuary. There were no submerged cultural resources found on the Tortugas Bank. Currently, it is unknown whether there are any submerged cultural resources on Riley’s Hump, located in Tortugas South.

OTHER POTENTIAL BENEFITS

In both the recreation industry (fishing and diving) and the commercial fishery sections above, the potential benefits to recreational and commercial fisheries from the replenishment effect of an ecological reserve were discussed. Also discussed in the recreation industry section were the potential benefits to non-consumptive recreational users (divers). Below, several of the most important benefits of an ecological reserve-non-use economic values, scientific values, and education values-are discussed.

Non-use Economic Values. Non-use or passive use economic values encompass what economists refer to as option value, existence value and other non-use values. See Kopp and Smith (1993) for a detailed discussion. All non-use economic values are based on the fact that people are willing to pay some dollar amount for a good or service they want but do not currently 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 condition and are willing to pay some dollar amount to ensure that actions are taken to keep the reserve in that condition.

Option value is a bit different from other non-use economic values in that option value is a willingness to pay for the possibility of some future use. The concept of option value was first introduced by Weisbrod (1964). As argued by Weisbrod, an individual uncertain as to whether he will visit some unique site at some future point in time would be willing to pay a sum in excess of his consumer's surplus to assure that the site would be available in the future should he wish to visit it. Option value then is characterized by uncertainty of both future supply and future demand. Some have questioned whether option value is a legitimate economic value, Freeman (1993). But, the U.S. Environmental Protection Agency (EPA) still lists option value as a legitimate value to be included in intrinsic benefits when conducting benefit-cost analysis required for proposed regulations by Executive Order 12886.

Other non-use values have traditionally been labeled according to motive (*e.g.*, existence value, bequeath value). The key distinctions between option value and other non-use values are that the other non-use values do not relate to any future use and uncertainty is not a factor. Existence value is an individual's willingness to pay a dollar amount to simply know that a resource will be protected in a given state. Bequeath value is an individual's willingness to pay a dollar amount to ensure the resource will be protected in a given state so one's heirs may have the opportunity to enjoy it. The motive themselves are unimportant as to the value's legitimacy, since, in economics, people's motives for their willingness to pay for any good or service are not questioned. Motives with respect to non-use values are used simply to differentiate them from use values. Randall and Stoll (1983) argued that when estimating non-use economic values, non-use economic values cannot be separated from use values for users of the resource. Methods available for estimating non-use economic values are only capable of revealing "total value" which cannot be broken down into separate components of use and non-use. Pure non-use economic values can only be estimated for non-users.

The terminology of "passive use" economic values has become more accepted when referring to non-use economic values. This change in terminology grew out of the debate over whether non-use economic values could actually be measured. People must have some knowledge of the resource they are being asked to place a dollar value on whether it is through a newspaper, magazine, television show, etc. People must first learn about the resource and it's current state and then must make a decision about what they would be willing to pay to ensure that the resource will be protected in that state. It is of key importance that the individuals are making this decision under their budget constraints. That is, willingness to pay is constrained by a person's income and wealth and the person is forced to make a budget allocation between spending for protection of the resource or for something else.

To date there are no known studies that have estimated non-use or passive use economic values for coral reefs or marine ecological reserves. However, Spurgeon (1992) has offered two sets of identifiable factors that will dictate the magnitude of non-use or passive use economic values. First, non-use economic values will be positively related to the quality, condition, and uniqueness of the ecosystem on a national or global scale. Second, the size of population, standard of education, and environmental perception of people in the country owning or having jurisdiction over the ecosystem will be positively related to non-use or passive use economic values. Thus, non-use or passive use economic values are determined by both supply and demand conditions. The existence of many similar sites would reduce the value. Although Spurgeon limits his scope to the people in the country owning or having jurisdiction over the ecosystem, people from all over the world may have non-use or passive use economic values for ecosystem protection in other countries. Debt-for-nature-protection swaps being conducted by The Nature Conservancy in South America are just one example. The legitimacy of including the values of people from other countries is more a judicial concern than an economic one. In some judicial proceedings, people from other countries might not have legal standing over issues of resource protection and their economic values may be eliminated from inclusion in the proceedings.

A literature search revealed 19 studies in which non-use economic values for natural resource protection efforts were estimated. Desvouges *et al.* (1992) summarizes 18 of the 19 studies. The remaining study was by Carson *et al.* (1992) on the Exxon Valdez Oil Spill. Sixteen (16) of the 18 studies summarized in Desvouges *et al.* (1992) reported values (not adjusted for inflation) of $10 or more per household per year for a broad variety of natural resource protection efforts. Of the two (2) studies that reported values of less than $10 per household per year, one reported a value of $3.80 per household per year for adding one park in Australia and $5.20 per household per year for a second park (these estimates were from a national sample of Australians). The other study that estimated non-use economic values of less than $10 per household per year was a study of Wisconsin resident's willingness to pay for protecting bald eagles and striped shiners in that state. For the bald eagle, non-use economic values had an estimated range of $4.92 to $28.38 per household per year, while for striped shiners the values ranged from $1.00 to $5.66 per household per year. Total value ranged from $6.50 to $75.31 per household per year.

Only two (2) of the 18 studies summarized in Desvouges et al (1992) used national samples of U.S. households, the others were limited to state or regional populations. The Exxon Valdez Oil Spill Study (Carson et al, 1992) used a national sample of U.S. households. An important caveat is that the sample included only English speaking households and excluded Alaskan residents. Alaskan residents were excluded to limit the sample to primarily non-users of Prince William Sound (site of the oil spill) and non English speaking households were eliminated because the researchers were not able to convert their questionnaires to other languages. This limited the sample to representing only 90% of U.S. households.

Carson *et al.* (1992) reported a median willingness to pay $31 per household. The payment was a lump sum payment through income taxes and covered a ten-year period. The funds would go into a trust fund to pay for equipment and other costs necessary to prevent a future accident like the Exxon Valdez in Prince William Sound. After 10 years, double hull tankers would be fully implemented and the need for the protection program would expire. Mean willingness to pay was higher and more variable to model specification than the median willingness to pay, so the authors argued that the median value was a conservative estimate. A non-use economic value of $31 per household based on a sample that was representative of only 90% of the U.S. population of households was also considered conservative since non English speaking people probably have positive non-use economic values as do Alaskans.

Estimate of Non-use Economic Values. Given what is known about non-use economic values, a range of "conservative" (*i.e.*, lower bound) estimates of non-use or passive use economic values for an ecological reserve in the Tortugas can be developed. To do this requires the following assumptions and facts:

Assumptions:

- One (1) percent of U.S. households would have some positive non-use or passive economic use values for an ecological reserve in the Tortugas.
- The one (1) percent of U.S. households, on average, would be willing to pay either $3 per household per year, $5 per household per year, or $10 per household per year for an ecological reserve in the Tortugas.

Fact:

- As of July 1, 1997, there were 113 million households in the U.S.

Using the above assumptions and the number of U.S. households in 1997, a probable lower bound set of estimates for the non-use or passive use economic values for the Tortugas Ecological Reserve is estimated.

1997 Annual Amount	$3/household/year	$5/household/year	$10/household/year
1997 Asset Value of	$3.39 million	$5.65 million	$11.3 million
Ecological Reserve:@ 3% discount rate	$113 million	$188.3 million	$376.7 million

The 1997 annual willingness to pay for the ecological reserve would range between $3.39 million and $11.3 million, depending on the assumed willingness to pay per household. Since the ecological reserve would exist into the indefinite future (into perpetuity), an estimated range of the asset values of the ecological reserve based simply on non-use economic value can be calculated. This latter estimate requires the assumption of a constant annual willingness to pay (value per household does not change and/or the number of households does not change) and a real discount rate of 3% to convert future dollar amounts to their present value. Since the population will increase in the future, this is again a conservative estimate. The asset value of an ecological reserve in the Tortugas for just non-use economic value is estimated to be between $113 million to $376.7 million. The asset value represents what someone would be willing to pay today for an ecological reserve in the Tortugas to ensure the future annual flow of non-use economic values.

If the estimated annual non-use economic values with the maximum potential losses are compared to the displaced recreational users and commercial fisheries (losses in consumer's surplus and economic rents), the non-use economic values would exceed the maximum potential losses to all current consumptive users under all the alternatives analyzed (Table 32). Thus, there would be net national benefits to adopting any of the alternatives for the proposed Tortugas Ecological Reserve.

Table 32. A Comparison of Nonuse Economic Values with Consumer's Surplus and Economic Rents from the Recreation Industry and Commercial Fisheries: Assuming Maximum Potential Losses and Without Considering Mitigating Factors

	Alternatives			
Industry/Range of Values	II	III Preferred	IV	V
Recreation Industry	$ 102,965	$ 127,029	$ 320,791	$ 381,108
Commercial Fisheries	$ 473,097	$ 879,973	$ 1,103,808	$ 1,239,587
Total	$ 576,062	$ 1,007,002	$ 1,424,599	$ 1,620,695
Nonuse Value				
Lowest	+	+	+	+
Mid-range	+	+	+	+
Highest	+	+	+	+

+ Means Nonuse Value exceeds the sum of recreational industry and commercial fishery maximum potential losses.

The non-use economic values would be expected to be greater the larger the area protected. But as described earlier, the willingness to pay would be expected to be positively related to both the characteristics of those valuing the reserve and the characteristics of what they are asked to value. Since the estimates of non-use economic values are based on an assumed range of values (at the lowest end of the distribution of values estimated in other studies), the values of the different alternatives cannot be compared in dollar terms. However, following the suggestions of Spurgeon, the characteristics of the U.S. population that would support the statement that the above estimates would likely be lower bound estimates can be demonstrated.

Factors Supporting Positive Non-use Economic Value. Three studies based on national surveys of U.S. households that evaluated adult perceptions and concerns about the environment were reviewed. Each of the surveys demonstrated that U.S. citizens have a high level of concern about the environment and believe the environment is threatened and requires action. In addition, one of the studies focused specifically on ocean-related issues (SeaWeb, 1996) and found strong support for marine protected areas. Also, the assumption that only one (1) percent of U.S. households would be willing to pay for an ecological reserve would appear to be a conservative lower bound estimate since the Roper survey (Roper 1990) indicated that in 1990 eight (8) percent of U.S. households made financial contributions to environmental organizations. Selected results from the three studies are summarized below. (See tables 33-35).

Table 33. Environmental Option Study, Inc. (National Sample of 804 Households Conducted 18-26 May, 1991

Environmental Opinion Study, Inc. (National sample of 804 households conducted 18-26 May 1991)	
Identification with Environmental Label:	%
Strong Environmentalist	31
Weak Environmentalist	29
Lean Towards Environmentalism	30
Neutral	6
Anti-Environmentalist	4

Table 34. Roper 1989 and 1990 National Surveys

Roper 1989 and 1990 National Surveys		
1. Things the Nation Should Make a Major Effort on Now	1989 (%)	1990 (%)
a. Trying to solve the problem of crime and drugs	78	88
b. Taking steps to contain the cost of health care	70	80
c. Trying to improve the quality of the environment	56	78
d. Trying to improve the quality of public school education	N/A	77
2. Contribute money to environmental groups	7	8

Table 35. SeaWeb 1996. (National Sample of 900 U.S. Households 10-15 May, 1996)

SeaWeb 1996. (National Sample of 900 U.S. Households 10-15 May, 1996)		
1. Condition of the ocean	49% very important	38% somewhat important
2. Destruction of the ocean on quality of life		
a. Today	52% very serious	35% somewhat serious
b. 10 years from now	63% very serious	23% somewhat serious
3. Oceans threatened by human activity	82% agree	
4. The federal government needs to do more to help protect the oceans	85% agree to strongly agree	
5. Destruction of ocean plants/ animals	56% very serious problem	
6. Overfishing by commercial fishermen	45% very serious problem	
7. Deterioration of coral reefs	43% very serious problem	
8. Protect sanctuaries where fishing, boating, etc, prohibited	62% strongly agree	
9. Support efforts to set up Marine Sanctuaries	24% say they are almost certain to take this action	
10. Marine Sanctuaries where no human activity is permitted	19% say they are almost certain to take this action	

The U.S. population is certainly a high income and highly educated population and, as the results above predictably show, the U.S. population has a high environmental concern. However, since the characteristics of the people valuing the reserve would be constant (U.S. households) across different proposed ecological reserve boundary alternatives, to differentiate among alternatives would require that some measurements that would serve as indicators of the relative quality, condition and uniqueness of the proposed reserve across alternatives be compared. Unfortunately, the information has not been compiled in a manner that would enable this to be done at this time.

Ecological reserves provide a multitude of environmental benefits. Sobel (1996) provides a long list of these benefits. Most of those benefits have been covered above. Scientific and education values were categorized by Sobel into those things a reserve provides that increase knowledge and understanding of marine systems. Sobel provides the following lists of benefits:

Scientific and Education Values

- Provides long-term monitoring sites
- Provides focus for study
- Provides continuity of knowledge in undisturbed site
- Provides opportunity to restore or maintain natural behaviors
- Reduces risks to long-term experiments
- Provides controlled natural areas for assessing anthropogenic impacts, including fishing and other impacts

Education

- Provides sites for enhanced primary and adult education
- Provides sites for high-level graduate education

OTHER REGULATIONS

Boundary Alternative I

This is the No-Action Alternative and would not result in the expansion of the Sanctuary boundary and would not establish a Tortugas Ecological Reserve.

Boundary Alternative II

This alternative limits the reserve to the existing Sanctuary boundary for a total area of approximately 55 square nm (Fig. 28). This alternative includes a portion of Sherwood

Forest and the coral pinnacles north of Tortugas Bank; it does not include Riley's Hump. It includes some coral and hardbottom habitat north of the DRTO.

Regulatory Alternative A: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South. The provisions of this alternative applicable to Tortugas South are not relevant under this boundary alternative. The Sanctuary-wide regulations already apply to Tortugas North and the effects of the ecological reserve regulations have been analyzed under the no-take discussion above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative B: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy. The provisions of this alternative applicable to Tortugas South are not relevant under this boundary alternative. The Sanctuary-wide regulations already apply to Tortugas North and the effects of the ecological reserve regulations have been analyzed under the no-take discussion above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative C: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas North and South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B). The provisions of this alternative applicable to Tortugas South are not relevant under this boundary alternative. The Sanctuary-wide regulations already apply to Tortugas North and the effects of the ecological reserve regulations have been analyzed under the no-take discussion above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

This regulatory alternative has no incremental impact on commercial fishing or recreational consumptive users since they are displaced by the "no-take" regulation. The dive operator servicing non-consumptive diving and currently operating in Tortugas North would be prohibited from anchoring. His vessel is less than 100 ft LOA and thus he would be unaffected by the prohibition on mooring. The location and availability of mooring buoys would constrain the number and choice of available dive sites. It is unknown whether this would have any impact on the future business volume of dive operators or the quality of the experience to non-consumptive divers. The extent of impact would be dependent on the number and locations of mooring buoys (to be determined).

This regulatory alternative would have little impact on commercial shipping because continuous transit would be allowed. Vessels 50m or greater in registered length are already prohibited from anchoring in 19.3% of Tortugas North. The main effect would be to ban such vessels from anchoring on the remainder of Tortugas North. There would be no incremental impact to treasure salvors since they would be displaced by the "no-take" regulation. The one dive operator servicing non-consumptive diving and currently operating in Tortugas North would be required to obtain Tortugas access permits. Any new dive operators would also be required to obtain a permit. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve will not exceed 10 minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit.

Regulatory Alternative D (Preferred Regulatory Alternative): Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); prohibit anchoring in and control access to Tortugas North via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B); and prohibit anchoring and restrict access to Tortugas South, other than for continuous transit or law enforcement purposes, to research or education activities only pursuant to a sanctuary permit. Because the provisions of this alternative applicable to Tortugas South are not relevant under this boundary alternative, the impacts of this alternative are the same as described for Regulatory Alternative C, above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Boundary Alternative III (Preferred Boundary Alternative)

This alternative involves a Sanctuary boundary expansion and represents the WG's recommendation adopted by the SAC and recommended to NOAA and the State of Florida for a reserve with a total area of approximately 151 square nm (Fig. 29). It is NOAA's Preferred Boundary Alternative.

Regulatory Alternative A: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South. Boundary Alternative III includes areas currently outside the Sanctuary boundary. A small portion of Tortugas North and all of Tortugas South would be outside the existing Sanctuary boundary. The Sanctuary-wide regulations would become effective in the expansion areas of Tortugas North and South. The existing and proposed Sanctuary regulations and their impacts are presented in Table 36 of the FSEIS/FSMP. More detailed descriptions of the regulations are included in Appendix C to the FSEIS/FSMP. The effects of the ecological reserve regulations have been analyzed under the no-take discussion above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative B: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy. Boundary Alternative III includes areas currently outside the Sanctuary boundary. A small portion of Tortugas North and all of Tortugas South would be outside the existing Sanctuary boundary. The Sanctuary-wide regulations would become effective in the expansion areas of Tortugas North and South. The existing and proposed Sanctuary regulations and their impacts are presented in Table 36 of the FSEIS/FSMP. More detailed descriptions of the regulations are included in Appendix C to the FSEIS/FSMP. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

The effects of the ecological reserve regulations have been analyzed under the no-take discussion above. The prohibition on anchoring would have no incremental impact on commercial fishing or recreational consumptive users since they are displaced by the "no-take" regulation. The one dive operator servicing non-consumptive diving and currently operating in Tortugas North would be prohibited from anchoring. There are no known recreational dive operators servicing Tortugas South. The location and availability of mooring buoys would constrain the number and choice of available dive sites. It is unknown whether this would have any impact on the future business volume of dive operators or the quality of the experience to non-consumptive divers. The extent of impact would be dependent on the number and locations of mooring buoys (to be determined). The prohibition on anchoring would impact commercial shipping in the boundary expansion areas, especially in Tortugas South. The prohibition on anchoring in Tortugas North is discussed under Boundary/Regulatory Alternative II.C above. Anchoring by large commercial vessels is known to occur on Riley's Hump, which would be included in the Sanctuary as part of Tortugas South under Boundary Alternative III and thus would be subject to the anchoring prohibition. The impact of this regulation on commercial vessel operators is expected to be small since other anchorages are available a short distance outside the Sanctuary boundary.

There would be no incremental impact on treasure salvors from the no-anchoring prohibition since they would be displaced by the "no-take" regulation. The permit requirements would have no incremental impact on fishermen or salvors because they would be displaced by the "no-take" regulations. There are no known non-consumptive dive operators currently operating in Tortugas South. Any non-consumptive dive operators operating in Tortugas South in the future would be required to obtain Tortugas access permits. It is not possible to gauge the extent of any such future activity. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve would not exceed 10 minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit.

Regulatory Alternative C: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas North and South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B). The only difference between the impacts of this regulatory alternative from those discussed under Regulatory Alternative B would be those associated with the requirement to obtain a permit for other than continuous transit access to Tortugas North. The permit requirements would have no incremental impact on fishermen or salvors because they would be displaced by the "no-take" regulations. There is only one known non-consumptive dive operator currently operating in Tortugas North. He and any new non-consumptive dive operators operating in Tortugas North would be required to obtain Tortugas access permits. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve would not exceed 10 minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative D (Preferred Regulatory Alternative): Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); prohibit anchoring in and control access to Tortugas North via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B); and prohibit anchoring and restrict access to Tortugas South, other than for continuous transit or law enforcement purposes, to research or education activities only pursuant to a sanctuary permit. The only difference between the impacts of this regulatory alternative from those discussed under Regulatory Alternative C would be those associated with limiting noncontinuous transit access to Tortugas South to research/educational purposes. For the commercial fisheries, salvors, and recreational consumptive users, there would be no incremental impacts since the "no-take" regulation would displace these user groups. There are no known non-consumptive dive operators currently operating in Tortugas South and no recreational diving is known to occur there. Under this alternative, none would be allowed in the future. The existing ecological reserve regulations would prohibit fishing in the Tortugas

Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Boundary Alternative IV

This alternative involves an expansion to the south by 23 square nm of Tortugas North to make it conterminous with the NPS's proposed Research/Natural Area within the DRTO for a total area of approximately 175 square nm not including the Park area (Fig. 30). It also involves the same boundary expansion as Boundary Alternative III.

Regulatory Alternative A: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South. A small portion of Tortugas North and all of Tortugas South would be outside the existing Sanctuary boundary. The Sanctuary-wide regulations would become effective in the expansion areas of Tortugas North and South. The existing and proposed Sanctuary regulations and their impacts are presented in Table 36 of the FSEIS/FSMP. More detailed descriptions of the regulations are included in Appendix C to the FSEIS/FSMP. The effects of the ecological reserve regulations which, under Boundary Alternative IV would apply to a larger area because of the southern expansion of Tortugas North, have been analyzed under the no-take discussion above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative B: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy. A small portion of Tortugas North and all of Tortugas South would be outside the existing Sanctuary boundary. The Sanctuary-wide regulations would become effective in the expansion areas of Tortugas North and South. The existing and proposed Sanctuary regulations and their impacts are presented in Table 36 of the FSEIS/FMP. More detailed descriptions of the regulations are included in Appendix C to the FSEIS/FMP. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

The effects of the ecological reserve regulations which under Boundary Alternative IV would apply to a larger area because of the southern expansion of Tortugas North have been analyzed under the no-take discussion above. The prohibition on anchoring would have no incremental impact on commercial fishing or recreational consumptive users since they are displaced by the "no-take" regulation. There are no known recreational dive operators servicing Tortugas South. The location and availability of mooring buoys would constrain the number and choice of available dive sites. It is unknown whether this would have any impact on the future business volume of dive operators or the quality of the experience to non-consumptive divers. The extent of impact would be dependent on the number and locations of mooring buoys (to be determined).

The prohibition on anchoring would impact commercial shipping in the boundary expansion areas, especially in Tortugas South. The prohibition on anchoring in Tortugas North is discussed under Boundary/Regulatory Alternative II.C. above. Anchoring by large commercial vessels is known to occur on Riley's Hump, which would be included in the Sanctuary as part of Tortugas South under Boundary Alternative IV and thus would be subject to the anchoring prohibition. The impact of this regulation on commercial vessel operators is expected to be small since other non-coral reef anchorages outside the Sanctuary boundary are available a short distance away.

There would be no incremental impact on treasure salvors from the no-anchoring prohibition since they would be displaced by the "no-take" regulation.

The permit requirements would have no incremental impact on fishermen or salvors because they would be displaced by the "no-take" regulations. There are no known non-consumptive dive operators currently operating in Tortugas South. Any non-consumptive dive operators operating in Tortugas South in the future would be required to obtain Tortugas access permits. It is not possible to gauge the extent of any such future activity. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve would not exceed 10 minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit.

Regulatory Alternative C: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas North and South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B). The only difference between the impacts of this regulatory alternative from those discussed under Alternative B would be those associated with the requirement to obtain a permit for other than continuous transit access to Tortugas North. Under this boundary alternative there are 2.75 more person-days of recreational non-consumptive use than under Boundary Alternatives II and III. While the area of Tortugas North would be increased by the expansion to the south, the permit requirements would have no incremental impact on fishermen or salvors because they would be displaced by the "no-take" regulations. There is only one known non-consumptive dive operator currently operating in Tortugas North. He and any new non-consumptive dive operators operating in Tortugas North would be required to obtain Tortugas access permits. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve would not exceed ten minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative D (Preferred Regulatory Alternative): Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); prohibit anchoring in and control access to Tortugas North via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B); and prohibit anchoring and restrict access to Tortugas South, other than for continuous transit or law enforcement purposes, to research or education activities only pursuant to a sanctuary permit. The only difference between the impacts of this regulatory alternative from those discussed under regulatory Alternative C would be those associated with limiting non-continuous transit access to Tortugas South to research/educational purposes. For the commercial fisheries, salvors, and recreational consumptive users, there would be no incremental impacts since the "no-take" regulation would displace these user groups. There are no known non-consumptive dive operators currently operating in Tortugas South and no recreational diving is known to occur there. Under this alternative, none would be allowed in the future. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Boundary Alternative V

This alternative involves a Sanctuary boundary expansion to the west by three minutes ending at longitude 83'09" instead of 83'06" and would increase the reserve area to 190 square nm (Fig. 31). Tortugas North would be expanded to the west and Tortugas South would be shortened to the north. Sanctuary-wide regulations would be applied to the expansion area.

Regulatory Alternative A: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South. The Sanctuary-wide regulations would become effective in the expansion area. The existing and proposed Sanctuary regulations and their impacts are presented in Table 36 of the FSEIS/FSMP. More detailed descriptions of the regulations are included in Appendix C to the FSEIS/FSMP. The effects of the ecological reserve regulations which, under Boundary Alternative V apply to a larger area because of the Sanctuary expansion, have been analyzed under the no-take discussion above. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative B: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy. A small portion of Tortugas North and all of Tortugas South would be outside the existing Sanctuary boundary. The Sanctuary-wide regulations would become effective in the expansion area. The existing and proposed Sanctuary regulations and their impacts are summarized in Table 36 of the FSEIS/FSMP. More detailed descriptions of the regulations are included in Appendix C to the FSEIS/FSMP. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

The effects of the ecological reserve regulations which, under Boundary Alternative V apply to a larger area because of the Sanctuary expansion, have been analyzed under the no-take discussion above. The prohibition on anchoring would have no incremental impact on commercial fishing or recreational consumptive users since they are displaced by the "no-take" regulation. There are no known recreational dive operators servicing Tortugas South. The location and availability of mooring buoys would constrain the number and choice of available dive sites. It is unknown whether this would have any impact on the future business volume of dive operators or the quality of the experience to non-consumptive divers. The extent of impact would be dependent on the number and locations of mooring buoys (to be determined).

The prohibition on anchoring would impact commercial shipping in the boundary expansion area, especially in Tortugas South. Anchoring by large commercial vessels is known to occur on Riley's Hump, which would be included in the Sanctuary as part of Tortugas South under Boundary Alternative V and thus would be subject to the anchoring prohibition. While the Sanctuary area has been expanded, the impact of this regulation on commercial vessel operators is still expected to be small since other non-coral reef anchorages are available a short distance away outside the Sanctuary boundary.

There would be no incremental impact on treasure salvors from the no-anchoring prohibition since they would be displaced by the "no-take" regulation.

The permit requirements would have no incremental impact on fishermen or salvors because they would be displaced by the "no-take" regulations.

There are no known non-consumptive dive operators currently operating in Tortugas South. Any non-consumptive dive operators operating in Tortugas South in the future would be required to obtain Tortugas access permits. It is not possible to gauge the extent of any such future activity. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve would not exceed 10 minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit.

Regulatory Alternative C: Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); and prohibit anchoring in and control access to Tortugas North and South, other than for continuous transit or law enforcement purposes, via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B). The only difference between the impacts of this regulatory alternative from those discussed under Regulatory Alternative B would be those associated with the requirement to obtain a permit for other than continuous transit access to Tortugas North. Under this boundary alternative there are 3.25 more person-days of recreational non-consumptive use than under Boundary Alternatives IV. While the area of Tortugas North would be increased by the expansion to the west, the permit requirements would have no incremental impact on fishermen or salvors because they would be displaced by the "no-take" regulations. There is one known non-consumptive dive operator currently operating in Tortugas North. He and any new non-consumptive dive operators operating in Tortugas North would be required to obtain Tortugas access permits. There would be minor time costs associated with obtaining a permit and getting permission to access the reserve. It is expected that fulfilling all the permit requirements and obtaining permission to access the reserve would not exceed 10 minutes of each permittee's time for each visit to the reserve. No special professional skills would be necessary to apply for a permit. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Regulatory Alternative D (Preferred Regulatory Alternative): Apply existing Sanctuary-wide and existing ecological reserve regulations to Tortugas North and South (as described in Regulatory Alternative A); prohibit anchoring in and control access to Tortugas North via permit, require call-in for entering and leaving, and prohibit vessels longer than 100 ft LOA from using a mooring buoy (as described in Regulatory Alternative B); and prohibit anchoring and restrict access to Tortugas South, other than for continuous transit or law enforcement purposes, to research or education activities only pursuant to a sanctuary permit. The only difference between the impacts of this regulatory alternative from those discussed under Regulatory Alternative C would be those associated with limiting noncontinuous transit access to Tortugas South to research/educational purposes. For the commercial fisheries, salvors, and recreational consumptive users, there would be no incremental impacts since the "no-take" regulation would displace these user groups. There are no known non-consumptive dive operators currently operating in Tortugas South and no recreational diving is known to occur there. Under this alternative, none would be allowed in the future. The existing ecological reserve regulations would prohibit fishing in the Tortugas Ecological Reserve consistent with 15 CFR 922.164(d) Ecological Reserves and Sanctuary Preservation Areas.

