ENVIRONMENTAL ASSESSMENT:
M/V *Wellwood* GROUNDING SITE RESTORATION
Florida Keys National Marine Sanctuary,
Monroe County, Florida

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1.1 INTRODUCTION

This Environmental Assessment has been prepared to systematically evaluate the short- and long-term environmental and socioeconomic effects related to the restoration of the grounding site of the motor vessel (M/V) *Wellwood*. The vessel ran aground on Molasses Reef in Key Largo National Marine Sanctuary (KLNMS) in the Florida Keys on August 4, 1984.

Six alternatives (including the "no action" alternative) are presented and comparatively evaluated to determine whether the quality of the marine environment would be significantly affected by the proposed action. This document has been prepared in compliance with the National Environmental Policy Act of 1969 (NEPA) and its implementing regulations and the guidelines of the National Oceanic and Atmospheric Administration (NOAA) and the NOAA Administrative Order 216-6 guidelines for compliance with NEPA.

1.2 BACKGROUND

Molasses Reef contains some of the most aesthetically valuable and heavily visited reefs in the continental United States. It is part of the Florida Reef Tract, the third largest barrier reef system in the world. In 1975, Congress recognized the significance of this area when it designated the Key Largo National Marine Sanctuary. The KLNMS was formally incorporated into the Florida Keys National Marine Sanctuary (FKNMS) in July 1997 with the publication of the final regulations implementing the 1990 congressional designation under the Florida Keys National Marine Sanctuary and Protection Act (FKNMSPA).

Pursuant to the National Marine Sanctuaries Act (NMSA) 16 U.S.C. 1431 et seq., and the FKNMSPA, NOAA is the federal trustee for the natural and cultural resources of the FKNMS. Under Section 312 of the NMSA, NOAA has the authority to recover monetary damages for injury, destruction, or loss of Sanctuary resources, and to use the recovered monies to restore injured or lost sanctuary resources. Appendix A contains the relevant sections of the NMSA related to this action.

On August 4, 1984, the M/V *Wellwood* ran aground on a coral reef on Molasses Reef off of Key Largo, FL. The 122-meter Cypriot-registered freighter ran aground on the upper forereef of Molasses Reef in a minimum of 6 meters of water. The *Wellwood* remained aground for 12 days. Additional injury to the coral occurred during the 12 days the vessel was aground as a result of an initial attempt to power off the reef, from tugboat propwash abrasion, from extended periods of shading under the vessel, and from cable abrasion during several failed attempts to remove the vessel before August 16. The grounding destroyed 5,805 square meters of living corals and injured over 75,000 square meters of reef habitat, including 644 square meters of coral reef framework. A settlement between NOAA and the responsible parties was agreed to on December 22, 1986. Under the terms of the settlement the responsible parties purchased an annuity to be paid to NOAA over 15 years in variable annual installments beginning in 1987 and scheduled to end in 2001. Between 1987 and 1995, the bulk of the payments were allocated to payment of civil penalties and repayment of response and damage assessment costs incurred by NOAA and the U.S. Coast Guard during and immediately following the grounding. Payment allocated for restoration costs did not begin until 1989 and the final installment was paid in December 2001.

The grounding caused severe adverse biological and physical impacts on the reef community and led to widespread mortality of benthic fauna and displacement of mobile fauna. The injuries are documented in Harrigan (1984) and Hudson and Diaz (1988). Figure 1-1 shows the location of Molasses Reef in the FKNMS and Figure 1-2 shows the area of injury at the reef. Five distinct areas were identified as injured. The injury ranged from superficial scraping of the reef surface and toppling of large coral heads to complete crushing of coral heads and severe cracking of the reef framework structure. Table 1-1 summarizes the injuries by location and further detail is provided below:

- <u>Inbound Track</u>. The vessel created an inbound grounding track approximately 20 meters wide and affecting bottom substrate at 6 meters depth as it approached the reef. Injury along this track was discontinuous. It toppled or injured thirteen large coral heads and left bottom paint embedded in exposed coral skeletons. The primary coral species in the pre-injury area was the *Montastrea* complex (boulder star coral), but many other species were present, including *Diploria* spp (brain corals), *Acropora cervicornis* (staghorn coral), *A. palmata* (elkhorn coral), *Siderastrea siderea* (massive starlet coral), and *Porites* spp (finger coral & mustard hill coral). The *Wellwood* also removed a KLNMS mooring buoy along this track. Toppled corals were stabilized, as appropriate, immediately following the grounding. For the most part, natural recovery (i.e., regrowth of tissue on coral heads) is occurring and thus restoration in this area is not necessary.

- <u>Hull Resting Area (“Parking Lot”)</u>. On the forereef where the hull of the *Wellwood* came to rest, there was near to total destruction of the coral cover. The pre-injury habitat was primarily composed of sea fans (*Gorgonia* spp.), other gorgonians, and colonies of *A. palmata* and *Montastrea* complex. This entire area was crushed through vessel pounding for 12 days and experienced severe shading during the 12 days the vessel was aground. This area is known as the “parking lot” because of its flattened nature and is the primary area in need of restoration and thus the subject of the proposed action.

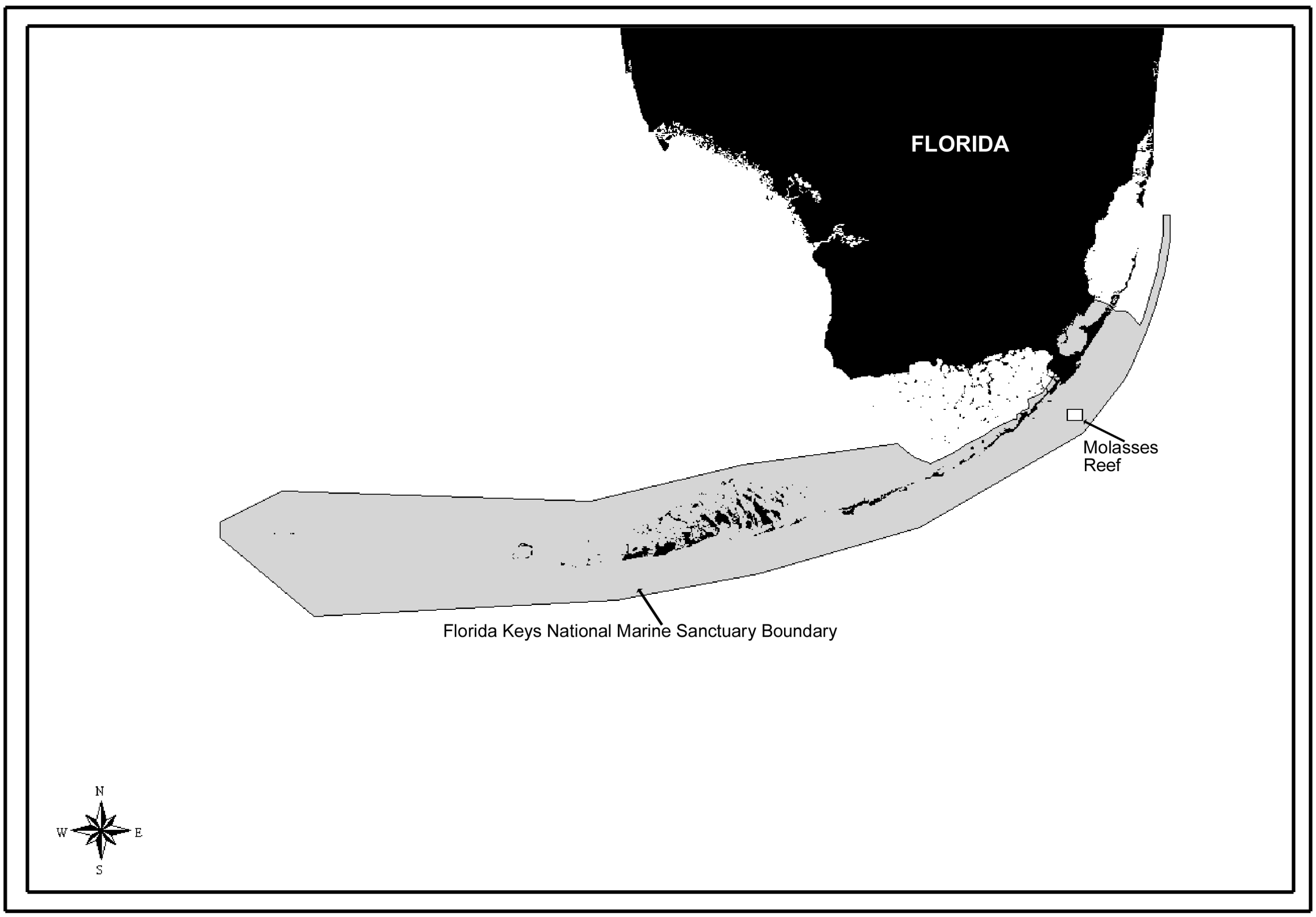

Figure 1-1

Molasses Reef Area Location Map

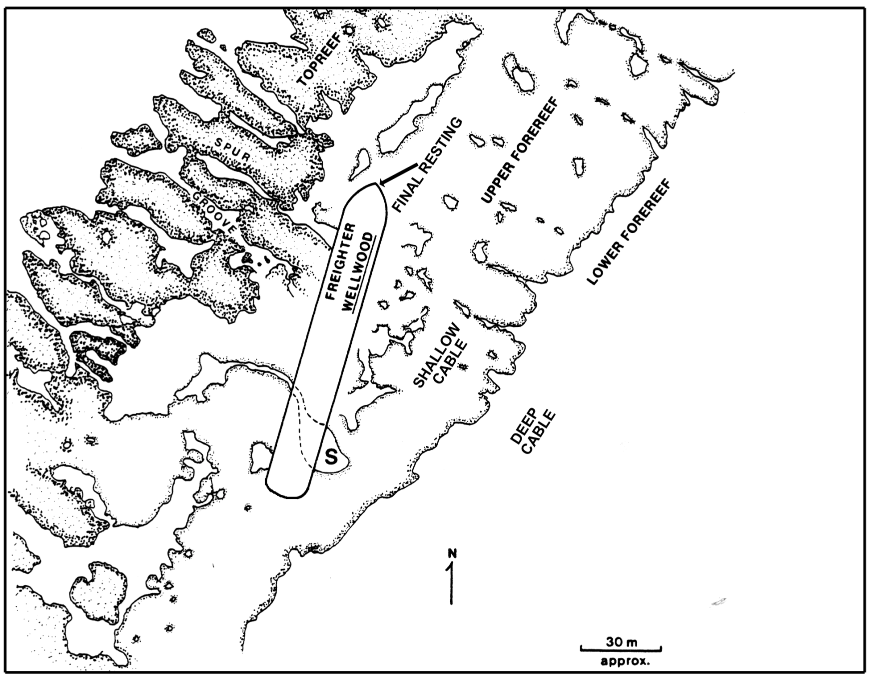

Figure 1-2

Grounding Location of the Freighter Wellwood

Table 1-1: Injury Areas

Injury Site	Species Injured	Type of Injury	Emergency Biological Triage	Current Status
Inbound path	*Montastrea* complex, *Diploria* spp., *Acropora cervicornis* & *palmata*, *Porites* spp.	Toppled large heads, paint embedded in coral skeleton, removed mooring buoy	Stabilized toppled coral heads	Natural recovery is occurring
Hull resting area; "parking lot"	*Acropora palmata*, *Montastrea* complex, *Gorgonia* spp., other gorgonians	Crushed framework and cleared substrate; severe shading	Some transplantation of small coral heads	Little recovery; primary area in need of restoration
Original hull resting area	*Montastrea* complex, *Colpophyllia natans*, gorgonians	Toppled coral heads, created a rubble berm, cleared substrate	Stabilized toppled coral heads	Little recovery, in need of restoration
Shallow cable abrasion area	*Montastrea* complex, *Dendrogyra cylindrus*	Patchy injury. Toppled coral heads, grooved abrasion in the sides of corals	Stabilized toppled coral heads	Patchy injury over large area; difficult to locate. Primarily recovering
Deep cable abrasion area	*Montastrea* complex, *Xestospongia muta*	Patchy injury. Toppling and abrasion of large coral heads and vase sponges	Stabilized toppled coral heads	Patchy injury over large area; difficult to locate. Primarily recovering

- Starboard Area. Along the starboard side of the hull resting site there was an extensive area that experienced patchy areas of destruction. This was the original resting area of the vessel before it pivoted during initial removal attempts. At least five large *Montastrea* complex and one large *Colpophyllia natans* (boulder brain coral) colonies and numerous smaller organisms were destroyed as the vessel scraped the bottom. This area, while not as flattened as the hull resting site, is in need of restoration and is also the subject of the proposed action.

