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Rapid Response and Restoration for Coral Reef Injuries in Southeast Florida: Guidelines and Recommendations

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RAPID RESPONSE AND RESTORATION FOR CORAL REEF INJURIES IN SOUTHEAST FLORIDA

Guidelines and Recommendations

A Maritime Industry and Coastal Construction Impacts Focus Area Project of the Southeast Florida Coral Reef Initiative

June 2007

Southeast Florida Coral Reef Initiative

Acting above to protect what's below.

Dedicated to Dr. Carl R. Beaver,
who guided us in the conservation and restoration
of Florida's coral reefs

This report was prepared for the Florida Department of Environmental Protection (FDEP) through an agreement with the National Coral Reef Institute (NCRI) at Nova Southeastern University. Funding for this report was provided in part by a Coral Reef Conservation Program grant from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Office of Ocean and Coastal Resource Management; and by FDEP, through its Coral Reef Conservation Program. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of NOAA or the Department of Commerce.

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I. INTRODUCTION

From the time an injury to coral reef resources is reported, a well-coordinated and implemented plan is critical to the success of response and restoration efforts. There are three major plan components, each of which is equally important: (1) the Initial Response period immediately following notification of the incident; (2) the Response period, during which the Responsible Party (RP) is identified, the Trustees and RP carry out their respective responsibilities, a Primary Restoration plan is developed, authorizations and contractors to conduct restoration activities are sought and obtained, and primary restoration activities are conducted; and (3) the Post-Response period, which is largely a monitoring, compensatory restoration/mitigation, and penalty assessment phase that takes place after primary restoration activities are carried out.

The guidelines and recommendations presented in this document were developed to examine reef injury response processes and to facilitate a rapid response to, and the successful restoration of, southeast Florida reefs. The document was developed as part of a Local Action Strategy (LAS) of the Southeast Florida Coral Reef Initiative (SEFCRI) to develop guidelines and recommendations for a rapid response and restoration process for reef injuries in the SEFCRI region (*Figure 1*).

Figure 1. The Southeast Florida Coral Reef Initiative spans Miami–Dade, Broward, Palm Beach, and Martin Counties, as well as the offshore waters from the northern boundary of Biscayne National Park to the St. Lucie Inlet (Figure courtesy of the FDEP Coral Reef Conservation Program).

In February 2006, a two-day workshop was held in Fort Lauderdale, Florida, to compile information on existing emergency response processes, identify deficiencies and develop solutions for those processes, and compile information on existing technologies and procedures for triage and the restoration of reef injuries. The first day of the workshop focused on process and policy issues. The second day addressed response, injury and mitigation assessment, restoration and repair, and monitoring. Workshop panelists[1] and attendees included representatives from local, state, and federal agencies with proprietary or regulatory authority or jurisdiction over sovereign submerged lands and reef resources located within Florida's waters. Also in attendance were technical and academic experts in the fields of coral reef research, injury assessment, and restoration, as well as marine contractors, private and public attorneys, nongovernmental organizations, and other interested parties. These guidelines and recommendations incorporate information from the combined experience of the workshop attendees, workshop outcomes, published documents, and numerous state and federal regulations, policies, and procedures.

Appendix 1 summarizes the rapid response process, and ***Appendix 2*** lists the 19 major recommendations of this report.

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[1] SEFCRI would like to extend its appreciation to the following workshop panelists: Capt. Laurie Luher, Florida Fish and Wildlife Conservation Commission, Division of Law Enforcement; F. Vincent Cesario, U.S. Coast Guard Sector Miami; Stephen Threet, Florida Department of Environmental Protection, Bureau of Emergency Response; John Studt, U.S. Army Corps of Engineers, Jacksonville District; Bill Goodwin, National Oceanic and Atmospheric Administration (NOAA), Florida Keys National Marine Sanctuary; Jim Jeannsonne, NOAA, Office of Response and Restoration; Dick Shaul, Sea Byte, Inc.; Richard Dodge, Ph.D., Nova Southeastern University, National Coral Reef Institute; Kurtis Gregg, Florida Department of Environmental Protection, Southeast District Office; Bruce Graham, Continental Shelf Associates, Inc.; Walt Jaap, Lithophyte Research LLC; Andrew Anderson, Houck, Hamilton, Anderson, P.A.; Regina Fegan, Florida Department of Environmental Protection, Office of the General Counsel.

II. CHARACTERIZATION OF THE SOUTHEAST FLORIDA REEF SYSTEM

Coral reef habitat in Florida is extensive—ranging from the Dry Tortugas in the south to Martin County (St. Lucie Inlet) in the north—and includes coral reefs and reef community colonized hard bottoms *(Figures 2, 3, 4, and 5)*. It is estimated that Florida shallow-water[2] coral reef habitat spans 30,801 square kilometers (km^2). This is much greater than the area estimated for other tropical reef areas. For example, Guam's potential coral reef habitat is estimated at 108 km^2, the Main Hawaiian Islands at 1,231 km^2, and Puerto Rico at 2,302 km^2[3]

The southeast Florida reef system extends north of the Florida Keys reef tract, approximately 170 km from Miami–Dade through Broward and Palm Beach Counties and into Martin County. The geographic range of the SEFCRI region extends from the northern border of Biscayne National

Figures 2, 3, 4 & 5. Coral reef community in Broward County (Photos courtesy of D. Gilliam, NCRI).

[2]Shallow water is defined as less than 18 meters (m) or 60 feet (ft) in depth.
[3]Rohmann, S.O., Hayes, J.J., Newhall, R.C., Monaco, M.E., and Grigg, R.W. 2005. The area of potential shallow-water tropical and subtropical coral ecosystems in the United States. *Coral Reefs* 24(3):370-383.

Park in Miami–Dade County, at Cape Florida off Key Biscayne (25º39.1 N, 80º09.6 W), to the St. Lucie Inlet (27º10.0 N, 80º08.4 W), in Martin County (*Figure 1*).

Florida is located at the convergence of the subtropical and temperate climate zones.[4] Additionally, a warm-water boundary current (the Gulf Stream) has a major influence on water temperature and the import of flora and fauna to the region.[5] The Gulf Stream intrudes into the Gulf of Mexico as the Loop Current and reverses flow, returning to the Straits of Florida to join the main body of the Florida Current. The Gulf Stream comes closest to the east coast of Florida off Palm Beach County, after which it follows a northeastward track to Europe. The Gulf Stream, with its influx of warm water, enables favorable conditions for coral reef development off the Florida coast, while also acting as a transport path for larvae from the Caribbean to Florida.

The southeast Florida reef system extending from Cape Florida (Miami–Dade County) north to central Palm Beach County—in particular, offshore Broward County—has linear reef complexes (referred to as reefs, tracts, or terraces[6]) running parallel to shore.[7] Inshore of the reef complex there are nearshore hardbottom ridges and colonized pavements (*Figure 4*). The Inner Reef (also referred to as the “First Reef”) crests in 3 to 7 m depths. The Middle Reef (“Second Reef”) crests in 6 to 8 m depths. A large sand area separates the Outer and Middle reef complexes. The Outer Reef (“Third Reef”) crests in 15 to 21 m depths. The Outer Reef is the most continuous reef complex in the system, extending from Cape Florida to northern Palm Beach County.[8]

The ridge complex comprises a series of outcroppings of Anastasia Formation limestone (created approximately 10,000 to 1.8 million years ago) north of Port Everglades, and carbonate grainstones south of Port Everglades.[9] Some areas in the north are composed of worm reef (*Phragmatopoma* sp.). These structures generally have low relief with variable populations of stony corals, octocoral, and macroalgae. Offshore of Broward County, the nearshore hardbottom ridges include some unique areas with higher stony coral cover (more than 10%), compared with the more typical stony coral coverage of 1 to 2% found in the SEFCRI region, as well as scattered colonies and patches of the threatened staghorn coral (*Acropora cervicornis*).[10]

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[4] Chen, E., and Gerber, J.F. 1990. Climate. In: Myers, R.L., and Ewel, J.J. (Eds). *Ecosystems of Florida*. Orlando, Florida: University of Central Florida Press, pp. 11-34.

[5] Lee, T.N., Williams, R.E., McGowan, M., Szmant, A.F., and Clarke, M.E. 1992. Influence of gyres and wind-driven circulation on transport of larvae and recruitment in the Florida Keys coral reefs. *Continental Shelf Research* 12(7/8):97-1002.

[6] Duane, D.B., and Meisburger, E.P. 1969. *Geomorphology and sediments of the nearshore continental shelf, Miami to Palm Beach, Florida.* Fort Belvior, Virginia: U.S. Army Corps of Engineers, Coastal Engineering Research Center. Tech. Mem. 29.
Goldberg, W. 1973. The ecology of the coral-octocoral communities off southeast Florida coast: Geomorphology, species composition, and zonation. *Bull. Mar. Sci.* 23(3):465-489.
Jaap, W.C., and Hallock, P. 1990. Coral reefs. In: Myers, R.L., and Ewel, J.J. (Eds). *Ecosystems of Florida.* Orlando, Florida: University of Central Florida Press, pp. 574-616.
Moyer, R.P., Riegl, B., Banks, K., and Dodge, R.E. 2003. Spatial patterns and ecology of benthic communities on a high latitude, South Florida (Broward County, USA) reef system. *Coral Reefs* 22:447-464.

[7] Moyer, R.P., Riegl, B., Banks, K., and Dodge, R.E. 2003. Spatial patterns and ecology of benthic communities on a high latitude, South Florida (Broward County, USA) reef system. *Coral Reefs* 22:447-464.

[8] Moyer, R.P., Riegl, B., Banks, K., and Dodge, R.E. 2003. Spatial patterns and ecology of benthic communities on a high-latitude SoWalker, B.K., Riegl, B., and Dodge, R.E. In press. Mapping coral reefs in suboptimal water clarity: Southeast Florida, USA. *Journal of Coastal Research.*
Banks, K., Riegl, B., Piller, W., Dodge, R.E., and Shinn, E.A. In press. *Geomorphology of the southeast Florida continental reef tract (Dade, Broward and Palm Beach Counties, USA).*

[9] Banks, K., Riegl, B., Piller, W., Dodge, R.E., and Shinn, E.A. In press. *Geomorphology of the southeast Florida continental reef tract (Dade, Broward and Palm Beach Counties, USA).*

[10] Gilliam, D.S., Dodge, R.E., Spieler, R.E., Jordan, L.K.B., and Monty, J.A. 2006. *Marine biological monitoring in Broward County, Florida. Technical Report 05-02.* Prepared for the Broward County Board of County Commissioners, Department of Planning and Environmental Protection, Biological Resource Division, p. 90.
Gilliam, D.S. In preparation. *Southeast Florida Coral Reef Evaluation and Monitoring Project 2006 Year 4 final report.* Prepared for the Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, and the Florida Department of Environmental Protection.

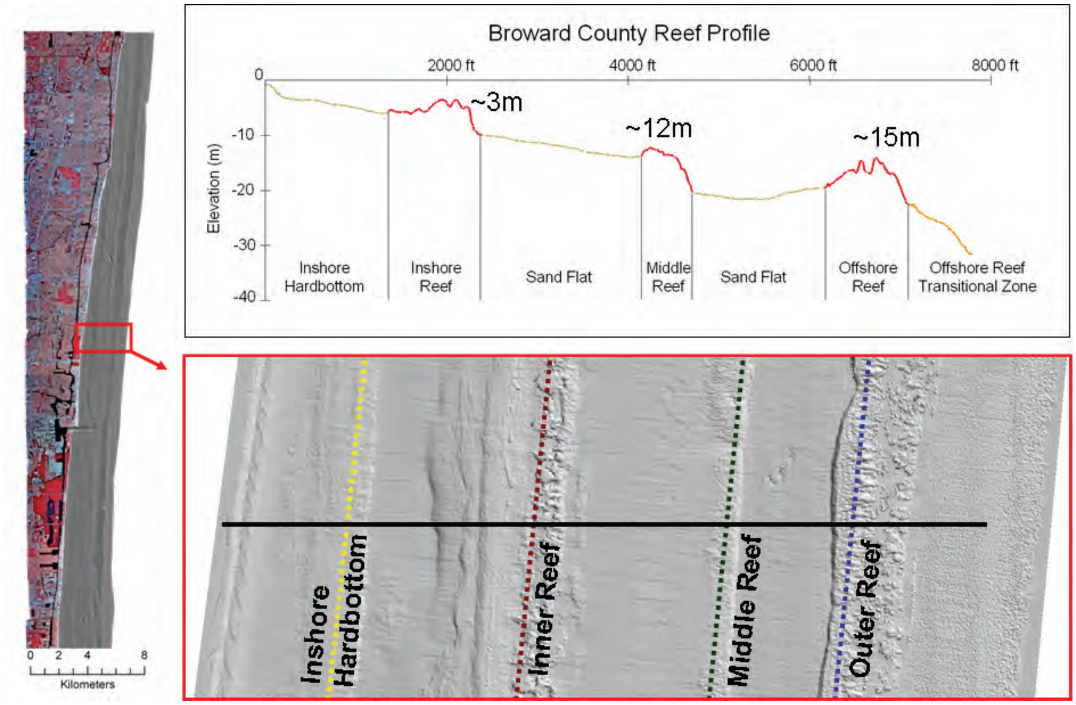

Figure 6. Panel A (at left): Southeast Florida coastline of Broward County, showing the land area in red and offshore submerged land in gray. Panel B (bottom right): The sea bottom is shown as sunshaded bathymetry from LIDAR data. The red square is enlarged in Panel B, showing the LIDAR bathymetry in greater detail. The black line shows the location of a bathymetric profile illustrated in Panel C (top right). (Figure courtesy of B.K. Walker, NCRI.)

The Inner and Middle Reefs have more structural complexity and contain dissecting channels, while the Outer Reef has stronger vertical relief and higher diversity, abundance, and average coverage of sessile reef organisms. The reef structure is often built on an ancient Acropora palmata framework. Stony coral coverage averages approximately 2 to 3%, with the most common species on the Inner and Middle Reefs being the great star coral (*Montastraea cavernosa*), massive starlet coral (*Siderastrea siderea*), and mustard hill coral (*Porites astreoides*). Octocorals are conspicuous, with some areas containing 30 per square meter (m^2).[11] On the Outer Reef, moderate-sized colonies of star corals are common, as are octocorals and large barrel sponges (*Xestospongia muta*).

The northern end of the southeast Florida reef system is composed of Anastasia limestone and colonized by scleractinian corals, octocorals, and zooanthids. The most common stony corals found in the St. Lucie Inlet Preserve State Park include *Diploria clivosa, Montastraea cavernosa, Siderastrea siderea, Isophyllia sinuosa, Solenastrea bournoni*, and *Oculina diffusa*.[12]

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[11] Gilliam, D.S., Dodge, R.E., Spieler, R.E., Jordan, L.K.B., and Monty, J.A. 2006. *Marine biological monitoring in Broward County, Florida.* Technical Report 05-02. Prepared for the Broward County Board of County Commissioners, Department of Planning and Environmental Protection, Biological Resource Division, p. 90.

[12] Herren, L. 2004. *St. Lucie Inlet Preserve State Park Reef Monitoring Program: Progress Report #2.* Florida Department of Environmental Protection.

Gilliam, D.S. In preparation. *Southeast Florida Coral Reef Evaluation and Monitoring Project 2006 Year 4 final report.* Prepared for the Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, and the Florida Department of Environmental Protection.

III. SOCIOECONOMIC STATUS, TRENDS, AND REEF IMPACTS

Southeast Florida is densely populated and urbanized (*Table 1*). The region is a mosaic of urban communities, light industry, and agriculture, and it experiences intensive tourism, particularly in coastal areas. The proximity of the southeast Florida reef system to such a populated urban area subjects the system to ever-increasing impacts from a variety of sources, including resource use (diving, fishing, boating), marine construction activities (beach renourishment, sewer and treated wastewater outfall pipes, fiber optic cable and pipeline installation, port maintenance and expansion), and ship groundings and anchoring. Resource management agencies are regularly faced with the problem of assessing and managing response, damage, and restoration requirements resulting from vessel groundings, anchor drag events, and other anthropogenic disturbances.