Table 36. Impacts on Small Businesses

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
1. No Take			**Boundary Alternative II**		
(a) Possessing, moving, harvesting, removing, taking, damaging, disturbing, breaking, cutting, spearing, or otherwise injuring any coral, marine invertebrate, fish, bottom formation, algae, seagrass or other living or dead organism, including shells, or attempting any of these activities. However, fish, invertebrates, and marine plants may be possessed aboard a vessel in the ecological reserve provided such resources can be shown not to have been harvested within, removed from, or taken within, the ecological reserve, as applicable, by being stowed in a cabin, locker, or similar storage area prior to entering and during transit through	**A. Maximum Potential Loss** 51 of the 105 to 110 commercial fishing operations are potentially impacted. Some operations are multi-species fisheries. 24 lobster, 6 shrimp, 15 king mackerel, and 37 reef fish operations potentially impacted directly. About $411 thousand in harvest revenue potentially lost or 6 % of the harvest revenue from the TERSA. On average, about $8,000 per fishing operation. Additionally, potential losses to 10 fish houses and other small businesses through the multiplier impact.	**A. Maximum Potential Loss** 9 of 12 charter boat operations operating within the TERSA would be potentially impacted. Direct business revenue would include 26.6% for diving for lobsters, 20% for spear fishing, and 2.9% for fishing. Across all three recreation consumptive activities, 9.48% of revenue would be potentially impacted and about 14% of profits. On average, maximum potential losses are estimated to be about $13,700 of lost revenue and $5,580 of lost profits per operation. Additional potential losses to an unknown number of small firms through the multiplier	**A. Maximum Potential Loss** No losses. Potential gains to one charter boat dive operation providing services to non-consumptive divers. Indirect gains to several small businesses due to the multiplier impacts. Gains from improvements in quality of sites in terms of diversity, number and size of various sea life. Improvements in quality of experience leading to increase in demand for charter boat services and corresponding multiplier impacts on other small businesses.	**A. Maximum Potential Loss** No impact. **B. Mitigating Factors, Off-setting Factors and Net Impact** No impact.	**A. Maximum Potential Loss** No expected impact. One permit for inventorying submerged cultural resources in Sanctuary waters was issued for the Tortugas area of the Sanctuary. There were no submerged cultural resources found. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating factors or offsetting factors. Sanctuary will not issue permits for treasure salvaging in the ecological reserve. Since no submerged cultural resources were located on Tortugas Bank, no expected impact.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative II (continued)		
1. No Take (continued)					
such reserve, provided further that such vessel is in continuous transit through the ecological reserve. (b) Fishing by any means. (c) Touching living or dead coral, including but not limited to, standing on a living or dead coral formation.	**B. Mitigating Factors, Off-setting Factors and Net Impact** Relocation. For lobster fishing operations, the potential losses are not likely to occur because the State of Florida's trap reduction program and fishermen are knowledgeable of other fishing locations throughout the Sanctuary. For king mackerel operations, potential losses are not likely to occur because king mackerel is a pelagic species that is highly mobile and could be caught in other locations. For shrimp operations, losses are not likely to occur because shrimp caught in the proposed reserve are such a small percentage of total catch. Highly likely that lost catch could be made up from other	impacts. Only a fraction of a percent of the total tourist/recreation business in Monroe County. **B. Mitigating Factors, Off-setting Factors and Net Impact** Substitution. Complete mitigation with no losses is a high probability because only a small portion of the Tortugas Bank is included in the ecological reserve. All users can substitute to other sites on the southern half of Tortugas Bank. Long-term Benefits from Replenishment Effect. Net result is no short term losses and long-term gains to small businesses that are directly and indirectly dependent on recreational			

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative II (continued)		
1. No Take (continued)					
	locations. For reef fish, the potential losses are likely to occur in the short term because reef fish stocks are overfished throughout the Sanctuary. Long-term Benefits from Replenishment. No expected benefits to king mackerel or shrimp operations. For lobster operations, expected net benefits from replenishment effect of ecological reserve. For reef fish operations, it is not clear whether the full 13 percent lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses to be less than the 13 percent reduction in the maximum loss case.	Consumptive use in the TERSA.			

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
			Boundary Alternative II (continued)		
2. No Anchoring/Required Mooring Buoy Use/No Discharges or Deposits					
(a) Anchoring on coral. (b) Anchoring when mooring buoys or designated anchoring areas are available (c) Discharges or deposits except cooling water or engine exhaust.	No incremental impact since "no take" regulations already displace all commercial fishing.	No incremental impact since recreational consumptive users are already displaced by "no take" regulations.	One charter operation that currently operates in Tortugas North potentially impacted. Mooring buoy use will constrain number and choice of available dive sites. It is unknown whether this will impact on future business of dive operators. Impact is dependent on the number and distribution (locations) of mooring buoys (to be determined). Prohibition against discharges or deposits will result in no incremental impact.	No impact.	No incremental impact since treasure salvaging displaced by "no take" regulations.
3. No Access					
Alternative A: Apply existing ecological reserve regulations to Tortugas North and South.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No incremental impact since "no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative II (continued)		
3. No Access (continued)					
Alternative B: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas South via permit and require call-in, call-out. Use of mooring buoys by vessels 100' or less in length.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No incremental impact. See regulations 1 and 2 above. Tortugas South not in this boundary alternative.	No impact.	No incremental impact since "no take" regulations displaces treasure salvaging.
Alternative C: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas North and South via permit and require call-in, call-out (as described in Alternative B). Use of mooring buoys by vessels 100' or less in length.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Currently one charter dive operator operates in Tortugas North, while none operate in the South. Minor amount of time cost to charter operations in reporting to Sanctuary staffer to obtain permit and to notify when entering a leaving ecological reserve. None of the current operators have vessels over 100 feet in length. Time costs expected to be limited to less than 15 minutes to obtain permit and access permission per operation per visit to the reserve.	No impact.	No incremental impact since "no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative II (continued)		
3. No Access (continued)					
Alternative D (Preferred): Apply existing ecological reserve regulations to Tortugas North and Tortugas South (as described in Alternative A). Prohibit anchoring in Tortugas North and South and control accesss to Tortugas North via permit and require call-in, call-out (as described in Alternative B). Restrict access to Tortugas South to research or educational activities only. Use of mooring buoys by vessels 100' or less in length.	No incremental impact since commercial fishing is already displaced by "no take" regulations.	No incremental impact since recreational consumptive users are already displaced by "no take" regulations.	Currently one dive operator operates in Tortugas North, none in Tortugas South. Minor time costs to dive charter operators in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecological reserve. Time cost is expected to be less than 15 minutes per operation per visit to the reserve.	No impact.	No incremental impact since "no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
	Boundary Alternative III: Preferred				
1. No Take					
(a) Possessing, moving, harvesting, removing, taking, damaging, disturbing, breaking, cutting, spearing, or otherwise injuring any coral, marine invertebrate, fish, bottom formation, algae, seagrass or other living or dead organism, including shells, or attempting any of these activities. However, fish, invertebrates, and marine plants may be possessed aboard a vessel in the ecological reserve provided such resources can be shown not to have been harvested within, removed from, or taken within, the ecological reserve, as applicable, by being stowed in a cabin, locker, or similar storage area prior to entering and during transit through	**A. Maximum Potential Loss** 64 of the 105 to 110 commercial fishing operations are potentially impacted. Some operations are multi-species fisheries. 27 lobster, 15 shrimp, 16 king mackerel, and 40 reef fish operations potentially impacted directly. About $844 thousand in harvest revenue potentially lost or 12 % of the harvest revenue from the TERSA. On average, about $13,000 per fishing operation. Additionally, potential losses to 10 fish houses and other small businesses through the multiplier impact.	**A. Maximum Potential Loss** 9 of 12 charter boat operations operating within the TERSA would be potentially impacted. Direct business revenue would include 26.6% for diving for lobsters, 20% for spear fishing, and 6.3% for fishing. Across all three recreation consumptive activities, 11.7% of revenue would be potentially impacted and almost 16% of profits. On average, maximum potential losses are estimated to be about $13,700 of lost revenue and $5,580 of lost profits per operation. Additional potential losses to an unknown number of small firms through the multiplier impacts. Only a fraction	**A. Maximum Potential Loss** No losses. Potential gains to one charter boat dive operation providing services to non-consumptive divers. Indirect gains to several small businesses due to the multiplier impacts. Gains from improvements in quality of sites in terms of diversity, number and size of various sea life. Improvements in quality of experience leading to increase in demand for charter boat services and corresponding multiplier impacts on other small businesses. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating or off-setting factors. Net gains (see A above).	**A. Maximum Potential Loss** No impact. **B. Mitigating Factors, Off-setting Factors and Net Impact** No impact.	**A. Maximum Potential Loss** No expected impact. One permit for inventorying submerged cultural resources in Sanctuary waters was issued for the Tortugas area of the Sanctuary. There were no submerged cultural resources found. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating factors or offsetting factors. Sanctuary will not issue permits for treasure salvaging in the ecological reserve. Since no submerged cultural resources were located on Tortugas Bank, no expected impact.

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
	Industries Impacted				
	Boundary Alternative III: Preferred (continued)				
1. No Take (continued)					
such reserve, provided further that such vessel is in continuous transit through the ecological reserve. (b) Fishing by any means. (c) Touching living or dead coral, including but not limited to, standing on a living or dead coral formation.	**B. Mitigating Factors, Off-setting Factors and Net Impact** Relocation. For lobster fishing operations, the potential losses are not likely to occur because the State of Florida's trap reduction program and fishermen are knowledgeable of other fishing locations throughout the Sanctuary. For king mackerel operations, potential losses are not likely to occur because king mackerel is a pelagic species that is highly mobile and could be caught in other locations. For shrimp operations, losses are not likely to occur because shrimp caught in the proposed reserve are such a small percentage of total catch. Highly likely that lost catch could be made	of a percent of the total tourist/recreation business in Monroe County. **B. Mitigating Factors, Off-setting Factors and Net Impact** Substitution. Complete mitigation with no losses is a high probability because only a small portion of the Tortugas Bank is included in the ecological reserve. All users can substitute to other sites on the southern half of Tortugas Bank. Long-term Benefits from Replenishment Effect. Net result is no short term losses and long-term gains to small businesses that are directly and indirectly dependent on			

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
			Boundary Alternative III: Preferred (continued)		
1. No Take (continued)					
	up from other locations. For reef fish, the potential losses are likely to occur in the short term because reef fish stocks are overfished throughout the Sanctuary. Long-term Benefits from Replenishment. No expected benefits to king mackerel or shrimp operations. For lobster operations, expected net benefits from replenishment effect of ecological reserve. For reef fish operations, it is not clear whether the full 20 percent lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses to be less than the 20 percent reduction in the maximum loss case.	recreational consumptive use in the TERSA.			

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Industries Impacted: Recreation Consumptive	Industries Impacted: Recreation Non-consumptive	Industries Impacted: Commercial Shipping	Industries Impacted: Treasure Salvors
Boundary Alternative III: Preferred (continued)					
2. No Anchoring/Required Mooring Buoy Use/No Discharges or Deposits.					
(a) Anchoring on coral. (b) Anchoring when mooring buoys or designated anchoring areas are available (c) Discharges or deposits except cooling water or engine exhaust.	No incremental impact since "no take" regulations already displace all commercial fishing.	No incremental impact since recreational consumptive users are already displaced by "no take" regulations.	One charter operation that currently operates in Tortugas North potentially impacted. Mooring buoy use will constrain number and choice of available dive sites. It is unknown whether this will impact on future business of dive operators. Impact is dependent on the number and distribution (locations) of mooring buoys (to be determined). Prohibition against discharges or deposits results in no incremental impact.	No impact.	No incremental impact since treasure salvaging displaced by "no take" regulations.
3. No Access					
Alternative A: Apply existing ecological reserve regulations to Tortugas North and South.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact since "no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
	Boundary Alternative III: Preferred (continued)				
3. No Access (continued)					
Alternative B: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas South via permit and require call-in, call-out. Use of mooring buoys by vessels 100’ or less in length.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No impact.	No incremental impact since “no take” regulations displace treasure salvaging.
Alternative C: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas North and South via permit and require call-in, call-out (as described in Alternative B). Use of mooring buoys by vessels 100’ or less in length.	No incremental impact because commercial fishing is already displaced by “no take” regulations.	No incremental impact because recreational consumptive users are already displaced by “no take” regulations.	Currently one charter dive operator operate in Tortugas North, while none operate in the South. Minor amount of time cost to charter operations in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecological reserve. permission. None of the current operators have vessels over 100 feet in length. Time costs expected to be limited to less than 15 minutes to obtain permit and access permission per operation per visit to the reserve.	No impact.	No incremental impact since “no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
	Boundary Alternative III: Preferred (continued)				
3. No Access (continued)					
Alternative D (Preferred): Apply existing ecological reserve regulations to Tortugas North and Tortugas South (as described in Alternative A). Prohibit anchoring in Tortugas North and South and control accesss to Tortugas North via permit and require call-in, call-out (as described in Alternative B). Restrict access to Tortugas South to research or educational activities only. Use of mooring buoys by vessels 100' or less in length.	No incremental impact since commercial fishing is already displaced by "no take" regulations.	No incremental impact since recreational consumptive users are already displaced by "no take" regulations.	Currently one dive operator operates in Tortugas North, none in Tortugas South. Minor time costs to dive charter operators in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecological reserve. Time cost is expected to be less than 15 minutes per operation per visit to the reserve.	No impact.	No incremental impact since "no take" regulations displace treasure salvaging.
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations					
Prohibited Activities					
a. Mineral and hydrocarbon exploration, development and production.	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
Boundary Alternative III: Preferred (continued)					
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
b. Removal of, injury to, or possession of coral or live rock.	No impact because the commercial and personal taking of coral and live rock is currently illegal. Live rock aquaculture permits will not be issued and none are currently in existence.	No impact because the commercial and personal taking of coral and live rock is currently illegal.	Not applicable.	Not applicable.	Not applicable.
c. Alteration of, or construction on the seabed (exemptions are made for installation of nav aids & mooring buoys).	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.
d. Discharge or deposit of materials or other matter except cooling water or engine exhaust.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No incremental impact since “ no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
Boundary Alternative III: Preferred (continued)					
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
e. Operation of vessels that strike or injure coral or seagrass; anchoring on live coral in depths less than 40'; exceeding 4 knots or creating wakes in designated areas; injuring or taking birds or marine mammals.	No incremental impact because commercial fishing already displaced by "no take" regulations.	No incremental impacts because recreational consumptive users already displaced by "no take" regulations.	No impact expected because dive operators already operate in this manner. No firms currently operate in these areas.	No impact.	No incremental impact since " no take" regulation displaces treasure salvaging.
f. Conduct of diving/ snorkeling without a dive flag.	Not applicable.	No incremental impact because recreational consumptive users are already displaced by "no take" regulation.	No impact expected because use of flags is already required by other Federal and State regulations. No firms currently operate in these areas.	Not applicable.	Not applicable.
g. Release of exotic species.	No impact because release of exotic species is already prohibited by other laws and there are no known aquaculture operations in the areas.	No impact because release of exotic species is already prohibited by other laws.	No impact because release of exotic species is already prohibited by other laws.	No impact because release of exotic species is already prohibited by other laws.	No incremental impact since " no take" regulation displaces treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
Boundary Alternative III: Preferred (continued)					
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
h. Damage or removal of markers.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No Incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No incremental impact expected because such prohibitions already exist for markers placed by other governmental entities and the regulation only applies to Sanctuary markers. No firms currently operate in these areas.	No incremental impact expected because such prohibitions already exist for markers placed by other governmental entities and the regulation only applies to Sanctuary markers.	No incremental impact since " no take" regulation displaces treasure salvaging.
i. Movement of, removal of, injury to, or possession of Sanctuary historical resources.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	No incremental impact since " no take" regulations displace treasure salvaging.
j. Take or possession of protected wildlife.	No impact because wildlife is already protected by other applicable law.	No impact because wildlife is already protected by other applicable law.	Not applicable.	Not applicable.	Not applicable.
k. Possession or use of explosives or electrical discharges (intent is to apply to take of marine species).	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Not applicable.	Not applicable.	Not applicable.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
Boundary Alternative III: Preferred (continued)					
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
l. Harvest or possession of marine life species (effect is to extend current State law into Federal waters).	No incremental impact because commercial fishing is already displaced by "no take" regulations. Currently there are no marine life collectors operating in these areas.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Not applicable.	Not applicable.	Not applicable.
m. Interference with law enforcement.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No impact expected because this provision is consistent with existing laws providing for penalties for interfering with law enforcement. No firms currently operate in these areas.	No impact expected because this provision is consistent with existing laws providing for penalties for interfering with law enforcement.	No incremental impact since " no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
			Boundary Alternative IV		
1. No Take					
(a) Possessing, moving, harvesting, removing, taking, damaging, disturbing, breaking, cutting, spearing, or otherwise injuring any coral, marine invertebrate, fish, bottom formation, algae, seagrass or other living or dead organism, including shells, or attempting any of these activities. However, fish, invertebrates, and marine plants may be possessed aboard a vessel in the ecological reserve provided such resources can be shown not to have been harvested within, removed from, or taken within, the ecological reserve, as applicable, by being stowed in a cabin, locker, or similar storage area prior to entering and during transit through	**A. Maximum Potential Loss** 65 of the 105 to 110 commercial fishing operations are potentially impacted. Some operations are multi-species fisheries. 27 lobster, 14 shrimp, 16 king mackerel, and 42 reef fish operations potentially impacted directly. About $1.12 million in harvest revenue potentially lost or 16.45 % of the harvest revenue from the TERSA. On average, about $17,300 per fishing operation. Additionally, potential losses to 10 fish houses and other small businesses through the multiplier impact.	**A. Maximum Potential Loss** 10 of 12 charter boat operations operating within the TERSA would be potentially impacted. Direct business revenue would include 73.3% for diving for lobsters, 59% for spear fishing, and 10.5% for fishing. Across all three recreation consumptive activities, 28.7% of revenue would be potentially impacted and almost 41% of profits. On average, maximum potential losses are estimated to be about $37,380 of lost revenue and $14,500 of lost profits per operation. Additional potential losses to an unknown number of small firms through the multiplier impacts. Only a fraction	**A. Maximum Potential Loss** No losses. Potential gains to one charter boat dive operation providing services to non-consumptive divers. Indirect gains to several small businesses due to the multiplier impacts. Gains from improvements in quality of sites in terms of diversity, number and size of various sea life. Improvements in quality of experience leading to increase in demand for charter boat services and corresponding multiplier impacts on other small businesses. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating or offsetting factors. Net gains (see A above).	**A. Maximum Potential Loss** No impact. **B. Mitigating Factors, Off-setting Factors and Net Impact** No impact.	**A. Maximum Potential Loss** No expected impact. One permit for inventorying submerged cultural resources in Sanctuary waters was issued for the Tortugas area of the Sanctuary. There were no submerged cultural resources found. Currently, it is unknown whether there are any submerged cultural resources on Riley's Hump, located in Tortugas South. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating factors or offsetting factors. Sanctuary will not issue permits for treasure salvaging in the ecological reserve.

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
			Boundary Alternative IV (continued)		
1. No Take (continued)					
such reserve, provided further that such vessel is in continuous transit through the ecological reserve. (b) Fishing by any means. (c) Touching living or dead coral, including but not limited to, standing on a living or dead coral formation.	**B. Mitigating Factors, Off-setting Factors and Net Impact** Relocation. For lobster fishing operations, the potential losses are not likely to occur because the State of Florida's trap reduction program and fishermen are knowledgeable of other fishing locations throughout the Sanctuary. For king mackerel operations, potential losses are not likely to occur because king mackerel is a pelagic species that is highly mobile and could be caught in other locations. For shrimp operations, losses are not likely to occur because shrimp caught in the proposed reserve are such a small percentage of total	of a percent of the total tourist/recreation business in Monroe County. **B. Mitigating Factors, Off-setting Factors and Net Impact** Substitution. Under this alternative, about 73% of diving for lobsters and 72% of spearfishing would be displaced. The potential for substituting to alternative sites is greatly reduced compared with Alternatives II and III. The reason is that under this alternative all of the Tortugas Bank falls within this boundary alternative. Some substitution is possible, but the probability of crowding effects rises considerably for diving for lobsters and spearfishing. For fishing, substitution mitigating all the losses is still highly			Since no submerged cultural resources were located on Tortugas Bank, no expected impact.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
	Boundary Alternative IV (continued)				
1. No Take (continued)					
	catch. Highly likely that lost catch could be made up from other locations. For reef fish, the potential losses are likely to occur in the short term because reef fish stocks are overfished throughout the Sanctuary. Long-term Benefits from Replenishment. No expected benefits to king mackerel or shrimp operations. For lobster operations, expected net benefits from replenishment effect of ecological reserve. For reef fish operations, it is not clear whether the full 28 percent lost catch from displacement would be replaced from replenishment, but the	probable since only 6percent of fishing activity would be displaced. This represents a relatively low amount of activity and given the wide distribution of this activity in the study area, crowding effects are still a low probability. Long-term Benefits from Replenishment Effect. For diving for lobsters and spearfishing, it is not clear whether there would be significant benefits offsite given that most of this activity currently takes place on the Tortugas Bank and none of the Bank is available for these activities. Not much is known about other areas that might benefit from the replenishment effect and where users could relocate to reap these benefits.			

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative IV (continued)		
1. No Take (continued)					
	costs of displacement would be mitigated and the losses to be less than the 28 percent reduction in the maximum loss case.	Whether the activities displaced could find alternative sites where both quantity and quality of activity could be maintained or enhanced seems less likely given the extent of displacement. For fishing, the small amount of displacement relative to the entire area plus the wide distribution of fishing activity still makes it highly likely that long-term benefits of replenishment will more than offset the potential losses from displacement with net benefits to this group. Net result is short term losses and low likelihood of long-term gains to small businesses that are directly and indirectly dependent on recreational consumptive use in the TERSA. For fishing, small amount of displacement not likely to result in short term losses and likely long-term gains.			

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
			Boundary Alternative IV (continued)		
2. No Anchoring/Required Mooring Buoy Use/No Discharges or Deposits					
(a) Anchoring on coral. (b) Anchoring when mooring buoys or designated anchoring areas are available (c) Discharges or deposits except cooling water or engine exhaust.	No incremental impact since "no take" regulations already displaces all commercial fishing.	No incremental impact since recreational consumptive users are already displaced by "no take" regulations.	One charter operation that currently operates in Tortugas North potentially impacted. Mooring buoy use will constrain number and choice of available dive sites. It is unknown whether this will impact on future business of dive operators. Impact is dependent on the number and distribution (locations) of mooring buoys (to be determined). Prohibition on discharges or deposits results in no incremental impact.	No impact.	No incremental impact since treasure salvaging displaced by "no take" regulations.
3. No Access					
Alternative A: Apply existing ecological reserve regulations to Tortugas North and South.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact since "no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative IV (continued)		
3. No Access (continued)					
Alternative B: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas South via permit and require call-in, call-out. Use of mooring buoys by vessels 100’ or less in length.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No impact.	No incremental impact since “no take” regulations displaces treasure salvaging.
Alternative C: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas North and South via permit and require call-in, call-out (as described in Alternative B). Use of mooring buoys by vessels 100’ or less in length.	No incremental impact because commercial fishing is already displaced by “no take” regulations.	No incremental impact because recreational consumptive users are already displaced by “no take” regulations.	Currently one charter dive operator operates in Tortugas North, while none operate in the South. Minor amount of time cost to charter operations in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecological reserve.. The current operator does not have vessels over 100 feet in length. Time costs expected to be limited to less than 15 minutes to obtain permit and access permission per operation per visit to the reserve.	No impact.	No incremental impact since “no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative IV (continued)		
3. No Access (continued)					
Alternative D (Preferred): Apply existing ecological reserve regulations to Tortugas North and Tortugas South (as described in Alternative A). Prohibit anchoring in Tortugas North and South and control accesss to Tortugas North via permit and require call-in, call-out (as described in Alternative B). Restrict access to Tortugas South to research or educational activities only. Use of mooring buoys by vessels 100’ or less in length.	No incremental impact since commercial fishing is already displaced by “no take” regulations.	No incremental impact since recreational consumptive users are already displaced by “no take” regulations.	Currently one dive operator operates in Tortugas North, none in Tortugas South. Minor time costs to the dive charter operator in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecoligcal reserve.. Time cost is expected to be less than 15 minutes per operation per visit to the reserve.	No impact.	No incremental impact since “no take” regulations displace treasure salvaging.
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations					
Prohibited Activities					
a. Mineral and hydrocarbon exploration, development and production.	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative IV (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
b. Removal of, injury to, or possession of coral or live rock.	No impact because the commercial and personal taking of coral and live rock is currently illegal. Live rock aquaculture permits will not be issued and none are currently in existence.	No impact because the commercial and personal taking of coral and live rock is currently illegal.	Not applicable.	Not applicable.	Not applicable.
c. Alteration of, or construction on the seabed (exemptions are made for installation of nav aids & mooring buoys).	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.
d. Discharge or deposit of materials or other matter except cooling water or engine exhaust.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No incremental impact since “ no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative IV (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
e. Operation of vessels that strike or injure coral or seagrass; anchoring on live coral in depths less than 40'; exceeding 4 knots or creating wakes in designated areas; injuring or taking birds or marine mammals.	No incremental impact because commercial fishing already displaced by "no take" regulations.	No incremental impacts because recreational consumptive users already displaced by "no take" regulations.	No impact expected because dive operators already operate in this manner. No firms currently operate in these areas.	No impact.	No incremental impact since " no take" regulations displace treasure salvaging.
f. Conduct of diving/ snorkeling without a dive flag.	Not applicable.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No impact expected because use of flags is already required by other Federal and State regulations. No firms currently operate in these areas.	Not applicable.	Not applicable.
g. Release of exotic species.	No impact because release of exotic species is already prohibited by other laws and there are no known aquaculture operations in the areas.	No impact because release of exotic species is already prohibited by other laws.	No impact because release of exotic species is already prohibited by other laws.	No impact because release of exotic species is already prohibited by other laws.	No incremental impact since " no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted				
	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative IV (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
h. Damage or removal of markers.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No Incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No incremental impact expected because such prohibitions already exist for markers placed by other governmental entities and the regulation only applies to Sanctuary markers. No firms currently operate in these areas.	No incremental impact expected because such prohibitions already exist for markers placed by other governmental entities and the regulation only applies to Sanctuary markers.	No incremental impact since " no take" regulations displace treasure salvaging.
i. Movement of, removal of, injury to, or possession of Sanctuary historical resources.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	No incremental impact since " no take" regulations displace treasure salvaging.
j. Take of possession of protected wildlife.	No impact because wildlife is already protected by other applicable law.	No impact because wildlife is already protected by other applicable law.	Not applicable.	Not applicable.	Not applicable.
k. Possession or use of explosives or electrical discharges (intent is to apply to take of marine species).	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Not applicable.	Not applicable.	Not applicable.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative IV (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
l. Harvest or possession of marine life species (effect is to extend current State law into Federal waters).	No incremental impact because commercial fishing is already displaced by "no take" regulations. Currently there are no marine life collectors operating in these areas.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Not applicable.	Not applicable.	Not applicable.
m. Interference with law enforcement.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No impact expected because this provision is consistent with existing laws providing for penalties for interfering with law enforcement. No firms currently operate in these areas.	No impact expected because this provision is consistent with existing laws providing for penalties for interfering with law enforcement.	No incremental impact since " no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative V		
1. No Take					
(a) Possessing, moving, harvesting, removing, taking, damaging, disturbing, breaking, cutting, spearing, or otherwise injuring any coral, marine invertebrate, fish, bottom formation, algae, seagrass or other living or dead organism, including shells, or attempting any of these activities. However, fish, invertebrates, and marine plants may be possessed aboard a vessel in the ecological reserve provided such resources can be shown not to have been harvested within, removed from, or taken within, the ecological reserve, as applicable, by being stowed in a cabin, locker, or similar storage area prior to entering and during transit through	**A. Maximum Potential Loss** 65 of the 105 to110 commercial fishing operations are potentially impacted. Some operations are multi-species fisheries. 27 lobster, 14 shrimp, 16 king mackerel, and 42 reef fish operations potentially impacted directly. About $1.22 million in harvest revenue potentially lost or 17.9 % of the harvest revenue from the TERSA. On average, about $18,843 per fishing operation. Additionally, potential losses to 10 fish houses and other small businesses through the multiplier impact.	**A. Maximum Potential Loss** 11 of 12 charter boat operations operating within the TERSA would be potentially impacted. Direct business revenue would include 86.66% for diving for lobsters, 69% for spear fishing, and 12.88% for fishing. Across all three recreation consumptive activities, 34% of revenue would be potentially impacted and about 48% of profits. On average, maximum potential losses are estimated to be about $40,248 of lost revenue and $15,668 of lost profits per operation. Additional potential losses to an unknown number of small firms through the multiplier impacts. Only a fraction	**A. Maximum Potential Loss** No losses. Potential gains to one charter boat dive operation providing services to non-consumptive divers. Indirect gains to several small businesses due to the multiplier impacts. Gains from improvements in quality of sites in terms of diversity, number and size of various sea life. Improvements in quality of experience leading to increase in demand for charter boat services and corresponding multiplier impacts on other small businesses. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating or offsetting factors. Net gains (see A above).	**A. Maximum Potential Loss** No impact. **B. Mitigating Factors, Off-setting Factors and Net Impact** No impact.	**A. Maximum Potential Loss** No expected impact. One permit for inventorying submerged cultural resources in Sanctuary waters was issued for the Tortugas area of the Sanctuary. There were no submerged cultural resources found. Currently, it is unknown whether there are any submerged cultural resources on Riley's Hump, located in Tortugas South. **B. Mitigating Factors, Off-setting Factors and Net Impact** No mitigating factors or offsetting factors. Sanctuary will not issue permits for treasure salvaging in the ecological reserve.

Table 36. Impacts on Small Businesses (continued)

Regulation	Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Industries Impacted		
			Boundary Alternative V (continued)		
1. No Take (continued)					
such reserve, provided further that such vessel is in continuous transit through the ecological reserve. (b) Fishing by any means. (c) Touching living or dead coral, including but not limited to, standing on a living or dead coral formation.	**B. Mitigating Factors, Off-setting Factors and Net Impact** Crowding and Relocation. For lobster fishing operations, there is some potential for crowding costs. However, the potential losses are not likely lto occur because the State of Florida's trap reduction program and fishermen are knowledgeable of other fishing locations throughout the Sanctuary. For king mackerel operations, potential losses are not likely to occur because king mackerel is a pelagic species that is highly mobile and could be caught in other locations. For shrimp operations, losses are	of a percent of the total tourist/recreation business in Monroe County. **B. Mitigating Factors, Off-setting Factors and Net Impact** Substitution. This alternative displaces 87% of the diving for lobsters and 85% of the spearfishing. Substitution possibilities for these activities are extremely low given that this alternative eliminates access to the Tortugas Bank. Losses close to the maximum potential are more likely for these two activities. For fishing, mitigating all the losses through substitution is still highly probable since only 8% of the fishing activity would be displaced. This represents a low amount of activity and given the wide distribution of fishing activity throughout the study area, crowding effects are still a low probability.			Since no submerged cultural resources were located on Tortugas Bank, no expected impact.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative V (continued)		
1. No Take (continued)	not likely to occur because shrimp caught in the proposed reserve are such a small percentage of total catch. Highly likely that lost catch could be made up from other locations. For reef fish, the potential losses are likely to occur in the short term because reef fish stocks are overfished throughout the Sanctuary. Long-term Benefits from Replenishment. No expected benefits to king mackerel or shrimp operations. For lobster operations, expected net benefits from replenishment effect of	Long-term Benefits from Replenishment Effect. Although four of the five spawning sites identified in the western portion of the TERSA are within this boundary alternative, the displacement from the entire Tortugas Bank makes it highly unlikely that those diving for lobsters or spearfishing will benefit and will most likely suffer losses close to the maximum potential. For fishing, the stock effects or replenishment effect could be substantial. Whether the benefits would be large enough to offset displacement cannot be determined. But given the past experience with reserves, it is still somewhat likely that long-term benefits would offset			

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
	Boundary Alternative V (continued)				
1. No Take (continued)					
	ecological reserve. For reef fish operations, it is not clear whether the full 29 percent lost catch from displacement would be replaced from replenishment, but the costs of displacement would be mitigated and the losses to be less than the 29 percent reduction in the maximum loss case.	displacement costs yielding net benefits to fishing. Net result is short term losses and long-term losses to small businesses that are directly and indirectly dependent on recreational diving for lobsters and spearfishing in the TERSA. Possibility of small short term losses to fishing, but long-term gains from replenishment effect.			