- Cable Injury Area. To the east of the grounding site, a large area was injured by abrasion from nylon and steel cables during the vessel removal attempts. There was patchy injury in this area; eight large *Montastrea* complex colonies were toppled, as were four large colonies of *Dendrogyra cylindrus* (pillar coral), but total destruction of entire colonies was limited. Abrasion created grooves in some coral heads and toppled others, but this area did not experience total crushing. Injury in this area was intermittent and was stabilized as appropriate immediately after the grounding event, including turning over several toppled coral heads. The area has now largely recovered (tissue has grown over injured areas on the coral heads). Restoration is not called for in this area and monitoring is inappropriate due to the patchiness of injury and difficulty in relocating specific coral heads throughout such a large area.

- Deep Cable Injury Area. Seaward of the grounding site, there was an additional cable abrasion area in a deeper zone (up to 20 meters depth). Intermittent injury similar to that at the shallow cable site occurred. Many large vase sponges (*Xestospongia muta*, giant barrel sponge) and several large coral colonies (*Montastrea* complex) were abraded or turned over. Though widespread throughout this large area, the injury was patchy. Injuries were stabilized as appropriate immediately after the grounding event, including turning over several toppled coral heads. Restoration is not called for in this area and monitoring is inappropriate due to the patchiness of injury and difficulty in relocating specific sponges and coral heads throughout such a large area.

Hudson and Diaz (1988) conducted an extensive survey of the site to identify framework damage and loss of coral cover. Looking at the inbound path, the original resting area and the final resting area, they concluded that of the 1,285 square meters of substrate surveyed, 50 percent--644 square meters—suffered framework fracturing. Because framework fracturing is caused by severe pressure on the substrate, the same area experienced 100% loss of live coral cover. The remaining survey area (628 square meters) experienced 70 – 90% loss of live coral cover in an area with original coral cover of between 25 – 50%.

Following the grounding, NOAA completed a series of activities to minimize the potential for further injury to the area. These included the following:

- *Vessel salvage (August 1984).* As soon as the incident was reported, KLNMS and Looe Key National Marine Sanctuary (LKNMS) staff responded and assisted on site until the *Wellwood* was removed. They provided technical assistance to the U.S. Coast Guard and performed reconnaissance dives to assess the threat of further injury to the reefs. The Coast Guard took charge of having the vessel removed while coordinating with the KLNMS staff.

- *Emergency biological triage (August 1984 and 1985).* Immediately following documentation of the grounding, NOAA biologists thoroughly searched the area for damaged coral colonies that could survive if turned upright immediately. Many corals did not survive the initial impact and the extended grounding period; however, those which did were salvaged and re-oriented in the area. In addition, several large head corals (greater than 6 feet diameter) were turned over and left in place.

- *Long-term monitoring.* Beginning immediately after the grounding event with surveys to determine the extent of injury and continuing until recently, NOAA has funded several monitoring efforts at the most heavily injured grounding site to document the recovery and status of the impact area. This has included monitoring of recovery of the coral community (Gittings, 1988; Gittings & Bright, 1990), fish populations (Dennis & Bright, 1990), and algal communities (Littler, et al, 1984; Hanisak, et al, 1989). A recent monitoring report by NURC (1997) documented the status of algae, coral, and fish communities 13 years after the grounding.

- *Development of a proposed restoration plan (1999-2001).* NOAA has developed this proposed restoration plan that draws on the experience gained from the restoration of other grounding sites in the area and outlines a preferred alternative for the restoration of the *Wellwood* grounding site. Restoration is long overdue, having been delayed due to the payment structure and associated programmatic issues.

Additional injury to the reef occurred as a result of Hurricanes Elena and Kate in 1985 and the active 1998 storm season (Groundhog Day Storm, Hurricane Georges). Hurricane Kate removed much of the loose rubble created by the grounding which had remained at the site during the first year, as well as some of the newly recruiting corals (Gittings, 1988). The 1998 storm season caused further vertical erosion of the "parking lot" area (H. Hudson, personal communication). The storms created several pits and exposed the underlying framework cracks to additional erosion potential. Current calculations by FKNMS staff estimate that an additional 46 cubic meters of material has been lost from the site since the original injury occurred. No volumetric measurements were taken at the time of grounding, but NOAA estimates that 75% of the volume of current excavations is the result of post-grounding injury; this is only a very rough estimate, but it represents the best estimate available from NOAA. The 1998 storm season also removed many of the juvenile coral recruits and the colonies that had been transplanted in 1985 from nearby Pickles Reef (Hudson and Diaz, 1988). Although damage from hurricanes is a natural occurrence, and Hurricane Georges caused large amounts of reef material loss from nearby undisturbed reefs, NOAA believes that the extent of hurricane damage was increased due to the already compromised state of the injured reef.

The original community at the Wellwood grounding site consisted of a transition habitat that was primarily hardground, but included numerous large boulder coral colonies and a diverse community of hard and soft corals and other benthic organisms. The principal coral species present at the site included *Montastrea* complex, *A. palmata*, *D. cylindrus*, *Agaricia agaricites* (lettuce coral), *Diploria* spp., *Favia fragum* (golfball coral), *Meandrina meandrites* (maze coral), and *Dichocoenia stokesii* (elliptical star coral). Cover also included a healthy gorgonian community, including *Gorgonia ventalina* (common sea fan) and *Briareum asbestinum* (corky sea finger), the zoanthid *Palythoa caribbea*, and fire corals, *Millepora* spp. Although the reef substrate did not have high relief, the presence of large coral colonies created visible relief throughout the area.

In 1993, NOAA sponsored a workshop in Key Largo gathering together coral reef scientists and other experts to solicit their recommendations regarding the best methods and approaches to coral reef restoration and monitoring in the FKNMS and specifically, the Wellwood site. This workshop resulted in a report produced by the National Undersea Research Center (NURC) titled “Guidelines and recommendations for coral reef restoration in the Florida Keys National Marine Sanctuary” (Miller, McFall and Hulbert 1993; [hereafter referred to as NURC 1993]). One recommendation of the report was that “A detailed quantitative re-evaluation of natural recovery at the Wellwood site (should occur)…The nine-year record should be carefully evaluated before any restoration activity begins at the site.” That evaluation has been conducted (see Section 3.8). The report also makes other recommendations which are referred to where appropriate. The proposed alternative following in this assessment is consistent with the recommendations of the workshop.

1.3 PURPOSE OF AND NEED FOR ACTION

The purpose of the proposed action is to restore a component of the structural relief of the reef at the grounding site to a state similar to its pre-injury condition. Natural recovery at this site is unlikely within a reasonable time frame, and ultimate community composition is uncertain due to the severity of the physical injury to the reef substrate and alteration of the physical habitat (e.g., topography and contours, reef framework). Significant natural reef accretion to replicate the pre-grounding structure could not be expected to occur in the foreseeable future, as evidenced by the low level of recovery over the past 16 years. In addition, stabilization of the injured area is needed to prevent further injury, as evidenced by the fact that the extent of the structural reef injury (both area and volume) has now increased as a result of the 1998 storm season, as described above.

The area where the injury occurred has ecological, cultural, economic, and social significance. These are described in detail in Chapter 2. The proposed action is needed to provide the former range of ecological and socioeconomic functions and values present in this area of the Sanctuary. This objective is in keeping with the goals and policies of the NMSA, the FKNMSPA, and the FKNMS Management Plan and implementing regulations.

Although it has been over 16 years since the grounding occurred, the structured payment of the settlement monies contributed to the delayed implementation of restoration at the Wellwood site. With the recovered funding and other resources now available, NOAA is now in the position to initiate a comprehensive restoration action.

1.4 PROPOSED ACTION

NOAA proposes to restore the M/V *Wellwood* grounding site at Molasses Reef, FKNMS and also to stabilize the additional injury caused by the 1998 storm season. The proposed action is to stabilize the injured reef framework to prevent further injury to the reef system, provide structural restoration to mimic the original relief, and re-establish biological communities. In contrast to an artificial reef, the proposed restoration would stabilize the substrate and restore a component of the vertical relief that existed at the site prior to injury by the ship's grounding. The exposed material would primarily be limestone, which is naturally occurring on the reef, and the design would emulate the shape and configuration of natural reef formations. The goal is to ultimately restore a component of the structural relief of the reef, to the greatest extent practicable, to a state similar to that, which existed before the injury occurred. Because Molasses Reef is a Sanctuary Preservation Area with high profile as a tourist destination, NOAA believes it especially important to design an aesthetically pleasing restoration solution for this grounding site. Restoration is intended to repair an injured reef area, as close as possible to its pre-injured condition.

It is proposed that the repairs would begin in May 2002. Construction would occur for approximately 30 days. The restoration would occur in a heavily used recreational dive and snorkel area, and it must be timed to coincide with good weather conditions. To ensure public safety, NOAA would request the public to avoid the area during restoration construction. NOAA would ensure that appropriate notice is given to the public to encourage the use of alternative locations. Boaters and shipping interests in the area would be notified of the upcoming construction through a Notice to Mariners. A Federal Register Notice would alert the public to the construction and request their cooperation in avoiding the immediate area for safety reasons. Additional notification to local dive shops, marinas, and boat rental agencies would be distributed through the Team OCEAN volunteer network, a sanctuary outreach program. Local and regional media would be notified with a NOAA press release. Additionally, a public information meeting on the project was held in Key Largo, Florida, on January 9, 2002. Based upon experience with previous restoration efforts, NOAA has found that prior notification is sufficient to secure public safety.

1.5 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

This assessment provides the following information:

- Description of the environment immediate to and surrounding the area affected by the proposed action.

- Description of the environmental and socioeconomic resources in the area affected by the proposed action.

- Description of the reasonable alternatives considered (including the "no action" alternative).

- Discussion of the potential environmental and socioeconomic effects of the alternatives, including mitigative measures that could be taken to minimize adverse impacts.ß

This assessment is based on existing information, reports, and data. The potential effects of the proposed restoration activity are based on the current available data for the proposed action with the understanding that specific logistical details are similar in scope to other reef restoration projects undertaken within the FKNMS. Should later information substantially change the results of the Environmental Assessment, appropriate supplemental analyses will be conducted.

SECTION 2. ALTERNATIVES BEING CONSIDERED

2.1 DESCRIPTION OF ALTERNATIVES

NOAA has been and continues to evaluate reef restoration alternatives from throughout the Caribbean and other reef areas, and is working to refine those and develop new techniques for the specific habitats and management requirements of the FKNMS (NOAA 1995a, b, c, 1996d, e). This has been an evolutionary process as NOAA staff strive to implement restoration techniques that provide the greatest overall environmental and socioeconomic benefit in the most cost-effective manner. This includes the use of both new and modified physical (structural) restoration techniques as well as innovative biological techniques. Traditional biological methods have involved only the transplantation of coral heads; as the understanding of reef ecology continues to expand, the options for biological restoration have also expanded. The restoration alternatives considered for the *Wellwood* site draw on the experience of previous NOAA restoration activities, in particular the restoration of the following vessel grounding sites: M/V *Alec Owen Maitland* and the M/V *Elpis* (1995) in the Key Largo portion of the FKNMS, the Contship *Houston* (1997) in the lower portion of the FKNMS, the M/V *Fortuna Reefer* (1997) off Mona Island, Puerto Rico, and the *R/V Columbus Iselin* (1999) in the Looe Key portion of the FKNMS. The experiences of Florida restoration activities, and of many coral researchers have also been crucial to the development of this plan, as have the recommendations of the workshop described in NURC (1993).

The goal of the restoration activities at the *Wellwood* grounding site is to recreate, to the extent practicable, suitable habitat that enhances recolonization on the injured reef without attempting to completely compensate for the loss of the thousands of years of growth that created the physical structure of the reef. In addition to the preferred and no action alternatives, there are four additional restoration options. These options are built upon four basic restoration methods (substrate stabilization, structural restoration, transplantation, and enhanced biological restoration) that can be used separately or be combined with one or more others for many alternative permutations. Several of these combinations have been eliminated for consideration because they do not meet the restoration goals of this action. Table 2-1 summarizes all the alternatives and provides justification for those that are not considered further. Those considered further are described below.

NOAA's preferred alternative is to use all four methods to best approximate pre-grounding conditions and habitat functions. It calls for the stabilization of injured framework with the use of reef modules and tremie concrete pour. Reef structures would be placed around the injury area to mimic the coral colonies destroyed by the grounding, and coral transplantation and other biological methods would be used to restore the coral community.