Table 1. Demographic information for southeast Florida: Miami–Dade, Broward, Palm Beach, and Martin Counties[13]

County	Miami–Dade	Broward	Palm Beach	Martin	Total
Land area (mi^2)	1,946	1,205	1,974	556	5,681
Population (2000)	2,253,362	1,623,018	1,131,184	126,731	5,134,295
Housing units (2000)	878,448	763,267	576,418	68,037	2,286,170
Density (People/mi^2)	1,157.9	1,346.5	573.0	296.4	903.77
Boat registrations (FY 2004)	49,794	38,797	38,097	14,735	141,423
Number of tourists (million) (FY 2004)	10.9	9.4	4.4	N/A	24.7

mi^2 – square miles; FY – fiscal year; N/A – not available

Coral reefs and associated biota are important to the economy of southeast Florida and are among the main attractions that draw many of the state's tourists. For example, the number of person-days spent on the water engaged in fishing, boating, diving, snorkeling, and glass-bottom boat tours in southeast Florida exceeded 15 million person-days for Miami–Dade, Broward, and Palm Beach Counties in 2001, and Martin County in 2003 combined (*Table 2*).[14]

[13] U.S. Census Bureau, U.S. Department of Commerce. 2000.
Johns, G.M., and Milon, J.W. 2004. *Socioeconomic study of reefs in Martin County, Florida. Final report.* Ft. Lauderdale, Florida: Hazen and Sawyer.

[14] Johns, G.M., Leeworthy, V.R., Bell, F.W., and Bonn, M.A. 2001. *Socioeconomic study of reefs in southeast Florida. Final report.* Ft. Lauderdale, Florida: Hazen and Sawyer.
Johns, G.M., and Milon, J.W. 2004. *Socioeconomic study of reefs in Martin County, Florida. Final report.* Ft. Lauderdale, Florida: Hazen and Sawyer.

Table 2. Coral reef economic data[15]

County	Miami–Dade	Broward	Palm Beach	Martin
Annual usage (person-days, millions)	6.22	5.46	2.83	0.529
Capitalized value ($ billions)	1.6	2.8	1.4	1.9
Estimated reef area (ha)	7,200	8,300	12,000	N/A

ha – hectares; N/A – not available

In addition to recreational marine activities, three major ports (Port of Miami, Port Everglades, and Port of Palm Beach) in southeast Florida have extensive arrivals and departures of large cruise ships and merchant and cargo vessels. These ports have nearby offshore anchorages for vessels waiting for an available berth or their next port of call. In southeast Florida, these U.S. Coast Guard (USCG)–designated anchorages are located near coral reefs.

The Port Everglades anchorage (*Figure 7*) has been subject to many vessel grounding and anchor drag events on and over adjacent reefs, causing economic losses to shipowners and insurers, and extensive economic and biological injuries to shipping and coral reef resources. From 1993 to 2006, there were 11 groundings and 6 anchor drag cases, resulting in more than 11 acres of coral reef injury in the vicinity of Port Everglades. Two groundings elsewhere in Broward and Martin Counties resulted in another 0.3 acres of injury.[16] Numerous unreported anchor drag and grounding incidents also occurred during this time. Local, state, and federal resource management agencies have been meeting regularly with the USCG to develop options for relocating the Port Everglades anchorage.

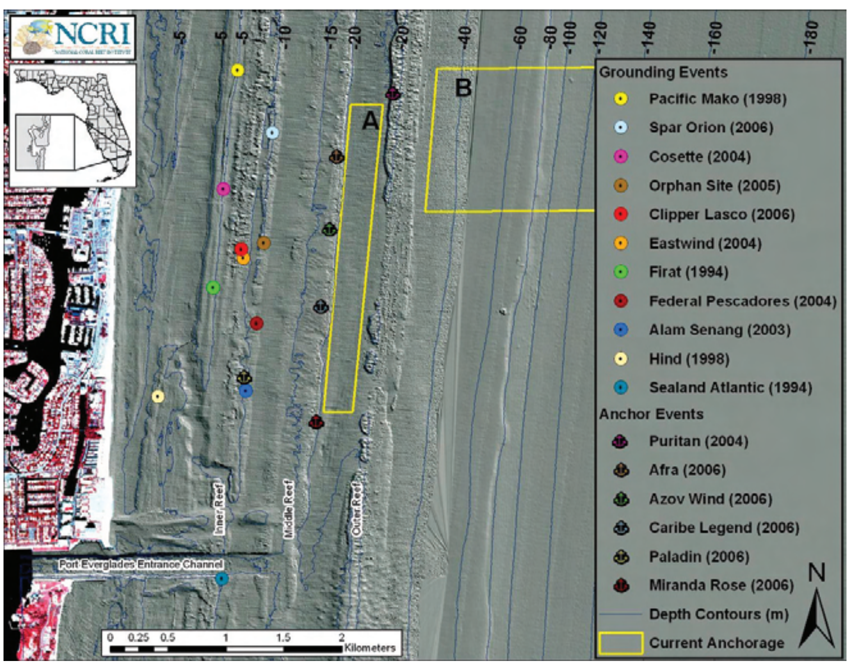

Figure 7. USCG–designated anchorages at Port Everglades shown in yellow, with locations of recent vessel groundings and known anchoring injuries (Figure courtesy of B.K. Walker, NCRI).

[15] Johns, G.M., and Milon, J.W. 2004. *Socioeconomic study of reefs in Martin County, Florida. Final report.* Ft. Lauderdale, Florida: Hazen and Sawyer.
Johns, G.M., Leeworthy, V.R., Bell, F.W., and Bonn, M.A. 2001. *Socioeconomic study of reefs in southeast Florida. Final report.*
[16] Coral Reef Conservation Program, Florida Department of Environmental Protection. 2007.

IV. REEF INJURIES FROM PERMITTED AND UNPERMITTED ACTIVITIES

Reef injuries in the southeast Florida reef system have historically included a combination of reef framework injury (fracturing, breakage, and crushing) and injury to the reef community (scraping, dislodging, overturning, crushing, and fragmenting of coral reef flora and fauna, including injury to sponges, octocorals, and stony coral colonies).[17] The loss of biological resources and physical resources (reef framework) disrupts normal coral reef ecosystem function. The detrimental effects extend far beyond the reef habitat to numerous reef-associated and reef-dependent species. Injuries resulting from permitted activities are almost exclusively anthropogenic in nature—i.e., they are caused by humans.

Reef injuries result from both permitted and unpermitted activities. Unpermitted activities are not governed by the same regulations as permitted activities and may result in both anthropogenic and nonanthropogenic injuries. The guidelines and recommendations in this document focus on unpermitted anthropogenic activities such as recreational misuse, vessel groundings, and injury resulting from anchoring, propeller wash, and salvage efforts, including towing cable drags. Nonanthropogenic injuries are acts of nature such as storms.

Permitted activities, which require authorization from local, state, or federal regulatory entities, include such activities as beach renourishment, dredging, surveying, pipeline construction, port maintenance and expansion, communication cable installation, and geotechnical drilling. While these guidelines and recommendations do not directly address administrative and legal actions for anthropogenic reef injuries resulting from permitted activities, the document contains sections on planning, coordinating, and implementing restoration efforts necessitated by injuries incurred during permitted activities.

Reef injuries resulting from permitted activities can be minimized through the permit process. Avoiding injury or destruction should be the first step. If a permit is issued for an activity that may or will injure reef resources, specific permit conditions should be developed and designed to best protect remaining and existing reef resources, monitor and enforce permit conditions, provide compensatory mitigation for the lost services over time caused by an injury, monitor restoration and mitigation activities, and assess penalties for violating permit conditions.

[17] U.S. Coral Reef Task Force. 2000. *The National Action Plan to conserve coral reefs*. Washington, D.C.: U.S. Environmental Protection Agency.
Jaap, W.C. 2000. Coral reef restoration. *Ecol. Eng*. 15:345-364.
Jaap, W.C., Hudson, J. H., Dodge, R.E., Gilliam, D.S., and Shaul, R. 2006. Coral reef restoration with case studies from Florida. In: *Coral Reef Conservation*. Cote, I.M., and Reynolds, J.D. (Eds.). Cambridge, United Kingdom: University of Cambridge Press.

Recommendation #1

Regulatory agencies issuing permits for activities that may affect reef resources should re-examine and improve permitting, compliance, enforcement, and penalty assessment processes to ensure that permit conditions provide the maximum protection for, and the least impact to, reef resources. Permit conditions should also ensure that compensatory mitigation adequately compensates the Trustees for the loss of biological services, the monitoring of restoration actions, permit condition compliance and enforcement, and the assessment of penalties for permit violations.

Responsible Agencies: Florida Department of Environmental Protection (FDEP), Water Management Districts, U.S. Army Corps of Engineers (ACOE), Local Governments

V. TERMINOLOGY

For the purposes of these guidelines and recommendations, the words “response,” “mitigation,” and “restoration” should not be confused with the definitions of these terms as defined in federal code or their use in the context of federal response processes.

VI. DEFINITIONS

Trustees

FDEP is the primary Trustee, with delegated authority from the Board of Trustees of the Internal Improvement Trust Fund, to manage, protect, and regulate sovereign submerged lands in the state. For the purposes of these guidelines and recommendations, a Trustee is any local, state, or federal entity claiming jurisdiction over an injury location or affected resources.

Responsible Party

The RP is the entity responsible for a reef resource injury. The acronym RP should not be confused with federal terminology referring to a Reporting Party or Potential Responsible Party.

VII. LEGAL ISSUES

FDEP has traditionally treated unpermitted coral reef injuries as proprietary violations and not regulatory violations. The drawbacks to the proprietary approach include a reliance on broadly written statutes and meager established case law, rather than more detailed and developed administrative procedures common in the regulatory sphere. Under the proprietary approach, any irresolvable issues between the Trustees and the RP must be litigated, which can be costly and time-consuming and does not necessarily facilitate resource restoration.

The remainder of this document contains recommendations to enhance the effectiveness of regulations for managing coral reef injuries in southeast Florida. These recommendations pertain to the development of regulations and/or the use of existing regulations to guide enforcement actions, the issuance of authorizations for primary and compensatory restoration activities, and penalty assessment. For each recommendation, the responsible agencies are also listed.

VIII. INITIAL RESPONSE

A well-developed initial response to coral reef injuries requires incident reporting (including the receipt and handling of reports), the notification of agencies needing to respond, interagency coordination, and agency response.

Who Should Report an Incident

Injuries to coral reefs should be reported by any individual having knowledge of an incident that causes injury to a coral reef. These include the RP, captains of commercial vessels and vessel-towing companies, boaters, divers, fishers, and other observers, as well as all local, state and federal employees.

Filing a Report

Filing a coral reef injury report entails (1) knowing *when* to report an incident, (2) knowing *how* to report the incident, and (3) knowing *what* information to report.

When To Report an Incident

All coral reef injuries should be reported as soon as possible.

How To Report an Incident

A number of state and federal agencies have 24-hour emergency hotlines responsible for handling environmental incidents. In Florida, these agencies include the Florida Fish and Wildlife Conservation Commission (FWC), FDEP's Bureau of Emergency Response, the Florida Division of Emergency Management's State Warning Point, the USCG National Response Center, and county and municipal law enforcement or environmental management agencies. Currently, there is no specific agency or hotline for reporting a coral reef injury.

What Information to Report

Details are very important when reporting an incident; however, a lack of details should not be a deterrent to reporting the incident. The following types of information are useful to authorities regarding an incident:

- ***What type of incident has occurred—for example, vessel grounding or sinking, anchoring, injured site found with no immediately known cause?***

- ***What is the location of the incident and the approximate size of the injured area?*** *GPS coordinates are most useful and easiest to work with; however, a physical description of the area may suffice if the description is specific enough to lead authorities to the location of the incident*.

- ***Is a vessel involved?*** *If so, provide specifics such as the vessel name, registration numbers, type of vessel, make, model, color, size, and any other identifying characteristics.*

- ***Are other environmental impacts associated with the reef injury, such as petroleum or other chemical releases?***

- ***If the vessel involved is still on the scene, is the operator attempting to dislodge the vessel, take other corrective actions, or flee?***

- ***Have any other agencies been notified by the individual reporting the incident, or are there any agency personnel or vessels at the scene?***

- ***What is the contact information of the individual reporting the incident? This is helpful but not required.***

- ***Is there visual documentation of the incident (photos or video)?***

Recommendation #2

A single 24-hour coral reef injury hotline should be established, or coordinated with other available hotlines, to receive reports of coral reef injuries and to facilitate a timely and effective agency response to such reports.[18] **The 24-hour coral reef injury hotline should be modeled after, and if possible integrated with, FDEP's Bureau of Emergency Response (BER) State Warning Point (SWP) hotline, which accepts calls statewide on a 24-hour basis regarding reports of environmental incidents and domestic security.**

When the hotline receives calls, basic information regarding the incident (see the section at the beginning of this chapter on What Information To Report) should be taken by the individual receiving the call. Federal, state, and/or local responders should be notified of the incident and, if necessary, agency personnel dispatched to the scene. If the RP is reporting the incident, they should be notified of their responsibilities and provided a list of qualified contractors from which to choose.

Ideally, the 24-hour coral reef injury hotline would be integrated with the SWP, and its operators would be trained to receive such calls. This would alleviate the need to purchase, develop, and maintain the infrastructure and employees associated with an independent coral reef hotline. SWP employees could be provided a set of appropriate questions to ask the individual reporting the coral reef injury. The employee would then contact agency personnel responsible for responding to coral reef incidents. However, if it is not possible to integrate with the SWP, a separate and independent coral reef hotline should be established.

Responsible Agency: FDEP

[18] Several state and federal reporting requirements obligate an RP to report certain environmental incidents. Examples include requirements in the Oil Pollution Act of 1990, (33 USC §§ 2701 *et seq.*), the Resource Conservation and Recovery Act (42 USC §§ 6901 *et seq.*), the Comprehensive Environmental Response, Compensation, and Liability Act (42 USC §§ 9601 *et seq.*), and FDEP's Noticed General Environmental Resource Permit regulations (Rule 62-341, Florida Administrative Code [F.A.C.]). This coral reef hotline is not recommended as a replacement to these requirements, nor would an RP who contacted the coral reef hotline be relieved of fulfilling any other reporting obligations. The coral reef hotline is envisioned merely as a means to facilitate agency response, enforcement, and restoration in the aftermath of an injury to a coral reef.

Recommendation #3

A public education campaign should be undertaken to inform the public of the necessity of, and correct protocol for, reporting reef injuries. Federal, state, and local employees should also be made aware of their responsibility to report coral reef incidents through the normal course of business and other standard operating procedures such as interoffice/agency memoranda and email.

Responsible Agencies: Lead—FDEP; Support—FWC

Interagency Coordination

Interagency coordination is an essential component of a timely and efficient response to emergency situations, including incidents that injure coral reefs. Many federal, state, and local agencies have established procedures and protocols for responding to specific environmental incidents.[19] They also possess the responsibility, expertise, and resources to respond to these incidents. Notifying each agency in a timely way also facilitates an effective response to incidents causing coral reef injuries.

Recommendation #4

To facilitate the coordination of agencies with established environmental response procedures, protocols, and responsibilities, operators of the proposed 24-hour hotline should notify the following agencies of an incident:

- **USCG, Marine Safety Office, Miami;**
- **FWC, Division of Law Enforcement (which would subsequently contact FWC Technical Staff);**
- **FDEP, BER (which would subsequently contact the Coral Reef Conservation Program and FDEP Office of General Counsel);**
- **National Marine Fisheries Service (NMFS), Damage Assessment and Restoration Program; and**
- **County environmental and law enforcement officials.**

Long-term coordination among all parties involved in the incident should be facilitated through the development and maintenance of a password-protected website[20] containing the following information:

[19] Examples of such agencies include the FWC Division of Law Enforcement; FDEP Bureau of Emergency Response; NOAA Emergency Response Division; and USCG National Response Center.

[20] This document is not recommending the development of a website in a manner that would serve as centralized incident management or storage for all documents associated with the incident. This type of website format would not allow for the necessary confidentiality associated with legal proceedings and would require a continued effort to maintain. The website should merely contain the basic information listed above and could be modeled after the NOAA Emergency Response Division's incident communication website ResponseLINK.

- **Information provided during the initial incident report to the 24-hour coral reef hotline;**

- **The RP contact information, including legal and technical contacts (if known);**

- **Contact information for each agency involved in any aspect of the response; and**

- **All contractor and subcontractor contact information.**

Each agency should be responsible for entering and maintaining its contact information after 24-hour hotline personnel implement the initial coordination. The website should be operated and maintained by FDEP's Coral Reef Conservation Program.

Responsible Agency: FDEP

IX. RESPONSE

Responding to reef injury incidents entails many factors. Depending on the cause of the injury and the availability of funding, the response may include identifying the RP, taking enforcement action against the RP, collecting evidence, obtaining the necessary authorization for restoration activity, selecting contractors to carry out response activities, and developing and implementing a restoration plan. A number of important issues are associated with these factors, including those arising as a result of overlapping jurisdictions: identifying the primary enforcement agency, taking enforcement action, issuing authorizations, and, if applicable, funding restoration activity.