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative V (continued)		
2. No Anchoring/Required Mooring Buoy Use/No Discharges or Deposits					
(a) Anchoring on coral. (b) Anchoring when mooring buoys or designated anchoring areas are available (c) Discharges or deposits except cooling water or engine exhaust.	No incremental impact since “no take” regulations already displace all commercial fishing.	No incremental impact since recreational consumptive users are already displaced by “no take” regulations.	One charter operation currently operating in Tortugas North potentially impacted. Mooring buoy use will constrain number and choice of available dive sites. It is unknown whether this will impact on future business of dive operators. Impact is dependent on the number and distribution (locations) of mooring buoys (to be determined). Prohibition against discharges or deposits results in no incremental impact.	No impact.	No incremental impact since treasure salvaging displaced by “no take” regulations.
3. No Access					
Alternative A: Apply existing ecological reserve regulations to Tortugas North and South.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact since “no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative V (continued)		
3. No Access (continued)					
Alternative B: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas South via permit and require call-in, call-out. Use of mooring buoys by vessels 100’ or less in length.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No incremental impact. See regulations 1 and 2 above.	No impact.	No incremental impact since “no take” regulations displace treasure salvaging.
Alternative C: Apply existing ecological reserve regulations to Tortugas North and South (as described in Alternative A). Prohibit anchoring in and control access to Tortugas North and South via permit and require call-in, call-out (as described in Alternative B). Use of mooring buoys by vessels 100’ or less in length.	No incremental impact because commercial fishing is already displaced by “no take” regulations.	No incremental impact because recreational consumptive users are already displaced by “no take” regulations.	Currently one charter dive operator operates in Tortugas North, while none operate in the South. Minor amount of time cost to charter operations in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecological reserve. The current operator does not have vessels over 100 feet in length. Time costs expected to be limited to less than 15 minutes to obtain permit and access permission per operation per visit to the reserve.	No impact.	No incremental impact since “no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
Boundary Alternative V (continued)					
3. No Access (continued)					
Alternative D (Preferred): Apply existing ecological reserve regulations to Tortugas North and Tortugas South (as described in Alternative A). Prohibit anchoring in Tortugas North and South and control accesss to Tortugas North via permit and require call-in, call-out (as described in Alternative B). Restrict access to Tortugas South to research or educational activities only. Use of mooring buoys by vessels 100’ or less in length.	No incremental impact since commercial fishing is already displaced by “no take” regulations.	No incremental impact since recreational consumptive users are already displaced by “no take” regulations.	Currently one dive operator operates in Tortugas North, none in Tortugas South. Minor time costs to the dive charter operator in reporting to Sanctuary staffer to obtain permit and to notify when entering and leaving ecological reserve. Time cost is expected to be less than 15 minutes per operation per visit to the reserve.	No impact.	No incremental impact since “no take” regulation displaces treasure salvaging.
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations					
Prohibited Activities					
a. Mineral and hydrocarbon exploration, development and production.	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).	No impact because the regulations only affect mineral and hydrocarbon firms (they are not small businesses).

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative V (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
b. Removal of, injury to, or possession of coral or live rock.	No impact because the commercial and personal taking of coral and live rock is currently illegal. Live rock aquaculture permits will not be issued and none are currently in existence.	No impact because the commercial and personal taking of coral and live rock is currently illegal.	Not applicable.	Not applicable.	Not applicable.
c. Alteration of, or construction on the seabed (exemptions are made for installation of nav aids & mooring buoys).	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.
d. Discharge or deposit of materials or other matter except cooling water or engine exhaust.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No impact. Other existing regulations already prohibit such discharges.	No incremental impact since “ no take” regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative V (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
e. Operation of vessels that strike or injure coral or seagrass; anchoring on live coral in depths less than 40'; exceeding 4 knots or creating wakes in designated areas; injuring or taking birds or marine mammals.	No incremental impact because commercial fishing already displaced by "no take" regulations.	No incremental impacts because recreational consumptive users already displaced by "no take" regulations.	No impact expected because dive operators already operate in this manner. No firms currently operate in these areas.	No impact.	No incremental impact since " no take" regulations displace treasure salvaging.
f. Conduct of diving/ snorkeling without a dive flag.	Not applicable.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No impact expected because use of flags is already required by other Federal and State regulations. No firms currently operate in these areas.	Not applicable.	Not applicable.
g. Release of exotic species.	No impact because release of exotic species is already prohibited by other laws and there are no known aquaculture operations in the areas.	No impact because release of exotic species is already prohibited by other laws.	No impact because release of exotic species is already prohibited by other laws.	No impact because release of exotic species is already prohibited by other laws.	No incremental impact since " no take" regulations displace treasure salvaging.

Table 36. Impacts on Small Businesses (continued)

Regulation	Industries Impacted: Commercial Fishing	Recreation Consumptive	Recreation Non-consumptive	Commercial Shipping	Treasure Salvors
			Boundary Alternative V (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
h. Damage or removal of markers.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No Incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No incremental impact expected because such prohibitions already exist for markers placed by other governmental entities and the regulation only applies to Sanctuary markers. One firm currently operates in these areas.	No incremental impact expected because such prohibitions already exist for markers placed by other governmental entities and the regulation only applies to Sanctuary markers.	No incremental impact since " no take" regulations displace treasure salvaging.
i. Movement of, removal of, injury to, or possession of Sanctuary historical resources.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	No incremental impact since " no take" regulations displace treasure salvaging.
j. Take or possession of protected wildlife.	No impact because wildlife is already protected by other applicable law.	No impact because wildlife is already protected by other applicable law.	Not applicable.	Not applicable.	Not applicable.
k. Possession or use of explosives or electrical discharges (intent is to apply to take of marine species).	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Not applicable.	Not applicable.	Not applicable.

Table 36. Impacts on Small Businesses (continued)

	Industries Impacted				
Regulation	**Commercial Fishing**	**Recreation Consumptive**	**Recreation Non-consumptive**	**Commercial Shipping**	**Treasure Salvors**
			Boundary Alternative V (continued)		
4. Boundary Expansion Areas: Additional Sanctuary-wide Regulations (continued)					
Prohibited Activities (continued)					
l. Harvest or possession of marine life species (effect is to extend current State law into Federal waters).	No incremental impact because commercial fishing is already displaced by "no take" regulations. Currently there are no marine life collectors operating in these areas.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	Not applicable.	Not applicable.	Not applicable.
m. Interference with law enforcement.	No incremental impact because commercial fishing is already displaced by "no take" regulations.	No incremental impact because recreational consumptive users are already displaced by "no take" regulations.	No impact expected because this provision is consistent with existing laws providing for penalties for interfering with law enforcement. One firm currently operates in these areas.	No impact expected because this provision is consistent with existing laws providing for penalties for interfering with law enforcement.	No incremental impact since " no take" regulations displace treasure salvaging.

Table 37. Statement of Estimated Cost of Establishing the Tortugas Ecological Reserve - As of October 1999

Labor		
It is estimated that the Science Coordinator devoted fifty percent (50%) of his time to support the working group and to develop the Draft Supplemental Environmental Impact Statement during the period 1998 to 1999. Other staff contributed lesser portions of their time for which an estimate is given.		
Salary for 1998	$50,881.00	
Salary for January - Oct, 1999	$45,231.00	
Total	**$96,112.00**	
Estimated Cost - $96,112 x 50%	$48,056.00	
Other staff (for the period 1998-Oct. 99)	$50,000.00	
Subtotal		**$98,056.00**
Meetings	Cost	
4 Working Meetings where room rental fee was charged	$2,089.00	
Note: Working Group members were not compensated for their time or travel		
One scoping meeting where room rental fee was charged	$789.00	
Staff travel costs	$3,348.00	
Security	$100.00	
Sub-total		**$6,326.00**
Contractors	Cost	
National Park Service for characterization of fish communities	$10,000.00	
Language translation services	$1,028.00	
Data entry of scoping comments	$375.00	
Sub-total		**11,403.00**
NOS Administrative Costs	Cost	
Staff: Two economists at 25% and one Sea Grant Intern at 5 %	$34,087.00	
Travel: Travel to public meetings and data collection	$4,280.00	

Contract: Thomas Murray & Associates for data on collection from commercial		
Fishermen	$20,000.00	
Sub-total		$58,367.00
TOTAL PLANNING COSTS		**$174,152.00**

Table 38. Costs of implementation of the proposed Tortugas Ecological Reserve: Management Costs

First Year Startup Costs	**Cost**
Boundary Buoys	
Tortugas North: 12 buoys (lighted, 3 mi. vis) @ $5000/each	$60,000.00
Tortugas South: No buoys due to depth.	0
Mooring Buoys	
6 buoys (1 each @ 6 sites) for $450/each	$2,700.00
Buoy Installation	
Salaries	$5,000.00
Housing	
Modular unit installed in Fort Jefferson	$60,000.00
Furnishings	$10,000.00
Personnel	
Law Enforcement Officer (1)	$50,000.00
General support staff (1)	$50,000.00
Vessels	
82’ vessel (2)	$80,000.00
Research support	
Sanctuary research vessel ($1000/day) x40 days	$40,000.00
Nitrox membrane system	$27,000.00

Supplies		
Fuel tank at Fort, etc.	$10,000.00	
Total		**$394,700.00**
Annual Costs (approximate)		
Salaries (FTE)	$120,000.00	
Boat maintenance	$3,000.00	
Research and monitoring support	$100,000.00	
Mooring buoy maintenance (salaries)	$12,000.00	
Mooring buoy maintenance (supplies)	$7,000.00	
Total		**$242,000.00**

PART VI: SELECTION OF THE PREFERRED ALTERNATIVE

Introduction

This section sets forth the Preferred Alternative and why it was selected.

Preferred Alternative

The Preferred Alternative is Boundary Alternative III (Figure 35) combined with Regulatory Alternative D.

General Rationale

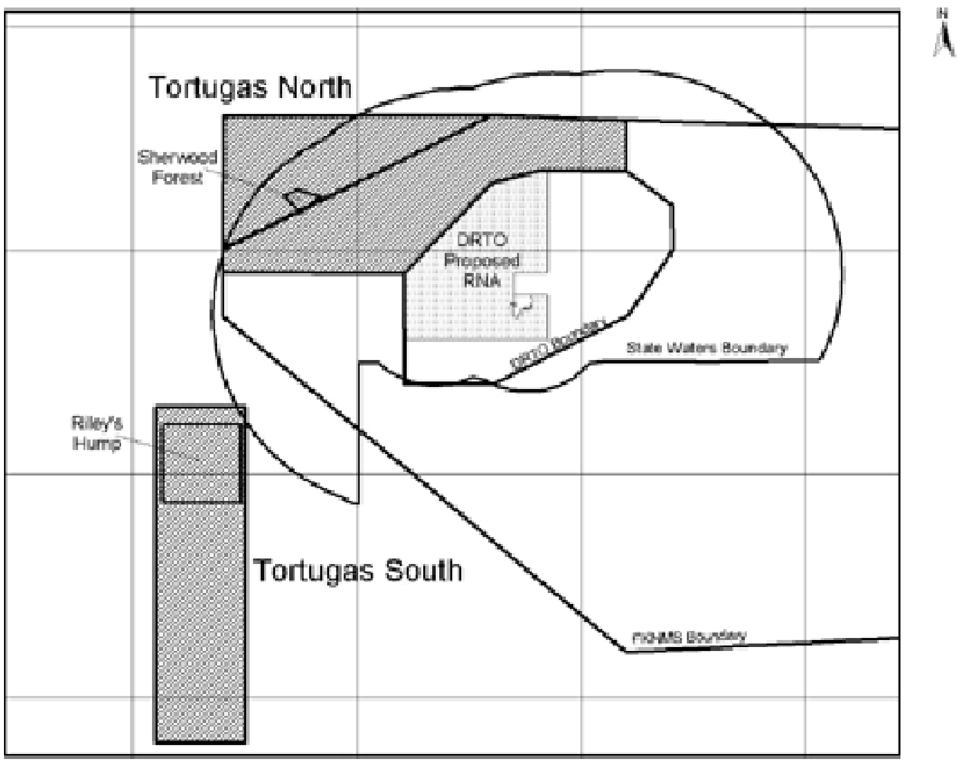
Boundary Alternative III combined with Regulatory Alternative D has been selected as the Preferred Alternative because this combination achieves the objectives of all of the criteria listed below.

This Preferred Alternative is of sufficient size and imposes adequate protective measures to satisfy the selection criteria and to fulfill the goals and objectives of the FKNMSPA and the NMSA. Boundary Alternative III is consistent with the recommendations of the WG and SAC to NOAA and the State of Florida. While the WG and SAC recommended Regulatory Alternative A (application of the existing Sanctuary-wide and existing ecological reserve regulations), the more protective approach of Regulatory Alternative D is warranted because of the threat to coral reef resources posed by the anchoring of vessels, the threat to the sensitive resources of Tortugas South from non-consumptive activities, and the difficulty of enforcement in this remote area, particularly in Tortugas South. Extremely high coral cover and deep water in the Tortugas preclude anchoring without damaging coral.

The Preferred Regulatory Alternative in the DSEIS was Alternative C. The Preferred Regulatory Alternative in the FSEIS is Alternative D. Under Alternative D, Tortugas South will be accessible only for continuous transit and law enforcement or, pursuant to a sanctuary permit, for scientific research and educational purposes. This change was made because of comments received regarding the potential effects of non-consumptive activities, particularly non-consumptive diving. Alternative D will better protect resources in Tortugas South, such as the spawning aggregation areas, which are more sensitive to this activity than those in Tortugas North, and will enhance enforcement surveillance in this remote part of the Reserve. Leaving Tortugas North accessible to non-consumptive activities, including diving, will not only provide significant opportunities for resource appreciation and public education but will also allow the comparison of Tortugas North to Tortugas South over time to better understand and document the possible effects of non-consumptive diving in Tortugas North. The permit system for access to Tortugas North will provide information that will allow NOAA to determine the number of vessels and divers using the area and will assist in monitoring impacts.

The draft final regulations implementing the Preferred Alternative have been revised to make them consistent with Regulatory Alternative D. Also, the prohibition on fishing has been revised to prohibit all fishing in the Reserve without exception. This change was in response to comments that the prohibition should be issued under the NMSA and that the exception clause that would have authorized fishing to the extent allowed under regulations issued pursuant to the Magnuson-Stevens Fishery Conservation and Management Act should be eliminated. Regulations under the Magnuson-Stevens Act must satisfy the requirements of that Act including the National Standards set forth in that Act. Sanctuary regulations including those governing fishing are issued under the NMSA. While some of the goals and objectives of the two Acts are similar, many of the goals and objectives of the two statutes are quite different.

Figure 35. Preferred Alternative.



Comparison of Alternatives

This section compares Boundary Alternatives II-V and Regulatory Alternatives A-D based on the selection criteria. Boundary Alternative I, the No-Action Alternative, is not compared because it would not be consistent with the goals of the FKNMSPA, the NMSPA, the FMP for the Sanctuary, and Executive Order 13089. Among other things, Part V of this FSEIS sets forth the environmental and socio-economic consequences of the No-Action Alternative. The selection criteria are: 1) protect ecosystem integrity; 2) protect biodiversity, including the maintenance or restoration of viable populations of native species; 3) enhance scientific understanding of marine ecosystems; 4) facilitate human uses to the extent consistent with meeting the other criteria; 5) minimize adverse socio-economic impacts to the extent consistent with meeting the other criteria; and 6) facilitate enforcement and compliance. Subcriteria for and the goals and sources of each of the criteria are set forth in the table below. The criteria are consistent with the goals of the FKNMSPA, the NMSA, the Final Management Plan for the Sanctuary, public scoping comments, design criteria developed by the Tortugas 2000 Working Group, Executive Order 13089 regarding Coral Reef Protection, the U.S. Coral Reef Task Force (CRTF) recommendations, and scientific literature on marine reserves. The criteria have been revised from those contained in the DSEIS based on comments received (Table 38).

Table 38. Criteria, Objectives, and Rational Developed by the Tortugas 2000 Working Group

Criteria	Objective	Rationale/Source
Protect ecosystem integrity. This includes the following sub-criteria: • Protect a wide range of contiguous habitats through deep water, • Maximize connectivity among habitats, • Protect unique coral formations and areas of high coral cover, including Sherwood Forest, • Provide adequate buffer areas, • Sustain ecological & evolutionary processes, • Protect against short and long-term environmental perturbations, and, • Encompass an area that is large enough and sufficiently protected that, when combined with existing protections, maintains the Tortugas region's contribution to the Florida Keys' ecosystem.	Choose an area and protection measures that protect a wide range of contiguous habitats, establish connectivity between those habitats, and protect unique structural formations.	FKNMSPA, NMSA, public comment, Working Group, CRTF, and literature.
Protect biodiversity, including the maintenance or restoration of viable populations of native species. This includes the following sub-criteria: • Protect the full range of species, • Protect natural spawning, nursery, and permanent residence areas, including Riley's Hump, • Protect and enhance commercially and recreationally important fish species, • Protect species with specific habitat requirements, • Protect endangered, threatened, rare, or	Choose an area and protection measures that will protect areas of high biodiversity, known or reported spawning areas and habitats that supports resident fish and other marine life.	Final Management Plan, public comment, Working Group, and literature.

imperiled species, • Protect areas with physical oceanographic characteristics that will enhance larval dispersal, • Protect areas of high coral and fish diversity, • Protect areas of high productivity, • Protect foraging areas for seabird and endangered sea turtle populations, and, • Protect areas of high endemism.		
Enhance scientific understanding of marine ecosystems. This includes the following sub-criteria: • Provide a reference area to monitor the effects of both consumptive and non-consumptive activities on ecosystem structure and processes, and, • Provide a reference area to discriminate between human-caused and natural changes in the Florida Keys' marine ecosystem.	Choose an area and protection measures that will facilitate the monitoring of anthropogenic impacts and the evaluation of the efficacy of the ecological reserve for protecting coral reef health and biodiversity.	FKNMSPA, NMSA, public comment, Working Group, CRTF, and literature.
Facilitate human uses to the extent consistent with the other criteria.	Choose an area and protection measures that will allow uses and provide a range of habitats to observe and study, consistent with the attainment of the other objectives.	FKNMSPA, NMSA, Final Management Plan, public comment, Working Group, and literature.
Minimize adverse socio-economic impacts to the extent consistent with the other criteria.	Choose an area and protection measures that meets the objectives of the other criteria but that does not unduly impact users.	FKNMSPA, NMSA, public comment, and Working Group.

Facilitate enforcement and compliance.	Choose an area and protection measures that facilitate enforcement of the ecological reserve and encourage compliance by users.	Working Group and literature.

- *Protect ecosystem integrity*. Boundary Alternative II does not encompass enough range of habitat or area to adequately protect the integrity of the ecosystem (Table 14). Boundary Alternative II does not adequately protect the full range of habitats and species found in the Tortugas area. The unique and ancient coral formations of Sherwood Forest are not part of this alternative. Boundary Alternative II does not include contiguous habitats nor is connectivity between habitats maximized. Boundary Alternative II does not provide a reasonable buffer area for coral reef features. Alternative II includes no deep water habitats greater than approximately 200 feet. By not having two reserve components, Alternative II offers no insurance against the effects of a catastrophic event (*e.g.*, cold weather, low salinity) that could potentially damage resources of the area. Alternative II is not large enough to sustain local or regional ecological or evolutionary processes. Boundary Alternatives III, IV and V, when combined with existing protections in the region, are sufficient to protect ecosystem integrity in the Tortugas and that region's contribution to the Florida Keys ecosystem. Boundary Alternatives III-V include two replicate components that help to ensure against the effects of catastrophic events. Boundary Alternative III includes a sufficient range of essential habitats for many species life stages and includes adequate buffers. The increased area of Boundary Alternatives IV and V has negligible increased benefit to protecting ecosystem integrity compared to Alternative III. Boundary Alternative V does not capture additional significant habitat to the west of the Tortugas Bank and does not preserve the critical deep water habitat south of Riley's Hump. Regulatory Alternative A would not adequately protect ecosystem integrity because of the threat to coral reef resources by anchoring. Regulatory Alternative B would not adequately protect ecosystem integrity in Tortugas North and the Sherwood Forest area because of the threat to coral reef resources by anchoring. Regulatory Alternative C adequately protects ecosystem integrity by prohibiting anchoring and controlling access to Tortugas North and South via an access permit. Regulatory Alternative D increases protection of ecosystem integrity over Alternative C by prohibiting access to Tortugas South except by permit for research or educational reasons. This will virtually eliminate human degradation and protect the ecological integrity of the Tortugas region.

- *Protect biodiversity, including the maintenance or restoration of viable populations of native species*. Boundary Alternative II does not protect the high coral species diversity of Sherwood Forest or the unique fish species richness of Tortugas South. Boundary Alternative II protects only one of eight known fish spawning aggregations and does not include Riley's Hump, which is an area of high endemism and a critical source area for larvae. Sherwood Forest, an important permanent residence area for a variety of species and area of high productivity, is not part of Alternative II. Boundary Alternative III protects 5 of the 8 known fish spawning areas as well as approximately 87% of the known coral reef habitat and 76% of the known hardbottom habitat. Boundary Alternative III also protects the habitat of several commercially important fish species and several uncommon species found in the deep water regions of Tortugas South. Boundary Alternatives III, IV, and V protect the high coral diversity of Sherwood Forest and they protect Riley’s Hump and the deep habitat around it which are a critical source of larvae for downstream areas of the Florida Keys. In addition, they help protect important foraging areas for seabirds and sea turtles. Boundary Alternative IV encompasses 6 out of 8 known fish spawning sites as well as 100% of the known coral and hardbottom habitat. Boundary Alternative V encompasses 7 out of the 8 known fish spawning sites and would protect all of the known coral and hardbottom habitat. Alternative V's expansion of Tortugas North to the west would provide increased protection for some additional habitats and associated species. However, its reduction in size of Tortugas South would provide less protection for critical deep water habitats and thereby has the least protection for associated species such as golden crab and snowy grouper. Regulatory Alternative A would not adequately preserve biodiversity and maintain viable populations because of the threat to associated habitats of many species by anchoring and the lack of protection for high diversity areas such as Sherwood Forest and Riley’s Hump. Regulatory Alternative B would not adequately preserve biodiversity and maintain viable populations in Tortugas North because of the threat to associated habitats of many species by anchoring. Regulatory Alternative C would preserve biodiversity by prohibiting habitat destruction from anchoring. However, Regulatory Alternatives A, B, and C would not protect the several natural fish spawning aggregations in Tortugas South from disturbance. Regulatory Alternative D would adequately preserve biodiversity and maintain viable populations by protecting critical habitat in Tortugas North and Tortugas South from anchor damage and by minimizing disturbance to natural spawning aggregations in Tortugas South.

- *Enhance scientific understanding of marine ecosystems.* Given the absence of unexploited areas in the Tortugas region, Boundary Alternatives II-V would all serve to increase our scientific understanding of marine ecosystems and their response to management of consumptive and non-consumptive activities, including their recovery from fishing impacts. Boundary Alternatives II-V would also facilitate scientific understanding by providing a reference area to gauge the broader changes occurring in the Florida Keys marine ecosystem. Boundary Alternatives III-V offer the added scientific benefit of protecting Riley's Hump, which would add to our knowledge of effective reserve design regarding networks and energy flow between marine reserves. The inclusion of Tortugas South will also significantly add to our knowledge of the importance of the Tortugas region in sustaining the Florida Keys ecosystem. Boundary Alternatives IV and V encompass all of Tortugas Bank and would compromise the study of fishing effects because there would be no comparable habitat for use as a reference site. Regulatory Alternatives A, B, and C would provide for essentially the same level of scientific understanding. Regulatory Alternative D will facilitate the most scientific understanding of human effects on ecosystem processes because it would create a research/education-only area in the Tortugas which could serve as a reference site from which to gauge the impacts of non-consumptive activities.

- *Facilitate human uses to the extent consistent with the other criteria.* All of the alternatives would serve well in enhancing opportunities for non-consumptive activities such as education, photography, underwater wilderness exploration, and ecotourism. Boundary Alternatives III-V provide enhanced opportunities over Boundary Alternative II because of the addition of Tortugas South and the expansion of Tortugas North to include the unique coral reef region known as Sherwood Forest. Regulatory Alternatives A, B, and C would provide the same non-consumptive opportunities. Though Regulatory Alternative D will prohibit all consumptive and non-consumptive activities in Tortugas South other than research and education, the disallowance of these activities will establish Tortugas South as a critical reference area by which any impacts of the non-consumptive activities occurring in Tortugas North may be assessed.

- *Minimize adverse socio-economic impacts to the extent consistent with the other criteria*. As stated in Part V of the FSEIS, all users are considered to be small entities within the meaning of the Regulatory Flexibility Act. Boundary Alternatives I and II and Regulatory Alternatives A, B, and C would have less of an adverse impact on users than the Preferred Alternative (Boundary Alternative III coupled with

Regulatory Alternative D). Boundary Alternatives IV and V would have a greater adverse impact on users than the Preferred Boundary Alternative. Boundary Alternative III has moderate impacts on users, mostly lobster fishermen and handline fishermen. Alternatives IV and V have significantly greater impacts because they include the southern half of Tortugas Bank, which is heavily utilized by both recreational and commercial users. Alternative III offers a compromise because it allows for continued consumptive use of the southern half of Tortugas Bank including trolling for pelagic fish species. Ignoring the potential of such effects as replenishment that would result in a net economic benefit, Regulatory Alternative A has significant adverse socio-economic effects on users. There are 12 recreational charter operations that would be affected by this alternative and approximately 110 commercial fishing operations. Regulatory Alternative A would not provide a sufficient degree of protection to Tortugas resources. It would not protect coral reef resources from anchoring and from the possible effects of non-consumptive uses and would not provide the FKNMS with adequate notice to facilitate enforcement. Regulatory Alternative B would provide adequate protection from anchoring damage in Tortugas South and would provide adequate notification to FKNMS to facilitate enforcement there, but would not provide adequate protection to Tortugas North. It would also not protect the resources of Tortugas South from non-consumptive uses. Regulatory Alternative C would provide adequate protection from anchoring damage in Tortugas North and South and would provide adequate notification to FKNMS to facilitate enforcement with insignificant incremental costs to users. However, it would not protect the sensitive coral reef resources from the possible effects of non-consumptive uses. The Preferred Alternative (Boundary Alternative III/Regulatory Alternative D) could potentially impact, if one assumes no mitigating factors, 9 recreational charter users with total annual revenue losses of approximately $152,054, 64 commercial fishermen with total annual revenue losses of approximately $843,583, and 673 person days of recreational fishermen using private boats with a maximum potential loss of $53,392 in consumer's surplus. Though Regulatory Alternative D would prohibit use of Tortugas South except for continuous transit, for law enforcement purposes, or for research or education activities pursuant to a sanctuary permit, this alternative would provide an important reference area to facilitate the study of non-consumptive impacts in Tortugas North. Additionally, unlike in Tortugas North where a moderate amount of non-consumptive diving activities has been identified, little diving has been identified in Tortugas South and as such the socio-economic impacts of the more restrictive Regulatory Alternative D are not expected to be significant or substantial to this user group in Tortugas South.

- *Facilitate enforcement and compliance.* Boundary Alternative II would be less likely to facilitate enforcement of and compliance by users of the ecological reserve due to its irregular boundary shape. Boundary Alternative III is the most likely to facilitate enforcement and compliance by users because the boundaries of Tortugas North and Tortugas South follow lines of latitude/longitude and share several of the existing boundaries and marked corners of the Dry Tortugas National Park. Boundary Alternatives IV and V would be less likely than Boundary Alternative III to facilitate compliance by users because the southern boundary of Tortugas North does not terminate at a marked corner of the Dry Tortugas National Park. Regulatory Alternative B would not adequately facilitate enforcement because it would not provide notice to FKNMS of the presence of users in the ecological reserve. Regulatory Alternative C adequately facilitates enforcement and compliance of Tortugas North but does not provide significant solutions for enforcing Tortugas South, the more remote portion of the ecological reserve. Regulatory Alternative D best facilitates enforcement and encourages compliance by limiting access to Tortugas South to continuous transit through the area with fishing gear stowed. Regulatory Alternative D will ease enforcement and provide additional environmental benefits by helping to control illegal spearfishing and lobster diving, as well as other illegal fishing and anchoring.

PART VII: SUPPLEMENTAL MANAGEMENT PLAN

The supplemental management plan complements the existing Sanctuary Management Plan in several respects. Many of the strategies described in the MP that are now being implemented in the majority of the Sanctuary will be applied to the proposed Tortugas Ecological Reserve. However, due to the unique characteristics of the Tortugas region (remoteness, deep water) some new strategies must be developed and implemented. Some of these strategies are described below. Specifically, this action further implements the Zoning Action Plan in the Sanctuary Management Plan, and adds strategies to the Education and Outreach Action Plan, Enforcement Action Plan, Mooring Buoy Action Plan, and Research and Monitoring Action Plan.

Administrative Action Plan

A supplement to the Administrative Action Plan targets the development of a Memorandum of Understanding (MOU) to clearly define the roles and responsibilities of the various agencies responsible for resource management in the Tortugas region. The MOU would cover, at a minimum, the following activities: cooperative enforcement, research, and sharing of facilities. Management of the Tortugas Ecological Reserve would necessitate a high degree of coordination and cooperation between the affected agencies, particularly the FKNMS and the NPS. Both agencies have similar missions and responsibilities. Consequently, cooperation would not only save money but would also improve resource protection. The NPS has a variety of assets such as land, housing, and dockage that, under a workable agreement, could potentially be used to support management of the ecological reserve. An agreement on the use of these lands and facilities would be pursued by the FKNMS and NPS.

The State of Florida is the co-trustee for a significant portion of the waters and marine resources within the proposed reserve and would co-manage these resources with the FKNMS.

NOAA’s National Marine Fisheries Service has a responsibility for managing the fisheries in federal waters of the reserve. NMFS has considerable expertise and some assets that could be utilized in managing the reserve, particularly in the areas of research and monitoring. The Office of Law Enforcement has responsibility for enforcing fishing regulations and has assets and technology that could potentially be used for enforcement.

The U.S. Coast Guard has responsibility for enforcing fishing regulations in federal waters. They have several large offshore patrol vessels based in Key West that could be used, in conjunction with Sanctuary patrol vessels, for enforcement of the reserve areas.