Table 2-1 Matrix of Alternatives

Options	Stabilization	Structural	Transplantation	Enhanced Biological	Considered Further	Justification
1					Y	Consideration of the No Action alternative is prescribed by CEQ regulations.
2	X				Y	NOAA believes that stabilization is the minimum requirement for long-term restoration. This option alone would provide long-term health with minimal disruption.
3		X			N	NOAA believes that stabilization is the minimum requirement for long-term restoration. These alternatives have been eliminated due to the absence of stabilization.
4			X		N	
5				X	N	
6	X	X			Y	NOAA believes that structural restoration in addition to stabilization would meet the goals of the restoration project.
7	X		X		N	NOAA believes that biological restoration without structural development would not meet the goals of the project, to re-create to the extent practicable, the pre-injury habitat.
8	X			X	N	
9		X	X		N	NOAA believes that stabilization is the minimum requirement for long-term restoration. These alternatives have been eliminated due to the absence of stabilization.
10		X		X	N	
11			X	X	N	
12	X	X	X		Y	NOAA believes that structural restoration in addition to stabilization would meet the goals of the restoration project, and that either biological restoration option would be appropriate.
13	X	X		X	Y	
14	X		X	X	N	NOAA believes that biological restoration without structural development would not meet the goals of the project, to re-create to the extent practicable, the pre-injury habitat.
15		X	X	X	N	NOAA believes that stabilization is the minimum requirement for long-term restoration. This alternative has been eliminated due to the absence of stabilization.
16	X	X	X	X	Y	NOAA believes that the combination of all components would provide a reef closest to the pre-injury habitat.

2.1.1 Preferred Alternative: Stabilization of Substrate and Structural Restoration of the Reef Substrate with Coral Transplantation and Enhanced Biological Restoration

This alternative calls for the stabilization of injured framework with the use of reef modules and tremie concrete pour, the subsequent addition of precast reef structures placed around the injury area to mimic the coral colonies destroyed by the grounding, and the use of coral transplantation and other biological methods to restore the coral community.

The extensive structural injury caused by the grounding of the M/V *Wellwood* (cracking of the underlying reef framework, flattening of the reef relief) has led to extensive impacts on the habitat and biological resources of the area. This alternative entails construction work, which would consist of repairing multiple damaged sites using specially formulated concrete, fiberglass rebar, limestone boulders and pre-fabricated reef modules. Some excavation would be required to deepen damaged areas to accommodate reef module placement and provide sufficient concrete for adequate repair. Up to twenty-two reef modules would be constructed for placement on the reef, to fill the pits that were recently expanded. The stabilization would bring the pits back up to resemble the surrounding topography and would decrease the potential for further erosion of the loose substrate surrounding the holes. The choice of materials and methods being used for the project would be based on NOAA's extensive experience with coral reef restoration techniques, in the FKNMS and at other sites. See Figure 2-1 for a schematic that illustrates this technique.

Limestone boulders and pre-fabricated reef structures would be placed in the injured area after framework stabilization is complete, and then stabilized with a tremie pour of concrete around them. The boulders would be designed and stacked so as to recreate the look of and replace the relief provided by the several large coral colonies that were destroyed by the grounding vessel. Plastic composite rebar (which is lighter, easier to use, and more durable than steel) would be placed in the boulders and concrete for improved attachment between boulder/concrete layers. The sides and surface of each repair structure would include exposed surfaces of the boulders to enhance the opportunities for benthic recolonization of the repaired surfaces, as well as holes or openings to provide habitat for cryptic organisms. Due to the nature and strength of the natural reef material at this particular site, attachment of the repair structures to the natural reef by rebar would not provide suitable stability. This repair would depend on the weight of each unit enhanced by direct attachment to the reef by concrete to provide structural stability in storm events. The design stability evaluation considered the impact of a severe storm event (i.e., 50-year storm). It should be noted that something less than 3.5% of the area of the "parking lot" would be covered by repair structures. This provides ample remaining area for control sites to monitor in evaluating natural rates of recovery, as recommended by NURC (1993) (see Figure 2-2).

After physical restoration, biological restoration would occur. This would consist of two activities: coral transplantation and the use of enhanced biological methods. Although some extant data (NURC 1997; see Section 3 below) does not provide evidence of convincing

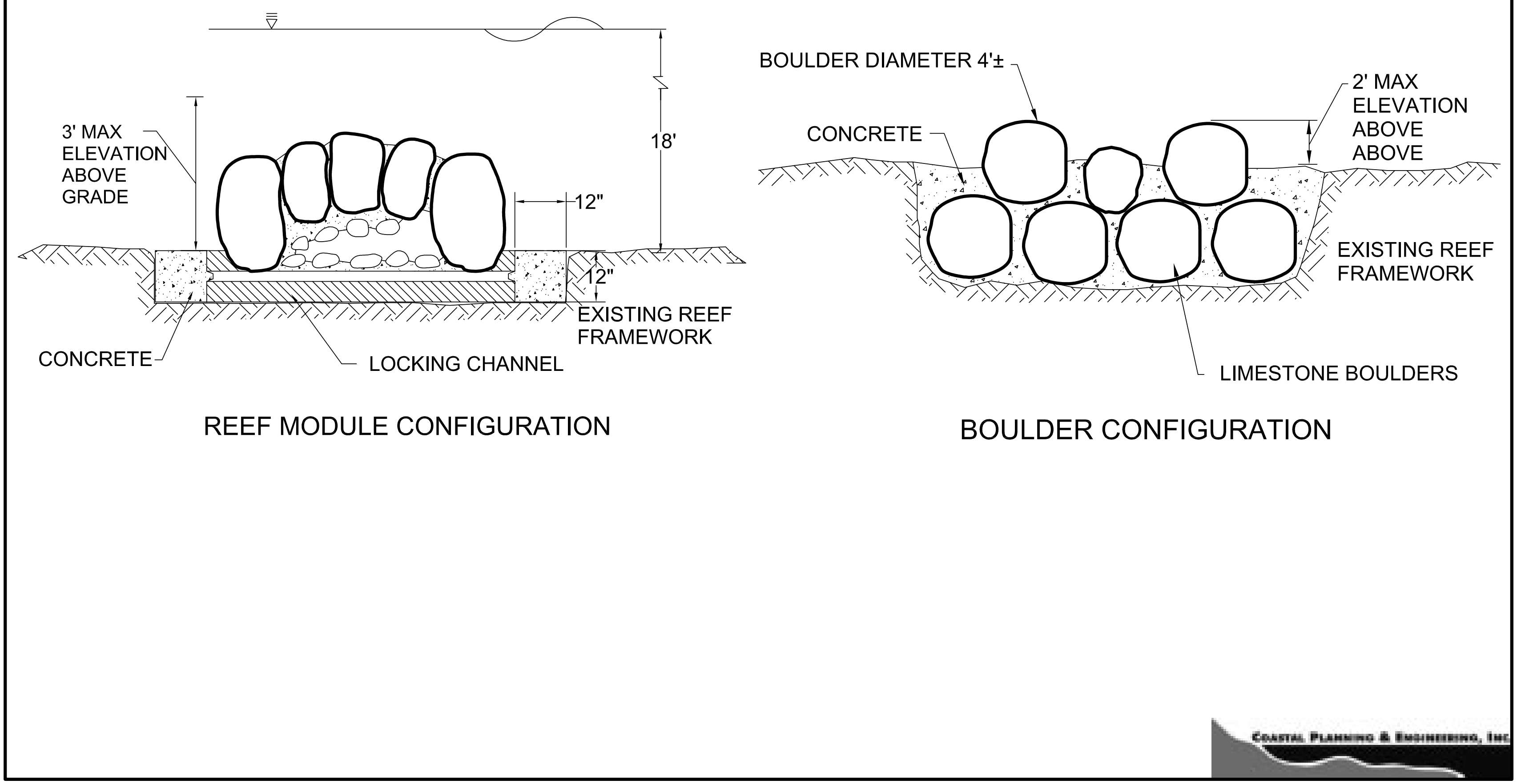

Figure 2-1

Stabilization Technique (Module)

Figure 2-2, module placement

ecological benefit for transplantation, the NURC study examined only the very small area to which corals were transplanted shortly after the grounding. Other studies have demonstrated significant benefits from transplantation (Bowden-Kerby 1997; Hudson and Goodwin 1997). Regarding the use of enhanced biological methods, such methods are not currently "scaled-up" sufficiently to have been used to play a significant role in restoring coral populations. Thus this restoration project may play a role as a large-scale model in further developing chemoinductive substrates or "flypapers," which do have proven efficacy in small field tests for successful recruitment of larvae on the reef (Morse 1999).

Transplantation would be primarily of small coral colonies. Species transplanted would be those originally found at the site, but specific numbers of each species would ultimately depend on the specimens available at the time of transplantation. There are several potential sources for the corals that would be transplanted, including coral pieces collected during storms and other small scale groundings and held until restoration is implemented; corals taken from nearby hardground areas where coral colonies are growing on loose substrate with little chance for long-term survival; selected coral heads that have been held for culturing, research or rescue purposes and are now available for return to the reef; and plugs taken from healthy donors. Except for the plugs, the colonies used for transplantation would not be taken from donors on surrounding reefs and thus would not increase injury to reef habitat. Plugs have been used successfully in the FKNMS and have shown little impact to the donor colonies. This would ensure that restoration of this site would not be accomplished at the expense of surrounding habitats.

In addition to the scleractinian corals, gorgonian colonies would also be transplanted. Although at least one species of gorgonian (*Pseudopterogorgia americana*) is common at the grounding site, slower recruiting gorgonians such as *Plexaura* spp. and *Gorgonia ventalina* were an important component of the original community (Harrigan, 1984; Gittings, 1988) but are rare now. Thus, these species and others would be candidates for transplantation. The transplanted colonies may be taken from recently dislodged colonies or clippings may be taken from local mature colonies without endangering the donor colony.

There are a variety of new biological technologies being used to restore coral populations, many of them focused on increasing the settlement of coral larvae. The two primary alternatives that are under consideration for the *Wellwood* site are the use of "larval flypaper" and the use of "settlement tents." The larval flypaper technique (Morse, et al, 1994; Morse and Morse, 1996) requires the placement of chemical stimuli (metamorphic inducers) on the reef surface to attract coral larvae. The use of the chemical stimuli increases the likelihood that coral larvae will settle onto the selected reef location. The settlement tent technique (A. Szmant, personal communication; S. Gittings, personal communication) uses larvae collected during spawning events and held in a lab until they are competent to settle (usually a few days). These larvae are then introduced into a fine-mesh net enclosure deployed over the injured area and held for another two or three days until they have settled onto the substrate. Constraining the larvae in a tent for a few days over the reef provides greater likelihood of their settling on the selected reef substrate than if they were free floating and subject to current and tidal influences. These two techniques take different approaches to capitalizing on the natural abundance of coral larvae throughout the Keys, with the intent of increasing the density as well as the species diversity of settlers at a specific site.

The combination of "traditional" transplantation and/or enhanced settlement techniques would be attempted on less than half the area of the grounding site. This would permit the continuation of long-term monitoring of natural recovery rates, one of the principal recommendations of the 1993 NURC workshop cited above (NURC 1993).

Construction materials would be transported to the site by a means deemed feasible by the contractor selected to do the restoration. Construction would require the use of a construction barge that would be moored over the site in a manner to prevent collateral injury to the reef. All operations would be planned and performed according to permit requirements and the environmental protection plan written for the restoration. This environmental protection plan would address the protection of land resources, water resources, air resources, and fish and wildlife resources in the restoration area. Solid waste and chemical waste generated during the restoration would be transported and disposed of in accordance with federal, state, and local regulations. In addition, materials would be placed in the water according to marine engineers' specifications in a manner approved by NOAA before construction. NOAA's construction contractor would prepare an environmental protection plan as a requirement of their contract. It would be reviewed prior to the issuance of the required FKNMS permit, but is not available for the publication of the Final EA. In addition, the plan would probably be too extensive to incorporate as an appendix.

1. Transplantation can be conducted from a small dive boat without major construction equipment or materials. Transplants would be transported to the site (if taken from a distance) in water-filled buckets, gently placed back into the water, and put in place and cemented by SCUBA divers. Both Portland Type II cement and Liquid Rock epoxy are commonly used for scleractinian transplantation throughout the FKNMS (B. Goodwin, personal communication). Portland Type II cement would be used as part of the project, as it is for nearly every reef restoration. It has proven to be the most effective for structural purposes. Limestone – the natural material of the reef itself -- would be used as "top dressing" so that little or no concrete will be exposed. If needed, Liquid Rock epoxy would be used for smaller reattachment purposes, as it is for most reef restoration projects. It has proven to work well in the underwater setting. Gorgonians can be

transplanted using several underwater epoxies. The use of hand tools such as hammers, picks, or chisels, would also be required. There are no specific construction needs for enhanced biological methods; the work can be conducted from small dive boats and using small hand tools in a manner similar to transplantation. These are the two biological/settlement enhancement techniques likely to be used at the *Wellwood* site; however, others are being investigated and may be considered and evaluated at a later date.

