RECORD OF DECISION
for the
FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
on
CORAL RESTORATION IN THE FLORIDA KEYS AND FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARIES

Introduction

This document comprises the National Oceanic and Atmospheric Administration (NOAA) Office of National Marine Sanctuaries' (ONMS) Record of Decision (ROD) for the Final Programmatic Environmental Impact Statement (FPEIS) on Coral Restoration in the Florida Keys and Flower Garden Banks national marine sanctuaries (FKNMS and FGBNMS, respectively) as required by the National Environmental Policy Act (NEPA).

The FPEIS programmatically evaluates the short and long-term environmental and socioeconomic effects related to the implementation of coral reef restoration and coral reef injury prevention projects in the Gulf of Mexico and Caribbean waters of the National Marine Sanctuary System, which includes the FKNMS and the FGBNMS. As this document focuses on the most likely and feasible future regional coral reef restoration and injury prevention activities within both sanctuaries, the discussion of potential impacts on biological resources, social considerations, and economic activities cannot be site- or case-specific. Therefore, the purpose of the FPEIS is to present and analyze the current technologies available for coral injury prevention and restoration in these regions in order to support the selection and implementation of specific actions when needed. In general, many restoration actions are expected to be adequately addressed by this FPEIS and would qualify for categorical exclusion when the decision is made. Larger more complex actions may require additional analysis and as such, the appropriate environmental analysis would tier off of this FPEIS and focus on the specific circumstances of the injury and location, or specific restoration requirements.

ONMS's coral reef restoration objectives are to conduct feasible and cost-effective restoration using the best available techniques to accelerate recovery of the injured areas to the pre-injury baseline levels. In addition, ONMS seeks to facilitate the prevention of future coral reef injuries through the implementation of preventative actions or projects. These restoration and injury prevention objectives are in keeping with the goals and policies of the National Marine Sanctuaries Act (NMSA), the Florida Keys National Marine Sanctuaries Protection Act, the FKNMS and FGBNMS Management Plans and the sovereign submerged land policies of the State of Florida. The NMSA, 16 U.S.C.§1443(d)(2), define the appropriate uses of recovered damages in order of priority as "(A) to restore, replace, or acquire the equivalent of the sanctuary resources that were the subject of the action…; (B) to restore degraded sanctuary resources of the National Marine Sanctuary that was the subject of action, giving priority to sanctuary resources and habitats that are comparable to the sanctuary resources that were the subject of the action; and (C) to restore degraded sanctuary resources of other National Marine Sanctuaries." Under the NMSA, ONMS sometimes considers salvage and prevention projects to be restoration; this is most likely in a situation where prevention of additional injury through removal of a large vessel could provide greater benefit than future restoration of a significant injury. Prevention projects may include the protection of equivalent resources, which falls under (A) above, and serve to reduce the likelihood that injury will occur at a later time.

Decision to Be Made

Although this FPEIS provides analysis of the impacts for typically expected restoration results, each injury site and circumstance will be unique. Each restoration will require an individual NEPA analysis. The purpose of this FPEIS is to provide an overarching NEPA analysis for these types of activities, such that any subsequent NEPA analysis can rely on and, as necessary, tier off this document. This will allow for timely and efficient analyses and help ensure restoration activities are initiated as soon as possible for the benefit of the resource.

Environmentally Preferable Alternative(s)

Due to the nature of this programmatic assessment, there is no one environmentally preferable alternative. Each of the alternatives evaluated has benefits and costs that will vary depending on the nature and specific circumstances of a particular injury.

Alternatives Considered

A summary of the alternatives considered is presented in Table 1.

No Action

The no-action alternative would leave the reef in its post-injury condition, allowing natural recovery processes to occur. The no-action alternative could have three general outcomes: 1) natural recovery on a longer time scale; 2) no recovery; or 3) further deterioration of the reef system. It is important to note that in cases where NOAA has recovered damages for coral injury under NMSA § 312, the no-action alternative may not be a legally acceptable choice. NOAA always retains the alternative, however, as a basis of comparison, and for purposes of technically complying with CEQ's NEPA regulations.