Strategy 1: Memorandum of Understanding

Develop and enter into a Memorandum of Understanding (MOU) that clearly defines the roles and responsibilities of the various agencies responsible for resource management in the Tortugas region. The MOU should cover, at a minimum, the following activities: cooperative enforcement, research, and sharing of facilities and assets.

Education and Outreach Action Plan

This action plan identifies and describes specific education and outreach strategies that will be implemented in association with the designation of the Tortugas Ecological Reserve. These strategies are expected to have a significant effect on protecting and preserving the natural resources found in the Tortugas by enhancing the general public's understanding of this unique region and new regulations associated with reserve designation. These strategies were developed according to the Sanctuary Education and Outreach goals and outcomes identified in the Final Management Plan.

Strategy E.13: Tortugas Site Brochure

To a large degree, marine reserves rely on visitor compliance and understanding in order for regulations to be effective. This is even more critical when reserves are remotely located or large in size, each of which would apply to the Tortugas Ecological Reserve. The Sanctuary has learned from experience that an important tactic for increasing compliance is to provide appropriate educational products and information to visitors of reserve areas. This strategy will produce a site brochure which details the regulations and boundaries for the Tortugas Ecological Reserve, how to obtain a permit to enter and visit the Tortugas North Reserve, the locations and numbers of mooring buoys, and the unique ecological features of the area. This product will complement the series of existing Sanctuary regional site brochures, and will interpret an area of the Sanctuary that is not currently covered in any existing products.

- Activity 1 – Design layout and content of brochure;
- Activity 2 – Identify partners to assist with brochure costs;
- Activity 3 – Print and distribute brochure.

Strategy E.14: Tortugas Ecological Reserve Exhibit, Garden Key

Most visitors to the Tortugas Ecological Reserve will stop at Ft. Jefferson on Garden Key in Dry Tortugas National Park at some point during their visit. Garden Key provides a convenient anchorage for private pleasure boats, commercial fishing vessels, live-aboard dive vessels, recreational fishing guides, and ferries and seaplanes that bring campers and day visitors from Key West. This strategy involves the development and construction of an information kiosk at Ft. Jefferson that will take advantage of this contact point to educate visitors about the Tortugas Ecological Reserve. The exhibit will include practical information on reserve boundaries and regulations, as well as information on the habitats and marine life found in the reserve and the reasons for designating the Reserve. The exhibit will be visually appealing, educational and interesting for the general public, while still conveying necessary regulatory information for those visitors who may be entering the reserve.

- Activity 1 – Consult with National Park Service staff to determine size and location of kiosk. Review construction designs and materials of similar kiosks;
- Activity 2 – Design content and layout for kiosk;
- Activity 3 – Produce and install kiosk.

Strategy E.15: Interagency Visitor Center, Key West

Due to the geographical remoteness of the Tortugas area and considerable depths at which unique coral reef resources are located, it is important to provide educational opportunities for the over 2.5 million visitors to the Keys that will not see these special features first-hand. The Florida Keys National Marine Sanctuary, working in conjunction with the National Park Service and the United States Fish and Wildlife Service, is establishing an interagency visitor center in Key West. This strategy will develop an exhibit for the visitor center in which the natural characteristics and habitats of the Tortugas region are featured. This exhibit will educate the visitor about natural resources while interpreting the multi-agency jurisdiction of the region. The development and designation of the Sanctuary's Tortugas Ecological Reserve and the Dry Tortugas National Park's Research Natural Area will also be explained.

- Activity 1 – Consult with National Park Service staff to determine content, design, and layout of exhibit;
- Activity 2 – Identify other possible agency or private partners for exhibit production;
- Activity 3 – Produce and install exhibit.

Strategy E.16: Tortugas Site Characterization

Several years ago a comprehensive site characterization for the Florida Keys National Marine Sanctuary was produced. This 10 volume series is rich in biological, oceanographic, chemical, geological, and other scientific information. A similar, though less voluminous, site characterization was produced for the Tortugas region as a component of the Tortugas Ecological Reserve planning process. In order to heighten the new Reserve users' awareness of the oceanographic and biological uniqueness of the Tortugas resources, a layperson's summary of the site characterization will be developed under this strategy. The Sanctuary will seek to create a product in cooperation with the National Park Service that takes an ecosystem approach to interpretation, starting at the islands of the Park, and progressing through the deep-water environments of the new Tortugas Ecological Reserve. This product will be produced in both electronic and printed format to increase accessibility and reduce printing costs. The web site document will contain hyperlinks to the full site characterization document and to research data from the region, including GIS maps.

- Activity 1 – Obtain electronic versions of Tortugas Site Characterization document and upload to Sanctuary web site;
- Activity 2 – Write summary of Site Characterization and conduct review of summary by original authors;
- Activity 3 – Produce printed version of summary and post electronic version to web site;
- Activity 4 – Improve web site page by identifying and creating relevant links to data, photos, and GIS maps.

Strategy E.17: Tortugas Ecological Reserve Documentary

This strategy will produce a documentary on the Tortugas Ecological Reserve to interpret the unique ecological resources of the reserve, explain the necessity of protection, summarize the Sanctuary's use of marine zoning as an effective management tool, and explain the process by which the reserve was created. The Sanctuary has received and continues to receive multiple requests from national and international sources on the process used to create the Tortugas Ecological Reserve. This film documentary will convey the breadth of information associated with the reserve and its creation. The documentary will also be duplicated for use by the many agencies that have undertaken action within the Tortugas area relative to reserve designation (e.g., National Park Service, regional fishery management councils, and the State of Florida).

- Activity 1 – Contract with videographer to produce documentary;
- Activity 2 – Produce duplicate copies of documentary and distribute as needed.

Strategy E. 18: Traveling Exhibit on Marine Zoning

Sanctuary Education and Outreach staff participate in more than twenty-five community fairs, trade shows, scientific and management conferences, and related events annually. A variety of traveling exhibits and display materials are used to interpret Sanctuary resources, regulations, and special projects. This strategy involves the development and production of a traveling exhibit on marine zoning in the Sanctuary, including the new Tortugas Ecological Reserve. Components of the exhibit will be interchangeable, focusing on a variety of topics such as zone designation, resources protected by various zone types, regulations, research and monitoring of zone performance, and the use of marine zoning in other national and international arenas.

- Activity 1 – Design content and layout for traveling exhibit;
- Activity 2 – Produce exhibit components.

Strategy E. 19: Interpretive Wayside Exhibits on the Tortugas Ecological Reserve

Of the 2.5 million visitors to the Florida Keys annually, 14.4% participate in boating activities using private vessels. In recent years, visitation to Dry Tortugas National Park has increased from 18,000 visitors in 1984 to 72,000 in 1998. This strategy aims to educate private boaters traveling to the Tortugas by developing and installing interpretive wayside exhibits such as information signs at boat ramps, chambers of commerce, and other strategic locations. Exhibits will provide important information about the Tortugas waters, natural resources, and regulations for the new reserve. The signs will also display information on minimal impact usage and safety considerations for traveling to this remote area.

- Activity 1 – Identify number of exhibits needed and appropriate locations for exhibits. Prioritize exhibit placement;
- Activity 2 – Investigate production costs and possible partners for funding exhibits;
- Activity 3 – Design content and layout for wayside exhibits;
- Activity 4 – Produce and install exhibits by priority area as funding permits.

Enforcement Action Plan

One of the goals of Sanctuary Managers is to gain the highest level of compliance by the public who enter and visit the Tortugas Ecological Reserve. This compliance can be achieved through several management actions including education and outreach and on the water presence of Sanctuary staff in programs such as Team OCEAN, where Sanctuary information is distributed along the waterfront or boat to boat by Sanctuary staff and volunteers.

The most effective management action used to achieve compliance to Sanctuary regulations is an effective law enforcement program. Currently, the primary enforcement of Sanctuary regulations is accomplished through an enforcement contract between NOAA/NMSP and the State of Florida Fish and Wildlife Conservation Commission. The enforcement efforts are consistent with the goals and objectives for enforcement described in the Final Management Plan for the FKNMS (July 1997). The Final Management Plan for the Sanctuary also calls for cross-deputization of other agency law enforcement personnel (e.g. National Park Service Rangers) to accomplish law enforcement responsibilities within the Sanctuary. This approach to enforcement has not been implemented to date and continues to remain as an option to fulfilling some enforcement obligations within the Sanctuary.

The FKNMS is committed to effective law enforcement in the Tortugas Ecological Reserve. A successful and effective Ecological Reserve will depend on the level of enforcement resources dedicated to the Tortugas Ecological Reserve. Several enforcement options are presently available for the Tortugas Ecological Reserve. Some of those options are:

- Installation and monitoring of a long-range radar unit at the Dry Tortugas National Park. This would allow remote monitoring of vessels entering and leaving the Reserve.
- Place two 82' vessels into service for patrolling the Ecological Reserve.
- Cross-deputize and fund National Park Service Rangers to assist in enforcement in the Tortugas Ecological Reserve.

Any or all of these enforcement options are possible for enforcement of Sanctuary regulations.

Law Enforcement Budget

Personnel

- Law Enforcement Officers (4-6) $50,000 per position
- General Support $50,000

Vessels

- 82' Patrol Vessels (2) No Cost - Agency Property Transfer

Other Enforcement Factors

The Preferred Regulatory Alternative "D" for the Tortugas Ecological Reserve will serve to facilitate enforcement within the Ecological Reserve. This alternative prohibits vessels from stopping within the Tortugas South portion of the Tortugas Ecological Reserve. Only permitted scientists and educators will be allowed in the reserve. This will make it possible to monitor vessel traffic remotely by radar and response will only be necessary when vessels without a permit stop within the reserve.

Additionally, access to Tortugas North will be allowed only by permit. This will help Sanctuary managers monitor the level of visitor use in the reserve and will facilitate enforcement efforts.

Mooring and Boundary Buoy Action Plan

Tortugas Ecological Reserve supplement

- Strategy 1. Install and maintain boundary buoys for Tortugas North.
- Strategy 2. Install and maintain an adequate number of mooring buoys in Tortugas North in appropriate locations.
- Strategy 3. Determine whether buoys are appropriate for Tortugas South and, if so, determine the number, type, and locations of buoys.

Regulatory Action Plan

A supplement to the Regulatory Action Plan would be the issuance of final regulations to implement the boundary expansion and the establishment of the reserve. The supplement would call for extensive coordination with other governmental entities, particularly the State of Florida, to ensure that all approvals and required regulations are obtained and in place. A complementary strategy to the issuance of regulations would be publication on NOAA nautical charts of the new boundaries for the Sanctuary and the reserve.

Research and Monitoring Action Plan

This action plan identifies and describes research and monitoring strategies that will be implemented in association with the designation of the Tortugas Ecological Reserve. These strategies are expected to have significant effects on Sanctuary resources by providing the knowledge necessary to make informed decisions about protecting the biological diversity and natural ecosystem processes of the Tortugas region. These strategies were developed according to the Sanctuary Research and Monitoring goals and objectives identified in the Final Management Plan.

Strategy T.1: Ecological Reserve Support Staff

This strategy involves hiring support staff to assist with regulatory implementation and interpretation of the Tortugas Ecological Reserve. This staff member will establish a permit issuance and tracking system for entrance into the reserve, answer inquiries from the general public while on-site at the reserve, and assist with research and other reserve issues as needed.

- Activity 1 – Review support staff logistics (office space, communications, lodging) with National Park Service personnel.

- Activity 2 – Advertise for and hire support staff.

Strategy T.2: Design and Implement Long-term Ecological Monitoring to Test the Efficacy and Ecological Integrity of the Tortugas Ecological Reserve

Ecological reserves are designated within the Sanctuary to protect and enhance biodiversity and to provide natural spawning, nursery, and permanent residence areas for marine life. This strategy establishes monitoring activities that compare reserve areas before and after designation, as well as monitoring which captures changes occurring inside and outside the protected area, which is critical to gauge the effectiveness of Ecological Reserves as a management tool. This monitoring will also assist Sanctuary management in determining if the area's biodiversity, productivity, and ecological integrity are being adequately protected by the regulations in place. Consistent with the existing Zone Monitoring Program, indicators for assessing ecosystem function and ecological integrity (such as changes in coral and fish diversity, trophic structure, and water quality) will be monitoring. An important element will be monitoring diving impacts by comparing changes in gross habitat morphology in Tortugas South and Tortugas North, particularly around mooring buoys.

- Activity 1 – Assess existing Tortugas monitoring activities. Prioritize baseline monitoring data needs and provide support to existing monitoring programs to gather necessary data. Contract with additional researchers as needed to fill baseline data gaps.
- Activity 2 – Develop post-implementation monitoring plan for the Tortugas Ecological Reserve and adjacent areas of varying protection levels.
- Activity 3 – Convene annual or biannual meeting of Tortugas researchers to share monitoring data with Sanctuary management and review monitoring schedule.

Strategy T.3: Dry Tortugas Marine Laboratory and Research Support Feasibility Study

Historically, the Dry Tortugas have been a place of marine research, supporting early pioneers in the fields of coral reef biology, ecology, oceanography, and underwater photography. A remote marine research station supported by the Carnegie Institution existed in the late 1800's and early 1900's on Loggerhead Key. The Carnegie facility was closed and dismantled decades ago, and since that time research efforts in the region have been sporadic. This strategy undertakes a feasibility study for the re-establishment of this laboratory or a similar facility. Such a facility would address the growing interest in Tortugas research and support the collection of much-needed data to assist National Park Service and Sanctuary managers in future decisions about Tortugas resources. Additionally, the feasibility study will consider other logistical needs to support researchers working in the Dry Tortugas area, such as shore-based lodging.

- Activity 1 – Meet with National Park Service personnel to plan feasibility study and desired conditions of research station. Discuss funding options for feasibility study.
- Activity 2 – Conduct feasibility study and discuss results with National Park Service. Implement next steps as appropriate.

Strategy T.4: Wireless Data Transfer

This strategy will establish wireless data transfer capabilities using the existing Motorola two-way radio network.

- Activity 1 – Contact Motorola to determine wireless data transfer capabilities using the existing two way radio network.
- Activity 2 – If the existing network can be used to transfer data, procure needed software and hardware.
- Activity 3 – Train staff on wireless data transfer.
- Activity 4 – Maintain and upgrade system as needed.
- Activity 5 – If existing two way radio network will not permit data transfer, research additional options.

Strategy T.5: Automated Oceanographic Data Collection

Throughout the Sanctuary a series of automated, continuously functioning sensors mounted on remote platforms or structures (C-MAN Stations) collect physical oceanographic data and report this information real-time to the Internet. This strategy will expand the C- MAN network to include similar data collection at a remote location in the Tortugas. Additionally, instruments that continuously collect data on biological parameters will also be installed.

- Activity 1 – Assess existing remote data collection activities in the Dry

Tortugas.

- Activity 2 – Contract with current C-MAN Station research team to install a new station in the Tortugas area. Develop maintenance plan
- Activity 3 – Investigate instrument capabilities and costs to expand data collection to include biological parameters. Purchase and install necessary instrumentation.

Strategy T.6: Tortugas Region Non-Use Valuation Study

During the official public comment period for the Draft Supplemental Environmental Impact Statement for the Tortugas Ecological Reserve, over 4000 comments were received from around the world. Nearly 95% of those commenting supported designating an ecological reserve in the Tortugas, which strongly indicates the value that American citizens place in protecting this area of ocean wilderness. In the development of the Sanctuary Final Management Plan, user attitude and economic values of the Sanctuary were established through a comprehensive socio-economic study. This strategy will complement the existing socio-economic studies of the Sanctuary by specifically identifying the non-use values that exist within the Tortugas region. Establishing these non-use values is critical for managers to accurately estimate the economic benefits and costs of newly designated reserve areas.

- Activity 1 – Discuss non-use valuation study requirements with Sanctuary economist.
- Activity 2 – Contract with economist to conduct study and publish results.

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GLOSSARY

abiotic- not relating to life or living things

accretion- growth or increase in size by gradual external addition

ahermatypic- non reef-building

algorithm- process or rules for calculation

anaerobic- capable of living or growing in an environment lacking free oxygen

annelids- any of various worms with cylindrical segmented bodies

anthropogenic- relating to humans; humans as a source of impact

arboreal- relating to, or like, a tree; in referring to species, those that inhabit or frequent trees

ascidians- "sack-like" tunicates; animals in which the larval stage resembles a tadpole but the adult is sedentary and sack-like (*e.g.* sea squirts)

atoll- a ring shaped coral reef enclosing a lagoon.

backcountry- primarily referring to the Florida Bay area of the Keys' islands and waterways

bathymetry- water depth measurement information used to produce depth-contoured charts

benthic communities- bottom-dwelling flora and fauna

Bermuda/Azores high- the subtropical anticyclone positioned over the southern Atlantic Ocean in the Northern Hemisphere; it is most pronounced in spring and summer

bioherm- a mound, dome, or reef-like structure built up by, and composed almost exclusively of, the remains of sedentary organisms, such as corals, algae, or mollusks

biomass- the total mass of living matter within a given volume of environment

biota- animal or plant life of a region considered as a total ecological entity

biotic- relating to life or living things

block-faulted- a type of normal faulting in which the Earth's crust is divided into structural or fault blocks of different elevations and orientations

calcareous- having characteristics of calcium carbonate, calcium, or limestone

Carolinian- refers to organisms and physical characteristics of the southeastern U.S. coastline

common property resources- resources that are not exclusively controlled by a single agent or source. Access to such resources is not restricted, and therefore the resources can be exploited on a first-come, first-served basis

consumer's surplus- the amount an individual is willing to pay for a good or service over and above what he or she is required to pay. It represents a net value or surplus value. In the context of natural resources and environmental services, consumer’s surplus associated with uses of coastal and ocean resources are often referred to as net user values. When related to willingness to pay to protect natural resources in a given condition, independent of use, it is referred to as non-use value or passive use value. For commercial fishing products, it is the net value for the fishery resources.

convective storm- storm characterized by vertically rising air

corallimorphs- false corals; related to corals and anemones

coralline- any animal related to or resembling corals; includes both branching and encrusting calcareous alga

crenulated (corals)- corals having tiny notches or scallops

crinoids- “sea lilies”; echinoderms that are suspension feeders with jointed arms and appendages that give a feathery appearance resembling a plant

cyclonic storms/systems- a windstorm with a violent whirling movement; a system of rotating winds over a vast area, spinning inward to a low pressure center (counterclockwise in the northern hemisphere) generally causing stormy weather

defaunated- all indigenous animals having been removed from a particular area

demersal- fishes and other aquatic organisms that live near the bottom of the water column

demosponges- a class of sponges containing 90% of the sponge species, including most of the common and familiar forms.

desiccation- removal of moisture; drying out

detrital- dead biologically generated material

downwelling- a reverse vertical flow of water, moving from the ocean's surface to great depths; occurs at oceanic convergence

DRTO- Dry Tortugas National Park

echinoderms- radially symmetrical animals that are exclusively marine and possess a spiny skin and a system of water filled canals that aids in feeding and locomotion. (*e.g.*, sea urchins, sand dollars, and sea cucumbers)

ecological reserve (ER)- (CFR 922.162(a) "…an area of the Sanctuary consisting of contiguous, diverse habitats, within which uses are subject to conditions, restrictions and prohibitions, including access restrictions, intended to minimize human influences, to provide natural spawning, nursery, and permanent residence areas for the replenishment and genetic production of marine life, and also to protect and preserve natural assemblages of habitats and species within areas representing a broad diversity of resources and habitats found within the Sanctuary."

economic rents- the amount a producer of a good or service receives over and above the cost of producing a good or service, including a normal return on investment. Economic rents exist because no one owns the natural resources and therefore no one charges for the right to use them. In a limited access fishery, fish are a free resource and economic rents accrue to fishermen because no one charges them for the fish.

Ekman transport- a process of water movement whereby wind-driven surface water moves at a 45° angle to the direction of the wind, to the right in the northern hemisphere, to the left in the southern hemisphere. Successively deeper water layers are deflected farther than those above them. The resulting net water movement is 90° to the wind.

emergent- breaking the ocean surface

endangered species- a species in danger of becoming extinct that is protected by the Endangered Species Act

endemic- restricted to or native to a particular area or region

epibenthic- organisms that live on the surface of a substrate, including motile organisms such as gastropods, sea urchins, sea stars, sea cucumbers, sea biscuits, and a wide variety of crustacea

epifauna- animals that live on the ocean bottom, either attached or moving freely over it

epiphytic- any organisms that grow on the blades of seagrasses or algae, including algae, diatoms, and other encrusting organisms

ephemeral- lasting or living for a brief period, transitory

escarpment- long steep slope at the edge of a plateau

eutrophication- the process by which nutrient- rich waters bring about a high level of biological productivity that may ultimately lead to reduced dissolved oxygen levels

exploitable- able to be legally fished

extirpated- no longer able to be found in a given area or after a given time

fauna- animal life of a particular region

fisheries-dependent- information on fisheries derived from fishermen.

fisheries-independent- information on fisheries derived from empirical studies.

flora- plant life of a particular region

Florida Current- the segment of current between the Gulf of Mexico Loop Current and the Gulf Stream from the Dry Tortugas to the Southeastern tip of Florida, and confined by the 250-meter and 500-meter isobaths

Florida reef tract- the third largest bank- barrier reef in the world, running from the Miami area southwest to the Dry Tortugas

Florida Aquifer- the rock mass of South Florida that contains groundwater

foraminifera- an order of planktonic and benthic protozoans having a calcareous shell

gastropods- Class of mollusks that have only one shell and usually move about on a muscular "foot" (*e.g.*, snail, slug, cowry, limpet)

geographic information system (GIS)- a computer system capable of holding and using data describing places on the earth's surface.

gorgonian- a type of octocoral (soft coral) commonly found in southeast Florida reefs at depths less than 30 meters; they include sea fans, sea plumes, sea whips, and sea rods

gravid- egg-bearing condition

Gulf of Mexico Loop Current- major surface current in the Gulf of Mexico; enters through Yucatan Straits, flows clockwise into the east central portion of the Gulf, and exits through the Straits of Florida becoming the Florida Current and eventually the Gulf Stream

gyre- circular spiral form; used mainly in reference to the circular motion of water in major ocean basins centered in the subtropic high- pressure regions

halophytic- type of plant that can survive in saltwater environments

headboat- is also referred to as a party boat. A per person charge is levied to access the boat (charge per head, thus headboat).

heterogeneous- diverse in character, varied in content

highly migratory species- species which in the course of their life cycle spawn and migrate over great distances.

Holocene Era- designating the present epoch of geologic time starting 11,000 years ago

homogeneous- of the same kind, consisting of parts all of the same kind

hydrography- the study, description, and mapping of oceans, lakes, and rivers with an emphasis on navigation

hydrology- the science dealing with the nature, distribution, and movement of water on and below the Earth's surface

hypothermic- subnormal temperature

infaunal- organisms that live buried in sediments, including a variety of polycheates, burrowing crustaceans, and mollusks

isobath- line connecting points of equal depth

isotope- any of two or more forms of an element differing from each other in atomic weight

keystone species- a single species whose activities determine community structure

larval- the immature stage of many fish and invertebrate species

lithology- the scientific study of rocks usually with the unaided eye or little magnification

live rock- rock to which living marine organisms are attached and often burrow into

Lower Keys- that part of incorporated Monroe County south and/or west of the Seven Mile Bridge (*i.e.*, Little Duck, Missouri and Ohio Keys, Bahia Honda, West Summerland/Spanish Harbor, and south to Stock Island)

management alternative- a set of management strategies that, when employed together, represent the means for achieving a desired level of protection within the Sanctuary

management strategy- an action or physical measure taken to address a specific issue; a management strategy is combined with an implementation incentive or mechanism to induce behavior; an institutional arrangement with authority to act; and a financing scheme to support the costs of implementation

market economic values- includes sales/output, income, employment and tax revenues in a local, regional or national economy.

maximum sustainable yield- management of a fishery that allows the maximum yearly harvest that can be sustained through time

Middle Keys- that part of Monroe County between Seven Mile Bridge and Whale Harbor Bridge (*i.e.*, Islamorada, Upper and Lower Matecumbe, Fiesta Key, Long Key, Conch Key, Walkers Island, Duck Key, Fat Deer Key, Marathon, and Pigeon Key)

military exclusion area- a region or tract reserved for military uses, where unauthorized persons may not enter

nektonic- highly motile organisms, such as fishes and squids that live above the sea floor

non-market economic values- includes consumer's surplus and economic rents (see definitions of each of these above).

nonpoint source pollutant discharges- those pollutant discharges not associated with a specific location (*e.g.*, urban and agricultural pesticide runoff)

non-use economic values- values 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. Also referred to as passive use value.

nutrients- any number of organic or inorganic compounds used by plants in primary production (typically nitrogen and phosphorus)

octocorals- soft coral type that includes sea plumes, sea whips, gorgonians, and soft corals

oolitic- made of a smoothed limestone composition consisting of many small grains of calcium and other carbonates cemented together

passive use economic values- see non-use economic values above.

patch reef- small circular or irregular reefs that arise from the floor of lagoons, behind barrier reefs, or within an atoll

pathogens- any agent, most commonly a microorganism, capable of causing disease

pelagic- free swimming in the open ocean

personal watercraft- a shallow-draft, jet drive watercraft on which the operator sits, kneels, or stands; excludes those vehicles piloted from inside the craft

person-days- a person day is one person doing something for a whole or any part of a day in a defined location.

perturbation- disturbance; a change in a biological system

planktonic- small organisms dependent on water movement and currents as their means of transportation, including phytoplankton (algae), zooplankton (animals), and ichthyoplankton (fishes)

Pleistocene epoch- the first epoch of the Quaternary Period of the Cenozoic Era, beginning approximately 1.6 million years ago; characterized by major worldwide climatic fluctuations, the spreading and recession of continental ice sheets with concomitant rise and fall of sea levels, and the appearance of modern humans

point source pollutant discharges- the discharge of pollutants from a distinct and identifiable source, such as a sewer or industrial outfall pipe

polychaetae- class of annelid worms that includes bristle and feather duster worms

potable water- water that is safe to drink

primary production- the production of biomass by plants through photosynthesis

puerulus- the larval/juvenile (transitional) swimming stage of the spiny lobster which has a transparent, swimming, lobster-like form

recruitment- the addition of new individuals into some life stage or size range of a population. Most often, recruitment is referenced to sexual maturity (that is, recruitment into the spawning stock) or to the size range that is vulnerable to fishing gear used in a specific fishery (recruitment to a fishery)

recruitment pathway- mechanism which allows for recruitment to a particular area

recruits- juveniles spawned in a given year

replenishment- process by which spawned individuals mature and are made available to a particular fishery

rookery- breeding colony or area where a breeding colony aggregates

scleractinian corals- stony corals. Closely related to sea anemones. Constitute the largest order of anthozoans. Secrete a skeleton composed primarily of calcium carbonate and are the framework for reef systems

seasonal population- any group of organisms of the same species that occupy a given space at a particular time of year (defined as winter, spring, summer, fall, wet, or dry)

serial overfishing- a process whereby harvesters who are faced with increasingly lower profits and greater debts due to a dwindling resource continue to invest in that fishery, often through government subsidies. Instead of leaving the fishery, fishers choose to upgrade their vessels and equipment in order to earn a living fishing for an already depleted resource

sessile- immobile organisms that are permanently fixed to the substrate

sheet flow- surface water runoff

slough- swamp, bog or marsh; especially one that is part of an inlet or backwater

solution holes- depression in the Earth's surface caused by dissolving of substrate composed primarily of calcium carbonate

continental shelf- the submerged shelf of land that slopes gradually from the exposed edge of the continent for a variable distance to the point where the steep descent to the ocean floor begins

spawning aggregations - areas in the ocean where fish of one or many different species form large mating groups

spawning potential ratio- a measure of the stock's potential capacity to produce optimum yield on a sustainable basis expressed as a ratio of exploited spawning stock biomass to the equilibrium unexploited spawning stock biomass.

spur and groove- coral formation endemic to fringing or bank reefs; spurs are usually composed of a framework or *Acropora palmata* that form ramparts protruding at right angles to the axis of the reef and projecting into the prevailing wind pattern; the spaces between the spurs are sand channels referred to as grooves

stock- a group of individuals of the same species that share common production characteristics, and support the same basic fishery. Stocks are often managed as single groups of organisms, even thought they may be comprised of individuals from more than one population of a species.

storm surge- temporary water elevation change due especially to tropical or extratropical storms

stratification- layering; water column stratification is based on temperature or salinity

substratum- underlying layer or substance; sedimentary surface; hard or sandy

terrestrial- of or on the earth, of or on dry land

threatened species- plant or animal species believed likely to be placed in the endangered category in the foreseeable future.

toxicant- toxin; a poisonous substance

trophic levels- feeding level within a food chain or web; e.g., herbivorous, carnivorous

turbid- the state of being clouded, opaque, or obscured by suspended sediment

Upper Keys- that part of unincorporated portion of Monroe County north of Whale Harbor Bridge; geologically, the segment of the Keys comprised of exposed Miami Limestone substrate; includes the area from Marathon to Soldier Key

upwelling - a vertical flow of water, moving from the ocean's depths to the surface; occurs at oceanic convergence and certain continental or island coastlines

vascular- typically describes tubular structures involved in fluid transport

viviparous- bearing or bringing forth live young, as with most mammals

Working Group- an *ad hoc* subcommittee of the Sanctuary Advisory Council and additional participants

YBP- years before present

yield- harvested portion of a population.

zoanthids- generally small anemone-like animals; may be colonial or solitary, and both symbiotic and free-living; the most common on the Florida reef tract is *Palythoa caribaeorum*, referred to as "golden sea mat"

zone- an area or region considered as separate and distinct from others because of its designated use, plant or animal life, etc.

zoning- the act of partitioning areas of land or water into sections dedicated to specific purposes and activities.

APPENDIX A: EXECUTIVE ORDER 13089: CORAL REEF PROTECTION

The United States Coral Reef Task Force was established by President William J. Clinton through Executive Order 13089 on June 11, 1998. The Order directs all federal agencies to protect coral reef ecosystems to the extent feasible and calls for additional actions to protect and restore valuable coral reefs.

This proposed action complies with this order by: (1) protecting one of the last remaining healthy coral reefs in the continental U.S., (2) establishing an ocean wilderness area encompassing some coral reef habitat, (3) coordinating with other relevant federal agencies to achieve comprehensive protection of the coral reef resources.

APPENDIX B: EXECUTIVE ORDER 12898: ENVIRONMENTAL JUSTICE

On February 11, 1994, President Clinton issued Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." This Executive Order is designed to focus the attention of federal agencies on the human health and environmental conditions in minority communities and low-income communities.