All operations would be planned and performed according to permit requirements and the environmental protection plan written for the structural restoration.

This is NOAA's preferred alternative because of a combination of factors.

- Substrate stabilization is vital to any restoration. Restoration of this site without stabilization has a high likelihood of failure due to the potential for continued erosion of the underlying substrate.

- NOAA believes that limited structural restoration is necessary in order to recreate a habitat that resembles the pre-injury state of the injured reef. This reef area is a transition zone between a spur and groove habitat and the deeper hard bottom habitats and occasional massive coral heads are a distinct characteristic of such habitats. Without the addition of some limited structure, any restoration initiated at this site will remain a low–relief habitat for the foreseeable future.

- While traditional transplantation will be a viable method at this site, NOAA believes that the use of innovative biological methods has few, if any, environmental costs, and potential major benefits to increase recovery of the benthic community. The combination of biological methods could provide far greater restoration of the reef community than either method alone.

- It encompasses the recommendations of the coral reef scientists and managers that were advanced as a result of the workshop convened to consider these issues (NURC 1993).

2.1.2 No Action

Inclusion of the no action alternative is prescribed by the Council on Environmental Quality regulations. It serves as a benchmark against which the preferred action can be evaluated. The no action alternative would leave the reef in its current condition, allowing natural recovery processes to occur. The no action alternative could have two general outcomes: natural recovery on a longer time scale or further deterioration of the reef system. It is NOAA's opinion that the no action alternative would result in further deterioration of the reef system, due to the previous framework damage and subsequent secondary damage caused by storms. Hurricane Kate in 1985 scoured the rubble remaining at the site, and the results of an active storm season in 1998 have further proven this hypothesis to be likely: scouring wave action from the Groundhog Day Storm (February) and Hurricane Georges (September) deepened and expanded the injury site.

2.1.3 Stabilization of Loose Substrate

This alternative calls only for the stabilization of loose substrate and damaged framework as described in Section 2.1.1. This approach would address the joint concerns of allowing the existing community to continue development while minimizing additional injury that might result from further deterioration of the substrate. The purpose of the restoration would be to fill in the blowholes and to stabilize the now exposed framework cracks to prevent further expansion of the pits and erosion of the reef substrate. NOAA believes that stabilization is the minimum restoration required; without stabilization the substrate will continue to erode and the injury area will enlarge. However, NOAA also believes that stabilization alone is not sufficient to restore the injury area because it would not restore the area to its original topography, nor would it provide any increase in biological cover.

2.1.4 Stabilization of Substrate and Structural Restoration of the Reef Substrate

The focus of the restoration effort is on recreating, to the extent practicable, the preexisting habitat, structure, and surface topographical relief of the former reef. Under this alternative, the damaged grounding area would be stabilized as described in Section 2.1.1, and then reef structures and boulders would be placed over the stabilized substrate to create additional relief and mimic the pre-injury topography, also as described in Section 2.1.1.

Construction would occur as described in Section 2.1.1.

NOAA does not believe that this alternative is sufficient to restore the *Wellwood* grounding site. Although the framework would be stabilized for future development of a coral community and the original topography would be recreated, this alternative would not provide any restoration of the biological community.

2.1.5 Stabilization of Substrate and Structural Restoration of the Reef Substrate with Coral Transplantation

This alternative would build upon the construction restoration option described in Section 2.1.4 by requiring the transplantation of corals onto the stabilized substrate and the new reef structures once construction is completed. This alternative addresses the critical loss of coral cover caused by the grounding by increasing the coral population and thus jumpstarting the natural colonization on both the stabilized reef substrate and the new reef structures.

Construction and transplantation would occur as described in Section 2.1.1. All operations would be planned and performed according to permit requirements and the environmental protection plan written for the restoration.

NOAA believes that this alternative would be sufficient to restore the site by stabilizing the substrate, recreating the original topography and initiating the development of a coral community. However, NOAA does not believe that this is the best alternative possible because the limited nature of transplanting corals does not recreate a reef ecosystem diverse in species composition.

2.1.6 Stabilization of Substrate and Structural Restoration of the Reef Substrate with Enhanced Biological Restoration

This alternative would build upon the construction restoration option described in Section 2.1.4 by using new biological methods to enhance the recruitment of corals onto the stabilized substrate and the new reef structures once construction is completed. This alternative addresses the critical loss of coral cover caused by the grounding by enhancing the settlement of naturally occurring coral larvae and thus jumpstarting the natural colonization on both the stabilized reef substrate and the new reef structures.

Construction and enhanced biological restoration would occur as described in Section 2.1.1. All operations would be planned and performed according to permit requirements and the environmental protection plan written for the restoration.

NOAA believes that this alternative would be sufficient to restore the site by stabilizing the substrate, recreating the original topography and initiating the development of a coral community. However, NOAA does not believe that this is the best alternative possible because the limited nature of enhanced settlement would require an extended time to recolonize the area and would result in a community of very similar age range.

2.2 OTHER COMMERCIALLY AVAILABLE RESTORATION ALTERNATIVES

Other commercially available restoration technologies commonly used in coastal and offshore construction projects were also considered as alternatives for restoration of the *Wellwood* grounding site. These technologies were evaluated during the planning phases of the earlier restoration of the *Elpis* and *Maitland* grounding sites (NOAA 1995a and 1995b) and again during the Contship *Houston* and R/V *Columbus Iselin* restoration planning processes

(Waxman and Christensen,1997; NOAA 1996d, 1999a). In general, they were inappropriate at the *Wellwood* site. Because the injury area has limited physical structure one of the main goals is to create additional relief; these other methods tend to be more appropriate for large areas of detached rubble. Specific methods were found to be inappropriate for use at the *Wellwood* site for a variety of reasons, as described below.

- Concrete-filled pillows, geotextile mattresses, or tubes filled with concrete and fitted onto the underlying reef structure. These methods are used to protect the perimeter of injured areas from further deterioration. The pillows, mattresses, or tubes would be constructed out of reinforced material, such as Kevlar, to add external support and filled with nonseparable marine concrete. The filling operations are fairly complex and require concrete preparation on site due to the distance from land. They would have to be filled on site and require a downhill gradient. Due to the relatively small size of the *Wellwood* grounding site, the complexity of installing these pillows is not a cost-effective option. This technology was also rejected due to its use of unnatural materials (Kevlar).

- Gabions, prefabricated steel, or tenser grid cages containing loose reef rubble and creating a flush cap similar to that of the underlying reef. The standard design for gabions consists of a very sturdy plastic webbed mattress that is filled with gravel, or sand if an internal filter fabric is used. It is uncertain whether gabions would crush or crack the underlying reef structure. Gabions are generally considered a temporary measure or interim relief until a more permanent structure can be constructed. Gabions were rejected for use at the *Wellwood* site because of the use of unnatural materials and as technically infeasibile due to the need for a permanent solution. Also, any potential for additional framework injury is inappropriate at this site.

- Revetment mats, similar to gabions but providing a semiflexible reef cap. Revetment mats are concrete blocks, usually 1 foot by 1 foot, interconnected by flexible polypropylene, kevlar, or similar cables. These mats are usually assembled on land and then installed in place from a construction platform, using a crane and spreader bar. They are relatively flexible structures that will conform to the shape of the natural contour. As with gabions, it is uncertain whether revetment mats would crush or crack the underlying reef structure. Revetment mats were used in the restoration of the Contship *Houston* site in 1997. Injury from Hurricane Georges has required some relocation and rearticulation of the mats at that site as the leading edge of one mat lifted and broke apart; in future uses, the mats will be more securely fastened to the bottom. Revetment mats were rejected for use at the *Wellwood* site due to the relatively small and steep nature of the holes to be filled, the use of unnatural materials, the lack of rubble berms needing stabilization, and as inappropriate due to the potential for further framework injury.

Although these restoration techniques have proven useful in other locations, the specific physical needs at the *Wellwood* site are incompatible with the use of these techniques. They do not meet the purpose of and need for the proposed action at Molasses Reef and therefore are not analyzed in detail in this Environmental Assessment.

SECTION 3. AFFECTED ENVIRONMENT

3.1 LOCATION AND AREA USES

The M/V *Wellwood* grounding site is located in the vicinity of 25°00' north latitude, 80°22' west longitude, offshore of Florida's Upper Keys (Figure 1-1). The site is approximately 6 nautical miles (11 kilometers) southeast of Key Largo in Monroe County, Florida, and is within the Key Largo portion of the Florida Keys National Marine Sanctuary (FKNMS). The *Wellwood* site is situated in a transition coral community in 6 to 10 meters of water.

Uses of the general area include diving, fishing, snorkeling, and boating. Molasses Reef holds not only recreational value but also scientific and educational value (NOAA, 2000). Many scientists view the region as a living laboratory in which numerous scientific studies and much research are being conducted (UNEP/IUCN 1988). Certain marine species found within the FKNMS's boundaries hold commercial or recreational value. These species include spiny lobster, grouper, mackerel, dolphin, snapper, hogfish, tarpon, pompano, jack, and bonefish (NOAA 1995b). Although fishing for these species in portions of FKNMS is allowed, certain restrictions apply, including not using harmful fishing methods such as wire fish traps (UNEP/IUCN 1988). Molasses Reef itself, including the site of the *Wellwood*, is a Sanctuary Preservation Area (SPA) and thus the following activities are prohibited: touching coral, anchoring, and discharging anything into the water, and most fishing activities (NOAA 1996a). Castnet baitfishing is the only type of fishing allowed within the SPA.

3.2 SURROUNDING LAND USE

Molasses Reef is located approximately 6 nautical miles southeast of Key Largo. Key Largo is predominately zoned for residential and commercial land uses with the exception of a large portion of land owned by the Florida State Department of Parks in the John Pennekamp Coral Reef State Park. Land use at the park includes camping areas, a marina with two boat launching ramps, commercial and administrative buildings, and open space (FDEP, 2000). Many commercial properties are located on Key Largo, including gas stations, shopping plazas, boat rentals/charters, bait and tackle shops, dive shops, motels, and restaurants. The marinas and boat launches in this area serve as gateways for many of the visitors to FKNMS.

3.3 CLIMATE

The Florida Keys are in a subtropical zone moderated by water temperatures. The area is characterized by warm, humid summers, with abundant rainfall and generally warm, moderately dry winters. The average annual temperature is 78 ºF (26 ºC) with an average low of 69 ºF (21 ºC) in January and an average high of 85 ºF (30 ºC) in July. The average annual rainfall is 39.4 inches (100 centimeters). The heaviest precipitation occurs during the summer and early to mid-autumn. Winds average 10 nautical miles (19 kilometers) per hour. The prevailing wind direction is from the east-southeast during the summer and from the northeast during the winter. Winds are typically strongest during the winter months and calmest in the spring and autumn. The hurricane season is from June to November, with the peak threat existing from mid-August to late October (NWS, 1994).

3.4 AIR QUALITY

3.4.1 Ambient Air Quality Conditions

National Ambient Air Quality Standards (NAAQS) have been set for six criteria pollutants (sulfur dioxide, carbon monoxide, ozone, nitrogen oxides, lead, and inhalable particulate matter). The problems associated with the pollutants carbon monoxide and inhalable particulate matter are usually related to localized conditions, such as congested traffic intersections or construction activities. The other criteria pollutants are associated with more regionalized problems that result from the interactions of pollutants from a great number of widely dispersed sources (e.g., a large city containing many stationary and mobile sources). The Florida Department of Environmental Protection (FDEP) monitors the concentrations of the criteria pollutants and, where necessary, is responsible for developing State Implementation Plans (SIPs) to ensure that the national standards are achieved and maintained. Areas within the state that fail to meet the NAAQS are designated as "nonattainment areas" and are potentially subject to regulatory enforcement. The *Wellwood* site is located in Monroe County, which is classified as being in complete attainment of the NAAQS as of August 1999 (USEPA, 2000).

3.4.2 Air Pollutant Emissions at Molasses Reef

No significant direct or indirect sources of air pollutant emissions are currently located in the immediate vicinity of Molasses Reef. The principal emission source in the vicinity of Molasses Reef is motorboat traffic. Although the number of boats arriving at FKNMS is relatively large, the boats are insufficient in number to cause a significant change in local or regional air quality.