Trustee Obligations

The goal of the Trustees is to restore the function and value of the resource that was injured or lost as a result of the incident. The Trustees play a vital role in responding to reef injury incidents, determining the cause and scope of the incident, and determining the identity of the RP. Trustees oversee the initial site assessment and biological triage, vessel salvage operations, primary and compensatory restoration actions, and monitoring. Furthermore, the Trustees engage in evidence collection at the site of an incident for any eventual enforcement actions against an RP; these also fall under the purview of the Trustees.

Identification of the Cause of Injury

Identifying the cause of the injury is critical to the assessment process. Direct observation of the incident is the most straightforward method of determining the cause of injury. Consequently, resource managers must remain vigilant in natural resource monitoring, especially in areas where injuries have been observed in the past. The general public also can and should be encouraged to report incidents when observed.

Unfortunately, not all anthropogenic injuries to natural resources are observed or reported to resource managers. However, anthropogenic injuries generally leave distinct scars or other signs indicating the cause of the injury. Anthropogenic injuries are generally finite in area with distinct boundaries, characterized by straight lines or a specific directionality, distinctive grooves or markings, and bottom paint, debris, and/or significant localized structural injury. Conversely, storm injury is usually widespread across the affected area.

Identification of the Responsible Party

There are two basic categories of RPs: those who are known and those who are discovered. Known RPs are those who have either reported an incident themselves, or who were witnessed in the act of injuring reef resources and reported to the local, state, or federal emergency hotline. Conversely, discovered RPs are those whose identity is unknown at the time the report is received but subsequently becomes known through investigative and forensic processes. Incidents where the RP remains unknown are generically referred to as orphan sites.

Vessel Salvage

In situations where a vessel is involved in a reef injury and has been stranded, the USCG is the primary agency providing support for salvage operations. Historically, injurious salvage techniques have caused collateral injuries to reef resources. These injuries often occur in the

area immediately surrounding the grounded vessel but can be avoided with the use of salvage techniques developed to prevent injury to reef resources. The principal causes of collateral injuries are dragging a vessel off the reef instead of floating it off; the use of steel towing cables that can drop on or drag across the substrate, impacting and dislodging resources (reef structure, corals, and sponges); and propwash and surge, generated by tugboat propellers, that displace sediment and dislodge organisms.

To avoid or minimize collateral injuries, a reconnaissance survey should be conducted while the vessel is grounded to evaluate reef resources in the immediate area surrounding the vessel and determine an appropriate extraction route. Bunker fuel and cargo may need to be offloaded. Floating or buoyed towlines should be used instead of steel cables, and towing activities should be conducted at or near high tide to facilitate floating the vessel. Before and during the extraction, global positioning system (GPS) coordinates at the bow and stern of the vessel should be recorded to assist with future injury assessment. GPS tracking should be operating on the grounded vessel during egress from the site and on all salvage vessels or tugboats involved with the salvage operation. The outbound path for vessel extraction may also need to be buoyed, to help avoid or identify injuries that may occur during the salvage operation.

Enforcement Action

Enforcement actions are the foundation for legal cases involving anthropogenic reef injuries. The issuance of a noncompliance letter, warning letter, or Notice of Violation (NOV) to an RP establishes the connection between the RP, the violation committed, and the state of Florida. The issuance of such a notice also establishes the Trustee's intent to pursue legal avenues for the recuperation of lost resources and for the imposition of monetary penalties if the RP is not responsive. Because enforcement has traditionally relied on the proprietary authority exercised by FDEP, Trustees have not regularly issued NOVs to RPs in an attempt to mitigate the loss of reef resources. Additionally, Trustees have not consistently instituted legal actions seeking to recuperate revenues that were spent in responding to reef injury incidents.

Recommendation #5

FDEP should explore the various avenues of potential enforcement authority and develop the one identified as producing the best results.

Responsible Agency: FDEP

Evidence Collection

The timely collection of evidence and the subsequent chain of custody are critical components to building a solid case if an RP is uncooperative, if criminal charges are levied against the RP, or if there are disputes regarding the need for, or the extent of, compensatory restoration/mitigation. The Trustees seeking restitution must make a solid case that can only be built through proper evidence collection processes.

Proper evidence collection for reef injuries caused by anthropogenic activities consists of (1) knowledge of the types of evidence necessary to build a solid case; (2) the use of divers who have been trained in accredited standards for the collection and maintenance of evidence; and (3) the use of divers who operate with appropriate safety standards.

Litigation Criteria

Currently there are no established evidence collection criteria to assist with the litigation of reef injuries.

> ## *Recommendation #6*
> **The Trustees should develop criteria for evidence collection associated with reef injury incidents, based on their anticipated future litigation needs. Law enforcement officers and/or scientific divers should then adopt these criteria as standard practice each time that data are collected for use as evidence in future litigation. NOAA's Damage Assessment, Remediation and Restoration Program (DAARP) provides a model for the development of Trustee criteria.**
>
> *Responsible Agencies: Lead—FDEP; Support—Local Governments and FWC*

Accredited Process

It is imperative to follow an accredited process when collecting evidence, so that any evidence collected may withstand litigation. Policies and procedures for evidence collection differ among federal, state, and local law enforcement entities;[21] however, all the policies and procedures have been accredited by a federal or state law enforcement accreditation commission.[22]

> ## *Recommendation #7*
> **All divers collecting evidence, including scientific divers collecting scientific data that may be used in a court of law, should be trained in an accredited evidence collection policy or procedure.**
>
> *Responsible Agency: FWC*

Safety Standard

The federal Occupational Safety and Health Administration (OSHA) considers evidence collection to be a commercial activity. Thus, divers collecting evidence must operate under OSHA standards unless an exemption applies.[23] Applicable exemptions to OSHA standards are extended to law enforcement officers diving for the purposes of public safety and scientists conducting

[21] Broward Sheriff's Office, Policy and Procedures Manual, Evidence and Property, 11.2; FWC, General Order 16, Collection, Preservation and Documentation of Evidence and Property; FDEP, General Order 4-5, Evidence Collection, Preservation and Documentation and Lost/Abandoned Property; NOAA, Enforcement Operations Manual, Procedure 4.5, Property and Evidence Management.

[22] Commission for Florida Law Enforcement Accreditation (CFA); Commission on Accreditation for Law Enforcement Agencies (CALEA).

[23] 29 CFR 1910, Subpart T; see also http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3449.

research (i.e., "scientific divers") under guidelines established by the Code of Federal Regulations (CFR) (e.g., the American Academy of Underwater Sciences [AAUS]).

For scientific divers to be exempt from OSHA standards, the goal of the diver must be the advancement of science. In cases where a reef injury results from anthropogenic activities, such as a vessel grounding, the scientific goal is to assess biological and physical injuries, gather information relevant to restoring the habitat to its pre-existing function and value, and subsequently develop a restoration plan. If data collected in pursuit of this scientific goal had an ancillary use as evidence to be used in litigation, it would not be considered a commercial activity; therefore, scientific divers would qualify for an OSHA exemption. However, if data were collected solely as evidence to support a civil or criminal case, it would be considered a commercial activity and thus subject to OSHA standards.[24]

Recommendation #8

To ensure that adequate safety standards are followed, only divers operating under standards set forth in 29 CFR § 1910 should collect evidence or scientific data that may be used as evidence in subsequent litigation.

Responsible Agencies: FWC, FDEP, and Local Governments

Initial Site Assessment

Once an injury is reported, the site declared safe, and the evidence collection process completed, the Trustees conduct an initial site assessment, which begins to define the extent of the loss of resource function and value and provides the preliminary data necessary for the Trustees to develop a primary restoration plan. To do this, the Trustees' technical experts conduct preliminary measurements, identify injury types, estimate the number and kinds of injured or dislodged organisms, determine injury boundaries, and document the injury via a variety of techniques, including photography and videography *(Figure 8)*. The chief technical expert prepares the initial site assessment report and submits it to FDEP, which reviews the report and decides on the appropriate response. If primary restoration is necessary, FDEP forwards a copy of the report to the RP as part of the enforcement action. See the section on *Detailed Site Assessment* below for information on the RP site assessment.

[24] Butler, S. 1996. *Exclusions and exemptions from OSHA's commercial diving standard.* Paper presented at the American Academy of Underwater Sciences 1996 Scientific Diving Symposium. Washington, D.C.

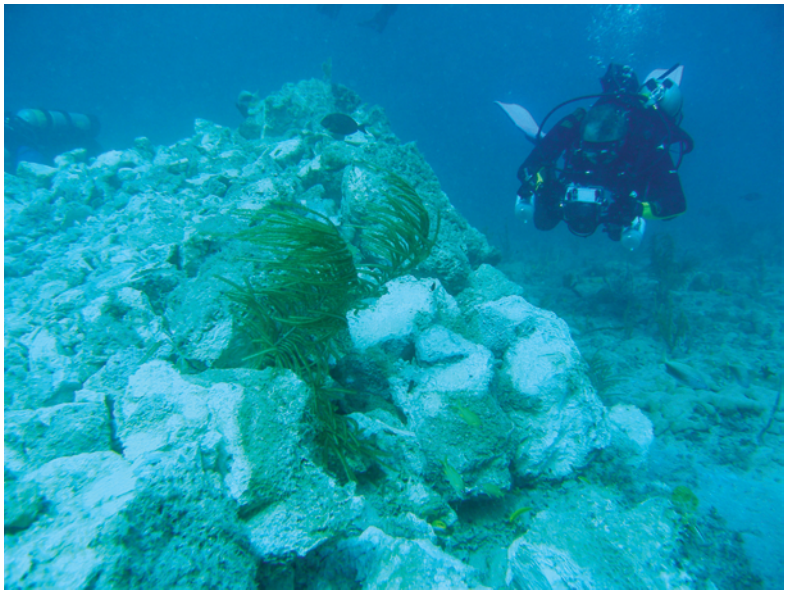

Figure 8. Divers conducting initial site assessment (Photo courtesy of C. Collier, FDEP).

Biological Triage

The goal of biological triage is to save those organisms that are at risk of mortality and/or loss from fragmentation or dislodgment from the reef. Biological triage may occur simultaneously with the initial site assessment and should consist of saving as many at-risk biological resources as possible. Any biological triage activities that are conducted should be coordinated so as not to interfere with any evidence or data collection.

Responsible Party Obligations

When an RP is known, certain activities are expected of them regarding the reef injury they have caused. These include assuming responsibility for triage and primary reef restoration activities, obtaining all permits and/or authorizations necessary to conduct such activities, conducting their own initial site assessment, carrying out all required biological triage activities, and performing all these functions with the approval of and under the supervision of the Trustees.

Contractor Selection

The RP may wish to hire a contractor to accomplish the requirements listed above. Trustee involvement with the selection of a contractor to conduct coral reef restoration has not traditionally been an integral part of the response process. Contractor approval by the Trustees should be driven by a certification or qualification process. The process that FDEP currently employs for Discharge Cleanup Organizations[25] provides a possible model for certification/qualification.

Recommendation #9

A tiered contractor certification or qualification process should be established, based on criteria such as past performance (documented success); the ability to work effectively with federal, state, and local governments; and the possession of necessary skills, certifications, or degrees verifying ability and equipment capability to conduct specific activities. A certification or

[25] Section 62N-16.012, F.A.C.

qualification process would ensure that contractors are qualified, in advance, to conduct restoration work and would shorten the length of time needed to obtain the necessary authorizations for conducting restoration activities.[26]

The recommended tiers and qualifications are as follows:

A. SCIENTIFIC SUPPORT—Activities consist of environmental project management, site assessment, surveying, mapping, monitoring, and reporting. Qualifications to conduct these activities should consist of:

a. Demonstrated skill and experience in successful project management and scientific report writing;

b. An understanding of the specific local habitat and the ecological processes governing that habitat; and

c. Demonstrated experience and knowledge of the current technology for surveying, mapping, assessing, restoring, and monitoring coral reef habitats.

B. BIOLOGICAL TRIAGE—Activities consist of righting, marking, and caching biological resources in preparation for restoration. Qualifications to conduct these activities should consist of:

a. An understanding of the specific local habitat and the ecological processes governing that habitat;

b. Specific local knowledge of the function and values of the reef habitat;

c. Specific knowledge of the biological/ecological requirements and limitations of the organisms being cached.

C. ORGANISM REATTACHMENT—Activities consist of reattaching biological resources—including, but not limited to, the use of cements, epoxies, wires, cable ties, nails, and bolts. Qualifications to conduct these activities should consist of:

a. An understanding of the specific local habitat and the ecological processes governing that habitat;

b. Specific knowledge of techniques for handling and attaching the specific types of organisms involved in the triage;

c. Specific knowledge of best management practices (BMPs) to minimize the impact of reattachment on surrounding organisms; and

d. Demonstrated experience and long-term success in organism reattachment

D. DEBRIS AND RUBBLE MANAGEMENT—Activities consist of debris removal and disposal, paint removal and disposal, rubble stabilization, and rubble removal and disposal. Qualifications to conduct these activities should consist of:

[26] Once a certification process is developed, notification should be provided to property and indemnity insurance companies that deal with the shipping industry regarding the certification requirements to notify them of the process in advance of an incident.

a. Specific knowledge of environmentally sound techniques for safely removing and disposing of debris and bottom paint;

b. Specific knowledge of environmentally sound techniques and a methodology for stabilizing rubble in a coral reef environment;

c. Specific knowledge of the permitting requirements for rubble and debris disposal; and

d. Specific knowledge of BMPs for removing and transporting coral rubble and debris to minimize injury to the surrounding environment and organisms.

E. REEF FRAMEWORK REPAIR—Activities consist of structural stabilization and reconstruction. Qualifications to conduct these activities consist of:

a. An understanding of the specific local habitat and the ecological processes governing that habitat

b. Specific local knowledge of currents and water flow patterns that may affect the successful stabilization and reconstruction of the reef framework;

c. Specific knowledge of BMPs for the use of cements, epoxies, or other suitable stabilizing agents in the marine environment to minimize injury to the surrounding environment and organisms.

Responsible Agency: FWC

Obtaining Authorizations

The authorizations required to conduct primary and compensatory restoration activities depend on agency jurisdiction, the identification of the cause of an injury, the identification of an RP, and the nature of the primary or compensatory restoration to be conducted.

Agency Authorization

Restoration activities require authorization from FDEP, which has authority over sovereign submerged lands in southeast Florida. Furthermore, a Special Activity License (SAL) authorization from the FWC, which has authority over fish and wildlife resources, is required to conduct any activity involving marine organisms.

Recommendation #10

FDEP should develop a joint proprietary/regulatory authorization process or employ an existing process (i.e., Environmental Resource Permitting) that incorporates the conditions requiring Trustees' approval for the authorization and regulation of primary restoration, compensatory restoration, and monitoring activities associated with reef injuries. An efficient authorization process is needed to facilitate a rapid response. This approach should provide guidance to an RP on how to properly conduct such activities and provide legal recourse for the Trustees if the RP does not comply with the conditions of the authorization.

Responsible Agency: FDEP

Recommendation #11

FDEP and FWC should develop a Memorandum of Understanding establishing delegation of authority in order to streamline authorization processes necessary for the oversight of primary restoration, compensatory restoration, and monitoring activities associated with reef injuries. If organisms are not being relocated, FDEP authorization should be sufficient to authorize and regulate these activities. If organisms are being relocated to or from an area other than a reef injury site, the FWC SAL should be used, as it addresses potential genetic and health issues. In turn, the SAL may be used in lieu of FDEP authorization to provide oversight for restoration and mitigation activities when no RP is identified for a reef injury.

Responsible Agencies: FDEP and FWC

Rubble Disposal

Rubble disposal is of concern in large reef injuries associated with vessel groundings. Rubble may be stabilized and/or used for reef framework repair; however, rubble not used in those processes must be disposed of. Unstabilized rubble may cause additional damage to the site if it is not removed. Past disposal methods have included the use of Ocean Dredged Material Disposal Sites (ODMDSs) and permitted artificial reef sites. The use of an ODMDS may not be appropriate if the site is not classified to accept such rubble, and the use of rubble as artificial reef material may also not be appropriate, since the rubble is not specifically designed to function as artificial reef habitat.