The proposed action is not expected to adversely impact minority or low-income populations, rather it is expected to have a positive impact on these and other groups as fish populations rebound outside of the reserve area. According to the socio-economic impact analysis the proposed action will not disproportionately affect minorities or low-income groups over other groups. The ethnicity of the groups affected by the Preferred Alternative is: 78.1% White, 20.3% Hispanic, and 1.6% African American. The ethnicity of Monroe County in 1990 was: 72.1% White, 12.3% Hispanic, and 5.4% African American.

APPENDIX C. REGULATIONS

This appendix provides the full text of each of the regulations listed in Table 29 that summarizes the impacts of the regulations on small businesses.

FKNMS regulations as amended for Tortugas Ecological Reserve

NOTE TO READER: The following are draft final regulations for the Tortugas Ecological Reserve. These regulations would amend Part 922, Subpart P of the National Marine Sanctuary Program regulations. Asterisks (*) are a placeholder for existing regulatory language which, for the sake of brevity, is not duplicated here.

PART 922-NATIONAL MARINE SANCTUARY PROGRAM REGULATIONS

1. The authority citation for part 922 continues to read as follows:

Authority: 16 U.S.C. 1431 et seq.

2. §922.161 is revised to read as follows:

§ 922.161 Boundary.

The Sanctuary consists of an area of approximately 2900 square nm (9,800 square kilometers) of coastal and ocean waters, and the submerged lands thereunder, surrounding the Florida Keys in Florida. Appendix I to this subpart sets forth the precise Sanctuary boundary.

3. In §922.162, definitions for “Length overall (LOA) or length,” “Stem,” and “Stern” are added alphabetically as follows:

§ 922.162 Definitions.

*****

Length overall (LOA) or length means, as used in § 922.167 with respect to a vessel, the horizontal distance, rounded to the nearest foot (with 0.5 ft and above rounded upward), between the foremost part of the stem and the aftermost part of the stern, excluding bowsprits, rudders, outboard motor brackets, and similar fittings or attachments.

*****

Stem means the foremost part of a vessel, consisting of a section of timber or fiberglass, or cast, forged, or rolled metal, to which the sides of the vessel are united at the fore end, with the lower end united to the keel, and with the bowsprit, if one is present, resting on the upper end.

Stern means the aftermost part of the vessel.

*****

4. In § 922.164, paragraphs (d)(1)(v) and (d)(1)(vi) are revised as follows:

§ 922.164 Additional activity regulations by Sanctuary area

*****

(d)***

(1)***

(i) ***

(ii) ***

(iii) ***

(iv) ***

(v) Anchoring in the Tortugas Ecological Reserve. In all other Ecological Reserves and Sanctuary Preservation Areas, placing any anchor in a way that allows the anchor or any portion of the anchor apparatus (including the anchor, chain or rope) to touch living or dead coral, or any attached living organism. When anchoring dive boats, the first diver down must inspect the anchor to ensure that it is not touching living or dead coral, and will not shift in such a way as to touch such coral or other attached organism. No further diving shall take place until the anchor is placed in accordance with these requirements.

(vi) Except in the Tortugas Ecological Reserve where mooring buoys must be used, anchoring instead of mooring when a mooring buoy is available or anchoring in other than a designated anchoring area when such areas have been designated and are available.

(vii) ***

4. In § 922.164, paragraphs (d)(1)(viii) and (d)(1)(ix) are added to read as follows:

§ 922.164 Additional activity regulations by Sanctuary area

*****

(d)***

(1)***

(viii) Except for passage without interruption through the area, for law enforcement purposes, or for purposes of monitoring pursuant to paragraph (d)(2) of this section: entering the Tortugas South area of the Tortugas Ecological Reserve; or entering the Tortugas North area of the Tortugas Ecological Reserve without a valid access permit issued pursuant to § 922.167 or 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 Ecological Reserve.

(ix) Tying a vessel greater than 100 feet (30.48 meters) LOA, or tying more than one vessel (other than vessels carried on board a vessel) if the combined lengths would exceed 100 feet (30.48 meters) LOA, to a mooring buoy or to a vessel tied to a mooring buoy in the Tortugas Ecological Reserve.

5. In § 922.164, paragraph (g) is revised to read as follows:

§ 922.164 Additional activity regulations by Sanctuary area.

*****

(g) Anchoring on Tortugas Bank. Vessels 50 meters or greater in registered length, are prohibited from anchoring on the portion of Tortugas Bank within the Florida Keys National Marine Sanctuary west of the Dry Tortugas National Park that is outside of the Tortugas Ecological Reserve. The boundary of the area closed to anchoring by vessels 50 meters or greater in registered length is formed by connecting in succession the points at the following coordinates (based on the North American Datum of 1983):

(1) 24˚39.00'N 83˚06.00'W

(2) 24˚32.00'N 83˚00.05'W

(3) 24˚37.00'N 83˚06.00'W

(4) 24˚40.00'N 83˚06.00'W

(5) 24˚39.00'N 83˚06.00'W

6. Revise the heading of § 922.166 to read as follows:

§ 922.166-Permits other than for access to the Tortugas North area of the Tortugas Ecological Reserve-application procedures and issuance criteria.

7. Renumber § 922.167 as § 922.168 and revise it to read as follows:

§ 922.168-Certification of preexisting leases, licenses, permits, approvals, other authorizations, or rights to conduct a prohibited activity.

(a) A person may conduct an activity prohibited by Secs. 922.163 or 922.164 if such activity is specifically authorized by a valid Federal, State, or local lease, permit, license, approval, or other authorization in existence on July 1, 1997, or by any valid right of subsistence use or access in existence on July 1, 1997, provided that:

(1) The holder of such authorization or right notifies the Director, in writing, within 90 days of July 1, 1997, of the existence of such authorization or right and requests certification of such authorization or right; for the area added to the Sanctuary by the boundary expansion for the Tortugas Ecological Reserve, the holder of such authorization or right notifies the Director, in writing, within 90 days of the effective date of these regulations, of the existence of such authorization or right and requests certification of such authorization or right.

(2) The holder complies with the other provisions of this

Sec. 922.168; and

(3) The holder complies with any terms and conditions on the exercise of such authorization or right imposed as a condition of certification, by the Director, to achieve the purposes for which the Sanctuary was designated.

(b) The holder of an authorization or right described in paragraph (a) of this section authorizing an activity prohibited by Secs. 922.163 or 922.164 may conduct the activity without being in violation of applicable provisions of Secs. 922.163 or 922.164, pending final agency action on his or her certification request, provided the holder is in compliance with this Sec. 922.168.

(c) Any holder of an authorization or right described in paragraph (a) of this section may request the Director to issue a finding as to whether the activity for which the authorization has been issued, or the right given, is prohibited by Secs. 922.163 or 922.164, thus requiring certification under this section.

(d) Requests for findings or certifications should be addressed to the Director, Office of National Marine Sanctuaries; ATTN: Sanctuary Superintendent, Florida Keys National Marine Sanctuary, P.O. Box 500368, Marathon, FL 33050. A copy of the lease, permit, license, approval, or other authorization must accompany the request.

(e) The Director may request additional information from the certification requester as he or she deems reasonably necessary to condition appropriately the exercise of the certified authorization or right to achieve the purposes for which the Sanctuary was designated.

The information requested must be received by the Director within 45 days of the postmark date of the request. The Director may seek the views of any persons on the certification request.

(f) The Director may amend any certification made under this Sec. 922.168 whenever additional information becomes available justifying such an amendment.

(g) Upon completion of review of the authorization or right and

information received with respect thereto, the Director shall communicate, in writing, any decision on a certification request or any action taken with respect to any certification made under this Sec. 922.168, in writing, to both the holder of the certified lease, permit, license, approval, other authorization, or right, and the issuing agency, and shall set forth the reason(s)for the decision or action taken.

(h) Any time limit prescribed in or established under this Sec. 922.168 may be extended by the Director for good cause.

(i) The holder may appeal any action conditioning, amending, suspending, or revoking any certification in accordance with the procedures set forth in Sec. 922.50.

(j) Any amendment, renewal, or extension made after July 1, 1997, to a lease, permit, license, approval, other authorization or right is subject to the provisions of Sec. 922.49.

8. Add a new § 922.167 to read as follows:

§ 922.167- Permits for access to the Tortugas Ecological Reserve.

(a) A person may enter the Tortugas North area of the Tortugas North Ecological Reserve other than for passage without interruption through the reserve, for law enforcement purposes, or for purposes of monitoring pursuant to paragraph (d)(2) of § 922.164 , if authorized by a valid access permit issued pursuant to § 922.167.

(b) 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. Access permits do not require written applications or the payment of any fee. Permits may be requested via telephone or radio by contacting FKNMS at any of the following numbers:

Key West office: telephone: (305) 292-0311

Marathon office: telephone: (305) 743-2437

The following information must be provided, as applicable:

(i) Vessel name.

(ii) Name, address, and telephone number of owner and operator.

(iii) Name, address, and telephone number of applicant.

(iv) USCG documentation, state license, or registration number.

(v) Home port.

(vi) Length of vessel and propulsion type (*i.e.* motor or sail).

(vii) Number of divers.

(viii) Requested effective date and duration of permit (2 weeks, maximum).

(c) The Sanctuary Superintendent will issue a permit to the owner or to the owner's representative for the vessel when all applicable information has been provided.

FKNMS will provide a permit number to the applicant and confirm the effective date and duration period of the permit. Written confirmation of permit issuance will be provided upon request.

9. Revise Appendices I, IV, to Subpart P of Part 922 to read as follows:

Appendix I to Subpart P of Part 922--Florida Keys National Marine Sanctuary Boundary Coordinates

(Appendix Based on North American Datum of 1983)

The boundary of the Florida Keys National Marine Sanctuary--

(a) Begins at the northeasternmost point of Biscayne National Park located at approximately 25 degrees 39 minutes north latitude, 80 degrees 05 minutes west longitude, then runs eastward to the point at 25 degrees 39 minutes north latitude, 80 degrees 04 minutes west longitude; and

(b) Then runs southward and connects in succession the points at the following coordinates:

(i) 25 degrees 34 minutes north latitude, 80 degrees 04 minutes west longitude,

(ii) 25 degrees 28 minutes north latitude, 80 degrees 05 minutes west longitude, and

(iii) 25 degrees 21 minutes north latitude, 80 degrees 07 minutes west longitude;

(iv) 25 degrees 16 minutes north latitude, 80 degrees 08 minutes west longitude;

(c) Then runs southwesterly approximating the 300-foot isobath and connects in succession the points at the following coordinates:

(i) 25 degrees 07 minutes north latitude, 80 degrees 13 minutes west longitude,

(ii) 24 degrees 57 minutes north latitude, 80 degrees 21 minutes west longitude,

(iii) 24 degrees 39 minutes north latitude, 80 degrees 52 minutes west longitude,

(iv) 24 degrees 30 minutes north latitude, 81 degrees 23 minutes west longitude,

(v) 24 degrees 25 minutes north latitude, 81 degrees 50 minutes west longitude,

(vi) 24 degrees 22 minutes north latitude, 82 degrees 48 minutes west longitude,

(vii) 24 degrees 37 minutes north latitude, 83 degrees 06 minutes west longitude,

(viii) 24 degrees 46 minutes north latitude, 83 degrees 06 minutes west longitude,

(ix) 24 degrees 44 minutes north latitude, 81 degrees 55 minutes west longitude,

(x) 24 degrees 51 minutes north latitude, 81 degrees 26 minutes west longitude, and

(xi) 24 degrees 55 minutes north latitude, 80 degrees 56 minutes west longitude;

(d) Then follows the boundary of Everglades National Park in a southerly then northeasterly direction through Florida Bay, Buttonwood Sound, Tarpon Basin, and Blackwater Sound;

(e) After Division Point, then departs from the boundary of Everglades National Park and follows the western shoreline of Manatee Bay, Barnes Sound, and Card Sound;

(f) then follows the southern boundary of Biscayne National Park to the southeasternmost point of Biscayne National Park; and

(g) then follows the eastern boundary of Biscayne National Park to the beginning point specified in paragraph (a).

The shoreward boundary of the Florida Keys National Marine Sanctuary is the mean high-water mark except around the Dry Tortugas where the boundary is coterminous with that of the Dry Tortugas National Park, formed by connecting in succession the points at the following coordinates:

(a) 24 degrees 34 minutes 0 seconds north latitude, 82 degrees 54 minutes 0 seconds west longitude;

(b) 24 degrees 34 minutes 0 seconds north latitude, 82 degrees 58 minutes 0 second west longitude;

(c) 24 degrees 39 minutes 0 seconds north latitude, 82 degrees 58 minutes 0 seconds west longitude;

(d) 24 degrees 43 minutes 0 seconds north latitude, 82 degrees 54 minutes 0 seconds west longitude;

(e) 24 degrees 43 minutes 32 seconds north latitude, 82 degrees 52 minutes 0 seconds west longitude;

(f) 24 degrees 43 minutes 32 seconds north latitude, 82 degrees 48 minutes 0 seconds west longitude;

(g) 24 degrees 42 minutes 0 seconds north latitude, 82 degrees 46 minutes, 0 seconds west longitude;

(h) 24 degrees 40 minutes 0 seconds north latitude, 82 degrees 46 minutes 0 seconds west longitude;

(i) 24 degrees 37 minutes 0 seconds north latitude, 82 degrees 48 minutes 0 seconds west longitude; and

(j) 24 degrees 34 minutes 0 seconds north latitude, 82 degrees 54 minutes 0 seconds west longitude.

The Florida Keys National Marine Sanctuary also includes the area located within the boundary formed by connecting in succession the points at the following coordinates:

(a) 24 degrees 33 minutes north latitude, 83 degrees 09 minutes west longitude,

(b) 24 degrees 33 minutes north latitude, 83 degrees 05 minutes west longitude, and

(c) 24 degrees 18 minutes north latitude, 83 degrees 05 minutes west longitude;

(d) 24 degrees 18 minutes north latitude, 83 degrees 09 minutes west longitude; and

(e) 24 degrees 33 minutes north latitude, 83 degrees 09 minutes west longitude.

Appendix IV to Subpart P of Part 922--Ecological Reserves Boundary

Coordinates

The Tortugas Ecological Reserve consists of two discrete areas, Tortugas North and Tortugas South.

The boundary of Tortugas North is formed by connecting in succession the points at the following coordinates:

Tortugas North

Point	Latitude	Longitude
(1)	24˚46’00" N	83˚06'00" W
(2)	24˚45’40" N	82˚54'00" W
(3)	24˚45’30" N	82˚48'00" W
(4)	24˚43’32" N	82˚48'00" W
(5)	24˚43’32" N	82˚52'00" W
(6)	24˚43’00" N	82˚54'00" W
(7)	24˚39’00" N	82˚58'00" W
(8)	24˚39’00" N	83˚06'00" W
(9)	24˚46’00" N	83˚06'00" W

The boundary of Tortugas South is formed by connecting in succession the points at the following coordinates:

Tortugas South

Point	Latitude	Longitude
(1)	24˚33'00" N	83˚09'00" W
(2)	24˚33'00" N	83˚05'00" W
(3)	24˚18'00" N	83˚05'00" W
(4)	24˚18'00" N	83˚09'00" W
(5)	24˚33'00" N	83˚09'00" W

Sanctuary-wide Prohibitions

The following sanctuary-wide regulations apply to boundary Alternatives III, IV and V because each of these alternatives includes areas currently outside the boundary of the Sanctuary. Some of these are more restrictive when applied to ecological reserves. The area within Alternative II is already subject to these regulations.

a. Mineral and hydrocarbon exploration, development and production.

"Exploring for, developing, or producing minerals or hydrocarbons within the Sanctuary."

This regulation codifies the prohibition contained in Section 6 (b) of the Florida Keys National Marine Sanctuary Protection Act (FKNMSPA, Pub.L. 101-605, Nov. 16, 1990, 104 Stat. 3089).

b. Removal of, injury to, or possession of coral or live rock.

(i) Moving, removing, taking, harvesting, damaging, disturbing, breaking, cutting, or otherwise injuring, or possessing (regardless of where taken from) any living or dead coral, or coral formation, or attempting any of these activities, except as permitted under 50 CFR part 638.

(ii) 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 National Marine Fisheries Service 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. See § 370.027, Florida Statutes and implementing regulations.

The purpose of this regulation is to protect and preserve an important resource of the Sanctuary. The damage to the resources of the Keys caused by the removal for resale or coral and live rock, from damage due to divers touching coral and live rock, and from vessels running aground are well documented. This was the primary reason for the designation of the Sanctuary by the FKNMSPA. The State of Florida already prohibits the taking of coral and live rock, as do the South Atlantic and Gulf of Mexico Fishery Management Councils. Live rock aquaculture, which may be conducted in Sanctuary waters outside ecological reserves pursuant to a State or Federal permit, will not be permitted in ecological reserves. Touching coral is also prohibited in ecological reserves.

c. Alteration of, or construction on, the seabed.

"Drilling into, dredging, or otherwise altering the seabed of the Sanctuary, or engaging in prop-dredging; or constructing, placing or abandoning any structure, material, or other matter on the seabed of the Sanctuary, except as an incidental result of:

Anchoring vessels in a manner not otherwise prohibited by this part (see §§ 922.163(a)(5)(ii) and 922.164(d)(1)(v));

(ii) Traditional fishing activities not otherwise prohibited by this part;

(iii) Installation and maintenance of navigational aids by, or pursuant to valid authorization by, any Federal, State, or local authority of competent jurisdiction;

(iv) Harbor maintenance in areas necessarily associated with Federal water resource development projects in existence on July 1, 1997, including maintenance dredging of entrance channels and repair, replacement, or rehabilitation of breakwaters or jetties;

(v) Construction, repair, replacement, or rehabilitation of docks, seawalls, breakwaters, piers, or marinas with less than ten slips authorized by any valid lease, permit, license, approval, or other authorization issued by any Federal, State, or local authority of competent jurisdiction."

The purpose of this regulation is to protect the seabed. Certain activities have been expressly exempted in order to lessen the costs on users of the Sanctuary. The exempted activities include the installation of navigational aids or mooring buoys.

d. Discharge or deposit of materials or other matter, except cooling water and engine exhaust.

"(i) Discharging or depositing, from within the boundary of the Sanctuary, any material or other matter, except:

(A) Fish, fish parts, chumming materials, or bait used or produced incidental to and while conducting a traditional fishing activity in the Sanctuary;

(B) Biodegradable effluent incidental to vessel use and generated by a marine sanitation device approved in accordance with section 312 of the Federal Water Pollution Control Act, as amended, (FWPCA), 33 U.S.C. 1322 et seq.;

(C) Water generated by routine vessel operations (*e.g.*, deck wash down and graywater as defined in section 312 of the FWPCA), excluding oily wastes from bilge pumping; or

(D) Cooling water from vessels or engine exhaust;

(ii) Discharging or depositing, from beyond the boundary of the Sanctuary, any material or other matter that subsequently enters the Sanctuary and injures a Sanctuary resource or quality, except those listed in paragraph (a)(4)(i) (A) through (D) of this section and those authorized under Monroe County land use permits or under State permits."

e. Operation of vessels.

"(i) Operating a vessel in such a manner as to strike or otherwise injure coral, seagrass, or any other immobile organism attached to the seabed, including, but not limited to, operating a vessel in such a manner as to cause prop-scarring.

(ii) Having a vessel anchored on living coral other than hardbottom in water depths less than 40 feet when visibility is such that the seabed can be seen.

(iii) Except in officially marked channels, operating a vessel at a speed greater than 4 knots or in manner which creates a wake:

(A) Within an area designated idle speed only/no wake;

(B) Within 100 yards of navigational aids indicating emergent or shallow reefs (international diamond warning symbol);

(C) Within 100 feet of the red and white "divers down" flag (or the blue and white "alpha" flag in Federal waters);

(D) Within 100 yards of residential shorelines; or

(E) Within 100 yards of stationary vessels.

(iv) Operating a vessel in such a manner as to injure or take wading, roosting, or nesting birds or marine mammals.

(v) Operating a vessel in a manner which endangers life, limb, marine resources, or property."

These restrictions apply to the operation of all vessels, including personal water craft (PWC).

To a certain extent, these activities are already prohibited by existing laws and may result in violations of the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) for certain Sanctuary resources. The restriction on operating a vessel in a manner which endangers life, limb, marine resources, and property is based primarily on existing restrictions in State law.

f. Conduct of diving/snorkeling without a flag.

"Diving or snorkeling without flying in a conspicuous manner the red and white 'divers down' flag (or the blue and white "alpha" flag in Federal waters)."

This prohibition is designed to prevent user conflicts and to protect the health and safety of diver/snorkelers from being damaged inadvertently by other Sanctuary users. The alternative of not including this regulation was rejected because it already mirrors Federal and State regulations already require the use of a dive flag and the regulation merely adopts existing requirements to be consistent.

g. Release of exotic species.

"Introducing or releasing an exotic species of plant, invertebrate, fish, amphibian, or mammals into the Sanctuary."

The damage to the Florida environment and to other areas of the United States from inadvertent or deliberate release of exotic species is well-known. The alternative of not including this regulation was rejected because it mirrors Federal and State laws and adopts this rule to be consistent with them.

h. Damage or removal of markers.

"Marking, defacing, or damaging in any way or displacing, removing, or tampering with any official signs, notices, or placards, whether temporary or permanent, or with any navigational aids, monuments, stakes, posts, mooring buoys, boundary buoys, trap buoys, or scientific equipment."

The overall cost to managers of markers, their placement, and upgrade is not insignificant but is necessary for the safety of Sanctuary users and for the protection of fragile ecological areas. The alternative of not including this regulation was rejected since there is no cost associated with a prohibition on removing or damaging a marker. If a

Sanctuary user damages a marker, it was felt that person should bear the costs of repair or replacement.

i. Movement of, removal of, injury to, or possession of Sanctuary historical resources.

"Moving, removing, injuring, or possessing, or attempting to move, remove, injure, or possess, a Sanctuary historical resource."

The regulation prohibits the removal or injury of Sanctuary historical resources. Permits will not be issued for recovery of historical resources in an ecological reserve or in any areas where coral or significant amounts of seagrass or other significant natural resources would be injured by recovery of submerged historical resources.

j. Take or possession of protected wildlife.

"Taking any marine mammal, sea turtle, or seabird in or above the Sanctuary, except as authorized by the Marine Mammal Protection Act, as amended, (MMPA), 16 U.S.C. 1361 et seq., the Endangered Species Act, as amended, (ESA), 16 U.S.C. 1531 et seq., and the Migratory Bird Treaty Act, as amended, (MBTA) 16 U.S.C. 703 et seq."

Taking or possessing protected wildlife is prohibited, except pursuant to permits, under a variety of statutes such as the Marine Mammal Protection Act and the Endangered Species Act. Civil penalties under the National Marine Sanctuary Act and the FKNMSPA will facilitate enforcement.

k. Possession or use of explosive or electrical discharges.

"Possessing, or using explosives, except powerheads, or releasing electrical charges within the Sanctuary."

This restriction is primarily to protect Sanctuary resources from non-selective destructive fishing practices. Use of explosives or electrical discharges to collect marine species already is prohibited in State waters by the State of Florida and by the National Marine Fisheries Service in Federal waters. This regulation remains in effect but is superceded by the more restrictive "no-take" regulation applicable to the ecological reserve.

l. Harvest or possession of marine life species.

"Harvesting, possessing, or landing any marine life species, or part thereof, within the Sanctuary, except in accordance with rules 46-42.001 through 46-42.003, 46-42.0035, and 46-42.004 through 46-42.007, and 46.42.009 of the Florida Administrative Code, reproduced in Appendix VIII to this subpart, and such rules shall apply mutatis mutandis (with necessary editorial changes) to all Federal and State waters within the Sanctuary."

This regulation remains in effect but is superceded by the more restrictive "no-take" regulation applicable to the ecological reserve.

m. Interference with law enforcement.

"Interfering with, obstructing, delaying or preventing an investigation, search, seizure, or disposition of seized property in connection with enforcement of the Acts or any regulation or permit issued under the Acts."

This regulation codifies the NMSA statutory prohibition and is intended to protect enforcement officers and the integrity of the enforcement process, including the collection of evidence.

APPENDIX D: WORKING GROUP MEMBERSHIP

	Name		Affiliation	Address	
Dr.	James	Bohnsack	NMFS, SE Fisheries Science Center	Miami	FL
Mr.	Robert	Brock	Everglades National Park	Homestead	FL
Mr.	John	Brownlee	Recreational fisherman	Islamorada	FL
Maj.	Bruce	Buckson	Florida Marine Patrol	Tallahassee	FL
Mr.	Billy	Causey	Florida Keys National Marine Sanctuary	Marathon	FL
Ms.	Felicia	Coleman	Gulf of Mexico Fishery Management Council	Tallahassee	FL
Mr.	Ed	Conklin	Florida Dept. of Environmental Protection	Tallahassee	FL
Mrs.	Fran	Decker	Citizen	Marathon	FL
Mr.	Don	DeMaria	Commercial Fisherman	Summerland Key	FL
Mr.	Richard	Diaz	Commercial Fisherman	Key West	FL
Dr.	Nick	Funicelli	US Geological Survey	Gainesville	FL
Mr.	Peter	Gladding	Commercial Fisherman	Key West	FL
Mr.	Andy	Griffiths	Charter boat captain	Key West	FL
Ms.	Debra	Harrison	World Wildlife Fund	Marathon	FL
Mr.	Ben	Haskell	Florida Keys National Marine Sanctuary	Marathon	Fl
Mr.	Dave	Holtz	Citizen	Key West	FL
Mr.	Tony	Iarocci	Commercial Fisherman	Grassy Key	FL
Dr	Joseph	Kimmel	National Marine Fisheries Service	St. Petersburg	FL
Mr.	Don	Kincaid	Recreational diver	Key West	FL
Mr.	Peter	Moffitt	South Atlantic Fishery Management Council	Swansboro	NC
Dr.	Erich	Mueller	Mote Marine Lab	Summerland Key	FL
Dr.	Russ	Nelson	Florida Marine Fisheries Commission	Tallahassee	FL
Mr.	Gene	Proulx	NOAA Office of Law Enforcement	St. Petersburg	FL
Mr.	Alex	Stone	ReefKeeper International	Miami	FL

BMC	Bob	Thomas	U.S. Coast Guard	Key West	FL

APPENDIX E: LIST OF AGENCIES AND PERSONS CONSULTED ON BOUNDARY EXPANSION AND PARTIAL LIST OF AGENCIES AND ENTITIES RECEIVING FSEIS/FSMP

Department of Defense
Department of Energy
Environmental Protection Agency
Department of Transportation
Department of the Interior
Department of State
Governor of Florida
South Atlantic Fishery Management Council
Gulf of Mexico Fishery Management Council
U. S. House of Representatives, Committee on Commerce, Science and Transportation
U.S. Senate, Committee on Resources
Monroe County Board of County Commissioners

APPENDIX F: SUMMARY OF PUBLIC SCOPING COMMENTS ON THE ECOLOGICAL RESERVE

Public scoping meetings were held in October and November 1998 at the following locations: Washington, DC; Fort Myers, Florida; Miami, Florida; Marathon, Florida, and Key West, Florida. The purpose of these meetings was to solicit public comments on the idea of establishing an ecological reserve. A total of 223 comments were received: 89% of which were in support of the idea of establishing a reserve, 9% were opposed, and 2% were undecided. The following is a breakdown of the number of comments received on certain issues (note: the numbers are not additive as commentors commented on more than one issue).

Issues mentioned in support of reserve	
	# comments
Should be a no-take area	69
Include a portion of the Dry Tortugas N.P.	65
Reserve should be large	60
Protect a range of habitats	55
Support protection (single statement)	46
Enhance/protect fisheries	36
Protect biodiversity	24
Protect ecosystem structure/integrity	22
Protect all life stages	16
Important reference/baseline value	15
Provide for monitoring and research	14
Provide for future uses	10
K.I.S.S. (keep regs. simple/consistent to avoid confusion)	10
Provide for adequate enforcement	9
Protect spawning stock/population age structure	7
Maintain wilderness	7
Replenishment of fisheries	6
Protect source of larvae	5
Protect seabirds	5

Provide for adequate education	5
Include Sherwood Forest	5
Should require reservations to enter area	4
No-entry at all	4
Include Riley's Hump	2
Allow sportfishing/catch and release	2
Protect genetic information	1
No-anchor at Sherwood Forest	1
Provide financial assistance	1
Allow snorkel/diving	1
Rotate reserves	1
Protect 50% of study area	1
Issues mentioned in opposition to reserve	
Don't restrict recreational fishers	8
Don't restrict access to public resource	4
Don't support reserve (single statement)	4
Already have a reserve (DRTO)	3
PERSONAL WATERCRAFT (neither opposed nor support)	
Don't restrict them	2
DEMOGRAPHICS	
Florida (outside of Monroe)	50%
Monroe County	28%
Out-of-state	22%

APPENDIX G: NO-TAKE RESERVE NETWORKS: SUSTAINING FISHERY POPULATIONS AND MARINE ECOSYSTEMS

By Steven N. Murray, Richard F. Ambrose, James A. Bohnsack, Louis W. Botsford, Mark H. Carr, Gary E. Davis, Paul K. Dayton, Dan Gotshall, Don R. Gunderson, Mark A. Hixon, Jane Lubchenco, Marc Mangel, Alec MacCall, Deborah A. McArdle, John C. Ogden, Joan Roughgarden, Richard M. Starr, Mia J. Tegner, and Mary M. Yoklavich

ABSTRACT

Improved management approaches are needed to reduce the rate at which humans are depleting exploited marine populations and degrading marine ecosystems. Networks of no-take marine reserves are promising management tools because of their potential to (1) protect coastal ecosystem structure and functioning, (2) benefit exploited populations and fisheries, (3) improve scientific understanding of marine ecosystems, and (4) provide enriched opportunities for non-extractive human activities. By protecting marine ecosystems and their populations, no-take reserve networks can reduce risk by providing important insurance for fishery managers against overexploitation of individual populations. Replicated reserves also foster strong scientific testing of fishery and conservation management strategies. Reserve networks will require social acceptance, adequate enforcement, and effective scientific evaluation to be successful. Processes for reserve establishment should accommodate adaptive management so boundaries and regulations can be modified to enhance performance. However, even well-designed reserve networks will require continued conservation efforts outside reserve boundaries to be effective. Establishing networks of no-take reserves is a process-oriented,

precautionary management strategy that protects functional attributes of marine ecosystems. As an addition to fishery management practices and other conservation efforts, no-take reserve networks may improve the status of exploited populations while conserving marine resources for future generations.