Physical Restoration

Alteration or destruction of three dimensional habitat complexity is one of the most common types of coral injury. In general, this complexity must be restored prior to restoration of the biological community. Physical, or structural, restoration only addresses injuries to the reef substrate, not the live coral community. The options for physically restoring coral habitat complexity were:

Debris and Vessel Removal

Groundings of large vessels often result in vessel debris—propellers, engines, running gear, anchors and associated chain, etc.—or even entire vessels left on the reef. Removal of vessels and debris is typically accomplished at high tide, when additional water over the reef facilitates vessel removal. Depending on its size, a vessel may be removed using a single floating towline to another vessel, or may require multiple tugs and floating towlines. Careful selection of an exit path is required in order to minimize collateral injury to surrounding reefs as the vessel is taken out. For larger efforts with multiple or heavy towlines, it is also important to monitor the placement and use of towlines to ensure that they do not get caught on reef material and break coral heads or scrape the tops of coral heads. Removal of other debris may require additional equipment, including cranes, specialized vessels, and commercial dive equipment.

Sediment and Rubble Removal

Removing large quantities of rubble can speed recovery and reduce additional injury. In general, clearing sites of rubble as soon as possible after the injury is done before other restoration actions are undertaken. This prevents collateral injury, allows preservation of large pieces of live coral, and provides a more suitable substrate for subsequent restoration actions. The rubble may be stockpiled for later use in constructing restoration replacement structures and/or ornamentation of other reef repairs. Small quantities of coral rubble can be removed by divers using baskets or lift bags, while larger amounts may require a barge with suction, guided by underwater divers.

Substrate Stabilization

Loose pieces of reef substrate can be stabilized using marine epoxy or concrete to fill in cracks and holes or to otherwise solidify the substrate. This is often referred to as a "puddle pour" since a small

Table 1: Coral Restoration Alternative Matrix/Comparison

ALTERNATIVE	SITE CONDITION FOR USE	RESULT
No Action: Leaving the injury unrestored.	The no-action alternative is most often used for cases when ONMS determines that an injury site is likely to recover in a short period of time with a low likelihood of injury expansion, or where other social, environmental, or logistical considerations dictate that no-action is the best course.	The no-action alternative would leave the reef in its current post-injury condition, allowing natural recovery processes to occur. The no-action alternative could have three general outcomes: natural recovery on a longer time scale; no recovery; or possible further deterioration of the reef system.
Debris and Vessel Removal	Appropriate where a vessel is sunk, aground or broken up. Also applicable for marine debris from a vessel or other source, such as debris dumped for artificial habitat or lost fishing gear.	Precludes further impacts from vessel or debris. Facilitates opportunities for either natural recovery or for additional restoration work as necessary. Does not restore any physical or biological properties.
Sediment, Rubble Removal: Removing loose material from the injury area.	Appropriate for disturbances that produce quantities of coral rubble and fine sediment material, including large vessel groundings and anchor injuries.	This prevents collateral injury and also allows preservation of large pieces of live coral. Does not repair any physical or biological properties.
Limestone Boulders and Modules: Placement of limestone boulders or preformed modules in injury area, stabilized with tremie concrete pour & rebar.	Appropriate for large areas of injured framework, rubble and sediment too copious for removal; requires stabilization in-place. Modules are capable of creating more natural internal void spaces (i.e., caves, tunnels, etc.) thereby more closely replicating the habitat functions of well developed yet highly bioeroded reef structures.	This provides long-term stabilization of substrate and creation of permanent relief. Provides physical restoration only. Given the use of artificial, man-made components, this option is only appropriate on a case-by-case basis.
Revetment Mats: Concrete blocks interconnected by flexible cables. Must be assembled on land and then installed in place from a construction platform, using a crane and spreader bar.	Appropriate for stabilization of large rubble zones in a relatively low energy environment. Revetment mats would likely be used in combination with other alternatives.	Because of bulky nature and the complexities of installation, these are not appropriate for temporary placement to facilitate short-term stabilization. Requires use of manmade materials and results in unnatural appearance.
Reattachment and Transplantation: Facilitate the redevelopment of coral (hard and soft) communities on injured or degraded reefs. Other benthos (such as sponges) may also be reattached and stabilized, typically during emergency restoration.	Used at any site with live coral fragments to save as much live coral as possible. Often used in combination with other structural options. Frequently used after structural restoration to re-create biological characteristics.	Stabilizes fragments to prevent further loss and injury. Reduces live coral loss; once cemented in place, corals recover a majority of their baseline function. Does not reestablish injured framework.
Emerging Biological Technologies: Diadema, recruitment enhancement, electroaccretion.	Potential for use in sites with low live coral cover to "jumpstart" coral growth. Many techniques are not appropriate for use until technology is better tested.	Increases coral cover, coral growth rates, and whole community. Establishes a more stable basis for long-term development of reef.