3.4.3 Regional Air Pollutant Emission Summary

No large point sources of air pollution that would affect local air quality are present within 30 miles (48 kilometers) of Molasses Reef. Large emission sources on the Florida mainland do not appear to be positioned to affect local air quality consistently. The prevailing wind patterns are such that air masses passing over the Keys from the Gulf of Mexico or the Atlantic Ocean do not first pass over the mainland. This diminishes the potential for distant emission sources to affect local air quality (NCDC, 1999).

3.5 NOISE

Noise at Molasses Reef predominately originates from recreational activities of boaters, particularly during the day as boaters approach and leave the moorings in the sanctuary. There are no other significant noise sources in the Molasses Reef area aside from natural wind and wave action or occasional aircraft. Given its location approximately 6 nautical miles (11 kilometers) offshore from the nearest land mass, noise from shore (e.g., traffic on U.S. Route 1) has no impact on ambient noise levels in the vicinity of Molasses Reef. Conversely, the noise of motorboat traffic around Molasses Reef is insufficient to affect any shoreside residences. Boats visiting FKNMS that depart from and return to shoreside locations may occasionally create annoying noise levels for residents.

3.6 GEOLOGY

Molasses Reef is a bank reef lying near the southern edge of the Florida Plateau, a large carbonate platform composed of carbonate marine sediments approximately 7,000 meters in thickness. The plateau includes all of Florida and the adjacent continental shelves of the Gulf of Mexico and the Atlantic Ocean. The platform has been an area of shallow water carbonate deposition since at least the Jurassic period (136 to 190 million years ago). Sediments accumulating in the area for 150 million years have been structurally modified by subsidence and sea level rise (Continental Shelf Associates, 1990).

Sea level fluctuations attributed to glaciation are largely responsible for the present morphology of the area. Sea level dropped by 100 meters during the Wisconsonian glaciation, exposing the entire platform to marine and subaerial erosion. Sea level began to rise again approximately 15,000 years ago, flooding the area and forming the current physiographic character of the region.

Molasses Reef, which is part of the Florida Reef Tract, exhibits features representing two distinct geological origins. An older, deeper reef developed on a former shoreline and exhibits spurs and grooves that probably represent erosional features that developed along a previous shoreline. In contrast, the shallower active reef has formed more than 5 meters of carbonate sand, primarily from the limestone-fixing algae *Halimeda*. Accretion of the shallower reef was slowed considerably due to an extensive die-off of elkhorn coral (*Acropora palmata*) starting a few years ago.

3.6.1 Geological Resources at the Grounding Site

The framework of most reefs consists not of a solid limestone layer, but instead a thin veneer of reef rubble cemented together under which is a loose consolidation of reef rubble. Under the unconsolidated layer the framework becomes firmly cemented together once again. The primary reef damage from the *Wellwood* consisted of fracturing that veneer through several days of resting and pounding on the substrate; this exposed the underlying reef rubble to increased erosion from water movement. Immediately after the grounding 50 percent (644 square meters) of the injured area showed signs of framework damage (Hudson & Diaz, 1988). Framework damage included cracked, crushed, split or otherwise mechanically altered reef substrate.

There has been no significant consolidation of damaged framework since the grounding, thus the area today contains that same area of framework damage as well as additional injury resulting from subsequent storms and other physical disturbances.

3.7 WATER RESOURCES

3.7.1 Water Quality

Reef-building corals require warm, clear water, low nutrient levels, and frequent and relatively strong ocean currents. Coral reefs cannot withstand continued exposure to water temperatures colder than 18 ºC (68 ºF) or warmer than 30 ºC (86 ºF). They are seldom found in continually turbid water. Most importantly, corals cannot tolerate great changes in water quality for prolonged periods of time. Such environments are primarily found 25 degrees north and south of the equator. Molasses Reef's exposure to open ocean circulation of warm, relatively low nutrient Gulf Stream waters and protection from the turbidity, high nutrient levels, rapidly fluctuating temperature, and salinity of Florida Bay waters provide for a favorable environment for reef-building corals.

Table 3-1 provides details of water quality characteristics recorded in the Molasses Reef area. With few exceptions, the water quality in and around Molasses Reef is good, although phosphorus levels have been on the increase over the past 5 years (Jones and Boyer 1999).

3.7.2 Physical Parameters

Currents. FKNMS is part of an open-ended environment influenced by the Caribbean Sea, Gulf of Mexico, and Florida Bay. The Straits of Florida lie to the south of the reef tract and Hawk Channel lies between the reef tract and the islands of the Florida Keys. A complex system of currents runs through these bodies of water. The most prominent current affecting

Molasses Reef is the Florida Current (Figure 3-1). The Florida Current is a surface current (less than 400 meters deep) that flows east and then north offshore of the Florida Keys. This current results from the combination of the Loop Current coming from the eastern portion of the Gulf of Mexico and the Yucatan Current. The Florida Current eventually becomes the Gulf Stream off the southeastern United States (Chiappone, 1996a).

The Florida Current is far enough offshore from Molasses Reef to have only a relatively small moderating effect. The effect is a north-flowing current on the seaward side of Molasses Reef moving at 4 centimeters per second (Lee et al., 1992). Fluctuations of flow and distance from the Florida Current can have periodic effects on Molasses Reef. These fluctuations are characterized by horizontal meanders and cyclonic, cold core frontal eddies. Meanders are low-frequency current fluctuations that appear as northward-flowing waves. The eddies are periodic reversals of the current and transport Florida Current waters into coastal waters.

Table 3-1. Water quality characteristics of bottom water in the vicinity of Molasses Reef (Medians of samples taken quarterly from 1995-1999)

Parameter	Range
Salinity, ppt	36.1
Temperature, ºC	25.6
Dissolved oxygen, sat (%)	93.8
$Si(OH)_4$	0.284
Nitrate, µM	0.060
Nitrite, µM	0.037
NH_4, µM	0.295
Total dissolved phosphorus concentration, µM	0.157
PO_4, µM	0.007
Chlorophyll *a*, µg/L (at surface)	0.202

Source: Jones and Boyer 1999
µM = micro molarity
µg/L = micrograms per liter

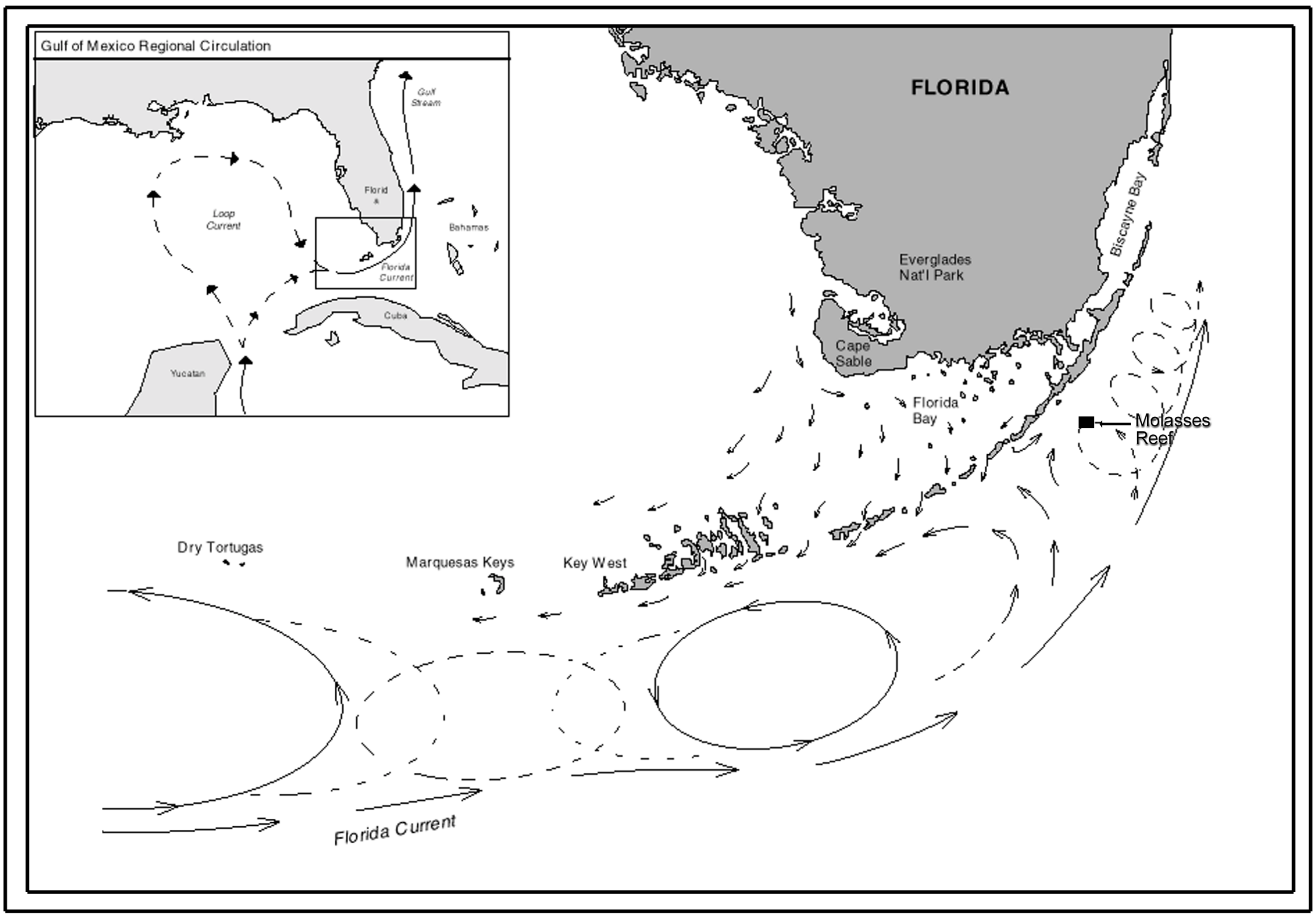

Figure 3-1

Currents Affecting the Florida Keys

A periodic water circulation feature referred to as the Pourtales Gyre has been documented off the Florida Keys. This cold cyclonic gyre is associated with the Pourtales Terrace, a topographic feature composed of a 200- to 300-meter platform in the middle and lower Keys. The gyre forms during fluctuations of the Florida Current where it meanders inshore toward Molasses Reef. It results in the periodic upwelling in nutrients and localization of plankton (Lee et al., 1992). The Pourtales Gyre forms for approximately 1 to 2 months and occurs mainly in the winter and spring (Lee et al., 1994).

Wind blowing over the surface of the water can induce wind-driven currents. Circulation within Hawk Channel is dominated by wind-driven currents which are characteristic of the Florida Keys because shallow depths prevail throughout the area (Schomer and Drew, 1982).

Tides. Tides in the Florida Keys generally exhibit two highs and two lows of uneven amplitude (height) per tidal day (Schomer and Drew, 1982). The tidal range decreases from Fowey Rocks in the upper Florida Keys to Sand Key off of Key West. Tides in the Molasses Reef area vary approximately 0.6 to 0.8 meter. The highest observed water level in the area was recorded at Ocean Reef Harbor, on the north end of Key Largo at 1.1 meters based on the mean lower low water (MLLW) level in 1975; the lowest observed tide was measured at Point Charles in Hawk Channel, at 0.5 meter below MLLW in 1979 (NOAA, 1999c). The major effect of tides on reef communities is the reduction of water depth during spring low tides when shallow reef flats may be close to or above the water's surface.

Tidal currents reverse in direction with the ebb and flow of tides. These currents show a slight westward component, especially in the middle and lower Florida Keys (Enos, 1997; Smith, 1991). However, recent studies indicate that there is a long-term net flow from Florida Bay/Gulf of Mexico to the Atlantic Ocean (Pitts, 1994; Smith, 1994). Tidal current velocities range from 5 to 15 centimeters per second, but velocities as high as 130 centimeters per second have been recorded.

3.8 BIOLOGICAL RESOURCES

3.8.1 Communities in the Vicinity

Coral reefs are complex and diverse ecosystems found in the tropics and subtropics where environmental conditions are relatively constant and not prone to large or frequent fluctuations. They are composed of concentrated complexes of corals and other similar organisms that, given the availability of suitable substratum, temperature, light, and limited sedimentation, construct a limestone structure in shallow water (Jaap, 1984).

The Florida Reef Tract is the third largest barrier reef system in the world. This reef tract consists of four discernible types of coral communities that occur in a generally seaward progression: hard bottom communities, patch reefs, transitional reefs, and bank reefs (Jaap, 1984). The relief, or height above the bottom, and the dominance of stony corals as a structural element also increase in a seaward progression. Molasses Reef is a bank reef.