Few of the world's coastal regions remain undisturbed by human activities (GESAMP 1991; NRC 1995; Vitousek *et al.* 1997). During the past century, America's coastal ecosystems have been changed by inputs of pollutants, modifications of watersheds, destruction of habitats, invasions of exotic species, and extractions of living resources (Suchanek 1994; Lubchenco *et al.* 1995; NRC 1995). Despite good intentions, existing efforts to manage and protect marine resources frequently are inadequate.

Many marine ecosystems show reduced biodiversity and other signs of degradation (Suchanek 1994; Lubchenco *et al.* 1995; NRC 1995). Moreover, many populations of exploited fish and invertebrates are declining in numbers and average size despite the efforts of fishery managers (FAO 1995; Roberts 1997; NRC 1999). In the United States, the tradition of open access and a lack of political will to change management strategies have inhibited implementation of effective measures to protect marine resources. Even marine ecosystems believed to be protected strongly, including many of those contained within U.S. marine sanctuaries and national parks, allow commercial and recreational fishing (Dugan and Davis 1993; McArdle 1997). Clearly, improved management approaches are required to sustain fisheries and effectively protect U.S. marine ecosystems and the goods and services they provide. Here, we discuss the potential of networks of no-take marine reserves to protect fishery populations and marine ecosystems.

Fisheries

Globally, the use of marine fish stocks is at or near a sustainable limit, and many populations are currently overexploited (NRC 1999). More than 40% of the world's marine fishery populations is heavily to fully exploited, and 25% is classified as overexploited, depleted, or recovering (NRC 1999). In the last decade, this high exploitation rate has led to the partial or complete collapse of many of the world's fisheries, and new, unexploited populations are no longer available to replace depleted stocks (Vitousek *et al.* 1997). Even in countries with active fishery management, the regulatory process has not prevented overfishing of many stocks. For example, in the United States, 36% of fishery stocks with known status under federal purview was classified as overutilized based on 1992-1994 data, and only 20% was underutilized with the potential to be fished more heavily (NMFS 1996).

Fishing activities also harm more than targeted populations. Many individuals of nontargeted species are killed incidentally as bycatch or discards and through the ghost-fishing of abandoned gear (NRC 1999). Global bycatch and discards between 1988 and 1990 amounted to approximately one-third of total landed biomass (Alverson *et al.* 1994), making the ecological consequence of bycatch and discard mortality a serious problem of modern fisheries management (Dayton *et al.* 1995; NRC 1999). Fishing also can change the genetic structure of exploited populations (Ricker 1981; Smith *et al.* 1991; Law *et al.* 1993). The selective removal of certain species by fishing can modify species interactions and result in changes that cascade throughout marine communities (Dayton *et al.* 1995; Hixon and Carr 1997; NRC 1999). Other fishing activities such as trawling and dredging disturb and alter seafloor habitats, and can modify the structure and diversity of benthic communities (Auster *et al.* 1996; Collie *et al.* 1997; Thrush *et al.* 1998).

Fishery management

Clearly, improved fishery management practices are needed to prevent overfishing and the serial depletion of exploited populations. Management of most fisheries is still based on single-species models despite the fact that multiple species are caught in almost every fishery (Mangel *et al.* 1996; Roberts 1997; NRC 1999). Existing single-species population models require a reliable time series of survey and catch-at-age data to reconstruct trends in stock biomass and exploitation rates. However, it is seldom possible to develop accurate models because of inadequate data, difficulties in estimating critical model parameters, and problems in accounting for environmental variability and uncertainty. Although increasingly promoted by fishery scientists and managers, multispecies models require even more information than single-species models and still are subject to problems of parameter estimation and in accounting for large, unexpected disturbances (NRC 1999). Thus, it is difficult to model exploited populations, to evaluate the risk involved in any fishery management decision, and to know when management actions are truly working to sustain fishery stocks. This can be true even for well-studied fisheries with seemingly stable populations (Gordon and Munro 1996; Hall 1998; Lauck *et al.* 1998).

Consequently, fishery managers need to allow for uncertainties and to use caution when establishing sustainable catch levels to protect against overfishing (Mangel *et al.*

1996; Hall 1998; Lauck *et al.* 1998). Because overexploitation often takes years to detect, the mid-course corrections in catch or effort needed to sustain targeted stocks may not be implemented soon enough if landings are set too high (Dayton 1998). Current practices usually place the burden of proof on fishery scientists by requiring overwhelming evidence of resource damage before limitations are placed on fisheries (Garcia 1994; Mangel *et al.* 1996; Botsford *et al.* 1997). However, even when the scientific evidence suggests that a fishery resource is being depleted, the political will to take a precautionary approach and restrict fishing is often lacking. Existing management practices also make it difficult to regulate new fisheries such as the commercial live-fish fishery off California, where fishing effort has increased ten-fold but catches only four-fold in the 1990s (Hardy 1996). Without immediate restrictions, this live-fish fishery may deplete many shallow-water West Coast fishes. Moreover, the removal of urchin-consuming California sheephead (Semicossyphus pulcher), a principal target of the live-fish fishery in southern California, could lead to destructive overgrazing by unfished urchin species in kelp forest communities (Dayton *et al.* 1998).

Other threats to marine ecosystems

Human activities other than fishing also threaten marine ecosystems. Land-based activities of an expanding human population harm marine ecosystems through the discharge of sediments, pesticides, sewage, industrial pollutants, and high concentrations of nutrients (Lubchenco *et al.* 1995; Agardy 1997; Vitousek *et al.* 1997). Nearly 40% of the world's population is concentrated within 100 km of the sea (Cohen *et al.* 1997). In the United States, almost half of the population can be found in coastal regions that account for only 5% of the land, and this population is growing by more than 1% each year (Culliton *et al.* 1990; NOAA 1990). The development of U.S. waterfront property has led to extensive destruction and modification of natural coastal habitats, including more than 70% of the original wetlands in Maryland and Connecticut, and 90% in California (Dahl *et al.* 1991). With greater coastal population densities, more people visit the shore for educational and recreational activities such as fishing, tidepool exploring, swimming, diving, and collecting organisms. Evidence is accumulating that these activities can harm coastal ecosystems (Hawkins and Roberts 1992; Keough *et al.* 1993; Brosnan and Crumrine 1994) and that existing management practices need to be reconsidered.

Marine reserves

Restricting fishing in nursery and spawning grounds or closing areas to rebuild depleted stocks has long been part of fishery management practices (Fogarty 1999). The establishment of no-take reserves, and specifically no-take reserve networks, however, has not received much attention despite the potential of reserves to improve fishery stocks and to support fisheries and fishery management. Marine reserves encompass less than one-quarter of 1% of the world's oceans, and only a fraction of these protected areas has been designated no-take reserves (McAllister 1996). Few no-take marine reserves exist in the United States. Planned networks of no-take reserves have not been instituted in North America until recently, when a set of no-take reserves was established in the Florida Keys National Marine Sanctuary (Bohnsack 1998a). Even in Florida, however, the combined area of the reserves comprising the network consists of less than 0.5% of the sanctuary's waters (Ogden 1997). In California, no-take reserves protect only 0.2% of state waters (McArdle 1997, 1998), and planned reserve networks do not exist.

Knowledge of requirements for effective marine reserves is less well-developed compared with terrestrial reserves, where a working theoretical framework exists for design and management (Simberloff 1988; Barrett and Barrett 1997). Because marine and terrestrial systems differ substantially, many of the management principles derived from terrestrial experiences are not applicable to marine reserves (Agardy 1997; Allison *et al.* 1998). Understanding the factors that determine population and community dynamics in marine systems is much more difficult than on land (Caley *et al.* 1996; Hixon 1998). For example, humans commercially exploit mostly plants and herbivores in terrestrial systems, whereas in the ocean predators are frequently targeted (Hixon and Carr 1997; Steneck 1998). Also, marine ecosystems are influenced to a much greater extent by variable, unpredictable physical processes (Agardy 1997; Botsford *et al.* 1997) and are more likely to experience decadal-scale shifts in physical conditions compared with their terrestrial counterparts (Steele 1991, 1998).

Moreover, because ocean currents transport organisms and materials great distances, marine sites are exposed to much broader regional influence than sites on land. Because many marine populations depend on larval recruitment from distant sources for replenishment (Roughgarden *et al.* 1994; Botsford *et al.* 1994; Palmer *et al.* 1996), sites providing sources of larvae and eggs need to be connected hydrographically to recipient sites to ensure the maintenance of local populations (Roberts 1998). The dependence of many marine populations on other areas for recruitment strongly underscores the need for multiple reserves that protect populations over regional scales (Ballantine 1995, 1997; Roberts 1998).

Benefits of no-take reserve networks

Protect ecosystem structure and functioning

Self-sustaining networks of marine reserves can potentially protect ecosystems by protecting habitats and communities from extractive activities that can lead to significant loss of biodiversity and changes in species interactions (Dayton *et al.* 1995; Boehlert 1996; Hixon and Carr 1997). Individual reserves can vary in design and management objectives (Agardy 1997), but effective networks that protect ecosystem structure and functioning should consist of a core of no-take reserves in which extraction of all living organisms is prohibited. In the absence of effective protection, many populations of predatory fish and other pelagic and continental shelf species already have been reduced to levels so low that they no longer perform their former ecological roles (Dayton *et al.* 1995, 1998; Pauly *et al.* 1998). Networks of no-take marine reserves can (1) help recover fishery populations; (2) eliminate mortality of nontargeted species within protected areas due to bycatch, discards, and ghost fishing; (3) protect reserve habitats from damage by fishing gear; and (4) increase the probability that rare and vulnerable habitats, species, and communities are able to persist.

Increase scientific understanding

Networks of no-take marine reserves can serve as sites for increasing scientific knowledge and understanding of marine ecosystems and their management. Without unexploited areas against which to measure change, scientists have little ability to fully evaluate the true impacts of fishing or other forms of human disturbance on marine populations and communities (Roberts 1997; Dayton *et al.* 1998). No-take reserve networks provide the required benchmark sites for separating effects of extractive human activities from those caused by natural shifts in physical regimes. This is important because natural oceanographic variability can significantly affect marine systems (NRC 1999) but can almost never be evaluated in the presence of cumulative effects of anthropogenic disturbance without benchmark sites (Dayton *et al.* 1995, 1998; Botsford *et al.* 1997). Baseline data from unfished stocks also can vastly improve estimates of population parameters for harvested species (Smith *et al.* 1999). The opportunity to improve understanding of marine ecosystems is particularly critical since modifications of physical, chemical, and biological systems by human activities are proceeding in new ways, at faster rates, and over larger spatial scales than ever before (Lubchenco 1998).

Enhance non-extractive human activities

No-take marine reserves create social and economic opportunities that otherwise would be impossible by supporting human activities dependent on minimally disturbed sites. These include activities such as wilderness experiences, ecotourism, scientific research, and advanced marine education. Other nonextractive activities also might be enhanced by no-take reserves, including diving, underwater photography, cultural and aesthetic uses, and environmental education. Many of these activities have substantial social and economic benefits that in some regions may even exceed the extractive uses of marine reserves (Dixon and Sherman 1990; Brock 1994; U.S. Department of Commerce 1996).

Benefit fishery populations

No-take reserve networks can directly and indirectly benefit exploited marine populations and fisheries. It has been repeatedly shown that the abundances, average sizes, and spawning biomass of exploited populations will rebound in no-take reserves (Rowley 1994; Bohnsack 1995; Roberts *et al.* 1995). These demographic changes are a predicted outcome of reserve protection because many fish and invertebrates live longer, reach greater body size, and produce significantly more eggs and larvae in the absence of fishing mortality (Bohnsack 1992, 1995; Roberts and Polunin 1993). No other form of fishery management provides the opportunity for a segment of a fishery stock to realize its full ecological and demographic potential.

No-take marine reserves have the potential to enhance exploited populations and benefit fisheries byd ispersing larvae that replenish fishing grounds removed from reserve source populations (Carr and Reed 1993; Rowley 1994; Bohnsack 1998b); however, the degree of augmentation will depend on the species, existing oceanographic conditions, and the magnitude of fishing mortality outside protected areas (Carr and Reed 1993; Sladek Nowlis and Roberts 1999); exporting biomass to adjacent fishing grounds in the form of emigrating juveniles and adults (Russ and Alcala 1989; Rowley 1994; Bohnsack 1998b); and protecting portions of exploited stocks from genetic changes, altered sex ratios, and other disruptions caused by selective fishing mortality (Ricker 1981; Law *et al.* 1993; Bohnsack 1992, 1998b).

Support fisheries and fishery management

No-take marine reserves also can support and benefit fisheries and fishery management. Sound fisheries management must allow for effects of changing environmental conditions and uncertainty or inaccuracies in stock assessment and projected sustainable catch levels (Roberts 1997; Dayton 1998; Lauck *et al.* 1998). Refugia provided by sufficiently large, no-take reserve networks can

1. Decrease the likelihood of stock collapse because reserves can act as regional buffers against unanticipated fishing mortality, unforeseen management errors, or environmental changes (Bohnsack 1998b). Hence, reserve networks that partition targeted species into exploited and unexploited populations can be used as a bet-hedging strategy to reduce risk to fishery managers over regional scales (Roberts 1997; Dayton 1998; Lauck *et al.* 1998);
2. Accelerate the rate of recovery of overexploited populations because of the increased spawning stock located in reserves (Bohnsack 1998b);
3. Theoretically decrease variability in annual catches by augmenting some fishery stocks, especially when reserves are large, and fishing mortality is high outside reserve boundaries (Sladek Nowlis and Yoklavich 1998; Sladek Nowlis and Roberts 1999);
4. Serve as sites for collecting valuable fishery-independent data and for conducting fishery research that cannot be carried out in exploited areas (Lindeboom 1995); and
5. Prevent modification and degradation of critical marine habitat caused by fishing practices (Dayton *et al.* 1995; Allison *et al.* 1998).

Designing effective reserve networks

Certain guidelines apply to the design of any marine reserve network regardless of its geographic location (Table 1). First, the goals, objectives, and expectations of each reserve in the network should be specified together with the species, communities, and habitats targeted for protection. Individual reserves can have different goals, but a reserve network should form a protective system that connects ecosystem functioning over regional scales. Thus, reserves forming the network should be distributed along latitudinal, depth, or other environmental gradients, and protect representative species and habitat types found in different biogeographic regions. For example, reserve networks in California should include habitats such as nearshore coastal waters, offshore islands, the edges of the continental slope, submarine canyons, and seamounts off the coast, whereas those in Florida should contain mangroves, seagrass beds, and coral reefs.

Table 1. Guidelines for developing functional reserve networks that link ecological processes (extended from Ballantine 1995, 1997).

1. Reserves should have clearly identified goals, objectives, and expectations. • Clearly identify and describe the purposes of each reserve. • Clearly identify the species, communities, and habitats to be protected. • Clearly identify the projected role and contribution of each reserve to the network.
2. Reserves should represent a wide variety of environmental conditions. • Locate reserves in each biogeographic region, in the path of major currents, and in major upwelling cells. • Distribute reserves across latitudinal and depth clines in each biogeographic region. • Design reserves to match the scale of ecological and oceanographic processes. • Include representative habitat types and biotic communities. • Consider habitat quality inside and outside each reserve. • Establish reserves in areas with high and low levels of human disturbance.
3. Reserves should be replicated in each biogeographic region. • Replicate reserves to protect similar habitats and biotic communities to maximize effectiveness and to guard against excessive damage from catastrophic events. • Replicate reserves to ensure effective designs for experimental and monitoring studies.

4. Reserves should accommodate adaptive management. • Develop flexible management practices to enable science-based revisions of reserve regulations and boundaries. • Develop scientific research and monitoring programs to evaluate biological and social performance. • Plan reserves to meet current and expected future needs.
5. Reserves should be of sufficient size to be self-sustaining. • Design reserve networks so coverage is large enough to sustain populations after local catastrophic events. • Make individual reserves large enough to limit deleterious edge effects and to facilitate enforcement.

The design of reserve networks should be based on knowledge of the natural systems, species' life cycles and habitat requirements, and existing conditions such as the degree of degradation or integrity of targeted habitats and populations. Individual reserve placement should take into account oceanographic conditions and major currents to maximize biological exchange among reserves and between adult and nursery habitats (Carr and Reed 1993; Carr and Raimondi 1998). For example, Pacific Coast reserves should include major upwelling cells that occur along the coast approximately every 100 km (Starr 1998) because the proximity of spawning adults to upwelling jets may be an important factor for dispersal and recruitment of several fish species, including rockfishes (Yoklavich *et al.* 1996; Morgan and Botsford 1998). In addition, eddies or counter currents near upwelling jets may enhance recruitment of invertebrates (Wing *et al.* 1995; Alexander and Roughgarden 1996; Bjorkstedt and Roughgarden 1997).

The type, distribution, and quality of habitats inside and outside reserve boundaries should be considered when locating individual marine reserves. Realizing the goal of improving fishing outside reserves requires suitable and sufficient habitat to support populations inside reserve boundaries, and the availability of appropriate habitat in adjacent fishing grounds where stocks are to be extracted (Carr and Reed 1993; DeMartini 1993). Reserve sites should be chosen based on available historical data and expected ecological benefits. They can include regions that have been subjected to both high and low levels of human disturbance. Whereas pristine areas and lightly exploited populations often are regarded as excellent candidates for protection, highly degraded systems also offer opportunities to restore marine ecosystems (Agardy 1997; Roberts

1998). In fact, highly exploited areas such as those adjacent to urban population centers may show stronger responses to reserve designation (Sladek Nowlis and Roberts 1997), but their success will depend on protection against other forms of human disturbance (Allison *et al.* 1998).

Replication of reserves is important for risk management because multiple reserves can serve as a hedge against isolated catastrophic events that affect populations or destroy habitat. Moreover, given the spatial and temporal variation of environmental processes that influence larval survival, protection of similar habitats in multiple locations can increase the chances that reserves will improve recruitment of individual species (Roberts 1998; Starr 1998). Reserves also must be replicated over appropriate regional scales to facilitate the scientific research and monitoring programs needed to provide accurate biological and social feedback on performance (NRC 1995; Ballantine 1997). Replication strengthens statistical inference and is important for rigorously testing hypotheses on reserve functions. Hence, the availability of replicated reserves is crucial for science-based improvement of reserve design and for increasing knowledge of fundamental processes in changing marine systems.

The common approach of establishing small, isolated reserves compromises the ability to achieve most conservation objectives, including enhancing fishery populations and improving fisheries (Roberts 1998). Whereas individual reserves can differ in size depending on their purpose (Carr *et al.* 1998), to be self- sustaining, an effective network must include reserves of sufficient size and number to protect key habitats and species' populations regardless of what happens outside reserve boundaries. Effective networks could include (1) large reserves that protect a substantial portion (*e.g.*, 20%-50%) of the spawning stock of a vulnerable species (*e.g.*, Mangel 1998; Sladek Nowlis and Yoklavich 1998; Sladek Nowlis and Roberts 1999), (2) reserves that protect typical habitats and communities (*e.g.*, 10%-20% of habitat coverage; Plan Development Team 1990), and (3) small reserves that protect critical, sensitive, or unique habitats, areas, or species.

Although more information about reserve size and the optimal distances for spacing reserves is needed to design networks that meet many management objectives, the best way to gather this information is to implement reserve systems and study how they function. Therefore, initial attempts to establish reserve sizes and locations must be based on reserve goals and the best available scientific data and models. Better guidance for reserve design will be possible when results from research performed in reserves become available, and when new scientific data on critical parameters such as recruitment and dispersal are obtained for populations targeted for protection. In the interim, the previously described lines of reasoning provide a strong rationale for significantly expanding the small, insufficient amount of marine habitat now being protected by no-take reserves if the goal is to enhance fishery populations (NRC 1999). Additionally, estimates of the habitat and home-range requirements for protecting spawning stocks (Bohnsack 1994; Starr 1998), and models of adult spillover (Polacheck 1990; DeMartini 1993) and larval export (Quinn *et al.* 1993; Sladek Nowlis and Roberts 1997, 1999) consistently support the need for a sizable increase in reserve areas that exclude fishing.

To be effective in the long term, reserve networks must be founded on adaptive resource management, where design modifications can be made using feedback loops between science and management (Agardy 1997; Allison *et al.* 1998). Improved scientific understanding of network function can lead to changes in the boundaries, locations, and regulations of individual reserves in an effort to better attain reserve goals. Therefore, effective scientific research and monitoring programs must be developed together with the establishment of reserve networks.

Reserve evaluation

To achieve desired goals, reserves and reserve networks must be both properly designed and evaluated (Carr and Raimondi 1998). Improper evaluation or misunderstanding of reserve goals can lead to inaccurate perceptions of reserve performance. For example, well-designed reserves might make important contributions to the larval replenishment of exploited populations, but flawed methods of evaluation (*e.g.*, poor measures of recruitment, measurements at inappropriate temporal or spatial scales, and low statistical power to detect changes) can fail to demonstrate their positive effects. Similarly, reserves also may protect some species but not others such as abalone and sea urchins in the presence of sea otters (Parker and Kalvass 1992; Karpov and Tegner 1992) or some fish populations under heavy predation by pinnipeds (Schmitt, *et al.* 1995). If the status of such a species forms the foundation for reserve evaluation, reserve performance may be perceived as unsatisfactory when, in fact, reserves have protected ecosystem functioning and increased regional abundances of other fishery stocks and populations. Timely and rigorous evaluation of reserve performances is essential if reserves are to function as effective management tools. If a reserve fails to yield expected results, and this failure is not detected in a timely manner, a false sense of insurance can be imparted to managers, user groups, and society. This mistaken security may jeopardize the future not only of an individual reserve, but also of regional policy, when reserve failure is ultimately detected (Carr and Raimondi 1998). For example, misperceptions of reserve protection might lead to resource collapse and environmental degradation if other management strategies have been relaxed or if fishing intensity has been allowed to expand or intensify outside reserve boundaries.

Strong scientific evaluation of reserve performance can be challenging because of difficulties in implementing rigorous statistical procedures to detect reserve effects over a large range of spatial and temporal scales. The inherent variability of marine systems can hinder the ability to detect, for example, a statistically significant increase in fish abundance within a reserve relative to reference areas, or reserve contributions to the larval recruitment of fishery stocks outside reserve boundaries. This problem emphasizes the need to develop stronger empirical and analytical approaches for evaluating reserve success. Modeling approaches to reserve evaluation will encounter many of the same problems that make parameter estimation difficult when employing typical models for assessing fishery stocks. Clearly, much greater scientific attention will be required to develop successful models (and model parameterization).

Social considerations

Social attitudes, economic concerns, institutional structures, and political processes must be considered to establish effective marine reserve networks. The potential for reserve networks to serve as successful resource management tools will be limited if the ways people value and use resources associated with reserves are not taken into account (Fiske 1992). This is because resource users frequently resist establishment of marine reserves or other conservation measures that restrict human activities. Part of this resistance is because the goals and economic and social benefits of marine reserves often are not well articulated by those promoting reserve protection or well understood by users who resist reserve establishment.

Restriction, termination, or displacement of activities such as fishing, oil development, and pollutant discharge involve real and perceived socio-economic costs that must be weighed against the expected benefits of creating reserves. Other issues that must be considered when assessing the potential benefits of reserve networks include the uncertainties of traditional fishery management; the magnitude of human impact on ocean ecosystems; and the importance of intact, functioning marine ecosystems. Because a critical goal of no-take reserve networks is to protect and sustain ecosystem functioning, the value of such functions must be recognized before benefits can be fully appreciated. However, a societal problem is the failure to appreciate the importance of ecosystem goods and services (Peterson and Lubchenco 1997), in part because most user groups focus only on extracting tangible marine products over short time scales. Moreover, a mismatch between operative time scales for ecological, socio-economic, and political processes can result in inaccurate expectations of the time-course for reserve outcomes to be realized. For example, considering the longevity and erratic recruitment of many rockfishes, it might be decades before reserve benefits to rockfish stocks outside reserve areas can be demonstrated (Yoklavich 1998). Such a lag would be perceived as too long for most fishers whose social and economic well-being is contingent on shorter schedules. Distinguishing real from perceived costs and weighing short- against long-term costs and benefits are issues that must be addressed when a reserve network is being established.

Knowledge of human systems can be used to anticipate potential support and opposition to establishing marine reserve networks or locating individual reserve sites. Recognition of the need for reserves, particularly in more remote settings, often comes from outside local communities (Wells and White 1995), but sociopolitical inertia can be difficult to overcome without adequate local support. Local individuals, groups, and institutions can greatly assist efforts to design and manage reserves (Johannes 1982; Fiske 1992; Walters and Butler 1995). Additionally, local or "traditional" knowledge of natural conditions can complement scientific knowledge and often provide otherwise unavailable and important information (Inglis 1993; Neis 1995). Institutional planning and coordination also are essential among local, state, and federal agencies (Agardy 1997).

Too often, U.S. reserves have been initiated by the public or special interest groups in response to a perceived opportunity or threat and created in the absence of a larger, regional plan. In California, this bottom-up tradition has resulted in a poorly designed, fragmented collection of individual reserves with unmatched or unclear objectives and weakly defined management goals (McArdle 1997, 1998). To develop effective reserve networks, better planning and adequate governmental mechanisms for creating functional reserves must be achieved, including structures that facilitate coordination among U.S. agencies with overlapping jurisdictions.

The success of no-take reserves depends on compliance with regulations (*e.g.*, Causey 1995; Ticco 1995; Proulx 1998), yet too often reserve management and enforcement practices have been weak (Beatley 1991; Alder 1996). Reserves may create incentives for some to break rules, especially if social or legal institutions are inadequate. This is because poaching can have high payoffs when reserves successfully protect valuable fishery populations such as abalone (Tegner *et al.* 1992, 1996). Compliance can be voluntary but in many cases may occur only with realistic levels of enforcement by responsible agencies and the threat of meaningful penalties for poaching. For example, in southern California, where most rocky shores are easily accessible, unlawful collecting and poaching of intertidal organisms have been widespread in existing reserves because enforcement has been virtually nonexistent (Murray 1998).

Granting exceptions to restrictions can compromise the performance of no-take reserves or reserve networks. Fishers frequently resist plans to establish reserves that eliminate fishing and often cite a lack of evidence in support of reserve benefits. However, the burden of proof should be shifted, with fishing exemptions granted only in certain cases (*e.g.*, fishing for migratory species, subsistence fishing by indigenous peoples using traditional or equivalent gear) where it can be shown that extractive activities will not prevent reserves from achieving their conservation goals. In some cases, it even may be necessary to restrict or limit nonextractive recreational activities. Because marine reserves can attract human visitors, increases in nonextractive use also can damage resources and potentially compromise reserve performance (Broome and Valentine 1993).

Conclusions

Impacts of human disturbance on marine ecosystem services and sustainability, including overfishing, are well documented (NRC 1995, 1999; Vitousek *et al.* 1997). Changes in ecosystem structure and functioning, and declines in exploited marine populations become even more likely as the pressures of fishing and other human activities increase. Moreover, fisheries and environmental managers are being challenged by marine systems that are changing in new and unpredictable ways, ranging from broad climatic changes (NRC 1999) to the more-regional cumulative impacts of human activities (Lubchenco 1998). Declining trends in the health of America’s fishery populations and marine ecosystems need to be offset by improved management approaches. Continued depletion of many exploited populations and reductions in marine biodiversity are likely outcomes if existing practices are maintained as the principal vehicles for managing fisheries and protecting marine ecosystems (Ludwig *et al.* 1993; Boehlert 1996). Improvements in fishery data and models, and the advocacy of more precautionary approaches toward establishing sustainable catch levels are needed, but alone they may be insufficient to significantly improve the status of many exploited populations.

Marine reserves are receiving increasing attention and have been identified as a viable management strategy for promoting the sustainable use of ocean resources (Costanza *et al.* 1998; NRC 1999). No-take reserve networks offer opportunities to improve the status of exploited populations, benefit fisheries management, and increase understanding of marine ecosystems. By protecting resident populations and ecosystem functioning, networks of no-take reserves provide a precautionary approach for managing wild resources. Reserve populations ensure against inaccuracies and inherent uncertainties in fishery models as well as unpredictable fluctuations in fishery stocks (Hall 1998; Lauck *et al.* 1998). No-take reserve networks might enhance and make more stable the landings of many fishery populations throughout the long term compared with existing practices (Sladek-Nowlis and Roberts 1997). Besides directly benefitting exploited stocks, effective reserves add an ecosystem-based management tool that focuses on processes and functioning, and extends fishery and conservation benefits beyond individual targeted populations (Agardy 1997; Roberts 1998; NRC 1999).

The degree to which no-take reserve networks can improve a fishery will be difficult to predict but will be based on characteristics of the species being protected and the network design. Nevertheless, a sufficient theoretical framework now exists for designing reserve networks in the United States. The short-term negative socio-economic effects of implementing no-take reserve networks should be less than the long-term repercussions of overfishing, including the disruptions that result from stock collapses. Short-term reductions in fishery landings, and the resulting social and economic adjustments required by fishers, may be mitigated partially by phasing in reserves to distribute the loss of fishing grounds and related catches throughout several years. During this period the benefits obtained from reserves may begin to offset losses due to displacement of fishing activities (Sladek Nowlis and Roberts 1997).

By protecting targeted and untargeted populations from extractive activities, no-take reserve networks also provide areas with intact ecosystems that enhance opportunities to build scientific understanding of complex marine processes. Without no-take reserve networks, fewer opportunities will be available to investigate and understand marine ecosystem functioning and to use this knowledge to improve fisheries management and conservation measures. Public access to reserves can increase the types and quality of many important non-extractive human activities that require minimally disturbed areas such as education, ecotourism, photography, recreational diving, fish watching, cultural activities, and wilderness enjoyment (Bohnsack 1998b). The economic and social benefits of non-extractive uses of a reserve in many cases can exceed its extractive value (Dixon and Sherman 1990; Brock 1994; U.S. Department of Commerce

1996). Although high levels of nonextractive use can significantly affect coastal populations (Brosnan and Crumrine 1994; Addessi 1995; Keough and Quinn 1998), these effects can be offset where necessary (*e.g.*, easily accessible urban shores and popular shallow-water reefs) by restricting or limiting public access and through public education. Public acceptance, a requirement for reserve success, can be strong with local support, education, direct experience, and adequate enforcement (Fiske 1992; Wolfenden *et al.* 1994; Ballantine 1995).