hole or area of unstable substrate is filled in by pouring concrete to bring it to grade. Such a pour is usually "dressed" with fragments of relict (or live, if available) coral to provide relief, a more natural appearance, and some cryptic habitat. This technique is typically used in combination with others, often the addition of limestone and/or preformed modules, and reattachment.

Limestone Boulders and Preformed Modules

In areas with significant alteration to three-dimensional structure, limestone boulders of appropriate size or preformed concrete and limestone modules can be used to fill depressions and re-create relief. Boulders of varied sizes can be placed in the injured area and then stabilized with underwater concrete that flows and has very low turbidity so it does not mix with the water column (known as a "tremie pour"). The boulders can be stacked so as to replace and recreate some of the relief and rugosity that were destroyed. Plastic composite rebar can be placed in the concrete to improve attachment between the boulders, and between boulder and concrete layers. For larger areas, modules created from a combination of materials, including concrete, limestone boulders, or reef rubble, and steel or composite reinforcing rods, are preferred. Modules are similar to tremied concrete/boulder conglomerate, but are larger and heavier, and they can be designed in a variety of shapes and sizes, depending on the nature of the restoration needs. Once in place, tremie is poured around the modules for stabilization and smaller rocks are placed in the concrete to cover the concrete and blend sharp vertical faces with the surrounding habitat. In addition to creating relief, the greater weight of modules can also be effective at stabilizing underlying framework injury. However, the use of large quantities of manmade material dictates that this option be used sparingly. Situations in which this would be reasonable include destruction of reef spurs or other large framework injury.

Revetment Mats

Revetment mats consist of concrete blocks, usually 1 square 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 conform to the shape of the natural contour. It is uncertain whether revetment mats could crush or crack the underlying reef structure. Situations in which this would be a reasonable alternative include sites with a large rubble zone in a relatively low energy environment where rubble needs to be stabilized and removal is not feasible or recommended. Due to their bulky nature and the complexities of installation, these are not appropriate for temporary placement to facilitate short-term stabilization.

Biological Restoration

Even though structural restoration has traditionally been the focus of coral reef restoration, the length of time required for a coral community to develop can mean that even after the physical environment has been restored the injured site will take many years to resemble (aesthetically and functionally) a mature coral ecosystem. Therefore, ONMS may use biological restoration techniques to enhance the rate at which coral communities re-develop in an injured area.