The most diverse coral communities of FKNMS are on bank reefs, elongated structures located near the abrupt change in bottom slope that marks the seaward edge of the Floridian Plateau. They occur mostly at a depth of 5 to 10 meters (Jaap, 1984). Distinctive characteristics of these reefs include vertical zonation of coral communities by depth, the presence of seaward spur and groove formations, and in many cases the presence of *Acropora palmata* (Jaap, 1984; Wheaton and Jaap, 1988). *A. palmata* became the primary spur builder at Molasses Reef 800 to 1,000 years ago (Chiappone, 1996b; Shinn et al., 1981). The large size often attained by multibranched *A. palmata* colonies attracts large schools of snappers, grunts, and other species of fish that seek structure for shelter. *A. palmata* uses fragmentation recruitment to exploit spatial resources, and broken branches would grow rapidly to form new colonies (Wheaton and Jaap, 1988).

Communities at Molasses Reef from inshore to offshore are seagrass flats, reef flat (mostly rubble), spur and groove, buttress zone, mixed hardgrounds and sediments, and slope platform (Chiappone, 1996b). The seagrass flats, which rarely exceed 3 to 4 meters in depth, are covered by the seagrasses *Thalasia testudinum* and *Syringodium filiforme* and sand-filled blowouts. Overhanging ledges are formed in some of the deeper holes by the rhizomes and roots of the seagrasses. The queen conch, *Strombus gigas*, inhabits this area, as do isolated brain and star coral colonies of *Diploria clivosa* and *Montastraea* complex, respectively; *A. palmata*; the sea fan *Gorgonia ventalina*; and the sea whip *Pterogorgia anceps*.

The back reef, located at a depth of 6 meters, is a marginally developed area consisting of isolated coral colonies but dominated by the octocorals *Plexaura flexuosa* and *Eunicea succinea* and the fire coral *Millepora alcicornis* (Chiappone, 1996b). The dominant algae are large frondose species such as *Laurencia*, *Dictyota*, *Sargassum*, *Liagora*, and *Acanthophora*.

Octocorals and stony corals become more prevalent in the transition from a relatively flat, high-energy, shallow reef to an elevated three-dimensional system where the increased depth and spatial diversity increase the availability of niches. In this transitional zone, *A. palmata* occurs on top and *Agaricia agaricites* (lettuce coral), is prolific on the vertical faces of the spurs (Wheaton and Jaap, 1988). Octocorals become more abundant, with the number of species doubling compared to the preceding shallower zone. Sheets of *Palythoa caribbea* are replaced by small, isolated mats, and *M. complanata* remains moderately abundant. The grounding occurred in the offshore transition zone between the spur and groove reef and the deeper low relief hardground.

The dominant algal species in the spur and groove community consists of nonarticulated coralline algae (*Porolithon, Hydrolithon, Lithophyllum*) and filamentous forms (*Wrangelia, Ceramium, Centroceras,* and *Polysiphonia*).

Throughout the Florida Keys, coral reefs in the past decade have experienced an overall decline in health as they are stressed by numerous natural and man-made phenomena. The *Wellwood* grounding area is not the lush Acropora reef it once was, and indeed is now populated by a large number of dead or dying Acropora communities. However, the corals that exist in the area, whether living or dead, continue to provide habitat for other reef communities and a certain level of biological function. Regardless of whether the coral community injured by the *Wellwood* would today be a living or dead reef, it would continue to provide habitat and other biological functions to the reef community, and it is those biological functions that NOAA aims to restore.

3.8.2 Other Benthic Organisms

The stratification of resources and space found in the community structure of coral reefs has similarities to that of rain forests (i.e., canopy, understory, and substory) (Continental Shelf Associates, Inc., 1990). The physical structure built by the corals provides the community's foundation and represents the canopy. Living within this structure is a complex and diverse assemblage of infaunal and epifaunal species that is another essential component of the reef environment.

The understory comprises photosynthetic organisms, such as algae, sponges, ascidians, and foraminfera that contain algal symbionts, which contribute to the organic productivity of the reef and benefit from nutrients brought to the reef by mobile organisms (Continental Shelf Associates, Inc., 1990). Epibenthic organisms such as polychaetes and bryozoans dwell on the dead portions of the coral reefs.

The substory is composed of cryptofauna, which live within the structural framework of the reef. Crustaceans, molluscs, ophiuroid (brittle stars) and crinoid (feather stars) echinoderms, fish, and polychaete and sipunculid worms inhabit the smaller caves and spaces within the reef. Larger caves and excavations are inhabited by fish, crabs, and lobsters and provide surfaces on and within the reef for sessile organisms like sponges, bryozoans, ascidians, and serpulid worms (Continental Shelf Associates, Inc. 1990).

Besides corals, algae and sponges are the organisms most critical to the reef community (Jaap, 1984). Four groups of benthic algae are found on coral reefs: crustose coralline algae, which encrust corals, reef rock, and other limestone skeletal material; filamentous and fleshy algae, which can be either sparse or dense depending on grazing pressure and nutrient levels; algae on unconsolidated sediments, which are erect macroalgae and mats of blue-green algae; and excavating or boring algae (Jaap, 1984).

Sponges are a major competitor for space on reefs and some have great overgrowth capability. Sponges play an important role in reef ecosystems by providing shelter and food for other reef organisms, and they are a major force in the bioerosional process on reefs (Jaap, 1984).

3.8.3 Fish Populations

Tropical coral reefs exhibit rich fish species diversity. Reef fish assemblages are typically associated with highly diverse coralline or hard-bottom habitats and have a high number of species within a relatively small spatial dimension (Chiappone and Sluka, 1996), although hard-bottom habitats tend to have lower species diversity than the more complex reef habitats. General characteristics of reef fish assemblages include individuals that are territorial and will strongly defend a particular site; mutualistic interspecific associations, such as cleaning stations; and Batesian mimicry, in which one inoffensive species mimics another noxious or dangerous species. Most reef fishes are highly sedentary, and even the larger predatory species such as snappers and groupers tend to be very reef-specific, rarely traveling far from the reef except for spawning (Chiappone and Sluka, 1996). Over 500 fish species have been recorded within the FKNMS.

3.8.4 Endangered and Threatened Species

Several species of turtles and marine mammals in the FKNMS have been listed as federally endangered species. Although not permanent residents of Molasses Reef, some are known to occur in or travel through the area during seasonal migrations. Federally endangered species of sea turtles that might be visitors to the reef include the leatherback turtle (*Dermochelys coriacea*), green turtle (*Chelonia mydas*), Kemp's ridley turtle (*Lepidochelys kempii*), and hawksbill turtle (*Eretmochelys imbricata*). In addition, the loggerhead turtle (*Caretta caretta*), listed federally as threatened, can also be a seasonal visitor. Marine turtles are provided protection through Florida's Marine Turtle Protection Act and the federal Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §§1531 et seq.) (Appendix B).

Endangered or threatened marine mammals that might occur in the area include the West Indian manatee (*Trichechus manatus*), a species indigenous to the FKNMS, as well as the humpback whale (*Megaptera novaeangliae*), right whale (*Balaena glacialis*), blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), Sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). Marine mammals are protected under the Marine Mammals Protection Act of 1972 (16 U.S.C. §1361), as well as the ESA of 1973.

Table 3-2. Endangered and threatened species occurrence in the Florida Keys.

Species	Approximate Time of Occurrence
Leatherback turtle (*Dermochelys coriacea*)	April to July
Green turtle (*Chelonia mydas*)	June to September
Kemp's ridley turtle (*Lepidochelys kempii*)	April to June
Hawksbill turtle (*Eretmochelys imbricata*)	July to October
Loggerhead turtle (*Caretta caretta*)	April to June
West Indian manatee (*Trichechus manatus*)	year-round depending on the temperature and distribution of seagrasses
Humpback whale (*Megaptera novaeangliae*)	Winter
Right whale (*Balaena glacialis*)	Winter
Blue whale (*Balaenoptera musculus*)	Winter
Finback whale (*Balaenoptera physalus*)	Winter
Sei whale (*Balaenoptera borealis*)	Unknown
Sperm whale (*Physeter macrocephalus*)	stranding record, but generally uncommon in water less than 300 meters deep

Sources: Lott, 1996; NMFS, no date a, no date b.

As stated previously, the federally listed species of turtles and marine mammals are not residents of Molasses Reef, but rather are known to occur in or travel through the area during seasonal migrations (see Table 3-2). The annual sea turtle nesting and hatching season in Monroe County, Florida, is considered to be April 15 to October 31. Although turtles might feed while in the vicinity of the reef, they have no specific dependence on it. Generally, marine mammals (other than manatees) might pass through the area during the winter months, but they do not depend on the reef for food, shelter, or necessary mating habitat (Lott, 1996). In Monroe County, manatees range from upper Key Largo to Key West and generally inhabit canals, creeks, and surrounding waters throughout the year (NOAA, 1996b).

3.8.5 Biological Resources at the Grounding Site

The *Wellwood* grounded in the transition zone between the shallow upper forereef (just seaward of the *A. palmata* reef crest) and a deeper forereef zone that is dominated by large head corals (see section 3.8.1). The habitat was primarily moderate to low-relief, but included numerous large heads of boulder corals and had a diverse community of hard and soft corals and other benthic organisms. The principal coral species present at the site included *Montastrea* complex, *A. palmata*, *D. cylindrus*, *A. agaricites*, *Diploria* spp., *C. natans*, *P. astreoides*, *Favia fragrum*, *Meandrina meandrites*, and *Dichocoenia stoksii*. Cover also included a healthy gorgonian community, including many sea fans (*G. ventalina*) and sea rods, the zoanthid *P. caribbea*, and fire coral, *Millepora* spp. In addition to direct physical damage from the vessel, many individuals under the vessel's hull were seriously damaged due to shading and subsequent tissue death. The dominant species injured in the deeper forereef zone during the salvage operations included the large basket sponge *Xestospongia muta*, large *Montastrea* complex colonies, and many octocorals. Coral loss over the entire area was estimated to include the complete destruction of at least 21 large (1- to 2-meter diameter) colonies of *Montastrea* complex, four colonies of *D. cylindrus* (a rare species), and 6 large colonies of other coral species, as well as grazing, abrasion, toppling or other injuries to many other colonies

The grounding site today consists of a low-relief area with scattered small (no greater than 25 cm diameter) coral colonies, including *Agaricia* spp., *Porites* spp., *M. meandrites*, *Millepora* spp., and large numbers of octocorals, primarily *Pseudopterogorgia americana*, as well as scattered colonies of other sea rods. The substratum is virtually devoid of other sedentary invertebrates but has an algae community. Some cryptofauna is present, although the increasing instability of the blowhole areas makes colonization in some areas unlikely.

Topographic complexity of the grounding site closely resembles that of nearby hardground sites, and is significantly less complex than at surrounding undamaged Molasses Reef spur and groove reference sites (NURC 1997). (Note: all data presented in this and the following 2 paragraphs are from the NURC 1997 report.) The percent cover of hard corals at the site is on the order of 1%, while at 6 spur and groove reference sites the median percent cover is approximately 5%. Hard coral colony counts per transect are significantly lower at the grounding site (again closely resembling hardground) than at the spur and groove sites. Percent cover of 3 encrusting cnidarians (2 gorgonians and a zoanthid) while highly variable at all sites, is generally lower at the grounding and hardground sites than at the undamaged reef sites. In contrast, colony counts per transect of erect gorgonians is not significantly different between the spur and groove and grounding sites, while counts at both are significantly higher than on hardground. There are no significant differences among the 3 types of sites for either sponge cover or sponge colony counts per transect. The combined cover of macroalgae and thick algal turfs is highest at the hardground sites, slightly lower at the grounding site, and substantially lower at the undamaged reef. Not surprisingly, the cover of fine algal turfs, crustose coralline algae, and bare space showed the opposite trend: cover was lowest in the hardground sites, somewhat higher in the grounding site, and highest in the spur and groove sites, with the differences being significant.

Patterns of coral recruitment and juvenile coral mortality were also assessed during the NURC study, to determine the state of recovery of the grounding area and determine if the site was returning to a spur and groove type reef or changing to a hardground type reef. The same grounding sites and reference areas (both hardground and spur and groove) referred to above were examined. Coral recruitment rates were low (1-6 m^{-2} yr^{-1}) and not significantly different between sites or reef types. Juvenile coral mortality took place at all sites over the study period. However, this mortality was significantly higher within the grounding sites and the spur and groove zone, compared to the hardground sites. The study also indicated that juvenile coral abundance was significantly higher (6-8 per m^2) at the grounding sites and the spur and groove sites compared to the hardground sites (2-3 per m^2). A portion of the grounding site at which transplantation had occurred shortly after the incident (known as “Harold’s Garden”) appeared to have fewer juvenile corals than other areas in the grounding site. However, this area is limited in size and the reduced juvenile populations may reflect spatial variation in juvenile coral density within the grounding site. Overall the dynamics of juvenile coral populations at the grounding site appeared to be more similar to spur and groove than hardground communities. The disparity, as compared to the remainder of the benthic community, probably results from the narrow focus of the project on juvenile corals.