No-take reserve networks can complement existing management practices, improve efforts to interrupt declining trends in fishery populations, and help preserve marine ecosystems for future generations. However, reserve networks can only supplement other management policies because ocean currents move across reserve boundaries (Allison *et al.* 1998), and on-site managers cannot control characteristics of reserve waters or recruitment of reserve populations dependent on sources outside reserve boundaries. Individual reserves or reserve networks cannot alone produce desired fishery and conservation outcomes (Roberts 1998; NRC 1999). The effectiveness of even well-designed reserve networks must depend on conservation and fishery management efforts undertaken outside reserve boundaries (Agardy 1997; Allison *et al.* 1998; Fogarty 1999).

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APPENDIX H: RESPONSE TO PUBLIC COMMENTS RECEIVED ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT AND DRAFT SUPPLEMENTAL MANAGEMENT PLAN (DSEIS/SMP) AND THE PROPOSED IMPLEMENTING REGULATIONS FOR THE PROPOSED TORTUGAS ECOLOGICAL RESERVE

INTRODUCTION

More than 4,000 comments were received on the DSEIS/SMP and the proposed implementing regulations for the proposed Tortugas Ecological Reserve. All comments received were treated as being directed to both the DSEIS/SMP and the proposed regulations. Almost 3000 of the comments were form letters expressing general support for the creation of the Tortugas Ecological Reserve. Two hundred and forty-five persons commented by signing a petition. The substantive comments received are summarized below followed by the agency's responses. Multiple but similar comments have been treated as one comment for purposes of response. Comments merely stating personal support or opposition to the establishment of the proposed Tortugas Ecological Reserve and comments supporting the process employed or complimenting the many individuals who participated in that process, while certainly appreciated, do not require responses. Comments beyond the scope of the proposed action, such as establishment of an ecological reserve within the Dry Tortugas National Park, establishing more ecological reserves in the Sanctuary, or making the entire Sanctuary a "no-take" zone, are neither summarized nor responded to. No comments were received on the Initial Regulatory Flexibility Act Analysis (IFRA) per se. However, a number of the comments requested changes to the Preferred Alternative because of impacts on users, all of which are considered small entities for purposes of the Regulatory Flexibility Act. Comments 1, 3, 4, 9, 13, 16-19, 21-23, 36, 41-43, and 50 and the responses thereto summarize the significant issues raised by those comments and the assessment of the agency of such issues. Although changes were made to the Proposed Rule, no changes were made as a result of those comments.

SUMMARY OF COMMENTS AND RESPONSES

Comment 1: A commentor wrote on behalf of over 100 commercial fishermen who are opposed to ecological reserves in the Sanctuary. They believe that ecological reserves are unnecessary for stock or environmental preservation and that reserves are a "back-door" approach to the eventual elimination of all commercial fishing within the Sanctuary. They believe that the statement in the DSEIS that the Tortugas process was a joint effort with the commercial fishing industry is misleading and highly offensive to the rank and file fishermen who oppose the reserve. The commentor stated that he did not participate in the process because he believed that establishment of the Tortugas Ecological Reserve was a "done deal" from the beginning. He requested that the FSEIS not state that establishment of the Reserve was supported by the commercial fishing industry.

Response: NOAA recognizes that some individual fishermen oppose reserves in the Sanctuary. However, NOAA worked with leaders in the commercial fishing industry who served on the Sanctuary Advisory Council, as well as the Tortugas 2000 Working Group. The commercial fishing representatives contacted other commercial fishermen for their input into the Tortugas 2000 process. Dozens of commercial fishermen participated in the process to draft the boundary alternatives for the proposed Tortugas Ecological Reserve. NOAA also worked cooperatively with the Gulf of Mexico Fishery Management Council in the development of the Reserve.

The successful use of ecological reserves or marine reserves as management tools to conserve, protect, and preserve stocks and marine environments is documented in the scientific literature. NOAA has its own positive experiences with the use of "no-take" reserves in the FKNMS since July 1997, as data from scientific research and monitoring of these areas supports the positive benefits of reserves. The Tortugas Ecological Reserve is proposed to protect remote areas that include varied habitats, exceptional coral reefs, and excellent water quality.

NOAA strongly disagrees that reserves are a "back-door" approach to the eventual elimination of commercial fishing in the Sanctuary. The proposal in no way represents an effort to eliminate commercial fishing from the rest of the Sanctuary. Including the Tortugas Reserve, approximately 6% of the total geographical area of the Sanctuary will be closed to fishing. NOAA recognizes that some of the commercial fishing that formerly occurred in the Reserve will relocate to other areas within and outside the Sanctuary.

Comment 2: NOAA should select Boundary Alternative III (Preferred Boundary Alternative). This alternative provides distinct longitudinal and latitudinal boundary lines for both compliance and enforcement purposes; incorporates important benthic communities that serve as critical foraging areas for coral reef species; provides important buffer areas to the critical coral reef community; protects Riley's Hump, a known fish aggregating and fish spawning site; and protects a wide range of deep water coral reef habitats.

Response: Boundary Alternative III remains the Preferred Boundary Alternative. The protection of the diverse and productive benthic communities of the Tortugas region is consistent with the FKNMSPA and NMSA, and it is therefore critical that the full extent of coral reef and related habitats lying within Boundary Alternative III be included in the Tortugas Ecological Reserve.

Expansion of the Sanctuary boundary as proposed in the Preferred Boundary Alternative is necessary to include unique coral structures and significant habitats lying outside the present boundary, such as Sherwood Forest and Riley's Hump. The on-going and immediate threat of anchor damage and other direct human impacts to the coral reef community outside the existing Sanctuary boundary further supports the Preferred Alternative.

The provision of buffer areas within the design of the Tortugas Ecological Reserve is necessary for several reasons. NOAA has learned from the Western Sambo Ecological Reserve and the Sanctuary Preservation Areas that fishermen will fish along the boundaries of these areas due to the success of no-take areas in increasing fish and other marine life abundance. Without an adequate buffer, traps and other fishing gear could become entangled in coral, threatening the effectiveness of the Ecological Reserve. Several different groups of scientists over the past two years have documented shrimp nets entangled on sensitive coral reef habitat in the proposed Tortugas North portion of the Reserve.

Scientists conducting research in the area of the proposed Tortugas Ecological Reserve have found that benthic primary production provides the base for the food web on this portion of the west Florida shelf. They also found that high levels of fishery production associated with the live bottom habitats are in fact directly supported by the surrounding open sand, algae and seagrass communities in the area. Buffer areas that include these habitat types will contribute to the overall functionality of the Ecological Reserve.

The Tortugas North portion of the Ecological Reserve as contained in Boundary Alternative III (Preferred Boundary Alternative) consists of coral reef communities that are unparalleled in the Florida Keys in their diversity and composition. Several carbonate banks of varying size and depth (30 feet to 75 feet) and low relief hardbottom habitats with patches of sand and rubble characterize Tortugas North. The most prominent features in the Tortugas North reserve are Tortugas Bank and Sherwood Forest. Tortugas Bank crests at 66 feet and supports abundant attached reef organisms such as sponges, corals, and soft corals. North of Tortugas Bank, in an area previously believed to be comprised only of sand, are several pinnacles covered with hard and soft corals and reef fish.

Sherwood Forest is an ancient stony coral forest exhibiting 30% or more bottom cover located along the western flank of Tortugas Bank. The top of Sherwood Forest rises to a depth of about 65 feet and covers an area of many acres. The area exhibits a complex habitat with various rock ledges, holes, and caves, providing hiding places for marine life. Unusual coral formations and previously unidentified coral species associations have been observed in this location. Gorgonians and black corals (*Antipathies* sp.), which are not common elsewhere in the Florida Keys, are also prolific. An abundance of groupers has been documented in Sherwood Forest as have sightings of uncommon and rare fish species such as jewfish, white-eyed goby, and orangeback bass.

The Tortugas South portion of the Ecological Reserve as contained in Boundary Alternative III (Preferred Boundary Alternative) includes a wide range of deep water coral reef habitats that will protect and conserve many rare and unusual reef species, and incorporates sufficient area to provide a buffer to the critical coral reef community. The upper portion of Tortugas South includes the relatively shallow Riley’s Hump area in less than 100 feet of water. Riley's Hump consists of attached algae, scattered small coral colonies, sand, and hardbottom habitats. It is also a known fish aggregating and spawning site for several snapper-grouper species.

During the 2000 Sustainable Seas Expedition (SSE), submersible pilots explored the lower portions of Tortugas South. Deep reef habitats with numerous soft corals but few stony corals were found in depths from 200 to 400 feet. A series of small pinnacles that surround a larger seamount were identified as part of an east-west running ledge that begins around 250 feet and drops to close to 400 feet in a nearly vertical profile. This is unlike any other coral reef habitat discovered within Sanctuary waters. These complex habitats support numerous fish species including streamer bass, yellowmouth grouper, snowy grouper, scamp, speckled hind, creole fish, bank butterflyfish, amberjack, and almaco.

The deepest portions (1,600 to 1,800 feet) of Tortugas South encompass limestone ledges where unusual deep-dwelling sea life such as lantern fish (myctophids), tilefish, golden crabs, and giant isopods have been observed by submersible pilots. Contrary to some opinions that these depths were devoid of life, the sand bottom habitat was observed to be teeming with unique deep sea species of shrimp, fish, sea cucumbers, anemones, and crabs.

These critical deep water communities of Tortugas South are vulnerable to a wide range of impacts from fishing gear including deep water trawls and traps, and impacts from anchoring. Fishing gear impacts have been observed on sand and limestone substrates in some deep water areas.

In order for the Ecological Reserve to be biologically effective and to ensure protection and conservation of the full range of coral reef habitats and species in the Tortugas region, it is critical that all of the various benthic habitats and their associated marine communities, from the shallowest to the greatest depths, be included within the boundary of the Tortugas Ecological Reserve.

Comment 3: NOAA should select the No-Action Alternative I. NOAA should not expand the FKNMS boundary or create an ecological reserve. The reserve "punishes the general public for the sins of commercial interests."

Response: If the no-action alternative is selected and the Sanctuary boundary is not expanded to create the Tortugas Ecological Reserve as contained in the Preferred Alternative, significant coral reef resources would be left at risk to physical destruction by ship and boat anchors and other human impacts including fishing. If the Sanctuary boundary is not expanded to include the geographical extent of the Tortugas Ecological Reserve as proposed in the Preferred Boundary Alternative (III), some of this nation's most significant coral reef resources would be left vulnerable (see environmental description contained in Response to Comment 2).

The Sanctuary boundary established by Congress in the FKNMSPA in 1990 was based upon the very best information available at the time related to the coral reef resources located to the far-western extent of the Florida Keys. Over the last decade scientists and managers have learned and documented a considerable amount about the existence of extensive and unique coral reef resources that are located outside the boundary of the FKNMS. This new information regarding those significant coral reef resources and the threats to them emphasis the critical need to take action and protect them.

The Tortugas Ecological Reserve is intended to preserve for all, including future generations, the critical coral reef ecosystem of the Tortugas and the extraordinary resources and qualities that are found there. Consumptive recreational activities have resource impacts that are inconsistent with the protection needed for these resources. All consumptive commercial and recreational activities are being prohibited in the Reserve. Most of the data used in the analysis of the environmental consequences and socio-economic impacts in the DSEIS/SMP refer to commercial activities because commercial activities represent the majority of use of the Tortugas area and because commercial data are more readily available.

Comment 4: NOAA should adopt Boundary Alternative II.

Response: The benthic community contained within the boundary of Alternative II does not include the significant and biologically diverse coral community known as Sherwood Forest. Unless this area is included within the Ecological Reserve, some of this nation's most significant coral reef resources will not be adequately protected for future generations. These unique coral reefs comprise some of the most biologically diverse coral reef communities and best water quality in the Florida Keys. Failure to protect these unique coral reefs will result in their decline from a variety of human impacts.

Additionally, Boundary Alternative II does not contain Riley's Hump, a known fish aggregating and spawning site, or its adjacent deep water shelf communities. Boundary Alternative II would not offer protection and preservation of these unique deep water habitats and their associated fish and invertebrate species (see description contained in Response to Comment 2).

Comment 5: NOAA should adopt Boundary Alternative IV.

Response: While this alternative would protect a larger area than the Preferred Alternative and provide greater ecological benefits, the adverse socio-economic impacts of this alternative on various fishing activities such as recreational charter fishing, commercial fishing, and spearfishing, would be significantly greater because all of Tortugas Bank would be closed to consumptive activities. On balance, the benefits of the increased area protected would be outweighed by the greater socio-economic costs.

Comment 6: NOAA should adopt Boundary Alternative V.

Response: While Alternative V would protect an even larger area than Alternative IV, it would not protect the full range of critical deep water habitat at the southern end of Tortugas South that would be protected by Alternatives III and IV (see description contained in Response to Comment 2). While it would expand protection to the west, the majority of the benthic communities located there are not as threatened from direct impact as those located within the boundary of the Preferred Alternative. Alternative V would not result in significant increased protection to coral reef communities located outside Alternative III, yet would have increased socio-economic costs.

Comment 7: Alternatives IV and V are more consistent than Alternative III with the goals that the Sanctuary has set for the ecological reserve, in addition to being more consistent with Executive Order 13089 by protecting national significant coral reef resources.

Response: See Responses to Comments 2, 5 and 6. Boundary Alternative III is the Preferred Boundary Alternative because it will protect ecosystem integrity; protect biodiversity; enhance scientific understanding of marine ecosystems; facilitate human uses to the extent consistent with the other objectives; minimize socio-economic impacts to the extent consistent with the other objectives; and facilitate enforcement and compliance. The Preferred Alternative is of sufficient size, together with the Dry Tortugas National Park, to protect all known nationally significant coral reef resources of the Tortugas region and fulfill the objectives of the FKNMSPA and the NMSA, while not unduly impacting user groups, and is consistent with Executive Order 13089.

The Preferred Boundary Alternative (Alternative III) provides an appropriate balance of significant resource protection while leaving other areas of Tortugas Bank available for consumptive uses, including commercial and recreational fishing, and spearfishing. A detailed comparison of the alternatives and an explanation for the selection of the Preferred Alternative is set forth in the FSEIS. The Preferred Boundary Alternative is consistent with the criteria and objectives established for selecting a Preferred Alternative.

Comment 8: NOAA should adopt Regulatory Alternative D (Preferred Regulatory Alternative).

Response: Regulatory Alternative D (Preferred Regulatory Alternative) differs from Regulatory Alternative C (the Preferred Regulatory Alternative in the DSEIS) by prohibiting all activities in Tortugas South except for continuous transit, law enforcement, and, pursuant to a sanctuary permit, scientific research and educational activities. Both Regulatory Alternatives C and D would prohibit any take. The reasons that Alternative D is now the Preferred Regulatory Alternative are to more fully protect fish spawning aggregations found on Riley's Hump, to permit effective enforcement of Tortugas South, the most remote region of the Sanctuary, and to provide a reference area for comparison to gauge the impacts of non-consumptive activities in Tortugas North. Riley's Hump is a known fish spawning aggregation site for at least five species of snapper and several species of grouper. Riley's Hump is also one of the only known spawning aggregation sites for mutton snapper, a highly targeted species for commercial fisheries.

Comment 9: NOAA should adopt Regulatory Alternative C.

Response: See Response to Comment 8.

Comment 10: The resources in the Tortugas area are in good shape overall and do not need the protection of an ecological reserve. The size and number of recreationally and commercially important species of fish remain healthy.

Response: The importance of the resources of the Tortugas region to the rest of the Florida Keys is documented throughout the DSEIS and FSEIS. Over the past few decades the Florida Keys have experienced a significant increase in visitation, particularly at Dry Tortugas National Park where visitation increased 300% from 1984 to 1998 (18,000 to 72,000 visitors). The current population of South Florida of approximately 6 million is expected to double by 2050. It is likely that population pressures, increase in tourism, and improved boating and fishing technology making it easier for more people to regularly visit the same remote sites, located well offshore, will result in greater visitation and pressure on the resources of the Tortugas area. By protecting the resources of the Tortugas area now, NOAA will be able to maintain them in a nearly pristine state, for the benefit of present and future generations. The protection of areas of the marine environment of special national significance due to their resource or human use values, such as the Tortugas region, is consistent with the FKNMSPA and NMSA.

Fisheries biologists have documented alarming declines in the size and abundance of commercially and recreationally important species of snapper, grouper, and grunts throughout the Florida Keys including the Tortugas region.

Comment 11: NOAA must provide an adequate number of mooring buoys in the Reserve. One commentor suggested that NOAA place at least 25 buoys in Tortugas North and a lesser number in Tortugas South. Several commentors suggested rotation of mooring buoys.

Response: Assuming implementation of the Preferred Alternative (III and D), an adequate number of mooring buoys will have to be provided in Tortugas North. It is not now known how many mooring buoys will be needed and where they should be installed. Some buoys will be installed at the more popular dive locations in Tortugas North prior to the effective date of the regulations. Non-consumptive users, such as dive charter operators, will be consulted to determine a desirable number and appropriate locations for buoys. The rotation of mooring buoys will be considered.

It has not yet been determined whether buoys will be installed in Tortugas South because, under the Preferred Alternative, diving will only be allowed for scientific research and educational purposes. Submerged moorings (i.e., moorings located beneath the surface) are being considered as a means to facilitate scientific research activities in this portion of the Ecological Reserve.

Comment 12: Non-consumptive diving should be prohibited throughout the Reserve to prevent any disturbance to the ecosystem. Even non-consumptive diving activity can cause substantial damage to corals.

Response: Prohibiting non-consumptive diving in Tortugas North is not needed to protect the resources or their ecosystem. One of the basic tenets of the FKNMSPA, the NMSA and indeed the Designation Document for the FKNMS, is to allow activities in the Sanctuary that do not cause an adverse effect on the resources or qualities of the Sanctuary, or that do not pose a threat of harm to users of the Sanctuary. However, the resources of Tortugas South, particularly the spawning aggregation areas, are unique and warrant the additional protection of prohibiting diving. Enforcement surveillance in this remote part of the Reserve would be facilitated by prohibiting all activities in Tortugas South except for continuous transit, law enforcement, and, pursuant to a sanctuary permit, scientific research and educational activities. Additionally, prohibiting diving in Tortugas South will provide a baseline to gauge the effects of non-consumptive activities on the resources in Tortugas North.

Tortugas North is less remote and protection and conservation can be more easily afforded to it than to Tortugas South. Allowing non-consumptive diving that is carefully monitored in Tortugas North will provide significant educational and resource appreciation benefits. Further, prohibiting non-consumptive diving in Tortugas North would unnecessarily increase adverse socio-economic impacts on charter dive operators without providing corresponding resource protection. The permit system for Tortugas North will allow the level of diving activity to be monitored, and combined with the reference of Tortugas South, will allow the effects of non-consumptive diving on resources in Tortugas North to be determined.

Education and outreach programs are being implemented that will continue to raise the awareness of divers about the potential impact from their activity on coral reefs. The presence of "no-take" divers in the Reserve is viewed by marine reserve experts as important to help convey the message of the benefits of marine reserves.

Comment 13: NOAA should prohibit commercial fishing in the Tortugas Ecological Reserve but allow recreational fishing, especially catch-and-release fishing. Recreational spearfishing should be allowed in the Reserve because it has little impact on the fish populations of the Tortugas region.

Response: No-take protection for the critically important coral reef ecosystem of the Tortugas is necessary to preserve the richness of species and health of fish stocks in the Tortugas and throughout the Florida Keys. Preservation of the full biodiversity of the area cannot be accomplished if exceptions are made to the "no-take" prohibition.

Even catch-and-release fishing can result in direct and indirect mortality. According to biologists, release mortality can be a significant contribution to total mortality depending on the intensity of fishing. Reef fishes are particularly vulnerable to catch-and-release mortality because of their behavior, long lives, and ecology. Fisheries biologists have reported mortalities ranging from 15-30 % of fish that are caught and released. One study suggests high mortality for Barracuda that fight for an extended period.

Spearfishers tend to target the largest members of particular species. Scientists have demonstrated the impact spearfishing activities have of removing top predators in the food chain. The selective removal of the largest individuals of a fish species by spearfishing affects the over-all trophic structure of coral reef communities. Spearfishing charters in the Tortugas region, in particular, often target "trophy" fish for their customers. Research at the Looe Key National Marine Sanctuary between 1983 and 1985 demonstrated a marked increase in fish populations after spearfishing was prohibited. Continued spearfishing in the Tortugas Reserve would adversely affect fish populations and undermine the ecological integrity of the Reserve.

Impacts from commercial and recreational fishing activities are occurring in the Tortugas, where the average size of black grouper has decreased from 22.5 pounds to 9 pounds. The scientific literature as well as NOAA's own experience in the Sanctuary have shown that prohibiting fishing in select areas directly benefits species abundance, size and diversity. Prohibiting all consumptive activities, including commercial and recreational fishing, will greatly help the species within the Reserve achieve greater ecological and demographic potential. As described in the FSEIS, this should result in benefits to some fish populations outside the Reserve. Prohibiting all forms of take will also yield significant scientific benefits because the Reserve will more accurately reflect a natural system against which the effects of extractive human activities can be compared.

In addition, enforcement of the remote Tortugas Ecological Reserve would be complicated significantly if limited extractive activities such as catch and release fishing or spearfishing were not prohibited. NOAA's experience with the existing Sanctuary Preservation Areas is that no-take regulations are more easily enforced and gain more compliance and acceptance from visitors than areas that allow varying extractive activities.

Comment 14: Adequate law enforcement cannot be provided for the Tortugas Ecological Reserve. The 90+ square mile Oculina Marine Reserve off Fort Pierce is unenforceable and the Tortugas Reserve will be, also.

Response: The proposed Tortugas Ecological Reserve is substantially different with respect to enforcement than the Oculina Marine Reserve. The Oculina Reserve is located in a remote area, well offshore of the east coast of Florida. It is not associated with an existing marine protected area and does not have the benefits of all the management programs that help increase the public's awareness of the reserve and the regulations with which they must comply. Education and outreach are important tools that help to gain the compliance of the general public, the majority of which are law-abiding citizens. The Management Plan commits substantial enforcement resources for the Reserve.

As set forth in the Enforcement Action Plan of the Supplemental Management Plan, one of the goals of Sanctuary management is to gain the highest level of compliance by the public who enter and visit the Tortugas Ecological Reserve. This compliance can be achieved through several management actions including education and outreach and on-the-water presence of Sanctuary staff in programs such as Team OCEAN, where Sanctuary information is distributed along the waterfront or boat to boat by Sanctuary staff and volunteers.

The most effective management action that can be used to achieve compliance to Sanctuary regulations is an effective law enforcement program. Currently, the primary enforcement of Sanctuary regulations is accomplished through an enforcement agreement between NOAA/National Marine Sanctuary Program and the State of Florida Fish and Wildlife Conservation Commission. The enforcement efforts are consistent with the goals and objectives for enforcement described in the Final Management Plan for the FKNMS (July 1997). The Final Management Plan for the Sanctuary also calls for cross-deputization of other agency law enforcement personnel (e.g., National Park Service Rangers) to accomplish law enforcement responsibilities within the Sanctuary. This approach to enforcement continues to remain an option.

A successful Ecological Reserve will depend to a large extent on the level of enforcement resources dedicated to the Reserve. Several enforcement options are presently available and are being evaluated for deployment in the Reserve. These options include:

- Installation and monitoring of a long-range radar unit at the Dry Tortugas National Park. This would allow remote monitoring of vessels entering and leaving the Reserve.
- Place two 82’ vessels into service for patrolling the Ecological Reserve.
- Cross-deputize and fund National Park Service Rangers to assist in enforcement in the Tortugas Ecological Reserve. Prohibiting vessels from stopping within Tortugas South except pursuant to a valid sanctuary permit for scientific research or educational purposes will facilitate enforcement. This will make it possible to monitor vessel traffic remotely by radar and response will only be necessary when vessels without a permit stop within the reserve.
- The permit system for Tortugas North will help Sanctuary managers monitor the level of visitor use in the reserve and facilitate enforcement efforts.

As set forth in the Management Plan for the Reserve, the law enforcement budget is as follows:

Personnel

Law Enforcement Officers (4-6)	$50,000 per position
General Support	$50,000

Vessels

82' Patrol Vessels (2)	No Cost - Agency Property Transfer

<u>Comment 15</u>: The economic analysis contained in the DSEIS/SMP did not adequately consider activities of fishing clubs in the Tortugas Ecological Reserve Study Area. In public testimony, one fishing club estimated that their membership had 673 person-days of fishing in the Dry Tortugas National Park area in 1998 and was not contacted for input for the socio-economic analyses.

<u>Response</u>: The recreational use of the Tortugas region has been adjusted in the socio-economic impact analysis in the FSEIS/SMP to reflect this comment. In preparing the DSEIS/SMP, NOAA staff relied on directory assistance search to locate private fishing clubs. Only one was found, and that was in Miami. The president of that club indicated that very few if any of its members went to the Dry Tortugas region. He provided names of a few members who were knowledgeable of the region's fishing patterns. Phone calls to these contacts produced no new information and their names were not kept. Additionally, commercial operators who work in the Tortugas area were asked if they saw other boats in the Tortugas but outside the boundaries of the Dry Tortugas National Park. They consistently said that they did not. Some members of the club said they fished in the National Park, but not in the Tortugas Ecological Reserve Study Area (TERSA). NOAA was not able to identify any private households that did any activity in the TERSA.

<u>Comment 16</u>: Representatives of shrimping activities criticized the socio-economic impact analyses on the shrimp industry provided in Leeworthy and Wiley (October 1999). First, they claim that the total catch estimate of 58,374 pounds of shrimp from the area within the Preferred Boundary Alternative should be one million pounds instead. Second, they claim the prices for shrimp used were incorrect and a higher price should have been used. Third, they claim that the assumption that shrimp lost from the no-take areas could be caught elsewhere is incorrect.

<u>Response</u>: The use of the total catch estimate of 58,374 pounds of shrimp caught in the area within the Preferred Boundary Alternative is valid. The commentors offered no quantitative support to justify their assertion that the estimate should be one million pounds. The only information they offered was boat tracking data. No quantities of catch were offered, only that 30 percent of their fishing time was spent in the Tortugas North area. The sample of shrimp fishermen used in the socio-economic impact analysis accounted for 90 percent of the 58,374 pounds that was estimated. Non-sampled

fishermen, including those that landed shrimp in counties other than Monroe and Lee (i.e., Hillsborough, Pinellas and Franklin) accounted for the other 10 percent. If all the shrimp catch from the non-sampled population estimated in the TERSA were caught in the area within the Preferred Boundary Alternative, this would only amount to 71,500 pounds. If 30 percent of all the shrimp caught in the Florida Marine Research Institute (FMRI) areas 2.0 and 2.9 and landed in Hillsborough, Pinellas and Franklin counties (183,319 pounds) were caught from the area within the Preferred Boundary Alternative, this would only amount to 54,996 pounds. None of these estimates support an estimate of one million pounds. Not even all the shrimp catch estimated in the TERSA (715,500 pounds) is close to the one million pound estimate and the economists' sample accounted for 90 percent of all the shrimp caught in FMRI areas 2.0 and 2.9.

NOAA economists used an average price per pound at the ex-vessel level of \$2.40. This estimate was derived from the NMFS landings and ex vessel value reported for Monroe County for the year 1997. The landings for Monroe County were reported in a mix of heads-on and heads-off (tails). NOAA economists converted all weights to heads-on before deriving the price per pound (price per pound is equal to total ex vessel value divided by total pounds of heads-on weight). Data provided by the commentors included a table showing pounds and ex-vessel value from the National Marine Fisheries Service (NMFS) and yields an average price of \$4.31 per pound. Both of these prices are correct, however the commentors did not specify the geographic region or the species mix of the sample with which they calculated their price. Furthermore, the NMFS weights cited by the commentors are heads-off weight, whereas the socio-economic analysis used heads-on weight. Most of the shrimp caught in the TERSA was landed in either Monroe County (Stock Island) or in Lee County (Ft. Myers Beach). NOAA economists concluded that the Monroe County landings price per pound was the appropriate price to use in the analysis.

The commentors stated that lost catch cannot be replaced by catch from other areas. This presumes that they are fishing all areas as intensely as they can be fished. This is why the socio-economic study uses 58,374 pounds of shrimp as the upper bound estimate of maximum potential loss of from the Preferred Boundary Alternative.

Comment 17: Shrimping should not be prohibited in areas outside the 20 fathom contour at the western end of the Tortugas North because these are not areas of high environmental value or special ecological sensitivity. The eastern boundary of Tortugas North, above the DRTO, should be moved to the west from 82˚ 47' to 82˚ 57' to accommodate shrimping. Shrimpers are already prohibited from fishing within a 3 million acre Tortugas Shrimp Nursery year-round in State waters and seasonally in EEZ waters. Shrimpers cannot afford to be excluded from any additional areas in the Tortugas region.

Response: A substantial sand buffer area around the coral reef community is needed to provide foraging areas for reef inhabitants without the potential of capture by shrimp trawling. Additionally, the bycatch of shrimping activities is well-known and documented. Trawling outside the 20 fathom contour at the western end of Tortugas North or moving the eastern boundary of Tortugas North to the west would result in mortality of reef fish species and other reef inhabitants through bycatch. Other shrimp fishermen have questioned the need to move the eastern boundary of Tortugas North in light of the bathymetric profile in this area.

Scientists have discovered and documented the remains of shrimp nets entangled around living corals in the proposed Tortugas Ecological Reserve. It is well known and stated by shrimp trawlers that they do not trawl on coral reefs. However, they do trawl off the reefs. Prohibiting shrimping in the Reserve will eliminate the incidental impact of shrimping gear to the living coral reefs.

Preservation of the richness of the species and health of the fish stocks in the Tortugas region and throughout the Florida Keys, and indeed preservation of the biodiversity of the Tortugas region, cannot be accomplished if only the coral reefs are protected. The protection of diverse habitats including sand and other benthic habitats is essential. A recent scientific study has substantiated the importance of sand and other "barren" habitats to the ecology of the west shelf of Florida. Scientists conducting research in the proposed Tortugas Ecological Reserve have found that benthic primary production provides the base for the food web on this portion of the west Florida shelf. They also found that high levels of fishery production associated with the live bottom habitats are in fact directly supported by the surrounding open sand, algae and seagrass communities in the area.

Comment 18: Shrimpers were not, but should have been, represented on the Tortugas 2000 Working Group.

Response: Prior to the establishment of the Working Group, shrimpers stated that the 110 square mile area to the east of the Dry Tortugas National Park originally proposed for the ecological reserve should not be established because it would have an adverse economic impact on their shrimping. In response to them and to other fishers, NOAA did not include this area in the proposed ecological reserve.