Reattachment and Transplantation

Fractured, dislodged, and overturned coral, if salvaged before mortality and degradation, can be stabilized via reattachment. Reattachment of live framework coral pieces and transplantation of live scleractinian and gorgonian coral, are effective techniques to facilitate the redevelopment of coral communities on injured or degraded reefs. In addition to on-site coral fragments that can be reattached, there are several other potential donor sources for scleractinian corals, including: at risk coral pieces collected from small or "orphan" groundings and held (cached) until restoration is implemented; corals removed from artificial structures (such as seawalls, piers, or pilings) prior to replacement; corals from within the footprint of proposed and permitted projects (e.g., construction or dredging); and nursery corals that have been grown under controlled conditions expressly for placement back on the reef. This includes on-site underwater nurseries (farms) as well as using coral husbandry techniques in laboratory settings to enhance recruitment, growth, and propagation of key species. Corals reared under laboratory settings must be certified for health prior to release back into the natural environment. The colonies used for transplantation should not be harvested from donors on surrounding reefs; this ensures that restoration is not accomplished at the expense of surrounding habitats.

Gorgonian coral colonies can also be translocated and reattached. Such colonies may be either entire colonies dislodged during the injury event, or clippings from local mature colonies. The branching nature of gorgonians means that clippings can readily be harvested from local donors without causing additional habitat injury or endangering the donor colony. When appropriate, other sessile benthic fauna such as sponges may also be reattached and stabilized. This typically occurs only during emergency restoration. In general, techniques for reattachment of other fauna are less developed than for scleractinian and gorgonian corals.

Reattachment is included as part of many ONMS injury response actions. As long as there are live fragments available, reattachment is appropriate for any injury, either used alone or to complement physical restoration. Reattachment can be accomplished quickly by ONMS staff using small boats, or contractors operating on a larger scale, as required.

Emerging Technologies
Although there are several new techniques currently being developed that should expand the range of alternatives available for restoration, ONMS will only consider techniques with a proven track record (i.e., field-tested and published in peer-reviewed literature) of successful implementation. As new techniques become less experimental, ONMS may consider adopting their use after an appropriate NEPA analysis. Examples of some of these new techniques include electroaccretion (the *in situ* formation of semi-artificial substrate by electrolysis), recruitment enhancement, and community modification.

Rationale for Selection of the Preferred Alternative

After consideration of the criteria for evaluating coral restoration options, the description of the restoration options, and the environmental and socioeconomic consequences, the restoration options below have been selected as the most preferred, depending on site-specific conditions. However, any of the alternatives described in the FPEIS may be appropriate for use on a case-by-case basis, depending on the specific injury parameters.

1. *Debris, Vessel, Sediment or Rubble Removal*: Removal of any loose items—vessel or fishing debris, and any reef material—provides two benefits. First, removal of loose items decreases the potential for future injury from movement and redistribution that can injure existing habitat. Second, it enhances the ability of the habitat to recover by providing more stable and suitable substrate for coral and other benthic colonization. Without adding anything to the reef, completion of this action as soon as possible after injury can provide great benefits for the majority of injuries, particularly the smaller ones. Based on field experience, it is estimated that 50% of restorations will include debris, sediment or rubble removal.

2. *Substrate Stabilization*: The stabilization of loose and fractured reef substrate creates a major benefit by providing stable substrate upon which juvenile corals and other benthic organisms can settle. This is a non-invasive technique that provides maximum benefit through use of stabilizing natural reef material and recreating, to the extent possible, any three-dimensional relief that was lost as a result of the injury. Based on field experience, it is estimated that 80% of restorations will include substrate stabilization.

3. *Reattachment and Transplantation*: Reattachment of corals that were dislodged or fragmented due to an injury has several benefits. First, it preserves natural material and mimics the relief and dimensions of the reef to the extent practicable. Second, it uses the original reef materials, which preserves the biological community, especially if fragments of living coral are reattached immediately after assessment. Based on field experience, it is estimated that 95% of injuries with live coral will require reattachment. Based on field experience, it is estimated that 20% of restorations will include framework reattachment.

These three preferred restoration options are not mutually exclusive. In fact, the majority of injured sites will most effectively be restored by employing at least two options, if not all three. In addition, it must be recognized that the selection of these preferred options is based upon a "typical" injury. As such, the selection of these preferred options does not preclude the use of the other restoration techniques at individual injury sites. Depending on site-specific conditions, other techniques may be most appropriate, especially for larger, more significant injuries, or those in unique habitats. Based on field experience, it is expected that modules and revetment mats will be included in less than 10% of restorations.