An available alternative for disposing of rubble not used during restoration activities is upland disposal, for use in landfill or other commercial activities. Rubble used for commercial activities should first be tested to provide reasonable assurance that the material is not contaminated. Examples of state testing standards may be found in FDEP rules[27] and in local county codes.[28]

Temporary Mooring

In many instances, restoration efforts at reef injury sites require the placement of site marker buoys and temporary moorings to facilitate the operations of vessels conducting restoration. Authorization is not required for the placement of site marker buoys, which are regularly used during scientific diving, law enforcement diving, and other working diver activities. However, the FWC,[29] FDEP,[30] ACOE,[31] USCG,[32] and NMFS[33] must currently review activities or issue some type of authorization for the placement of temporary moorings. These processes are lengthy and do not facilitate a rapid response process.

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[27] Rule 62-777, F.A.C.
[28] Chapter 24, Code of Miami–Dade County, Risk Based Corrective Action provisions.
[29] FWC Florida Uniform Waterway Marker Permit.
[30] FDEP Environmental Resource Permit, which also provides Coastal Zone Management consistency on behalf of the state of Florida to allow operation under a Department of the Army Nationwide Permit.
[31] ACOE Department of the Army Nationwide Permit #10.
[32] USCG only requires that it be advised at the earliest possible convenience of the mooring buoy placement location, length of time the buoy will be in place, and a summary of activities that will be conducted. It uses this information to determine if it is necessary to

Recommendation #12

A streamlined process for issuing authorizations for the installation of temporary moorings at reef injury sites should be adopted by the FWC, FDEP, USCG, and NMFS to facilitate rapid restoration activities for reef injuries.

Responsible Agencies: Lead—USCG; Support—FWC, FDEP, ACOE, and NMFS

Paint Removal and Disposal

Paint removal and disposal is generally unregulated if the paint has been applied and is not in a wet or semiwet form. However, paint chips and/or paint dust disposal are regulated when paint chips or dust are considered hazardous waste. Paint chips or dust containing lead or chromium must be disposed of properly in a licensed hazardous waste facility. Paint from vessel hulls generally contains either tributyltin or copper. While neither of these chemicals is classified as hazardous in their stable form, they are known to be toxic to marine organisms and must be removed.[34] No authorizations are necessary to remove or dispose of bottom paint.[35] If the removal of bottom paint from submerged substrate *(Figure 9)* or the disposal of bottom paint chips were to become regulated in the future, the RP would bear the legal responsibility of obtaining the required authorization to conduct these activities.

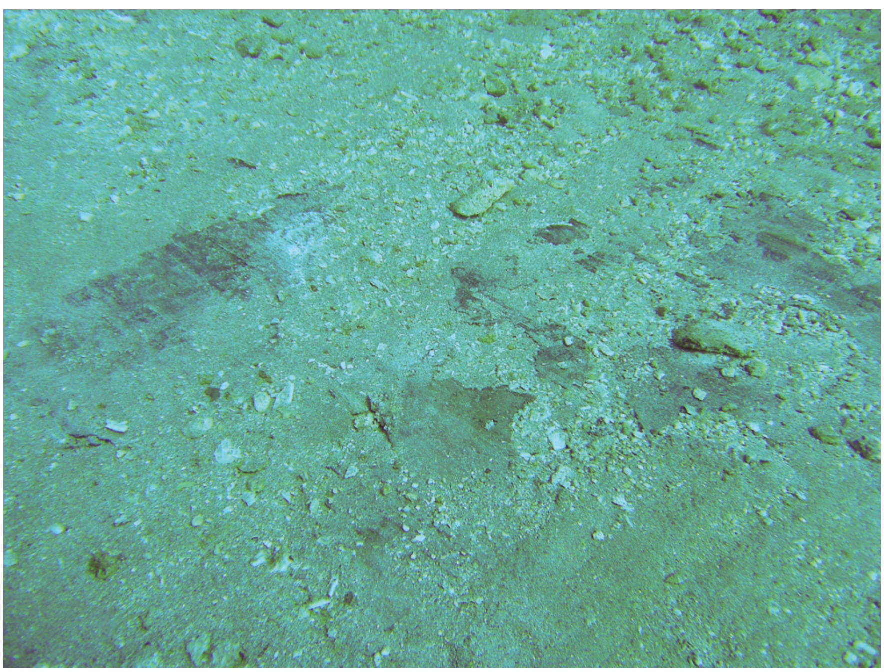

Figure 9. Hull paint on scraped reef substrate (Photo courtesy of C. Collier, FDEP).

issue a Broadcast Notice to Mariners or publish in the Local Notice to Mariners. If lighting is deemed necessary, a Private Aid to Navigation permit may be required.

[33] NMFS may be required to review the placement of mooring buoys if the buoy location is in a designated critical habitat area for listed species.

[34] Nias, D.J., McKillup, S.C., and Edyvane, K.S. 1993. Imposex in Lepsiella vinosa from Southern Australia. *Marine Pollution Bulletin.* 26 (7) 380-384. U.S. Environmental Protection Agency. January 2004. *Aquatic life criteria for tributyltin (TBT)*. Fact Sheet. Available: http://epa.gov/waterscience/criteria/tributyltin/fs-final.htm.

[35] 33 USC, Chapter 37, known as the Organotin Antifouling Paint Control Act of 1988.

Endangered Species Act Consultation

Two species of coral were listed as threatened under the federal Endangered Species Act (ESA) in May 2006.[36] As additional marine species are listed under the ESA, it is important that ESA consultation be conducted for species that may potentially be affected by restoration activities.

Detailed Site Assessment

The goal of the detailed site assessment conducted by the RP under the supervision of the Trustees is twofold: to minimize risk to their vessel and reduce their financial liability for the resource injury. The site assessment conducted by the RP, or their designated contractor, must consist of a site map, including the delineation of boundaries (size and GPS coordinates) and the extent of different types of resource injuries (e.g., rubble piles, fractured reef framework, scraped areas, dislodged organisms, and transferred bottom paint). The species identification, quantification, and location marking of overturned, dislodged, crushed, or otherwise injured living organisms and biological triage (see the section below on *Biological Triage)* must also be carried out. This site assessment concludes with the delivery of a comprehensive, detailed site assessment report, provided in both written and electronic formats, to the Trustees. The report should include a discussion of methods used to assess and map the site, as well as maps and images of the injured area. GIS shape files (NAD 83, US feet) for the maps must also be provided.

Common assessment methods are as follows:

Aerial Photography. Aerial photographs can be an excellent tool in mapping injury areas. However, certain environmental conditions must be present: the injury must be recent and shallow in depth (typically less than about 20 m, depending on water clarity); there must be minimal cloud cover and wind speed; the sun angle should minimize reflection from the water surface; and the sea must be calm to reduce reflection. Scaled-reference marker(s) outlining the injury area or setting forth the scale need to be visible in the photographs. Photographs are taken from a practicable altitude to ensure sufficient coverage and resolution, and perpendicular to the sea surface to facilitate accurate injury area measurements using georeferencing and a geographic information system (GIS). Obliques are often useful as well. It is necessary to collect *in situ* information to collaborate injuries visible in the aerial photograph. Aerial photographs, however, have not always proved to be successful in southeast Florida due to reduced water visibility.

Bathymetric and Seismic Surveys. When a large vessel grounding occurs, losses to reef structural relief often result when the ship's hull plows through and crushes reef substrate. A bathymetric survey may provide information on topographic losses. When appropriate, bathymetric surveys should be conducted after the injury, restoration, and rubble stabilization or disposal. Light Detection and Ranging (LIDAR), Laser Airborne Depth Sounder (LADS), single-beam, multibeam, side-scan sonar, and hyperspectral imaging systems provide useful information, with multibeam and side-scan sonar providing the highest resolution. The LADS bathymetry database for Palm Beach, Broward, and Miami–Dade Counties is a valuable resource for comparisons between pre- and post-injury incident conditions *(Figure 4*). Seismic surveys may be used to determine sediment overburden on the injured area and onto adjacent areas. Survey track lines should have sufficient overlap within the injury area to ensure adequate survey

[36] Elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*).

and outside the injury area to adequately capture injury area boundaries. Bathymetric data are corrected with Differential or Wide Area Augment System (WAAS) GPS and should be provided in formats approved by the Trustees.

***In Situ* Diver Data Acquisition.** Aerial photography, bathymetry, and acoustic surveys can be useful for determining the total injury area; however, in most cases a more detailed injury assessment is necessary and requires *in situ* observations and measurements by divers. Divers swimming the area perimeter towing a surface buoy can map injury areas. The buoy is maintained directly overhead of the diver (depth and currents are limiting factors). To record a position, the buoy is submerged several times in rapid succession to communicate with the dive boat, which records the time and GPS location of the buoy. This allows the diver's notes (for example, notes on the type of injury and the boundary of the injury area) to be coordinated with the GPS points. A modification of this system is for the dive team to tow a surface buoy with an attached GPS. To mark locations, the diver activates a triggering device in the GPS unit. Both techniques are most effective in shallow, low-current areas. Greater depths and high-current locations reduce their accuracy.

A systematic survey based on a grid of transects, or quadrats, must be performed for each injury site. Quantitative quadrat (e.g., point intercept, cell count cover estimate) and/or transect (e.g., line point intercept, continuous data acquisition) methods are employed. Cameras are used to document the injuries and/or collect assessment data.

One method used to assess an injury area is the "fishbone" method,[37] in which a transect tape (baseline) is deployed down the long axis of the injury area; the width of the injury area is estimated by deploying transects at 2 m intervals perpendicular to the baseline out to the boundaries of the injury area. The data are compiled to produce a map and description of the injury. These methods are generally limited to small and medium injury sites (less than 1,500 m^2) with minimal current. Regardless of the assessment method selected, the injury report includes injury data, maps, and images.

Integrated Geographic Imagery Systems. Integrated geographic imagery systems used during past southeast Florida reef restoration activities include the Integrated Video Mapping System (IVMS) *(Figure 10)* and AquaMap™ *(Figure 11)*.

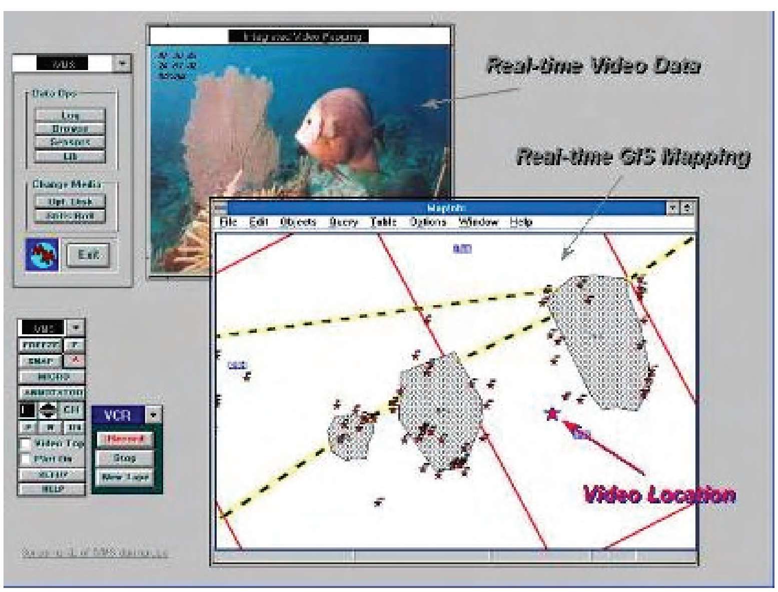

Figure 10. IVMS cartoon showing computer image (Image courtesy of SeaByte, Inc.).

[37] Hudson, J,H., and Goodwin, W.B. 2001. Assessment of vessel grounding injury to coral reef and seagrass habitats in the Florida Keys National Marine Sanctuary, Florida: Protocol and Methods. *Bulletin of Marine Science* 69(2):509-516.

The IVMS uses a tethered video and sound communication system mounted on a diving helmet. When the video camera is focused on an object of interest, the diver triggers an overhead floating GPS antenna, which records the video coordinates. Simultaneously, the diver notifies topside support to take GPS coordinates. Software application logs data (e.g., Hypack) in a mapping format. The data are used to compile a georeferenced injury map by superimposing the GPS coordinates on the video image. A summary table of injury characteristics (e.g., species, size, injury cause) is also generated.

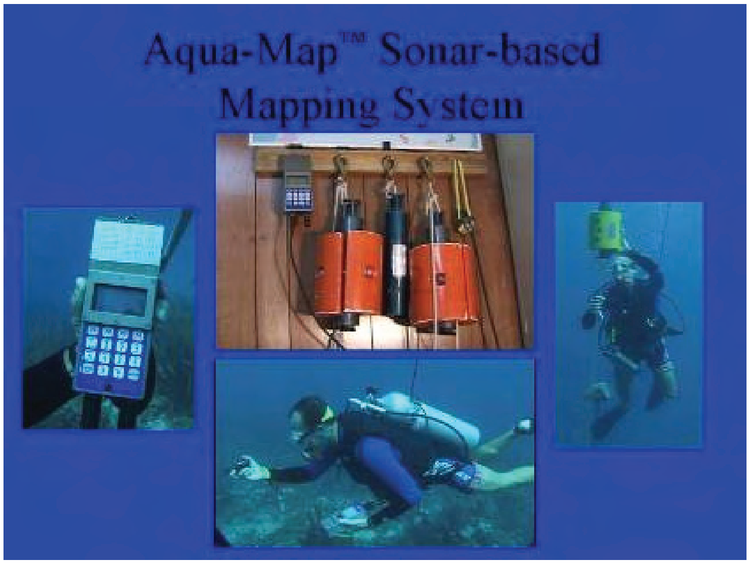

Figure 11. AquaMap^{TM}, a commercial underwater mapping system (Image courtesy of Desert Star Systems).

AquaMap uses sonic triangulation to map the injury area. Three acoustic transmitters are deployed at the injury site's boundaries (typically in an "L" configuration). Transmitter coordinates are captured and recorded using a high-resolution GPS on the surface. The diver uses a computer-acoustic receiver to acquire data on injuries; after placing the handheld device over an injury, the diver presses a key to indicate a preprogrammed injury type and capture triangulation transmission signals to position the injury. The system is ineffective in shallow water (3 to 5 m) and if there are structures between the transmitter and the receiver. Because its maximum range is 500 m, the system must be redeployed for larger areas. Typically the assessment includes a GIS map with color-coded polygons to describe the spatial relationship of the injuries *(Figure 12).*

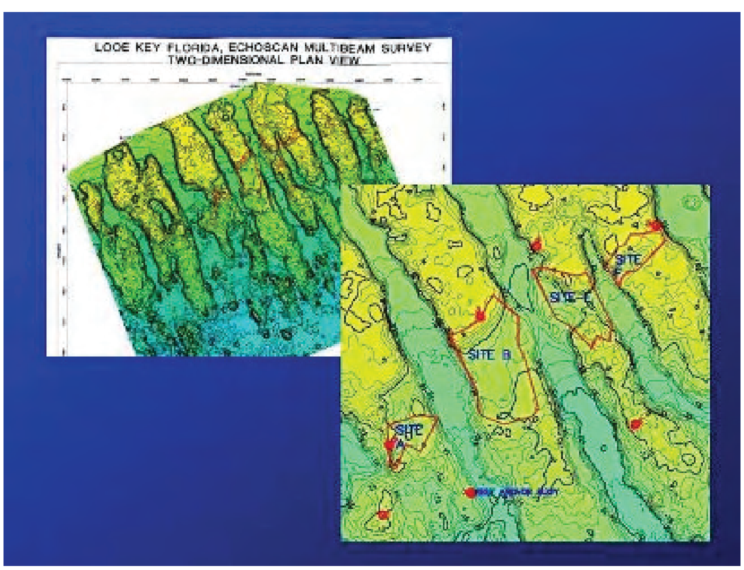

Figure 12. AquaMap^{TM} GIS map of a ship grounding site in the Florida Keys. The red outlined areas indicate the actual injury areas (Image courtesy of Desert Star Systems).

Biological Triage

Biological triage activities should occur as soon as possible following an injury. Fractured, dislodged, and overturned biological resources have a short window of opportunity in which they can be salvaged and stabilized. Therefore, the first step of biological triage is to right any overturned, dislodged, buried, or otherwise injured living organisms and mark them for repair. Often, it is possible to turn large corals right side up and they will remain stable temporarily without aid; however, small colonies and fragments can be easily overturned or washed off site by surge and wave energy. Small and fragmented stony coral, octocoral, and sponge colonies can be placed in baskets, milk crates, or other containers for temporary safekeeping (*Figure 13*).