Commercial fishing representatives on the Tortugas 2000 Working Group communicated with and received input from shrimpers regarding the proposal and reported this information back to the Working Group. Shrimpers, when shown the proposed boundaries, expressed no concern over the proposed Tortugas Ecological Reserve boundaries. No shrimper expressed an interest in participating in the Tortugas Working Group.

Additionally, 18 of the 28 shrimp operations known to fish in the area were interviewed by NOAA economists. These operations accounted for 65 of the 75 shrimp vessels and 193 of the 213 captains or crew that fish in the TERSA.

<u>Comment 19</u>: The following comments were provided by a charter spearfishing operation:

1. The majority of the reefs where the company takes passengers spearfishing are in the proposed Reserve area. Areas south of Fort Jefferson (not on Tortugas Bank) are not suitable for spearfishing because they are too deep and therefore unsafe, and have poor visibility. The Tortugas Bank area south of the proposed Reserve (south of 24˚ 30') is mostly sand and low patch reef, with poor conditions for spearfishing.
2. The company provided detailed information to NOAA regarding the numbers of trips, days, and passengers the company takes. The survey that was done on the company in 1998 indicates 60 trips per year, 180 days with 550 divers. The information on pages 46 and 47 of the DSEIS is incorrect. The DSEIS does not reflect the company's information and it appears that deliberately falsified information was provided to the Working Group. The Working Group was provided incorrect information regarding the socio-economic impact on small businesses creating a false impression that small businesses would not be negatively impacted.
3. The commentor questioned the data attributed to one of the other two operators. The commentor requested the identity of the operator.
4. The company will go out of business and its employees will loose their jobs if it cannot conduct spearfishing charters in the area of the proposed Reserve, because 90% of the company's business is on the reefs north of latitude 24˚ 39'. South of that area are sandy patch reefs. A permit should be issued to the company allowing it to continue its business or the southern boundary of Tortugas North should be moved to 24˚ 40'50"N.

5. The DSEIS does not reflect that the company conducts approximately 30 spearfishing trips per year on Riley's Hump.

6. The commentor challenged specific conclusions regarding his business at pages 46, 47, and 123 of the DSEIS, which indicate a maximum potential loss of $13,700.00 of lost revenue and $5,580.00 of lost profits. The commentor claims that his business has grown significantly and that he now operates in the Tortugas more than 260 days per year. He states that he would lose $288,000.00 in revenues and experience a potential profit loss of $144,000.00. The real potential loss could be $460,000.

7. The figures on the Nitrox membrane system are not accurate. The amount should be increased by $10,000.

8. Statements about increased visits to Dry Tortugas National Park are misleading because most visitors only go to Garden Key because of the daily ferry boat service from Key West. These visitors never leave the island and do not impact the reefs.

Response: The DSEIS reports a total maximum potential adverse impact on spearfishing revenues of $66,816 for Boundary Alternatives II and III, $196,944 for Alternative IV, and $230,380 for Alternative V. The analysis and estimates of impacts were based upon survey data collected in 1998 and included information provided by three spearfishing operators. Data provided by the company submitting the above comment indicated that it operated in 48 one square nautical mile grid cells identified in the study area. Boundary Alternatives II and III would exclude the company from only 8 of those grid cells (16.67%). Alternative IV would exclude the company from 26 grid cells (54.17%) and Alternative V would exclude the company from 29 of the 48 grid cells (60.42%). The DSEIS and information provided to the Working Group accurately reflect the information that was reported by the three operators in response to the survey.

The impact estimates in the DSEIS are the maximum losses from displacement of the consumptive recreational activities. Based on the existing patterns of use provided by each of the three operators, it was concluded that they could relocate to other sites in the study area that they indicated they are using and completely offset their losses. While monitoring would be required to verify this conclusion, the estimates of maximum potential loss in the DSEIS represent the upper bound of potential losses based on the data collected in 1998. The FSEIS has been revised based on the assumed validity of the more recent data provided by the commentor. While it is hoped that the spearfishing operators will be able to shift to different locations and to different economic activities (such as non-consumptive dive charters), the need to protect the ecosystem of the Tortugas Ecological Reserve from the impacts of spearfishing justifies the adverse economic impacts on the operators. See also the Response to Comment 13.

NOAA accurately forwarded information to the Working Group. No information was falsified.

The laws governing the collection of business information by the government prevent the disclosure of proprietary information.

The cost estimate for the Nitrox system has been revised.

The overall trend in tourism at Dry Tortugas National Park suggests increased visitor use in the Tortugas area, particularly with the ability of larger, faster vessels from Key West to reach the Park and reef areas beyond the Park. See Response to Comment 10. One company has indicated that its business has increased in the Tortugas area in the last two years.

Comment 20: The National Marine Fisheries Service (NMFS) commented that it is incorrect to state, "the National Marine Fisheries Service (NMFS) is amending the Final Fishery Management Plan for Atlantic Tunas, Swordfish and Sharks (FMP) and its implementing regulations to be consistent with the no-take status of the proposed reserve."

Response: The FSEIS/SMP has been corrected to reflect this, as it is not necessary under that FMP's framework provision to amend the FMP.

Comment 21: NMFS stated that there is a lack of analyses of impacts on commercial and other fishermen and businesses from other counties who may be displaced by the proposed Reserve.

Response: The socio-economic analyses includes catch landed in Monroe, Collier and Lee Counties from each boundary alternative. Catch from the Tortugas that was landed in other counties was insignificant. The quantities and values cited by NMFS are irrelevant as far as impact, since the numbers referred to measure the total catch from FMRI areas 2.0 and 2.9. In Leeworthy and Wiley (October 1999), a set of steps are described showing how they estimated the proportion of this catch from the Tortugas Ecological Reserve Study Area (TERSA). The TERSA is a 1,020 square nm area and is a sub-set of the larger FMRI Areas 2.0 and 2.9. They estimated how much of the TERSA catch was caught in each boundary alternative. These are the relevant numbers for potential impact. They included all catch landed in all counties but only reported estimates of impact for Monroe, Collier and Lee counties because the catch in all other counties impacted was not significant. Below are summarized the steps used in estimating the impacts from shrimp catch since it was the most valuable portion of total catch, but the same procedures were followed for all species.

Steps in Estimating Economic Impact

Step 1. Examine Landings Data in FMRI Areas 2.0 and 2.9

FMRI areas 2.0 and 2.9 represent a large area generally referred to as the Tortugas, but also include the Marquesas. FMRI keeps landings and value information for this large statistical grid from Florida's trip ticket. The landings cited by NMFS for FMRI areas 2.0 and 2.9 are correct. But these values do not represent impact by the proposed Tortugas Ecological Reserve. Only a small portion of these landings are impacted by any of the proposed boundary alternatives.

Step 2. Examine Landings from the Tortugas Ecological Reserve Study Area (TERSA)

Leeworthy and Wiley selected a portion of FMRI Areas 2.0 and 2.9 for the study area and a 1,020 nautical square mile area, called the Tortugas Ecological Reserve Study Area (TERSA). NOAA attempted to collect information on catch from all commercial fishermen that reported catch from FMRI areas 2.0 and 2.9. Thomas Murray and Associates limited the sample to those in Monroe, Dade, Collier and Lee counties for cost reasons and because the catch from FMRI areas 2.0 and 2.9 landed outside Monroe, Collier and Lee counties was only a small proportion of total catch. For example, 97.21 percent of the shrimp caught in FMRI areas 2.0 and 2.9 was landed in Monroe and Lee counties. The other 2.79 percent was landed in Hillsborough, Pinellas and Franklin counties which amounted to 183,319 pounds valued at $450,021.

The sample of shrimp fishermen included 18 of the 28 shrimp operations known to fish in FMRI areas 2.0 and 2.9. These 18 operations accounted for 65 of the 75 shrimp vessels and 193 of the 213 captain or crew shrimping in the area. The sample accounted for over 90 percent of the shrimp catch in FMRI areas 2.0 and 2.9.

The sample indicated they caught only 10 percent of all their catch from FMRI areas 2.0 and 2.9 in the TERSA. Using an average of 1997-1998 catch in FMRI areas 2.0 and 2.9, Leeworthy and Wiley estimated that 715,500 pounds of shrimp was caught from the TERSA. This amount includes those amounts landed in all counties of Florida, not just Monroe and Lee counties. NOAA used a factor of 1.10 to account for the non-sampled shrimp catch. This factor was applied to each one square mile grid cell to extrapolate sampled shrimp catch to the total population estimate of shrimp catch. See Leeworthy and Wiley (October 1999). The 715,000 pounds of shrimp caught in the TERSA still does not represent impacted catch, it simply represents the total amount estimated for the study area.

Step 3. Examine Landings Potentially Impacted by a Particular Boundary Alternative for the No-Take Area.

The spatial distribution of shrimp catch from our sample of shrimpers was used to derive the distribution of all shrimp catch for the TERSA. The Leeworthy and Wiley sample accounted for 665,500 pounds of the total of 715,500 pounds of shrimp catch estimated for the TERSA. The key assumption used was that the non sampled catch had the same distribution as the sampled catch.

Catch within a boundary alternative was labeled maximum potential loss under the assumption that all catch within the no take area could not be replaced. For the Preferred Boundary Alternative, they estimated the maximum potential loss of 58,374 pounds of shrimp. This amount includes catch landed in all counties of Florida including Monroe, Lee, Hillsborough, Pinellas and Franklin counties. Since 2.79 percent of the total shrimp catch from FMRI areas 2.0 and 2.9 was landed in Hillsborough, Pinellas and Franklin counties, this would imply that only 1,629 pounds of shrimp (.0279 times 58,374) valued at $3,910 would be lost from the three counties. Given the insignificance of this amount, they did not present separate estimates of this impact in Leeworthy and Wiley (October 1999). Actually, Leeworthy and Wiley included the amounts in the impacts for Monroe, Collier and Lee counties, thus slightly overstating the impacts in these counties. But again, these amounts are insignificant.

The same procedures were followed for finfish and all other species and are documented in Leeworthy and Wiley (October 1999). The document Proposed Tortugas 2000 Ecological Reserve, Draft Socio-economic Impact Analysis of Alternatives, October 1999 by Dr. Vernon R. (Bob) Leeworthy and Peter C. Wiley can be found at http://www-orca.nos.noaa.gov/projects/econkeys.econkeys.html.

Comment 22: NMFS stated that “the economic outcomes relative to private recreational fishing and diving do not appear to be addressed.”

Response: Leeworthy and Wiley (October 1999) and the DSEIS documented that no information could be found to support private household use for any recreational activity in the TERSA. Leeworthy and Wiley identified the known population of charter/party operators in the TERSA. The Rod and Reel Club, Inc. in Miami, Florida, provided other contacts and which also reported no activity in the TERSA. Leeworthy and Wiley found that although some members of the club occasionally went to the Dry Tortugas National Park, they did not fish in the TERSA. In addition, each of the commercial operators that operated in the TERSA was asked whether s/he had seen any private household boats in the TERSA and all reported seeing each other, but no private household boats. Leeworthy and Wiley concluded that the private household boat usage, if it existed at all, was insignificant. In this case, usage was close enough to zero to be treated as zero.

Comment 23: NMFS stated that the DSEIS lacks an analysis of community impacts and should be analyzed at the City or Census Designated Place level.

Response: Leeworthy and Wiley had Thomas Murray and Associates go back to the data and assign FIPSCODES for City and Census Designated Places for where commercial fishermen live and where they landed their catch. They did the same for recreational charter boat operations.

Comment 24: The United States Environmental Protection Agency (EPA) rated the DSEIS as "EC-2" which means EPA has environmental concerns regarding the proposed Reserve, and believes more information is needed to fully assess the impacts. In particular, EPA stated further details are needed regarding measurable activities that could be used to manage natural resources in the Reserve, such as the number of permits NOAA plans to issue and the amount of visitor education/communication expected. Information should also be given regarding the frequency of ecological monitoring activities. It would also be helpful if the FSEIS included a map that showed the formerly proposed area that was in the Draft EIS and DMP for the FKNMS (1997) but that was later rejected, as compared to the Preferred Alternative in the DSEIS (2000), explaining how the Preferred Alternative protects the environment and prevents adverse economic impacts, as contrasted with the former proposal.

Response: At this time, there are no plans to limit the number of access permits for Tortugas North. However, as described in the Final Supplemental Management Plan, it will be possible to use the access permit system to determine the number of divers visiting Tortugas North annually and the areas in the vicinity of mooring buoys will be examined as primary sites for diver impact. This will enable sites to be monitored for impacts from diving. This information can then be used to determine whether it is necessary to limit the number of access permits for those who visit Tortugas North. The questions regarding public education and outreach and the frequency of ecological monitoring have also been addressed in the Education and Outreach Action Plan and Research and Monitoring Action Plan of the FSEIS/SMP. A map showing the previously considered site for the Reserve has not been added to the FSEIS because we believe it would confuse the public with regards to the current Ecological Reserve proposal.

Comment 25: The United States Department of the Interior, Fish and Wildlife Service, commented that the importance of the Tortugas area as a spawning site and as a "source" reef for the fish communities found in the Key West and Great White Heron National Wildlife Refuges is just beginning to be understood scientifically. The ability of the Refuges to maintain a healthy ecosystem for the wildlife that inhabit them is directly dependent upon a healthy marine component. The avian resources of the Refuges feed upon the fish communities of the Refuges. Those fish communities depend upon a healthy "upstream" ecosystem, which includes the Tortugas region. Marine reserves are a viable tool for resource protection. The protection of marine resources in the Tortugas region will benefit the Refuges. Because of this, the USFWS endorses the Tortugas 2000 Preferred Alternative and proposed rules.

Response: The FSEIS has been revised to reflect the importance of the Tortugas area to the Key West and Great White Heron National Wildlife Refuges. It is recognized that the Tortugas Ecological Reserve will serve as important feeding grounds for many bird species that frequent the Key West and Great White Heron National Wildlife Refuges. Additionally, several threatened and endangered sea turtles that nest in the Key West National Wildlife Refuge spend a portion of their life cycle in the Tortugas Ecological Reserve region.

Comment 26: The Florida Fish and Wildlife Conservation Commission (FWC) was concerned that no limits were being placed on the level of non-consumptive diving that would be allowed. The FWC stated that non-consumptive diving results in some morbidity and mortality to coral reef habitat and asked that controls be placed on the number of divers and dive trips to assure minimal acceptable damage to the habitat. The FWC was also concerned over the adequacy of the enforcement resources. The FWC believes that the minimal enforcement resources needed to enforce the Reserve would be two vessels 50 feet or greater in length with a Lieutenant and two officers for each vessel. The FWC encourages NOAA to work with it to develop these enforcement resources in order to assure the success of the reserve.

Response: Regulatory Alternative D allowing non-consumptive diving in Tortugas North but closing Tortugas South to all diving except for scientific research or educational purposes, pursuant to a valid sanctuary permit, provides an appropriate degree of public access. See Response to Comment 12 regarding non-consumptive diving in the Reserve. If the monitoring of impacts from non-consumptive diving in Tortugas North demonstrates that its carrying capacity is being exceeded, limits can be imposed. See Response to Comment 14 regarding the Enforcement Action Plan for the Tortugas Reserve. NOAA will work with the FWC and its other enforcement partners to develop the enforcement resources that all agree are necessary to assure the success of the Reserve.

Comment 27: The Gulf of Mexico Fishery Management Council (GMFMC) requested that the Sanctuary Program use its authority to prohibit anchoring and all diving within the portions of Tortugas North and Tortugas South that are within the Council's jurisdiction (all of Tortugas South and 13 square nm of Tortugas North). Non-consumptive diving can impact and damage bottom habitat through the inadvertent touching of corals or the stirring up of sand and silt on the bottom. Non-consumptive diving can adversely affect sensitive habitats, the normal behavior of fish, and spawning activity. Anchoring and non-consumptive diving could also adversely affect essential fish habitat in the Reserve. In addition, if non-consumptive diving is allowed, it will be difficult to enforce prohibitions against spearfishing and the taking of lobster.

Response: Under the Preferred Alternative, all anchoring in Tortugas North and South would be prohibited as well as all activities in Tortugas South except for continuous transit, law enforcement, and, pursuant to a sanctuary permit, scientific research and educational activities. Non-consumptive diving will be allowed in all of Tortugas North. See Responses to Comments 9 and 12. NOAA does not anticipate that there will be significant non-consumptive diving in the area of Tortugas North within the GMFMC's jurisdiction because of the lack of coral reef formations.

Comment 28: Monroe County commented that the socio-economic section of the DSEIS seems to have been inserted out of context. This rather lengthy section should be reduced to some simpler explanations, tables and conclusions, then attach the larger document as an appendix.

Response: NOAA has retained the socio-economic section in the main body of the FSEIS/SMP but has revised it to make it clearer.

Comment 29: Monroe County commented that the FSEIS should provide some additional explanation concerning the table of benthic habitats in the DSEIS. It is not clear whether the 59% of unmapped acreage is a less significant area within the overall total (it should be noted if so). If it is not, then this area needs significant additional exploration.

Response: The benthic habitats categorized in Table 1 of the FSEIS represent those identified as the result of one mapping project based on aerial photographs and limited groundtruthing in the Tortugas region. Extensive characterization of the benthic communities within Dry Tortugas National Park has been completed (Agassiz 1883, Davis 1982, and Jaap 1998). Also, scientific exploration of benthic habitats within the proposed Tortugas Ecological Reserve area has occurred since the completion of the DSEIS (Miller, unpubl. data). However, NOAA agrees that additional mapping and exploration are needed to accurately assess the full extent of marine resources throughout the Tortugas region.

Comment 30: Monroe County commented that the FSEIS should include a table summarizing the regulatory alternatives.

Response: A table summarizing the regulatory alternatives has been added to the FSEIS.

Comment 31: The management plan should be designed to: (1) protect ecosystem structure, function, and integrity; (2) improve fishery yields; (3) expand knowledge and understanding of marine systems; and (4) enhance non-consumptive opportunities.

Response: The regulations implementing the designation of the reserve are designed to protect ecosystem structure, function and integrity and should improve fishery yields outside of the closed areas. The management plan has been redesigned with many objectives including better understanding of marine systems as well as providing better opportunities for non-consumptive activities within the Tortugas North area of the Reserve.

Comment 32: The regulations concerning fishing in the Reserve should be issued pursuant to the National Marine Sanctuaries Act and the exception clause that would authorize fishing pursuant to regulations issued pursuant to the Magnuson-Stevens Fishery Conservation and Management Act at 50 CFR Parts 622 and 635 should be eliminated from the fishing prohibition.

Response: The fishing regulations will be issued under the National Marine Sanctuaries Act and have been revised to prohibit all fishing in the reserve without exception.

Comment 33: Fishing and other consumptive activities should be prohibited in the Reserve, including all forms of diving-related extraction. Carefully regulated non-consumptive diving should be allowed to continue to the extent consistent with resource protection.

Response: See Response to Comment 12. All consumptive activities are prohibited within the Reserve. As described in the FSEIS/SMP, the permit system for Tortugas North will allow NOAA to monitor the level of non-consumptive diving activity and its effect on resources in Tortugas North.

Comment 34: The Reserve should be permanent and should not be subject to sunset provisions.

Response: The only portion of the Tortugas Reserve that would be subject to termination would be the areas located in State waters. Pursuant to NOAA's Memorandum of Agreement with the State of Florida, the State has the right to review the portions of the Sanctuary located in State waters and the applicable regulations after 5 years. Based on its review, the Governor of the State may object to the designation of any portion of the Sanctuary in State waters and the continued application of the regulations.

Comment 35: NOAA should implement the Tortugas Reserve with strong enforcement, research and monitoring, education and outreach programs, and interagency cooperation to maximize the value of the Reserve.

Response: The Final Supplemental Management Plan so provides. See Response to Comment 14.

Comment 36: The economic analysis contains a bias toward hypothetical, short-term economic losses to a handful of consumptive users. Such losses are highly speculative in real-world terms and the quantitative analysis provided in the DSEIS lends them more weight than appears appropriate. The economic analysis also does not appear to account adequately for likely future migration of fishing economic activity to other economic sectors. The likelihood of continuing future reductions in fishing activities as a result of overfishing do not appear to be incorporated into the DSEIS' discussion.

Response: NOAA staff primarily analyzed data from users engaged in activities within the Tortugas Ecological Reserve Study Area. To assess maximum economic impacts, they assumed that the users could not replace their losses if the Tortugas Reserve were closed to consumptive activities. This a very conservative assumption because, as stated in the DSEIS, many users will likely be able to relocate their activities outside of the Reserve. The protections afforded to the habitats in the Tortugas Reserve will also benefit displaced users by increasing production in areas outside of the Reserve. However, there is no hard data indicating the extent of mitigation or the likely future migration of fishing economic activity to other economic sectors.

Comment 37: The DSEIS does not describe clearly defined and scientifically justifiable goals. In particular, there are five fundamental objectives that are consistent with the overarching goal of maintaining the native biodiversity of a region in perpetuity:

a) represent all ecosystem types across their natural range or variation;
b) maintain or restore viable populations of all native species in natural patterns of abundance and distribution;
c) sustain ecological and evolutionary processes within their natural ranges of variability;
d) build a conservation network that is adaptable and resilient to short-term and long-term environmental change; and

e) regulate human uses that are consistent with conservation of native biodiversity, and eliminate those that are not.

The Plan should also consider additional criteria in order to protect endangered, threatened, rare or imperiled species, small populations, species with limited vitality, species with very specific habitat requirements, areas of high endemism, areas of productivity, areas of high diversity, and movement and migration corridors.

Response: Most of the five biodiversity goals are contained within the criteria for choosing the location and protection measures for the Ecological Reserve (see Part VI of this FSEIS). Specific subcriteria have been added to clarify what is contained in each criterion. Likewise, protecting endangered, threatened, rare, or imperiled species is included within the criterion "Protecting biodiversity, including the maintenance or restoration of viable populations of native species."

Part II of the FSEIS includes clear objectives for the Reserve. As stated, the goal for the Sanctuary zoning plan is to protect areas representing diverse Sanctuary habitats and areas important for maintaining natural resources and ecosystem functions. The objectives of the Reserve are to: protect ecosystem integrity; protect biodiversity including the maintenance or restoration of viable populations of native species; enhance scientific understanding of marine ecosystems; and facilitate human uses to the extent consistent with the other objectives. These are scientifically justifiable goals and objectives.

The goals listed by the commentor are essentially the goals and objectives that the establishment of the Reserve and issuance of the implementing regulations are designed to achieve. Likewise, the Supplemental Management Plan is designed to achieve the goals and objectives for which the reserve is being established and regulated.

Comment 38: The DSEIS does not define or identify indicators for assessing ecological integrity.

Response: Indicators for assessing ecological integrity have been incorporated in the Research and Monitoring Action Plan. These indicators include: changes in fish and coral diversity, changes in predation, herbivory and trophic structure, changes in water quality (nutrients and transmissivity), and changes in user activities.

Comment 39: The Draft Supplemental Management Plan is inadequate and needs to be more comprehensive. It should include:

- specific goals and objectives;
- performance measures with an implementation schedule;
- an estimate of management costs for implementing and maintaining the reserve;
- an expanded education plan;
- an expanded enforcement plan;
- a description of the permitting system with defined criteria and capacity limits;
- a mooring and boundary buoy component that includes criteria for placement and costs for placement and maintenance; and
- an expanded research and monitoring plan that includes a resource inventory, monitoring of ecological performance measures, cooperative research agreements, and database of research.

Response: See Response to Comment 37. The FSEIS/SMP includes:

- specific goals and objectives;
- estimate of management costs for implementing and maintaining the reserve;
- an expanded education plan;
- an expanded enforcement plan;
- a description of the permitting system;
- a mooring and boundary buoy component that includes costs for placement and maintenance; and
- an expanded research and monitoring plan that includes a resource inventory, monitoring of ecological performance measures for assessing ecological integrity, and cooperative research agreements.

Comment 40: NOAA should develop a broader research initiative including, at a minimum:

a) further identification and study of spawning aggregations including grouper, snapper and jewfish;

b) further studies of patterns of short- and long-distance larval dispersal;

c) complete inventories of biodiversity and habitat structure in the Reserve and Sanctuary waters in the region;

d) further documentation of the distribution and abundance of threatened, endangered, and rare species in the Reserve; and,

e) field experiments and comparative studies to test hypotheses generated by these studies.

Response: The Research and Monitoring Action Plan has been expanded to include long-term ecological monitoring to test the efficacy of the Reserve. As modified, the Plan will compare reserve areas before and after designation, as well as monitor changes occurring inside and outside the protected areas, in order to determine the overall effectiveness of the reserve. Over time, these efforts will examine larval dispersion and spawning aggregations. There should also be complete inventories of biodiversity and habitat structure in the Reserve, which would include more complete descriptions of the presence of endangered, threatened and rare species. Also the Plan has been expanded to monitor the effects of non-consumptive diving activities on the resources in Tortugas North using the reference provided by Tortugas South.

Comment 41: Scuba diving and underwater exploration in the Reserve should be permitted only in the company of a qualified guide.

Response: It is not necessary to require that diving in the Reserve be conducted with a guide to adequately protect coral reef resources. As explained elsewhere (see Response to Comment 12) diving effects will be monitored to determine whether the Reserve's resources are being impacted. Also, a sufficient enforcement presence will be maintained to deter and detect violations of the no-take provisions.

Comment 42: Neither the Everglades National Park nor the Dry Tortugas National Park prohibit recreational fishing and they have the best fishery management system in the world. NOAA should not prohibit recreational fishing in the Tortugas Reserve.

Response: See Responses to Comments 3 and 13. The Dry Tortugas National Park is proposing changes to its management plan that would prohibit recreational fishing in approximately 40% of the Park that would be adjacent to the Tortugas Reserve.

Comment 43: The United States Government does not have jurisdiction over the area that would be included in the proposed reserve.

Response: The Tortugas Reserve is within the Exclusive Economic Zone and the authority of the United States to establish and manage the Reserve is well-established and consistent with international law. In 1983, President Ronald Reagan declared a 200 nautical mile Exclusive Economic Zone, in which the United States may conserve and manage natural resources, consistent with international law (Presidential Proclamation 5030, March 10, 1983). The NMSA expressly applies to the EEZ. In 1989, President Reagan extended the territorial sea to twelve nm (Presidential Proclamation 5928, December 27, 1988). In 1999, President William J. Clinton extended the contiguous zone from twelve to twenty-four nm, extending the jurisdiction of the United States over customs, fiscal, immigration, and sanitary laws (Presidential Proclamation 7219, August 2, 1999).

Comment 44: Sanctuary staff working at Dry Tortugas National Park should live and work aboard ships rather than increase environmental pressure on existing facilities at the Park.

Response: NOAA will work with the National Park Service so that Sanctuary personnel will be stationed at the Park in a manner that is consistent with environmental protection of the islands and waters in the Park.

Comment 45: NOAA's plan for a visitor center in Key West is redundant and would detract from other visitor centers in Key West dedicated to interpretation of the marine environment.

Response: The creation of the visitor facility in Key West is not a part of this action. The facility has already been established and is located within the existing Dr. Nancy Foster Environmental Center at the Truman Annex. The visitor center complements existing interpretive centers in Key West. Among other things, the facility will present information derived from research conducted within the Sanctuary (including the Reserve) as well as describe ongoing research projects and other various activities related to the Sanctuary.

Comment 46: A nominal charge should be assessed for access permits to the Reserve.

Response: As proposed, the access permit system will require minimal effort by users and will be relatively inexpensive for NOAA to operate. The system will be simple and reduce the time imposed on permit applicants. The cost to NOAA of administering the access permit system is expected to be small. If a fee were charged to offset the cost, the system would increase in complexity, increasing the cost that would need to be offset as well as increasing the burden on users applying for permits. In the interest of administrative efficiency and of not placing a burden on permit applicants, a permit fee would not be imposed.

Comment 47: The greatest threat to the marine resources of the area is pollution and degradation of water quality. Vessel discharges should not be permitted in the Reserve.

Response: Pollution and degradation of water quality is a serious threat to Sanctuary resources. Under the regulations applicable to ecological reserves, only engine cooling water and exhaust can be discharged in the Reserve.

Comment 48: Select a Preferred Alternative for the reserve that allows for fishing to the northwest of Loggerhead Key.

Response: The only alternative which would allow fishing to the northwest of Loggerhead Key is the No-Action Alternative (see Response to Comment 3).

Comment 49: Prohibit the use of motorized Personal Watercraft in the Ecological Reserve.

Response: While the use of Personal Watercraft has not been documented in the TERSA, Regulatory Alternative D will prohibit all activities in Tortugas South except for continuous transit, law enforcement, and pursuant to a Sanctuary permit, scientific research and educational activities. Should the use of motorized Personal Watercraft in Tortugas North be documented as a problem, NOAA will consider initiating appropriate rulemaking.

Comment 50: The Tortugas 2000 Working Group did not have a representative of the tourism industry and did not consider non-consumptive activities.

Response: Among its membership, the Tortugas 2000 Working Group had two non-consumptive diving representatives and one citizen-at-large representative. Additionally, the Working Group's proposal was recommended to Sanctuary managers by the Sanctuary Advisory Council which, among its members, has representatives of the tourism industry and other non-consumptive interests.

Comment 51: Several commentors addressed vessel discharge restrictions, pumpout facilities, and other public access issues related to the DRTO and surrounding

Sanctuary waters. One commentor suggested that NOAA charts be updated to reflect any new regulatory changes in the Tortugas area.

Response: The NPS General Management Plan revisions are taking into consideration pressures and limitations on infrastructure and other Park resources. Sanctuary regulations will prohibit vessel discharges in the Tortugas Ecological Reserve, with the exception of engine cooling water and exhaust. NOAA nautical charts will be updated to include relevant information once regulations to implement the Ecological Reserve are issued and effective.

Comment 52: A number of commentors suggested various education, mooring buoy, research and monitoring, and enforcement programs for the Tortugas Ecological Reserve.

Response: The Final Supplemental Management Plan has been updated to reflect these comments and suggestions.

Comment 53: A commentor stated that it appeared that several disparate agency processes were going on with regard to an appropriate fishing regime for the Tortugas area and that no proposal should be adopted until all disparate processes are concluded.

Response: Providing comprehensive protection to the critical coral reef resources of the Tortugas must take precedence over awaiting the completion of the many other agency processes. However, NOAA has gathered input from the seven resource management agencies with jurisdiction in the TERSA with the ultimate goal of achieving a consensus to the extent consistent with requirements of the FKNMSPA, NMSA, and other applicable law. The Tortugas 2000 Working Group process, boundary and regulatory alternative development, and subsequent public hearings effectively brought all resource management entities to the table and ensured that federal and state regulations will be thoroughly integrated. This process has served as a model for interagency and stakeholder collaboration.