The fish community at the *Wellwood* grounding site is that of a hardground community, with low diversity and low abundance parameters. Hardground areas and the grounding site have similar numbers of fish per transect, and that mean number is about half that for spur and groove sites. Likewise, the mean numbers of species found at hardground and the grounding sites are nearly identical, and is about half the species richness found at spur and groove sites. As far as species composition is concerned, while fish assemblages on hardground and the grounding site are quite similar to each other, they are quite different from the assemblages to be found on the reference undamaged reefs. Inspection of actual species lists indicates that the differences in species composition between spur and groove assemblages versus grounding site (and very similar hardground) assemblages are not due to the strict restriction of some species to a particular habitat. Very few of the observed species are seen exclusively on one habitat type—and most of those found on only one type of habitat are uncommon to rare in the others. Rather, there are many species that are more common on the structurally complex spur and groove sites than on the relatively flat hardground and grounding sites or *vice versa.*

3.9 INFRASTRUCTURE (Construction and Vessel Moorings)

3.9.1 Mooring Facilities

The Mooring Buoy Action Plan of the FKNMS Management Plan is one of the simplest and most effective management tools used to protect FKNMS resources. The FKNMS staff initiated the reef mooring buoy system used on coral reefs throughout the Keys in 1981. The mooring buoy system was established to provide a location for small- to medium-sized boats to be secured when visiting the reef and to reduce the potential for damage to coral from boat anchors, as well as chafing of corals from anchor ropes and chains.

Twenty-eight mooring buoys are located on Molasses Reef (Figure 3-2). Mooring buoys numbered M11 and M12 are adjacent to the grounding site; M12 is closest at 50 meters southwest of the spar buoy that marks the injured area. The other buoys are arrayed by depth: buoys numbered M1-M18 are in 5-8 meters; buoys numbered M19-M25 are in 8–11 meters; and buoys numbered M26-M28 are in 13-18 meters (NOAA, 2000). A mooring buoy south of the injured area was removed and its anchor pin permanently damaged by the *Wellwood* on its inbound track; this buoy was never replaced, in part because the area was off-limits for several years after the grounding to allow recovery and research.

3.9.2 Transport Facilities

U.S. Route 1 is the only major roadway providing access from the south Florida mainland to the Keys. The roadway varies between two and four lanes. There are numerous marinas throughout Key Largo and the rest of the Keys that provide access to boat traffic from the south Florida mainland.

The contractor will load the construction barge and mobilize their equipment, boulders and materials, from the Miami area, then proceed by water to the construction site. The contractor will move the reef modules from Key Largo to Miami via a flatbed truck. There will not be a local shore-side location for operations support. FKNMS staff will use their normal dockage during the project.

3.10 CULTURAL RESOURCES

3.10.1 Background

The Florida Keys region is considered to have excellent potential for human and animal remains that are between 12,000 and 15,000 years old based on terrestrial archaeological studies conducted over the past 30 years. In 1991, a 600-meter-diameter sinkhole that is considered to potentially contain Pleistocene archaeological sites was found off Key Largo at a depth of 10 meters. Due to the location of the sinkhole and its steep banks, the sinkhole is a likely candidate for containing human remains. In addition, the sinkhole is filled with impenetrable lime muds thought to preserve any remains contained within (NOAA, 1996b).

European contact in the Florida Keys began with Spanish explorers in the 1500s. Spanish control of the Florida Keys region lasted into the 1700s. During this period, the Spanish established a chain of missionaries across what is now known as the state of Florida and also

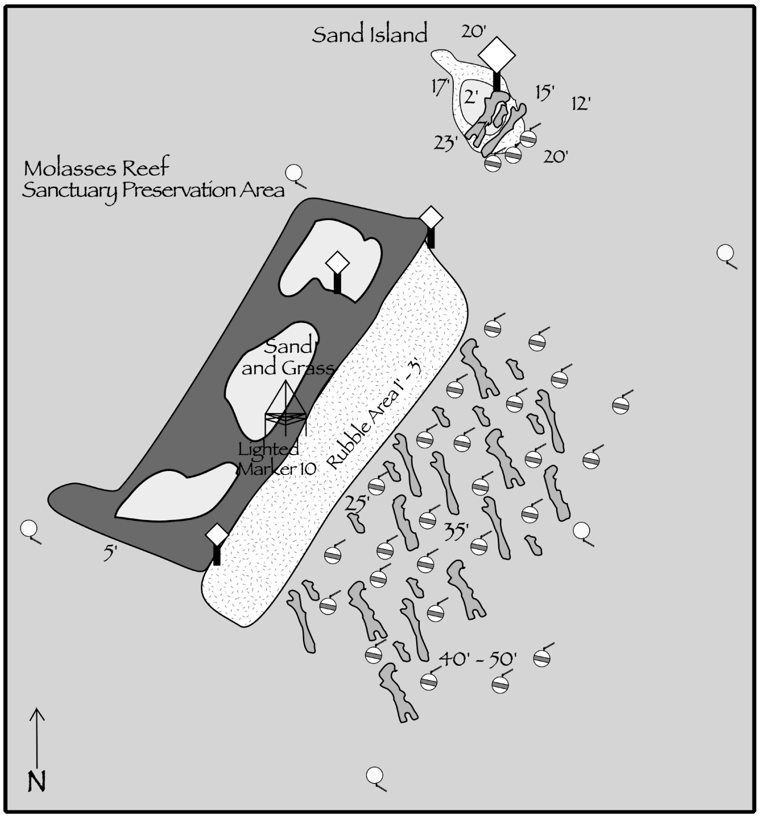

Figure 3-2

Molasses Reef Sanctuary Preserve Area
Public Mooring Buoys

established a small but prosperous maritime trade network based in Cuba. In addition to the maritime trade network, the number of ships increased in the Florida Keys as other European countries began to travel back and forth to their colonies in the Americas. The shipping industry had a dramatic increase in volume during the period of 1700 to 1820 as trade and maritime technology made great advances. From 1820 to 1865, coastal commerce continued to grow, and coastal forts were constructed to defend the nation's southern boundary, particularly during the Civil War. This time period was also marked by the Seminole wars. The Seminoles were the predominant Native American group in the area before complete Euro-American settlement. From 1865 to 1912, various coastal ports began to flourish in Florida, a system of lighthouses was developed to aid in coastal navigation, and the American Merchant Marines and the modern Navy were established. Also during that time, wreckers began to salvage cargos from ships that had run aground on the Florida reef tract (NOAA, 1996b).

3.10.2 Historic Resources in the Florida Keys Region

Because the Florida Keys are located on important trade routes, shipwrecks have occurred in the area for centuries. The shallow waters in the area, the sporadically occurring coral reefs, and a low land profile have also contributed to a large number of shipwrecks in the Keys region. Historically, Spanish ships dominated the waters in the Keys. Hurricanes, reefs, and military conflicts claimed hundreds of Spanish ships; in some cases, entire fleets were lost in the area (NOAA, 1996b).

Extensive databases have been developed to identify shipwrecks in the Florida Keys region. There is evidence of several shipwrecks in the area of Molasses Reef, but there are few identifiable vessels. The majority of wreck material in the area consists of various anchor, ballast, windlass, and other vessel parts, dating from the 17th century up through modern times. Named shipwrecks in the area include the Three Sisters Wreck (no date), and the USCG *Bibb* and *Duane* (20th Century) (Hayes, 1997). Salvage operations for shipwrecks began as early as the mid-1500s. Various groups (e.g., Spaniards, French, Dutch, English, Calusa Indians) are documented to have attempted recovery of vessels lost in the Keys (NOAA, 1996b).

Because of the numerous shipwrecks, many lighthouses have been constructed in the Keys region. Approximately 16 lighthouses are located within or near the FKNMS. Three of the lighthouses are listed on the National Register of Historic Places. Of the existing lighthouses in the Sanctuary, some are built directly on the reef. The first of six original lighthouses constructed on the reef was begun in 1852. Other significant historical reef lighthouses include Carysfort Reef Light (1852), Sand Key Light (1853), Sombrero Key Light (1858), Alligator Reef Light (1873), Fowey Rocks Light (1878), and American Shoal Light (1880) (NOAA, 1996b). None of the lighthouses are situated on Molasses Reef.

3.10.3 Previous Historic Resource Investigations at the Site

No artifacts were found during the response to the grounding or the salvage efforts. However, a cultural resources survey that was conducted at the *Wellwood* grounding site in August 2001 located five areas containing shipwreck debris (Tidewater Atlantic Research, Inc. 2001) but none are directly in the restoration area. Each area reflects the general patterns of trade and transportation typical of the Keys, although none can be positively associated with a specific vessel (TAR, 2001). In addition, there are several cultural resources sites elsewhere within the Molasses Reef area, although none are located within the immediate vicinity of the injured area (Hayes, 1997).

3.11 HAZARDOUS AND TOXIC SUBSTANCES

Hazardous and toxic substances typically include (1) inventoriable materials currently used as part of day-to-day manufacturing operations, (2) regulated substances such as asbestos and lead-based paints, and (3) any improperly disposed-of materials such as spilled or buried hazardous waste. None of these issues are encountered at Molasses Reef due to its offshore location. In fact, there are no Superfund sites located in Monroe County. The United States Environmental Protection Agency's (USEPA) database indicates only one nearby Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 Toxic Release Site in Marathon, the Royal Palm Ice Plant, from which there has not been a reported release since 1988 (USEPA, 1999b). Accordingly, the environment around Molasses Reef is lacking any known significant quantities of hazardous materials or substances.

3.12 SOCIOECONOMICS

3.12.1 Region of Influence

The socioeconomic indicators described in this section include regional economic activity, employment statistics, and demographics. These indicators characterize the region of influence (ROI).

An ROI is a geographic area selected as a basis on which the social and economic impacts of projects are analyzed. The ROI is the area most affected by changes resulting from project implementation and is usually based on where project employees reside, local commuting and purchasing patterns, and the size and scope of the proposed project. Typically, a county is the smallest unit of analysis for an ROI. Because the proposed activity is relatively limited in scope and will involve few workers over a short period, the ROI for the social and economic environment is defined as Monroe County, Florida. Furthermore, the inclusion of other surrounding counties such as Broward and Dade counties, whose populations and economies are substantially larger than those of Monroe County, would significantly dilute any positive or negative effects of the proposed project.

3.12.2 Regional Economic Activity

In 1996, employment in the ROI was exclusively nonagricultural. The primary sources of employment were services, retail trade, and government enterprises. As shown in Table 3-3, these sectors accounted for more than 75 percent of the county's total employment.

Table 3-3. ROI employment by major sectors

Employment Sector	Percent of Total Employment
Services	34.2
Retail and Wholesale Trade	26.8
Government Enterprises	15.2
Finance, Insurance, Real Estate	7.0
Construction	6.5
Agricultural Services, Forestry, Other	4.2
Transportation	4.2
Manufacturing	1.5
Mining	0.3

Source: U.S. DOC, 1998.

The economy of Monroe County is heavily dependent on tourism. In 1996, proprietors' employment accounted for more than 21 percent of the county's total employment, compared to 14.5 percent for Florida and 16.4 percent for the United States (U.S. DOC, 1998). This statistic indicates the central importance of small businesses in the tourist economy. In fact, a recent study estimated that tourist/recreational activities provided more than 46 percent of the county's employment and about 60 percent of the county's total economic output (English et al., 1996). Consistent with these statistics, four of the six largest employers in the county are tourism-related.

In 1990 about two million tourists visited the Keys, totaling about 13 million visitor days, with a direct spending impact of almost $800 million. Total gross sales amounted to approximately $1.6 billion (NOAA, 1996b). In addition, a significant number of retired persons live in Monroe County, generating a large amount of income in transfer payments flowing into the local economy in the form of pensions, retirement pay, dividends and interest on investments, and social security. In 1997 an estimated 16 percent of the total population was 65 years of age or older, compared to 13 percent for the United States. This creates a base of income in Monroe County that is independent of employment. In 1996, Monroe had a per capita personal income of $28,959, which ranked seventh in the state and was 120 percent of the state average ($24,198) and 119 percent of the national average ($24,436).

The military and the commercial fishing industry are also important sectors of the region's economy. The unemployment rate for Monroe County was 2.7 percent in 1996, compared to 5.3 percent for the United States. It should be noted that much of the employment is seasonal and rates vary during the year.