Octocorals and sponges are more prone than other species to being moved by wave energy and surge, and thus need special care. Weighted baskets with lids are commonly used to secure them. These biological resources are vital to primary restoration and should be collected and cached in areas where they will be protected as much as possible from further injury while restoration activities are under way. Rubble should be stabilized or removed as soon as possible to prevent further injury to the site from rubble movement caused by rough seas or storms. Prompt biological triage and primary restoration are especially critical during the hurricane and winter frontal storm seasons.

Figure 13. Metal cylinder and laundry basket used to cache hard corals (Photo courtesy of Richard Shaul, SeaByte).

Primary Restoration

Primary restoration consists of activities designed to restore resources in the area where the injury occurred. A primary restoration plan should be developed by the RP and approved by the Trustees.

Primary restoration activities include the repair of reef framework, the reattachment of salvaged organisms, the stabilization or removal of remaining rubble, and the removal of bottom paint and debris. Nursery-reared corals may later be transplanted to areas suffering significant coral losses.[38] As part of rubble stabilization, and contingent upon agreement by the Trustees and RP, boulders and rubble from the injured area may be used to restore previous reef relief and rugosity.

[38] Monty, J.A., Gilliam, D.S., Banks, K.W., Stout, D.K., and Dodge, R.E. 2006. *Coral of opportunity survivorship and the use of coral nurseries in coral reef restoration.* Proceedings of the 10th International Coral Reef Symposium, Okinawa, Japan, pp. 1665-1673.

Funding

Funding for restoration work can come from three sources: the RP, the Trustees, or the Oil Spill Liability Trust Fund in situations invoking the 1990 Oil Pollution Act. In situations where the RP is responsive, funding is not an issue because the RP has assumed funding responsibilities. In situations where the RP is not responsive or the site is an orphan site, the Trustees bear the responsibility for funding or not funding restoration activities. The state of Florida provides statutory funding mechanisms through the Ecosystem Management and Restoration Trust Fund (EMRTF), [39] which is designed in part to be the repository for all damages recovered for injury to, or the destruction of, coral reefs and other natural resources of the state. The money deposited into the trust fund is earmarked specifically to reimburse FDEP for reasonable costs incurred in obtaining the payment of damages, including administrative costs and the costs of experts and consultants.

The assessment of civil penalties provides the EMRTF with funds if the Trustees need to restore a reef injury. However, there are difficulties associated with this funding mechanism, including the following:

- *There is no established penalty assessment schedule;*
- *Monetary compensation may be difficult to recuperate without litigation;*
- *Available funding to conduct restoration efforts for reef injuries, when there is an unresponsive RP or the injury site is an orphan site, is limited to available EMRTF funds from past penalty assessments; and*
- *There is no established adequate spending authority to facilitate immediate action and fund restoration needs.*

The section on the *Habitat Equivalency Analysis Approach* below discusses penalty assessment more thoroughly.

Recommendation #13

The Legislature should allow ready access to, and provide flexible spending authority for, EMRTF funds for rapid response to reef injuries; otherwise the potential for the resource to return to its original function and value may be greatly diminished.[40] FDEP should pursue amending Sections 380.0558 or 403.1651, F.S., to include flexible spending authority to facilitate rapid response to reef injuries.

Responsible Agency: FDEP

No-Action Option

There may be times when no action is taken to restore reef resources following an injury incident. The No-Action option serves as a benchmark against which other restoration efforts may be compared, and is usually the last resort when funding or human and other resources are not

[39] Sections 380.0558 and 403.1651, F.S.
[40] For an example of such flexible spending authority, see Subsection 403.1651(2)(a), F.S., regarding the Hillsborough County pollution control program.

available to conduct the primary restoration of an injury site. The No-Action option relies solely on natural processes of recovery, recruitment, settlement, and growth of biological resources. In some cases, the nature and/or extent of the injured area may be better suited to recovery through natural processes than restoration activities. Generally, however, No-Action results in longer resource recovery times compared with primary restoration recovery times. Exercising this option increases the risk of injury to nearby coral communities if unstable conditions created by fractured reef framework and loose rubble are present at the injury site. Furthermore, if physical conditions in the injured area are dangerous, creating significant risks to life and resources, taking No-Action may be the only option. Selecting the No-Action option for primary restoration, however, does not preclude the assessment of compensatory restoration costs or the possibility that restoration efforts may be conducted when monetary resources become available.

> ***Recommendation #14***
>
> **A database should be developed to track injured areas and their restoration status so that areas where no action is taken due to monetary constraints may be identified and prioritized for restoration efforts at a later time.**
>
> *Responsible Agency: FWC*

Primary Restoration Plan

A primary restoration plan is developed following the initial and detailed site assessment of a reef injury site. The plan should contain a detailed list of specific restoration tasks to reduce or mitigate the injury, the required schedule, and reporting documentation. Primary restoration plans typically include the following:

1. **Background Information**—*Provides information on the incident, including law enforcement reports; contact information for the RP or their representative; the name and type of vessel; date, time and location of the incident; vessel heading; water depth; and general description of the injured habitat.*

2. **Site Assessment**—*Provides the results from the detailed site assessment report.*

3. **Biological Triage**—*Describes the proposed methods and schedule for performing triage on displaced organisms.*

4. **Debris Removal**—*Describes the proposed methods for removing and disposing of debris and substances such as bottom paint.*

5. **Reef Framework Repair**—*Describes the proposed methods for stabilizing and/or repairing injury to the substrate.*

6. **Rubble Stabilization**—*Describes the proposed methods for stabilizing rubble at the site.*

7. **Rubble Disposal**—*Describes the proposed methods for removing and disposing of rubble that cannot be stabilized on-site.*

8. **Organism Reattachment**—*Describes the proposed methods for attaching each category of benthic organisms.*

9. **Mapping of Reattached Organisms**—*Outlines the proposed plan for mapping reattached organisms.*

10. **Authorization**—*Identifies authorizations necessary to conduct proposed restoration activities, and whether any authorizations have already been obtained.*

11. **Schedule**—*Provides a proposed schedule of restoration tasks.*

12. **Reporting**—*Describes the proposed schedule and delivery of reports to the Trustees detailing the progress of each task and problems or issues that may delay restoration.*

Primary restoration activities may include the following:

Injury Loss Assessment

It is unlikely that the characteristics of an injury site would be known in detail before the injury occurs; therefore an injury assessment describes and documents the states of both the injured area and a reference or control site (or sites). The state of the uninjured reference site is assumed to correspond physically and biologically to the injured site had the injury not occurred.[41] The difference between the estimates (injured and uninjured) is the injury loss.

Representatives for the Trustees and/or the RP contractor should review the initial and detailed site assessments to determine survey boundaries and the most expedient and accurate injury loss assessment methods. Over the past two decades, various methods have been employed that remain appropriate for future incidents. These include data from GPS units, vessel tracking systems, law enforcement reports, and aerial photos to define the potential injury area. In large vessel groundings there are often scrapes, anchor drag scars, and propeller washouts along the vessel ingress and egress tracks. Tugboats may also cause injuries during salvage.

During and upon completion of the injury assessment, the Trustees verify the results with field inspections. The assessment and inspection are the basis for scheduling and planning primary and compensatory restoration.

Debris Removal

A ship grounding or the salvage process may result in the accumulation of debris on or in the vicinity of the reef. The debris may consist of anchors, cables, or similar equipment specifically placed to facilitate vessel removal, or it may be an incidental loss of equipment during the salvage operation. Debris poses a significant threat to reef resources and should be removed.

Reef Framework Repair

When the reef framework is crushed and fractured, loose material often present in the reef structure is exposed. Both the loose material and the structure need to be stabilized or repaired to reduce further expansion of the injured area. Exposed loose framework material can also

[41] Osenberg, C.W., and Schmitt, R.J. 1996. Detecting ecological impacts caused by human activities. In: Schmitt, R.J., and Osenberg, C.W. (Eds). *Detecting ecological impacts: Concepts and applications in coastal habitats.* San Diego, California: Academic Press.

mobilize, increasing the injury area and impeding recovery by reducing the natural recruitment or the survival of reattached organisms.

Smaller framework cracks can be stabilized with cement mortar and other reinforcement materials. Mechanical reinforcement often includes fiberglass and stainless steel rods. Smaller craters and fissures can be backfilled using rubble materials combined with a cement mixture. If currents and wave energy are problematic, a fabric mat can be placed over the cement and temporarily secured with weights or sandbags.

Rubble Stabilization

Rubble stabilization is critical to reducing potential injury to surrounding resources. Because rubble that is easily moved during storm events can injure or destroy nearby organisms, it must be stabilized as much as possible. Rubble may be stabilized with cement or incorporated into reef framework gouges and fractures. In addition to stabilizing rubble, incorporating rubble reduces the amount of cement mortar needed to repair the reef framework. In all cases, rubble should be stabilized in a manner that minimizes the impacts on surrounding habitat.

Rubble Disposal

Although it is preferable to incorporate as much of the rubble as possible into the on-site reef framework repair, in some cases, it may be necessary to remove rubble from the site. When this is the case, it is the responsibility of the RP to determine a suitable offsite disposal option and secure the appropriate authorizations if necessary. Disposal methods must be incorporated into the primary restoration plan for approval by the Trustees.

Organism Reattachment

The rescue and reattachment of dislodged and fragmented organisms are conducted to begin restoring natural species richness, percent cover, and density, all of which may accelerate natural reef recovery (*Figure 14*). The organisms collected during triage should be reattached to areas that are structurally sound and away from sand and rubble movement. Organisms should be returned to their original location and depth where possible. Ideally, the target reattachment density (number of organisms/area of reef) should be similar to the preinjury density. The data recorded from reference sites should be used to estimate the preinjury density.

Figure 14. Divers assess dislodged and fragmented coral colonies for reattachment and rubble and boulders requiring stabilization (Photo courtesy D. Gilliam, NCRI).

Stony Corals (Scleractinia). Stony corals were transplanted using cement for growth experiments at the Dry Tortugas in the early twentieth century.[42] Currently, Portland cement or mixtures of Portland cement and sand are the most common methods used to reattach stony corals *(Figures 15 and 16)*. Other methods include epoxy, bolts, cable ties, and stainless-steel wire. In cases where wire, cable ties, and bolts are employed, there are many problems and failures. Wave action causes the corals to move, stretching the wire and/or cable tie; eventually the coral surface is injured by abrasion and never grows onto the reef substrate.

The normal attachment sequence is to position colonies (assuming that the corals can be manipulated by hand) close to the attachment point. A wire, stiff fiber brush, or metal scraper is used to clean away silt, algal films, and loose debris from the attachment point and the underside of the dislodged colony. A mass of cement is placed on the attachment point; the colony is placed in the cement, carefully forced down, and rotated slightly to maximize contact. Additional cement is worked in around the colony edge to reduce potential bioersion. If current or wave surge is causing the cement to wash away, soft weights or sand tubes can be used to protect the cement until it cures. Large coral colonies and fragments that cannot be moved by hand are moved using a lift bag (or bags) to provide buoyancy. Once the colony is manipulated into place, the lift bag is deflated. After the coral or fragment is set into the mass of cement, additional cement is used to fill in around the edge as necessary to provide strength. Stainless-steel or fiberglass rods can be inserted into the cement to reinforce the fixture.

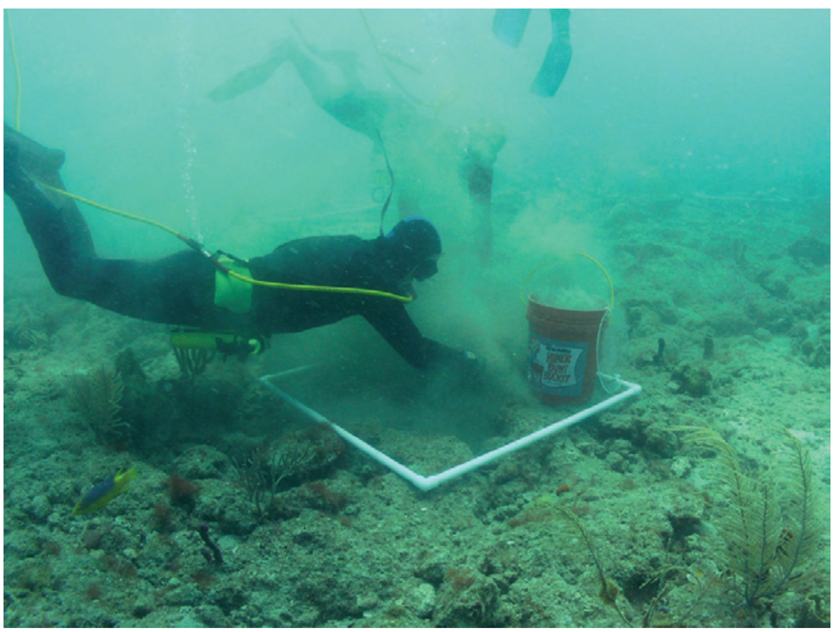

Figure 15. Cement is transported to the site in buckets and used to secure stony corals at a restoration site. In this image the diver is using a 1m² quadrat to facilitate reattaching colonies in the desired density (Photo courtesy of D. Gilliam, NCRI).

[42] Vaughan, T.W. 1916. *Growth rate of the Florida and Bahamian shoal-water corals*. Washington, D.C.: Carnegie Institution. Year Book 14: 221-231.

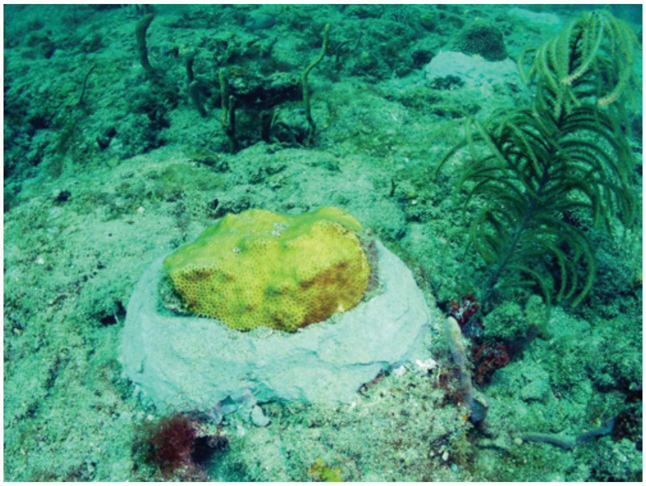

Figure 16. Example of a stony coral colony reattached using cement (Photo courtesy of D. Gilliam, NCRI).

Octocorals (Gorgonians). Octocorals (sea fans, sea plumes, and whips) present reattachment challenges because wave and current movement reduce colony stability as the reattachment material hardens. A number of methods can be used to reattach octocoral colonies. When the octocoral remains attached to a piece of dislodged substrate, the octocoral is generally reattached using the methods described in the section on *Stony Corals* (*Scleractinia*) below (*Figure 17*). If the dislodged colony still has a holdfast, nails can be driven through the holdfast into the substrate. Cement or epoxy is then placed over the substrate and the holdfast. The nail provides support while the attachment material is hardening. Soft weights or sandbags can also be used to temporarily support the colony until the reattachment material hardens. When there is no holdfast, reattachment methods should include the use of additional structural support for the colony stem. One method involves drilling a small hole into the reef substrate, and inserting the colony stem into the hole and securing it with epoxy or cement. Removing tissue from the stem before it is inserted into the hole may increase the rate of success. Another method uses thin stainless-steel rods secured into the substrate. The colony is secured to the rod with wires, cable ties, and/or cement or epoxy. Octocorals can also be reattached by pushing the stem of the dislodged colony into an existing small reef crack or crevice and securing it with cement or epoxy. Small rubble can be used to fill gaps and increase colony support.

Figure 17. Example of a gorgonian colony reattached using cement (Photo courtesy of D. Gilliam, NCRI).

Sponges (Porifera). The reattachment of whole sponge colonies or fragments of colonies has been attempted, [43] but the rate of long-term success is unknown. When whole colonies or fragments remain attached to a piece of dislodged substrate, the colony is generally reattached using the methods described in the section on *Stony Corals* (*Scleractinia*) above (*Figure 18)*. Alternatively, dislodged smaller colonies and fragments can be secured in reef crevices and holes with no adhesives. Larger sponges such as the barrel sponge (*Xestospongia muta*) are generally more difficult to reattach. Using the methods described for stony corals, fragments have been secured to the reef substrate using cement and epoxy. The placement of masonry nails in the cement and the sponge may provide additional support. Stainless-steel wire has also been used to hold the fragments against the reef substrate. The recovery and growth of sheared Xestospongia bases have been recorded. [44]

Figure 18. Reattached barrel sponge (X. muta) (Photo courtesy of Bruce Graham, CSA).