Mitigation Measures and Monitoring

Prior to the implementation of any restoration activities, a detailed restoration plan, including any necessary mitigation measures, must be prepared and approved by ONMS. This ensures that the most appropriate methodologies are used, given the nature of the restoration and the environmental circumstances at the injury site. During the restoration activities, mitigation measures would be undertaken to minimize the potential long-term and short-term adverse effects that could result from restoration activities. These measures would be employed at restoration sites as appropriate. If a contractor were used, ONMS resource protection field staff would be onsite at all times during construction to oversee contractor activities in order to minimize and mitigate any potential adverse impacts.

Geology: Precautions will be taken to ensure that vessels and equipment do not contact or injure the seabed or reef framework. Navigation by the construction team within the site area during darkness or periods of reduced visibility is not permitted, and a foul weather and hurricane evacuation contingency plan must be developed to remove work vessels from the reef area if conditions warrant.

Water Resources: Mitigation measures include use of the tremie placement technique to minimize turbidity resulting from concrete placement, inclusion of an anti-washout ingredient in cement mixtures, and avoiding contact with fresh pours to minimize mixture of the cement and water. Any construction contractor hired would be required to comply with all applicable environmental regulations and would be required to have adequate prevention, response and clean-up plans. Turbidity monitoring would take place during implementation as appropriate and required.

Biological Resources: Numerous mitigation measures would be required, including:

- Corals would be temporarily relocated away from the injury site, with transplantation back onto the site once construction is complete.
- ONMS resource protection field staff would oversee the activities of any contractors to minimize potential direct impacts.
- ONMS, and any contractor used, would carefully monitor and oversee construction related activities to minimize injuries to fish, wildlife, and habitat, including *Acropora* species. This includes instructing personnel on the proper procedures for conducting work in this type of habitat.
- Personnel would be required to: prevent any blockage to the movement of manatees, sea turtles, dolphins, porpoises, or whales in the environment; operate vessels at "no wake/idle" speeds when

in shallow waters; and stop work when manatees, sea turtles, or whales move to within 15.2 meters (50 ft) of the construction operation.
- Any contractor used would be required to periodically relocate the barge to prevent coral bleaching.

Infrastructure (Construction and Vessel Moorings)
Consideration would be given to the use of buoyant mooring lines to keep the lines from striking the bottom during loading from wave attack. Substantial anchors, placed off the reef in sand or bedrock areas, might be necessary to resist wave-induced mooring loads. Anchoring and installation of additional mooring buoys may require an ONMS permit. In addition, the contractor would also be required to establish a storm anchor point in deep water. If required, the installation of temporary exclusion buoys could create additional injury, though adherence to standard installation considerations would be required and would limit collateral injury. Adequate, approved disposal options would be required to be available for solid waste.

Cultural Resources
Consideration of known artifacts would be required in any construction plan. Mitigation measures would require that the sanctuary superintendent would be notified immediately if any previously-unknown artifacts were discovered post injury or during restoration. Any such artifacts would be mapped in-place and recovered, if necessary, by a marine archaeologist and then turned over to the sanctuary if they came from federal waters, or to the state if they came from state waters, to be conserved following accepted conservation standards in accordance with federal and state standards.

Hazardous and Toxic Substances
Spill prevention, response and clean-up plans would be developed for approval by ONMS prior to the restoration activity. The plan would include spill response actions and delineate the remediation activities of responsible parties. Additionally, the contractor would be required to comply with all applicable federal, state, and local regulations governing environmental pollution control and abatement.

Socioeconomics
ONMS would request that the public avoid the area during restoration activities to ensure public safety, and would ensure that appropriate notice was given to the public to use alternative locations. Only construction-related persons/activities would be allowed on site.

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Date