3.12.3 Demographics

In 1997, the population of Monroe County was estimated at 82,684, an increase of 6 percent since 1990. The population grew almost 30 percent between 1980 and 1990, an annual rate of almost 3 percent. The population is projected to continue to grow albeit at a slower rate. The population is projected to reach more than 101,000 by 2010, a 1.5 percent growth rate. As noted above, the county has a large population of retirees. Table 3-4 shows the racial/ethnic breakdown of the population estimates for 1997.

Peak tourist populations occur from January to March of each year. The tourist season is longer in the Upper Keys than in the Lower Keys, extending from January to August, and is based on weekend tourists from Miami and South Florida. The functional population (the sum of the peak seasonal and resident population) was 134,600 in 1990 (NOAA, 1996b). The seasonal population accounts for nearly 42 percent of the functional population during the peak tourist season.

3.13 QUALITY OF LIFE

One of the most valued aspects of the Molasses Reef ROI is its natural aesthetic beauty. Many people have moved to this area to enjoy the bountiful natural resources. The quality of life of the local residents depends on the condition of the coral reef ecosystem. Thousands of tourists come to the region each year to enjoy recreational fishing, snorkeling, and diving around the reef's ecosystem. Tourism is a major part of the economy and supports local

SECTION 4. ENVIRONMENTAL CONSEQUENCES OF PROPOSED AND OTHER ALTERNATIVES

4.1 INTRODUCTION

The alternatives analysis describes the environmental and socioeconomic consequences of implementing each alternative. The alternatives considered are summarized in Table 4-1. The preferred alternative is intended to restore a component of the structural relief of the reef at the grounding site to as close to its preexisting natural condition as practicable. The focus of the preferred alternative is to recreate preexisting habitat, structure, and surface topographical relief, and then to transplant corals to reestablish a coral community, and to enhance the recruitment of corals. This restoration would allow the recolonization of the area by benthic and associated reef species.

The direct and indirect effects of each alternative are discussed with respect to 13 resource categories. The effects (adverse or beneficial) or lack thereof, are described according to duration (short-term or long-term) and intensity (minor or major). Table 4-2 summarizes the impacts associated with each alternative.

4.2 PREFERRED ALTERNATIVE: Substrate Stabilization, Structural Restoration, Coral Transplantation and Enhanced Biological Restoration

4.2.1 Location and Area Use

Direct Effects. Long-term major beneficial effects would be expected. Restoration of the reef would restore the ecosystem and increase its habitat value. Restoration would increase the number of people using the immediate area for recreational diving and snorkeling.

The type of restoration planned (a relatively small percentage of the damaged area) would provide a control for natural recovery, adding value for scientific study. NOAA determined that only a small portion of the injured reef should be restored, for several reasons. First, it has been 18 years since the grounding incident occurred and the site, as well as the surrounding area, has changed from their condition immediately following the grounding. It is not possible to restore the site to its original pre-grounding condition. Second, the research community has conducted a significant amount of monitoring and research effort at the site in the interim, so portions of the site serve the purpose of demonstrating the natural recovery of an un-restored area. NOAA is still committed to stabilizing portions of the site because otherwise it would continue to deteriorate, and to restoring some of the vertical relief to increase habitat at the site.

SECTION 5. REGULATORY REVIEW

The implementation of the preferred restoration alternative would require that NOAA obtain proper work permits, comply with the provisions of federal and state regulations, and notify appropriate organizations before conducting any restoration activity. To prepare for implementation in a timely manner, NOAA has initiated efforts to meet these requirements. The requirements are briefly described below, and the supporting documentation is enclosed as Appendices A, B, D, and E.

5.1 National Environmental Policy Act of 1969 (Public Law 91-190)

The National Environmental Policy Act (NEPA) requires that environmental information on the project has been compiled. The environmental assessment that must be completed in accordance with NEPA is provided in the form of this document. It assists in determining whether the proposed major federal action will have significant impacts on the quality of the human environment. Relevant sections of NEPA are provided in Appendix D.

5.2 National Marine Sanctuaries Act (16 U.S.C. § 1431 et seq., as amended)

As required by the National Marine Sanctuaries Act (NMSA) (also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972), NOAA will expend the settlement monies (received from the owners of the *Wellwood*) toward restoration of the damaged site. Detailed investigations into the damage caused by the grounding began in 1984; efforts to formulate the structural restoration alternatives for the *Wellwood* grounding site began in 1999. The work proposed in this Environmental Assessment represents the preferred alternative identified by NOAA. The NMSA stipulates that recovered amounts, in excess of that required to be expended for response costs and damage assessments, must be used, in order of priority: 1) to restore, replace, or acquire the equivalent of the sanctuary resources; 2) management of the sanctuary where the subject resources are located, and; 3) to manage and improve any other national marine sanctuary. Relevant sections of the NMSA are provided in Appendix A.

5.3 Florida Keys National Marine Sanctuary and Protection Act (Public Law 101-605)

The Florida Keys Marine Sanctuary and Protection Act requires that NOAA coordinate with the appropriate federal, state, and local governmental agencies and entities to support implementation of the management plan for the FKNMS. The proposed action analyzed in this document will occur within the boundaries of the FKNMS, and therefore NOAA will ensure that all activities comply with the sanctuary management plan. All appropriate permits for work within the FKNMS will be obtained from the Sanctuary Office prior to project initiation.

5.4 Clean Water Act (33 U.S.C. § 1251 et seq.)

The Wellwood grounding site is in Federal waters, outside the 3 mile boundary of the State's permitting jurisdiction. A notification was submitted to the Florida Department of Environmental Protection including a copy of the draft EA. Written confirmation that the project was exempt from the need for an environmental resource permit was received. No authorization from the Submerged Lands Program was required. The project was also exempted from a US Army Corps of Engineers permit.

5.5 Coastal Zone Management Act (16 U.S.C. § 1451 et seq.)

The *Wellwood* restoration site is outside State waters and is unlikely to affect any coastal resources within Florida's coastal zone. However, under the Coastal Zone Management Act (CZMA), all Federal activities must be consistent with the enforceable policies of State management programs. A consistency determination was submitted to the State Clearinghouse was submitted and NOAA received a concurrence for this restoration.

5.6 Florida Department of Environmental Protection, Bureau of Wetland Resources Management

Under State law, Florida has jurisdiction over dredge and fill operations conducted in or connected to waters of the State. Prior to issuing the Sanctuary permit NOAA will obtain confirmation by the Bureau of Wetland Resource Management that a Water Quality Certification for Works in the Waters of Florida is not required since restoration work will take place outside state waters.

5.7 Florida Department of Environmental Protection, Bureau of Submerged Lands and Environmental Resources

The Florida Bureau of Submerged Lands and Environmental Resources determined that the work is located outside the State's sovereign submerged ownership and does not require a lease or an easement from the Division of Environmental Resource Permitting (Submerged Lands).

5.8 Florida Department of State, Division of Historical Resources

The Division of Historical Resources' State Historic Preservation Officer (SHPO) was contacted pursuant to National Historic Preservation Act of 1966. CONCA cultural resource survey and report was conducted in August of 2001. Five areas containing shipwreck debris were located outside of the restoration area and recommended to be avoided. Pursuant of the recommendation, NOAA would require the contractor to avoid these areas during construction. The SHPO has concurred with the report's recommendations and findings.

5.9 United States Coast Guard

NOAA will notify the Coast Guard concerning the nature and timing of restoration activities so that the Coast Guard can issue a notice to mariners.

5.10 Endangered Species Act (16 U.S.C. §§ 1531-1543)

The Office of National Marine Sanctuaries made a determination that the proposed project is not likely to adversely effect endangered or threatened species. This determination was transmitted with the draft EA to both the US Fish and the NOAA Southeast Regional Office, Protected Resources Division. A letter of concurrence was received from FWS, and a verbal acknowledgement from NOAA. Section 7 is provided in Appendix B.

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SECTION 8. FINDING OF NO SIGNIFICANT IMPACT

NOAA Administrative Order (NAO) 216-6 (revised May 20, 1999) provides eleven criteria for determining the significance of the impacts of a proposed action. These criteria are discussed below with respect to the proposed action (alternative 1):

1. Impacts may be both beneficial and adverse -- a significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.

The beneficial effects of the proposed action are expected to be significant with no adverse effects. The restoration would limit future threat to damaged pre-existing habitat while providing habitat to both locally threatened coral reef communities.

2. What is the degree to which public health or safety is affected by the proposed action?

Public health and safety will not be affected by the proposed action. The only potential health risk is if a catastrophic petroleum, oil, or lubricant leak occurred. The likelihood of this type of spill is very small, and the short duration of the construction phase would help to minimize the potential for a catastrophic release. In the case of this event occurring, spill prevention, response and clean-up plans have been developed. However, even if this occurs, the impact will be on the coral reef communities and only come into contact with members of the public who venture out to molasses reef.

3. Are there unique characteristics of the geographic area in which the proposed action is to take place?

The coral reef ecosystem of the Florida Keys is unique as compared to other coral reefs in the world. However, the site of the proposed action is particularly unique to the Florida Keys because it is an ecological reserve. The reserve designation is because Molasses Reef is the most heavily visited reef in the Florida Keys.

4. What is the degree to which effects on the human environment are likely to be highly controversial?

The effects to the human environment are expected to be positive (refer to section 4.10 for a discussion of the socioeconomic impacts). Therefore, the effects are not at all likely to be controversial amongst the residents of the Florida Keys. In fact, restoring the reef will support more coral habitat for divers to enjoy and therefore beneficially impact the human environment.

5. What is the degree to which effects are highly uncertain or involve unique or unknown risks?

The restoration draws on the experience of previous NOAA restoration activities (refer to section 2.1 for details). Restorations such as that of the *Columbus Iselin* included placement of modules in areas of damaged reef. The monitoring projects in restoration areas have shown coral recruitment. The only unknown factor, which is not a risk, is the population diversity and density in coral re-colonization of the restored area.

6. What is the degree to which the action establishes a precedent for future actions with significant effects or represents a decision in principle about a future consideration?

The FKNMS has already issued numerous authorizations for coral reef restorations in the past. Therefore, this action does not set a precedent. Furthermore, the more restorations that occur in the sanctuary will enable FKNMS to make more informed decisions about similar projects in the future.

7. Does the proposed action have individually insignificant but cumulatively significant impacts?

The proposed action is expected to have individually insignificant impacts. The cumulative impacts of restored reefs along the Florida Keys reef tract is expected to be a positive benefit to the coral reef ecosystem. These reefs were injured by ship groundings and are now being restored to approximate their original, pre-injury condition. This will provide marine life habitat and encourage coral recruitment.

8. What is the degree to which the action adversely affects entities listed in or eligible for listing in the National Register or Historic Places, or may cause loss or destruction of significant scientific, cultural, or historic resources?

The proposed action will not adversely affect any entity listed in or eligible for listing in the National Register of Historic Places. The State of Florida Historic Preservation Officer has concurred with this finding in accordance with the National Historic Preservation Act. A comprehensive cultural resource survey of the project site was performed. The only artifacts noted in the area were outside the actual work site for this project. Refer to section 4.7.10 for a discussion.

9. What is the degree to which endangered or threatened species, or their critical habitat as defined under the Endangered Species Act or 1973, are adversely affected?

The proposed action will not have a significant impact on any species listed as endangered or threatened under the Endangered Species Act. The National Marine Sanctuary Program has coordinated with both the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, who have both concurred.

10. Is a violation of Federal, state, or local law for environmental protection threatened?

The proposed action does not threaten any violation of Federal, state, or local environmental law. While this activity would otherwise be prohibited by FKNMS regulations (15 CFR 922), an FKNMS permit has been issued for the project. All necessary approvals have been obtained from the Army Corps of Engineers and the State of Florida.

11. Will the proposed action result in the introduction or spread of a nonindigenous species?

The proposed action should not affect the status of any invasive species. All materials being used are natural limestone or domestic products. All vessels being used to conduct the project work are domestic and will not be taking on ballast in a foreign port prior to entering the ecosystem.

8.1 FINDING OF NO SIGNIFICANT IMPACT STATEMENT

In view of the analysis presented in this document, the proposed restoration of a coral reef at Molasses Reef off Key Largo, Florida, will not significantly affect the quality of the human environment, with specific reference to the criteria contained in Section 6.1 or NAO 216-6, Environmental Review Procedures for implementing the National Environmental Policy Act. Accordingly, the preparation of an Environmental Impact Statement for the proposed action is not necessary.

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Margaret A. Davidson Date
Acting Assistant Administrator
For Ocean Services and Coastal Zone Management