Mapping

Each restoration element (framework repair, rubble stabilization, and organism reattachment) requires inspection and monitoring. The development of a reference map for relocating these elements in the future is imperative and should occur concurrently with restoration actions. For example, after framework repair and organism reattachment are completed in a particular area, the area should be mapped in sufficient detail to facilitate future inspections and monitoring. Typically, a series of coded reference markers (tags and/or pins) is installed on the site. Each marker is georeferenced using a GPS receiver accurate to 3 m. Restored elements, such as stabilized rubble or a reattached organism, are referenced (bearing and distance) from two or more reference markers. The Trustees archive these data, compiled in tables and maps, for monitoring recovery status and trends.

[43] Marine Resources Inc. 2003. *M/V Alam Senang grounding, Broward County Florida: Assessment and Restoration. Report for Scandinavian Underwriters Agency.*
Continental Shelf Associates, Inc. 2006. *Habitat Restoration: M/V Spar Orion grounding, Broward County, Florida.* Report for Independent Maritime Consulting, Ltd.
Gilliam, D.S., Moulding, A.L., and Kosmynin, V. 2007. *Monitoring of initially restored corals and the coral reef mitigation study and pilot project.* Year 1 report submitted to the Hillsboro Inlet District by the National Coral Reef Institute, Nova Southeastern University Oceanographic Center.

[44] Gilliam, D.S., Moulding, A.L., and Kosmynin, V. 2007. *Monitoring of initially restored corals and the coral reef mitigation study and pilot project.* Year 1 report submitted to the Hillsboro Inlet District by the National Coral Reef Institute, Nova Southeastern University Oceanographic Center.
Marine Resources Inc. 2003. *M/V Alam Senang grounding, Broward County Florida: Assessment and restoration.* Report for Scandinavian Underwriters Agency.

Schedule

The development of a primary restoration plan schedule depends on the nature and extent of the resource injuries, and is determined through agreement between the RP/contractor and the Trustees. Safety concerns, inclement weather delays, and other logistical issues are considered on a case-by-case basis.

Reporting

Contractors are expected to provide progress reports to the Trustees upon the initiation and through the completion of primary restoration activities. The frequency of these reports is to be determined by the Trustees and incorporated into the primary restoration plan.

X. POST-RESPONSE

The post-response period is limited in scope primarily to post-primary restoration assessment, compensatory mitigation, monitoring, and penalty assessment. The post-response period is potentially the longest component of the restoration process. Penalty assessment may take years due to the nature of the litigation process, and monitoring of the reef injury incident site may also last for years with the potential for additional restoration activities.

Post-Primary Restoration Assessment

After primary restoration activities are complete, the RP and Trustees carry out a post-restoration assessment that seeks to answer the following questions: (1) Was the work completed according to plan, (2) is recovery now likely (if the primary restoration is inadequate, the inadequacies should be identified and corrections addressed), and (3) what is the current status of the injured resource (quantification of the extent of the injury after primary restoration)? A typical evaluation compares the biological and ecological attributes of the restoration site with a reference site (or sites). Attributes of interest include species richness, evenness, biological cover, and community similarity of the restored reef habitat to reference sites. The eventual recovery of the injured resource is considered satisfactory if the biological attributes meet or exceed those of the reference sites.

The Trustees' post-primary restoration assessment should be documented with photography and/or videography, and GPS coordinates should be recorded for any areas where work is incomplete, or inadequate. The chief technical expert for the Trustees should prepare a post-primary restoration report whose purpose is to communicate the results of the assessment to the RP and to facilitate compensatory mitigation assessment.

Compensatory Mitigation Assessment

Compensatory mitigation is assessed after primary restoration has been completed, and is designed to provide for the interim loss of ecological services from the time of the injury until natural recovery returns the resources to their baseline condition. Compensatory mitigation assessment considers the temporal loss of the resource and the risk associated with the compensatory mitigation action. Compensatory mitigation assessment methodologies vary, but provide a standardized approach to quantifying the amount of needed compensatory mitigation to offset the lost functions of the resource.

Habitat Equivalency Analysis Approach

The most appropriate compensatory mitigation assessment method used for reef injuries in southeast Florida is Habitat Equivalency Analysis (HEA). HEA has been applied in multiple cases to spatially scale compensatory mitigation.

HEA[45] is used to determine the amount of a compensation action that will provide adequate replacement for the lost services of an injured resource. The HEA model requires the quantification of losses from the injury, which are entered into the model as injury area parameters, and compensatory action recovery values. The model uses explicit formulas for calculating the HEA.[46] The HEA approach is particularly well suited to reef injury analysis because it can be used to quantify the amount of loss and gain of resources and services over time *(Figure 19)*.

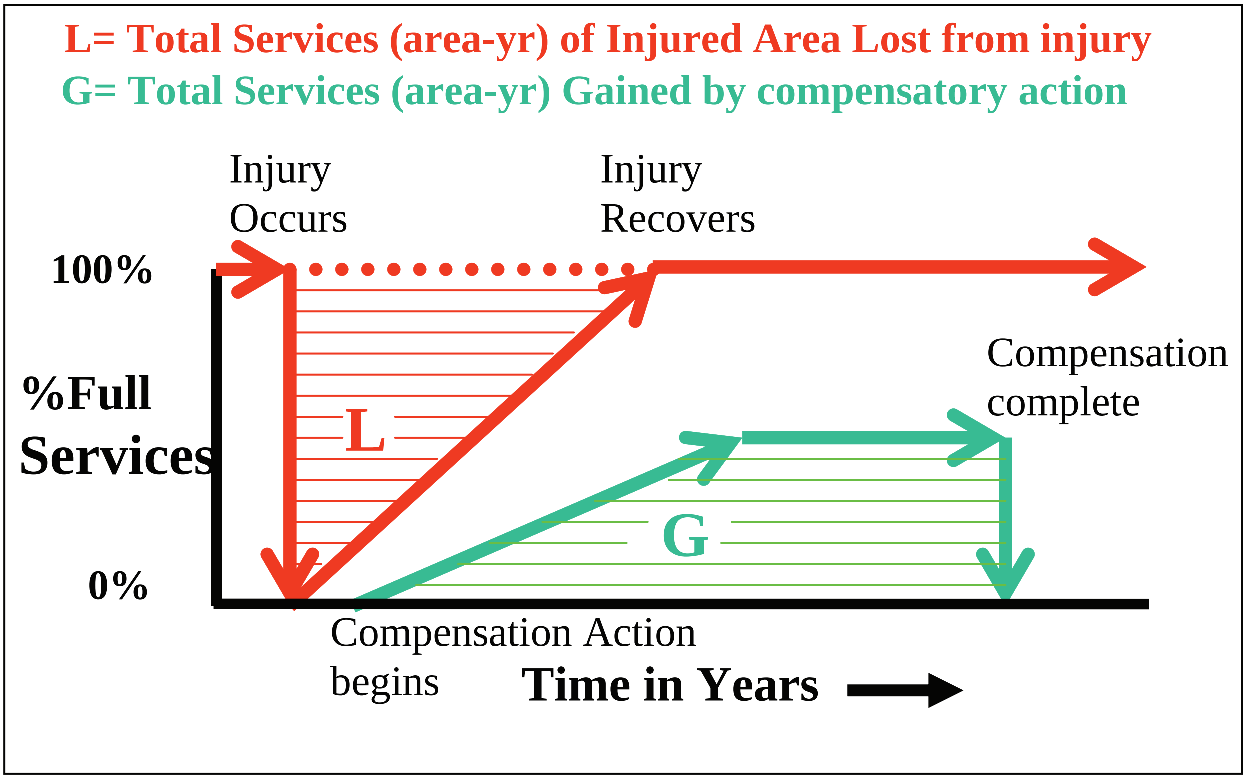

Figure 19. Illustration of injury and compensatory action. Biological services begin at some level, here 100%. An injury occurs, causing a decrease in services to 0%. Recovery from the injury occurs over time in a linear fashion, back to 100%. The area within L is the amount of lost services over time. With the parameters of an assumed compensatory action, HEA is used to calculate the amount of that action needed to balance the services lost. A compensatory action, illustrated above, begins with 0% services; these increase over time to 50% and continue for a long period, after which the compensatory action ceases. HEA provides the amount of the compensatory action needed to provide those services gained in G, which balance those lost in L.

[45] Milon, J.W., and Dodge, R.E. 2001. Applying Habitat Equivalency Analysis for coral reef damage assessment and restoration. *Bull. Mar. Sci.* 69. 975-988.
Mazzotta, M.J., Opaluch, T., and Grigalunas, T. 1994. Natural resource damage assessment: The role of resource restoration. *Nat. Resources J.* 34: 153-178.
Kohler, K.E., and Dodge, R.E. 2006. V*isual_HEA: Habitat Equivalency Analysis software to calculate compensatory restoration following natural resource injury.* Proceedings of the 10th International Coral Reef Symposium, Okinawa, Japan, pp. 1611-1616.
Unsworth, R., and Bishop, R. 1994. Assessing natural resource damages using environmental annuities. *Ecol. Econ*. 11: 35–41.
[46] Milon, J.W., and Dodge, R.E. 2001. Applying Habitat Equivalency Analysis for coral reef damage assessment and restoration. *Bull. Mar. Sci.* 69. 975-988.
Kohler, K.E., and Dodge, R.E. 2006. Visual_HEA: H*abitat Equivalency Analysis software to calculate compensatory restoration following natural resource injury.* Proceedings of the 10th International Coral Reef Symposium, Okinawa, Japan, pp. 1611-1616.
National Oceanic and Atmospheric Administration, U.S. Department of Commerce. March 21, 1995 (revised October 4, 2000). *Habitat Equivalency Analysis: An overview, damage assessment and restoration program.*

Injury Area Parameters

The following are the minimal injury parameters necessary to complete a HEA:

- ***The baseline level of services at the injury areas prior to and following the injury.***
- ***The extent and nature of the injury****—The spatial extent of injury and the initial reduc tion in service level from baseline at the injured area, characterized as a percentage of the baseline level of services. These parameters may be combined to measure the "effective-acres" of an injury.*
- ***Injury recovery trajectory and level (with natural recovery)****—The maximum level of services (as a percent of baseline) to be achieved and the history over time of the recovery.*
- ***Recovery period for injured resources****—The recovery start year and year that the maximum level of services are expected to be achieved.*

Compensatory Action Parameters

The following are the compensatory action parameters necessary to complete a HEA:

- ***The initial level of services provided by the compensatory action at the installation site, calculated as a percentage of baseline services at the injury site.***
- ***Replacement project maturity function****—The rate of (incremental) service growth and the maximum level of services achieved, calculated as a percentage of the baseline level of services at the injury site.*
- ***The maturity period for replacement resource****—The year that services increase and the year that the maximum level of services will be achieved.*
- ***Recovery period for injured resources****—The recovery start year and year that the maximum level of services are expected to be achieved.*
- ***Discount rate****—This is based on the assumption that resources available in the present are valued more highly than if their availability is delayed until the future, and the further into the future that a service is provided the less it is valued today. The federal Office of Management and Budget (OMB) does not specify a discount rate; however, since 1971 the discount rate has averaged 6%.[47] When assessing resource values, NOAA by policy uses a 3% discount rate.[48]*

Applications

HEA has been widely used in federal, state, and local assessments of unpermitted and permitted injury to coral reef ecosystems. It has also been used for determining compensatory mitigation for beach renourishment projects and ship groundings (i.e., the USS Memphis) and anchor

[47] OMB. 1992. Guidelines and discount rates for benefit-cost analysis of federal programs. OMB Circular A-94. Washington, D.C. Available: http://www.whitehouse.gov/omb/circulars/a094/a094.pdf. OMB, 1992, states its Discount Rate Policy as the following: "8. Discount Rate Policy. In order to compute net present value, it is necessary to discount future benefits and costs. This discounting reflects the time value of money. Benefits and costs are worth more if they are experienced sooner. All future benefits and costs, including non monetized benefits andcosts, should be discounted. The higher the discount rate, the lower is the present value of future cash flows. For typical investments, with costs concentrated in early periods and benefits following in later periods, raising the discount rate tends to reduce the net present value. (Technical guidance on discounting and a table of discount factors are provided in Appendix B.)"

[48] www.newyorkfed.org/markets/statistics/dlyrates/fedrate.html.

drag cases in south Florida. In particular, in litigated grounding cases in Florida, the courts have supported the use of HEA to determine the restitution of lost resources and the value of the resource during recovery.[49] Although HEA application has been accepted by the courts, most grounding cases settle before court.

The Florida Statutes and FDEP rule[50] currently require the use of the Uniform Mitigation Assessment Method (UMAM) for determining compensatory mitigation for regulatory activities. UMAM is deficient when applied to reefs and other marine habitats due to inappropriate scoring assessment parameters. It is also not peer reviewed. The incorporation of regulatory processes into reef injury incidents may require modifications to the Florida Statutes or FDEP rules to allow for the use of HEA versus the use of UMAM, or to modify UMAM so that it is applicable to marine habitats.

Recommendation #15

The use of HEA is recommended for determining compensation for reef resource injuries. If appropriate scoring assessment parameters are developed, UMAM application to reef resource injuries may also be suitable.

Responsible Agency: FDEP

Compensatory Mitigation Options

The purpose of compensatory mitigation is to provide compensation for the loss of injured resources in a manner that directly benefits the type of resource impacted. Many actions may provide compensatory mitigation for reef resource injuries, including special studies,[51] special projects,[52] and equipment purchases[53] designed to directly benefit the reef resources that were injured by improving resource protection. Historically, the compensatory mitigation option preferred by the Trustees has been compensatory restoration.

[49] Lum, A.L. Spring 2006. *Coral reef damages and cost recovery, seeking practical solutions.* NR&E, pp. 70-72.
Lum has stated "…[A]pplication of HEA was approved by the courts in at least two cases for which there exist reported opinion the first case, United States v. Fisher, 97 E. Supp. 1193, 1201 (S.D. Fla. 1997), the district court approved, without discussion, the use of HEA to value restoration cost due to sea grass destruction from a ship grounding in the Florida Keys National Marine Sanctuary (FKNMS). Since the injury occurred within a marine sanctuary established pursuant to the Marine Protection, Research, and Sanctuaries Act (MPRSA), the courts noted that restoration costs were explicitly recoverable under 16 U.S.C. P 1432(6)(A) of the MPRSA, which provides for cost recovery based on the cost of replacing, restoring, or acquiring the equivalent of the injured resource, as well as the value of the lost use of the resource pending its restoration or replacement. Similarly, in United States v. Great Lakes Dredge & Dock Co., 259 F3d 1300, 1305 (11th Cir. 2001), another case involving a ship grounding in the FKNMS, the court of appeals affirmed the use of HEA as a methodology for valuing restoration costs of injured sea grass beds. In light of the explicit language set forth in the MPRSA mandating the recovery of restoration costs, it is not surprising that the HEA methodology for valuing restoration was approved by the courts, since it meets the goal of the statute."

[50] Subsection 370.414(18), F.S.; Rule 62-35, F.A.C.

[51] Calypso Pipeline Project in Broward County, Florida—compensatory mitigation includes the development of a feasibility study to evaluate practicality and relocation options for the Port Everglades anchorage area.

[52] AES Ocean Express Pipeline Project and Calypso Pipeline Project in Broward County, Florida—compensatory mitigation includes the removal of tires from coral reefs in Broward County, Florida.

[53] *M/V Houston* vessel grounding in the Florida Keys—compensatory mitigation included the purchase of Racon beacons for installation in the Florida Keys, as navigation aids to warn ships they are nearing a reef.

Compensatory Restoration

Primary restoration attempts to return the natural resources to their baseline condition—i.e., the condition preceding the injury. Compensatory restoration compensates the public for the interim loss of ecological services from the time of the injury until natural recovery returns the resources to their baseline condition. After the injury, primary restoration may consist of salvaging live organisms (principally scleractinian corals), reattaching organisms, removing rubble from the reef areas, and using large boulders created by the injury to restore reef structure. However, primary restoration does not achieve a return to baseline status. A logical next step is to proceed with compensatory restoration to provide ecological services to compensate for those lost from the injury.

The body of knowledge on compensatory restoration as a means to recover lost ecological services in southeast Florida is found in Sheppard,[54] Hoppe, [55] Yoshioka and Yoshioka,[56] Mazzotta et al.,[57] Fonseca et al.,[58] Jaap,[59] Gilliam et al.,[60] Milon and Dodge,[61] Dodge,[62] Moyer et al.,[63] Dodge and Kohler,[64] and Jaap et al.[65] The process involves reaching concurrence on the injury areas, the time for recovery for each of the injury categories, and the appropriate project(s) that should be executed for compensatory restoration.

Monitoring Plan

A monitoring plan is essential to document the success of restoration efforts. Ideally, monitoring should continue over the long term (more than 10 years) due to the life history of corals and associated reef organisms. Monitoring must be comprehensive, providing biological, ecological, and physical assessments such as the success of reattached organisms, reproductive capacities, recruitment, changes in community structure, and the stability of the stabilized rubble and reef framework. Monitoring allows for the improvement of triage and reattachment techniques and provides guidance for future restoration efforts.

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[54] Sheppard, C. 1982. Coral population on reef slopes and their major controls. *Mar. Ecol. Prog. Ser.* 7, 83-115.
[55] Hoppe, W.F. 1988. Growth, regeneration and predation in three species of large coral reef sponges. *Mar. Ecol. Prog. Ser*. 50 (1-2): 117-125.
[56] Yoshioka, P.M., and Yoshioka, B.B. 1991. A comparison of the survivorship and growth of shallow-water gorgonian species of Puerto Rico. *Mar. Ecol. Prog. Ser.* 69, 253-260.
[57] Mazzotta, M.J., Opaluch, T., and Grigalunas, T. 1994. Natural resource damage assessment: The role of resource restoration. *Nat. Res*. J. 34: 153-178.
[58] Fonseca, M., Julius, B., Kenworthy, W. 2000. Integrating biology and economics into seagrass restoration: How much is enough and why? *Environ. Eng.* 15: 227-237.
[59] Jaap, W.C. 2000. Coral reef restoration. *Ecol. Eng.* 15: 345-364.
[60] Gilliam, D.S., Thornton, S.L., and Dodge, R.E. 2001. *One-year post-baseline monitoring and assessment of coral reattachment success and coral recruitment, at the C/V Hind grounding site, Broward County Florida.* Report submitted to the Florida Fish and Wildlife Commission, Florida Marine Research Institute.
[61] Milon, J.W., and Dodge, R.E. 2001. Applying Habitat Equivalency Analysis for coral reef damage assessment and restoration. *Bull. Mar. Sci*. 69(2): 975-988.
[62] Dodge, R.E. 2002. *An application for calculating Broward near-shore mitigation amount.* Technical report. National Coral Reef Institute, Nova Southeastern University Oceanographic Center.
[63] Moyer, R.P., Riegl, B., Banks, K., and Dodge, R.E. 2003. Spatial patterns and ecology of benthic communities on a high-latitude south Florida (Broward County, USA) reef system. *Coral Reefs* 22(4):447-464.
[64] Dodge, R.E., and Kohler, K. 2004. *Visual_HEA: Habitat Equivalency Analysis software to facilitate calculation of compensatory restoration following natural resource injury.* National Coral Reef Institute, Nova Southeastern University Oceanographic Center.
[65] Jaap, W.C., Hudson, J.H., Dodge, R.E., Gilliam, D.S., and Shaul, R. 2006. Coral reef restoration with case studies from Florida. In: *Coral Reef Conservation.* Cote, I.M., and Reynolds, J.D. (Eds.). New York: Cambridge University Press, pp. 478-514.

Recommendation #16

A publication on Guidelines to Restoration Monitoring should be initiated as a follow-up to this document.

Responsible Agencies: Lead—FDEP; Support—FWC

Penalty Assessment

There are four key components of penalty assessment: (1) The existence of statutes or rules authorizing penalties for infractions; (2) within those statutes or rules, the definition of the type of infraction that the penalties are applicable to; (3) the enforceability of statutory provisions by other agencies' law enforcement officers with shared jurisdiction over the same resources; and (4) assurance that Trustees have the ability to collect penalties to the full extent necessary to recuperate for injured or lost resources. Any injury to state lands and resources is an offense that may be litigated to ensure the full protection and conservation of state lands.[66] Additionally, FDEP has authority to develop a schedule for the assessment of civil penalties for injury to coral reefs in state waters. Penalties of up to $1,000 per square meter of area injured and additional penalties for aggravating circumstances, not to exceed $250,000 per occurrence, are permissible. However, there is no express requirement in the statute that restoration to the maximum extent must be achieved. To date, FDEP has not exercised its option to establish a penalty schedule by rule. As a result, only a case-by-case approach based on existing processes for the Florida Keys National Marine Sanctuary[67]or based on negotiation has been employed.

A potential hurdle to the collection of compensation and monetary penalties lies in the federal regulations. Admiralty law provides for the ability to move litigation from state jurisdiction to federal where the Limitation of Vessel Owners' Liability Act[68] is available. Using this Act may benefit parties responsible for larger vessel groundings when the cost of restoration may exceed the value of the vessel and its cargo.

Section 253.04, F.S., is deficient in that the penalty guidance established is not self-executing and the ability to institute rulemaking is limited to the discretion of FDEP. A penalty assessment schedule developed by FDEP rule rather than statute would need to specify that law enforcement officers from other local, state, and federal agencies have the ability to use the FDEP schedule. Multiple agencies have jurisdiction over reef resources, and these agencies should possess the ability to enforce the provisions of this statute and use the same penalty assessment schedule for consistency.

Recommendation #17

FDEP should (1) develop a penalty assessment schedule by rule, including explicit authority for any law enforcement officer to enforce the provisions in the rule, or (2) request that the legislature amend statutory language in Section 253.04, F.S., to establish a penalty assessment schedule to be used for

[66] Section 253.04, F.S.
[67] See 15 CFR Part 922, Subpart P.
[68] 46 USC §§ 181 *et seq.*

assessing civil penalties associated with injury to coral reefs in state waters. Amended statutory language should include penalties for repeat offenders and explicit authority for any law enforcement officer to enforce the provisions in the statute.

Responsible Agency: FDEP

Recommendation #18

FDEP should amend the statutory language in Section 253.04, F.S., to require restoration to the maximum extent possible of sovereignty submerged lands and associated biological resources to their original function and value. Oversight for restoration activities would be provided by a regulatory authorization process (as previously recommended), or by reimbursing the Trustees for restoration costs. It should be considered whether or not the restoration of an injury site would serve in lieu of assessing civil penalties as an incentive for the restoration of larger vessel grounding sites.

Responsible Agency: FDEP

Recommendation #19

Trustees should jointly support congressional legislation to protect the state's right to collect appropriate monetary penalties and require that restoration efforts be completed in total, regardless of vessel and cargo value. The Oil Pollution Act, Exemption from Limitation and Exoneration of Liability,[69] provides an example of applicable existing legislation that protects state rights to collect monetary penalties.

Responsible Agencies: Lead—FDEP; Support—FWC, Local Governments

[69] 33 USC §§ 2701 *et seq.*

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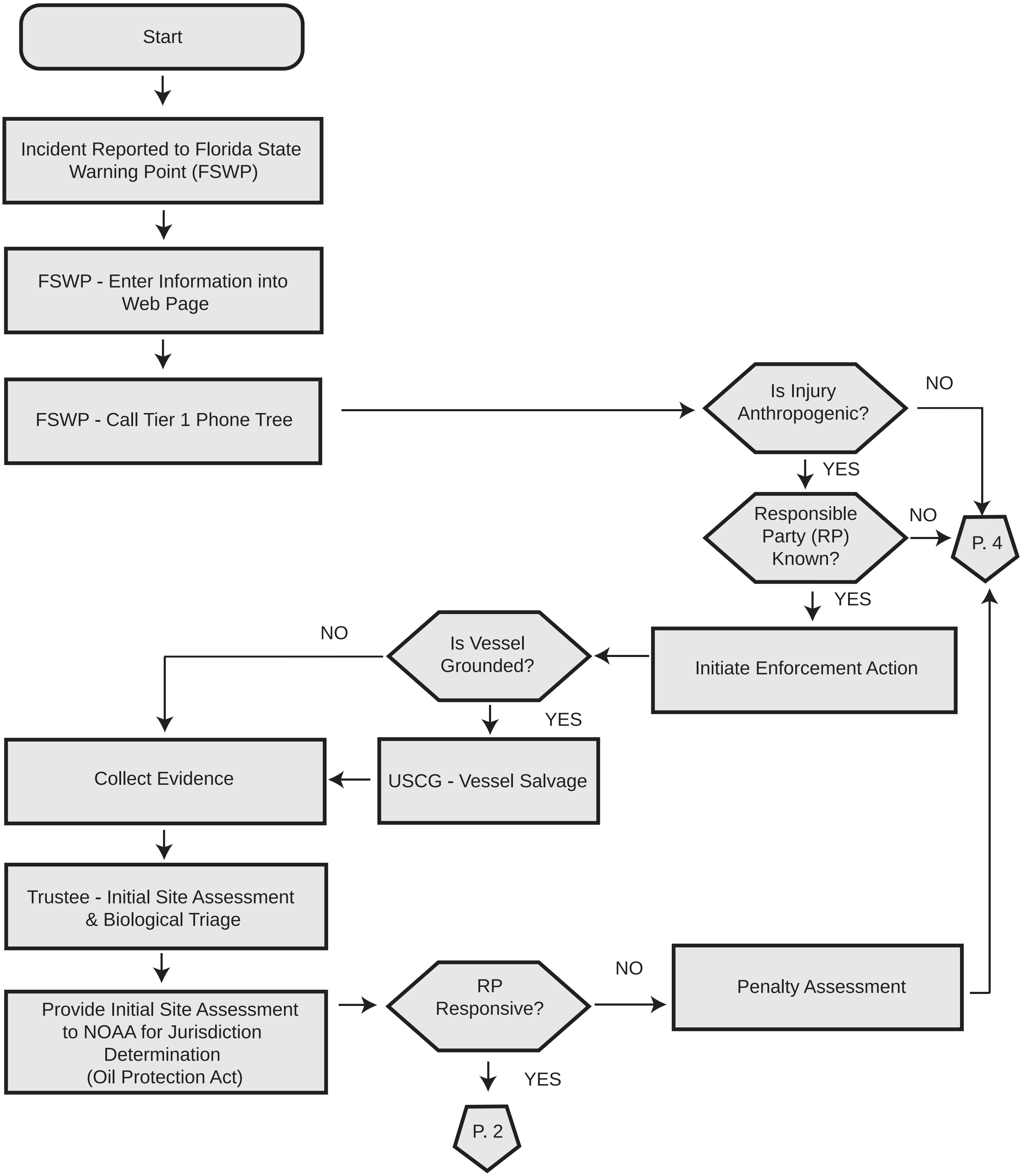
APPENDIX I: RAPID RESPONSE PROCESS FLOW CHART



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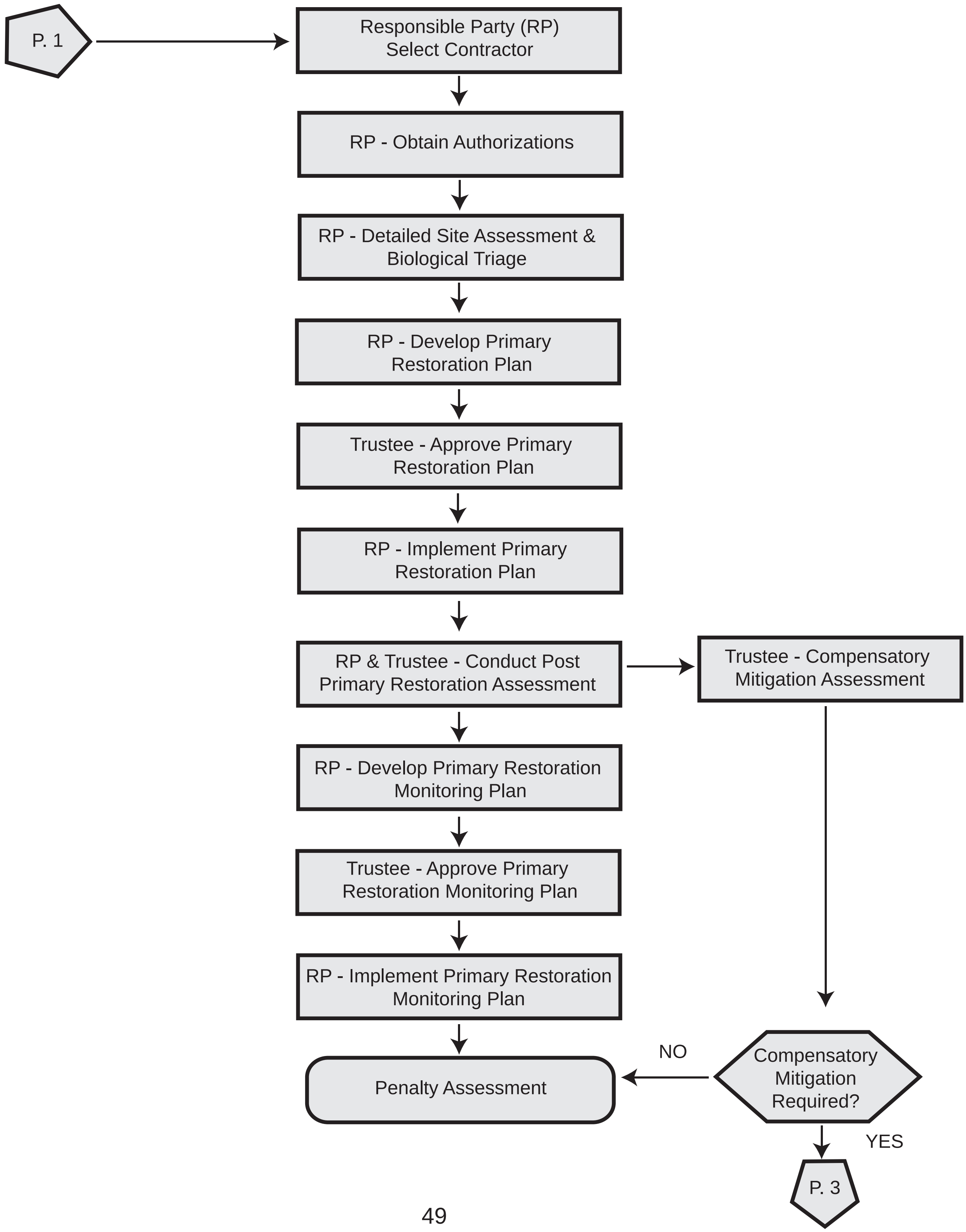

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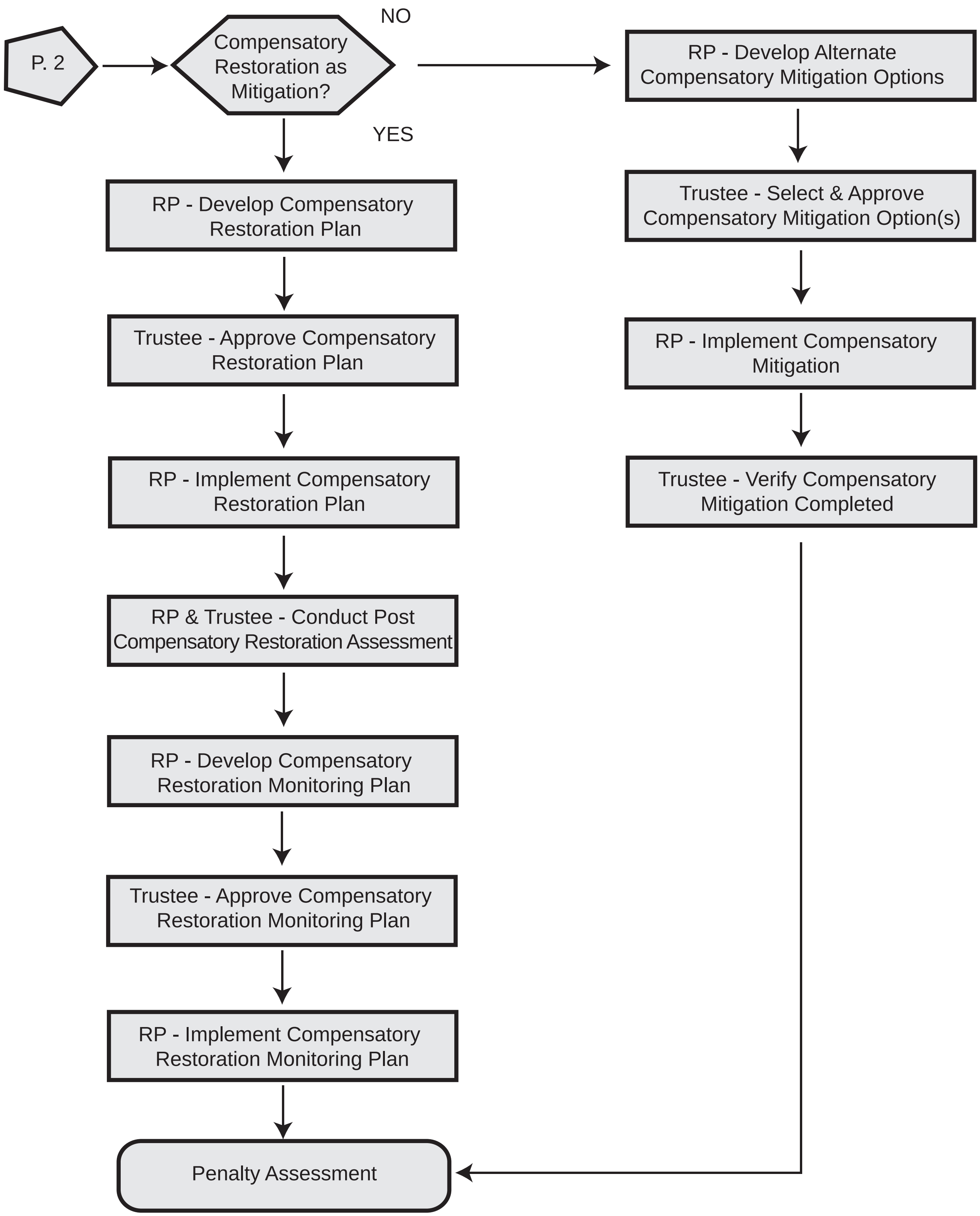

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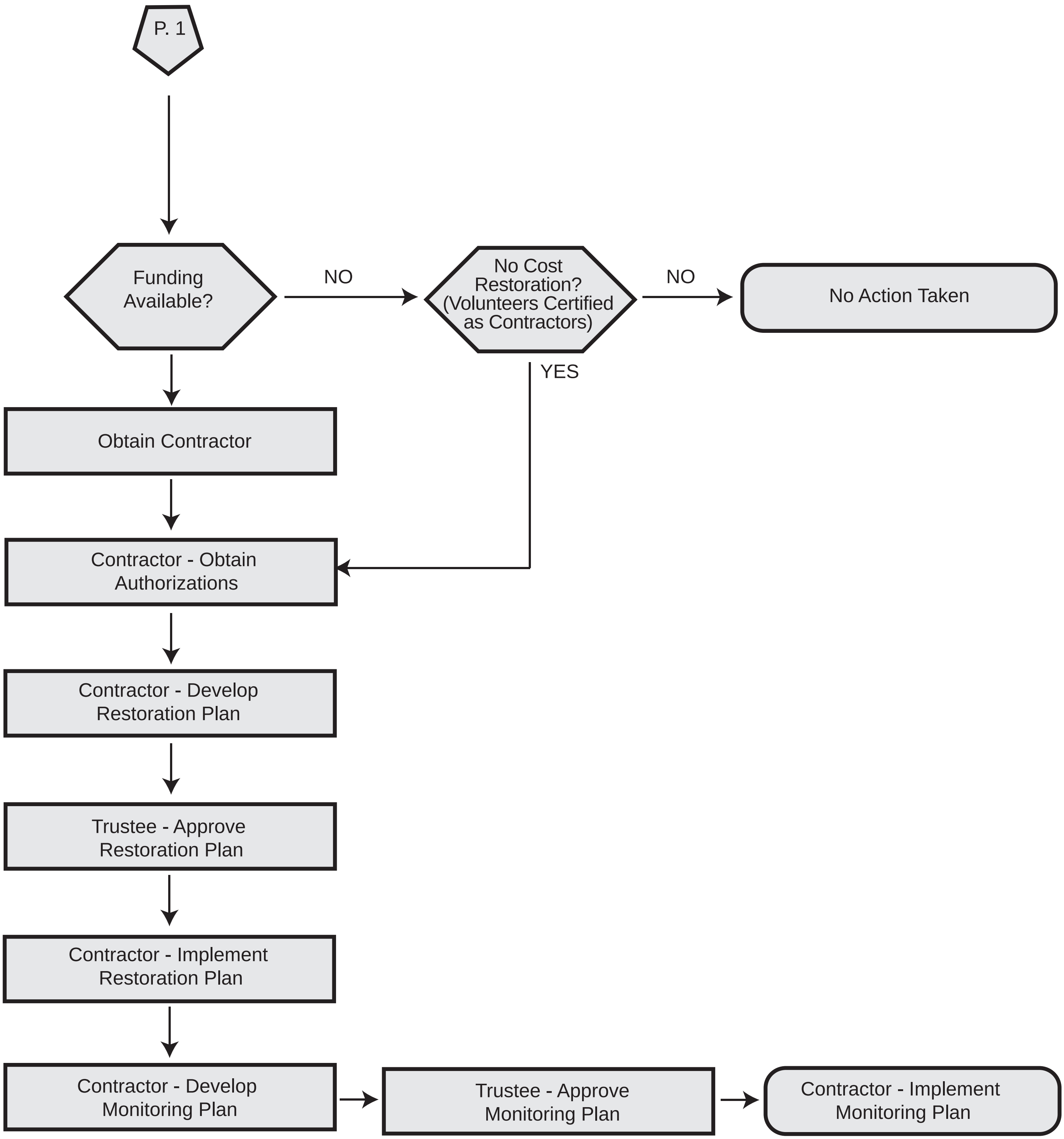

APPENDIX 2: SUMMARY OF RECOMMENDATIONS

1. **Regulatory agencies issuing permits for activities that may affect reef resources should re-examine and improve permitting, compliance, enforcement, and penalty assessment processes to ensure that permit conditions provide the maximum protection for, and the least impact to, reef resources. Permit conditions 1should also ensure that compensatory mitigation adequately compensates the Trustees for the loss of biological services, the monitoring of restoration actions, permit condition compliance and enforcement, and the assessment of penalties for permit violations.**

   Responsible Agencies: Florida Department of Environmental Protection (FDEP), Water Management Districts, U.S. Army Corps of Engineers (ACOE), Local Governments

2. **A single 24-hour coral reef injury hotline should be established, or coordinated with other available hotlines, to receive reports of coral reef injuries and to facilitate a timely and effective agency response to such reports. The 24-hour coral reef injury hotline should be modeled after, and if possible integrated with, FDEP's Bureau of Emergency Response (BER) State Warning Point (SWP) hotline, which accepts calls statewide on a 24-hour basis regarding reports of environmental incidents and domestic security.**

   When the hotline receives calls, basic information regarding the incident should be taken by the individual receiving the call. Federal, state, and/or local responders should be notified of the incident and, if necessary, agency personnel dispatched to the scene. If the RP is reporting the incident, they should be notified of their responsibilities and provided a list of qualified contractors from which to choose.
   Ideally, the 24-hour coral reef injury hotline would be integrated with the SWP, and its operators would be trained to receive such calls. This would alleviate the need to purchase, develop, and maintain the infrastructure and employees associated with an independent coral reef hotline. SWP employees could be provided a set of appropriate questions to ask the individual reporting the coral reef injury. The employee would then contact agency personnel responsible for responding to coral reef incidents. However, if it is not possible to integrate with the SWP, a separate and independent coral reef hotline should be established.

   Responsible Agency: FDEP

3. **A public education campaign should be undertaken to inform the public of the necessity of, and correct protocol for, reporting reef injuries. Federal, state, and local employees should also be made aware of their responsibility to report coral reef incidents through the normal course of business and other standard operating procedures such as interoffice/agency memoranda and email.**

   Responsible Agencies: Lead—FDEP; Support—Florida Fish and Wildlife Conservation Commission (FWC)

4. **To facilitate the coordination of agencies having established environmental response procedures, protocols, and responsibilities, operators of the proposed 24-hour hotline should notify the following agencies of an incident:**

- *U.S. Coast Guard (USCG), Marine Safety Office, Miami;*
- *FWC, Division of Law Enforcement (which would subsequently contact FWC Technical Staff);*
- *FDEP, BER (which would subsequently contact the Coral Reef Conservation Program and FDEP Office of General Counsel);*
- *National Marine Fisheries Service (NMFS), Damage Assessment and Restoration Program; and*
- *County environmental and law enforcement officials.*

Long-term coordination among all parties involved in the incident should be facilitated through the development and maintenance of a password-protected website containing the following information:

- *Information provided during the initial incident report to the 24-hour coral reef hotline;*
- *The Responsible Party (RP) contact information, including legal and technical contacts (if known);*
- *Contact information for each agency involved in any aspect of the response; and*
- *All contractor and subcontractor contact information.*

Each agency should be responsible for entering and maintaining its contact information after 24-hour hotline personnel implement the initial coordination. The website should be operated and maintained by FDEP's Coral Reef Conservation Program.

Responsible Agency: FDEP

5. **FDEP should explore the various avenues of potential enforcement authority and develop the one identified as producing the best results.**

Responsible Agency: FDEP

6. **The Trustees should develop criteria for evidence collection associated with reef injury incidents, based on their anticipated future litigation needs. Law enforcement officers and/or scientific divers should then adopt these criteria as standard practice each time that data are collected for use as evidence in future litigation. The National Oceanic and Atmospheric Administration's (NOAA) Damage Assessment, Remediation and Restoration Program (DAARP) provides a model for the development of Trustee criteria.**

Responsible Agencies: Lead—FDEP; Support—Local Governments and FWC

7. **All divers collecting evidence, including scientific divers collecting scientific data that may be used in a court of law, should be trained in an accredited evidence collection policy or procedure.**

   Responsible Agency: FWC

8. **To ensure that adequate safety standards are followed, only divers operating under standards set forth in 29 CFR § 1910 should collect evidence or scientific data that may be used as evidence in subsequent litigation.**

   Responsible Agencies: FWC, FDEP, and Local Governments

9. **A tiered contractor certification or qualification process should be established, based on criteria such as past performance (documented success); the ability to work effectively with federal, state, and local governments; and the possession of necessary skills, certifications, or degrees verifying ability and equipment capability to conduct specific activities. A certification or qualification process would ensure that contractors are qualified, in advance, to conduct restoration work and would shorten the length of time needed to obtain the necessary authorizations for conducting restoration activities.**

   The recommended tiers and qualifications are as follows:

   A. **SCIENTIFIC SUPPORT—Activities consist of environmental project management, site assessment, surveying, mapping, monitoring, and reporting. Qualifications to conduct these activities should consist of:**

      a. *Demonstrated skill and experience in successful project management and scientific report writing;*
      b. *An understanding of the specific local habitat and the ecological processes governing that habitat; and*
      c. *Demonstrated experience and knowledge of the current technology for surveying, mapping, assessing, restoring, and monitoring coral reef habitats.*

   B. **BIOLOGICAL TRIAGE—Activities consist of righting, marking, and caching biological resources in preparation for restoration. Qualifications to conduct these activities should consist of:**

      a. *An understanding of the specific local habitat and the ecological processes governing that habitat;*
      b. *Specific local knowledge of the function and values of the reef habitat;*
      c. *Specific knowledge of the biological/ecological requirements and limitations of the organisms being cached.*

   C. **ORGANISM REATTACHMENT—Activities consist of reattaching biological resources—including, but not limited to, the use of cements, epoxies, wires, cable ties, nails, and bolts. Qualifications to conduct these activities should consist of:**

a. *An understanding of the specific local habitat and the ecological processes governing that habitat;*
b. *Specific knowledge of techniques for handling and attaching the specific types of organisms involved in the triage;*
c. *Specific knowledge of best management practices (BMPs) to minimize the impact of reattachment on surrounding organisms; and*
d. *Demonstrated experience and long-term success in organism reattachment.*

D. DEBRIS AND RUBBLE MANAGEMENT—Activities consist of debris removal and disposal, paint removal and disposal, rubble stabilization, and rubble removal and disposal. Qualifications to conduct these activities should consist of:

a. *Specific knowledge of environmentally sound techniques for safely removing and disposing of debris and bottom paint;*
b. *Specific knowledge of environmentally sound techniques and a methodology for stabilizing rubble in a coral reef environment;*
c. *Specific knowledge of the permitting requirements for rubble and debris disposal; and*
d. *Specific knowledge of BMPs for removing and transporting coral rubble and debris to minimize injury to the surrounding environment and organisms.*

E. REEF FRAMEWORK REPAIR—Activities consist of structural stabilization and reconstruction. Qualifications to conduct these activities consist of:

a. *An understanding of the specific local habitat and the ecological processes governing that habitat;*
b. *Specific local knowledge of currents and water flow patterns that may affect the successful stabilization and reconstruction of the reef framework;*
c. *Specific knowledge of BMPs for the use of cements, epoxies, or other suitable stabilizing agents in the marine environment to minimize injury to the surrounding environment and organisms.*

Responsible Agency: FWC

10. FDEP should develop a joint proprietary/regulatory authorization process or employ an existing process (i.e., Environmental Resource Permitting) that incorporates the conditions requiring Trustees' approval for the authorization and regulation of primary restoration, compensatory restoration, and monitoring activities associated with reef injuries. An efficient authorization process is needed to facilitate a rapid response. This approach should provide guidance to an RP on how to properly conduct such activities and provide legal recourse for the Trustees if the RP does not comply with the conditions of the authorization.

Responsible Agency: FDEP

11. **FDEP and FWC should develop a Memorandum of Understanding establishing delegation of authority in order to streamline authorization processes necessary for the oversight of primary restoration, compensatory restoration, and monitoring activities associated with reef injuries. If organisms are not being relocated, FDEP authorization should be sufficient to authorize and regulate these activities. If organisms are being relocated to or from an area other than a reef injury site, the FWC SAL should be used, as it addresses potential genetic and health issues. In turn, the SAL may be used in lieu of FDEP authorization to provide oversight for restoration and mitigation activities when no RP is identified for a reef injury.**

    Responsible Agencies: FDEP and FWC

12. **A streamlined process for issuing authorizations for the installation of temporary moorings at reef injury sites should be adopted by the FWC, FDEP, USCG, and NMFS to facilitate rapid restoration activities for reef injuries.**

    Responsible Agencies: Lead—USCG; Support—FWC, FDEP, ACOE, and NMFS

13. **The Legislature should allow ready access to, and provide flexible spending authority for, Ecosystem Management and Restoration Trust Fund (EMRTF) funds for rapid response to reef injuries; otherwise the potential for the resource to return to its original function and value may be greatly diminished. FDEP should pursue amending Sections 380.0558 or 403.1651, F.S., to include flexible spending authority to facilitate rapid response to reef injuries.**

    Responsible Agency: FDEP

14. **A database should be developed to track injured areas and their restoration status so that areas where no action is taken due to monetary constraints may be identified and prioritized for restoration efforts at a later time.**

    Responsible Agency: FWC

15. **The use of HEA is recommended for determining compensation for reef resource injuries. If appropriate scoring assessment parameters are developed, UMAM application to reef resource injuries may also be suitable.**

    Responsible Agency: FDEP

16. **A publication on Guidelines to Restoration Monitoring should be initiated as a follow-up to this document.**

    Responsible Agencies: Lead—FDEP; Support—FWC

17. **FDEP should (1) develop a penalty assessment schedule by rule, including explicit authority for any law enforcement officer to enforce the provisions in the rule, or (2) request that the legislature amend statutory language in Section 253.04, F.S., to establish a penalty assessment schedule to be used for assessing civil penalties associated with injury to coral reefs in state waters. Amended statutory language should include penalties for repeat offenders and explicit authority for any law enforcement officer to enforce the provisions in the statute..**

    Responsible Agency: FDEP

18. **FDEP should amend the statutory language in Section 253.04, F.S., to require restoration to the maximum extent possible of sovereignty submerged lands and associated biological resources to their original function and value. Oversight for restoration activities would be provided by a regulatory authorization process (as previously recommended), or by reimbursing the Trustees for restoration costs. It should be considered whether or not the restoration of an injury site would serve in lieu of assessing civil penalties as an incentive for the restoration of larger vessel grounding sites.**

    Responsible Agency: FDEP

19. **Trustees should jointly support congressional legislation to protect the state's right to collect appropriate monetary penalties and require that restoration efforts be completed in total, regardless of vessel and cargo value. The Oil Pollution Act, Exemption from Limitation and Exoneration of Liability, provides an example of applicable existing legislation that protects state rights to collect monetary penalties.**

    Responsible Agencies: Lead—FDEP; Support—FWC, Local Governments