FINAL

PHASE II OF THE COMPREHENSIVE PLAN FOR THE 2006 T/V MARGARA INCIDENT NATURAL RESOURCE DAMAGE ASSESSMENT: COMPENSATORY RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT

GUAYANILLA, PUERTO RICO

Top left photo: T/V MARGARA aground with tugs alongside on April 27, 2006. Photo courtesy of Puerto Rico Department of Natural and Environmental Resources. Injuries to coral reefs at the T/V MARGARA Incident site in the other photos. Photos taken by NOAA's Restoration Center in 2006.

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November 2021

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1.0 INTRODUCTION: PURPOSE OF AND NEED FOR RESTORATION

1.1 DESCRIPTION OF THE INCIDENT & RESPONSE ACTIVITIES

On or about April 27, 2006, the T/V MARGARA, a 228-meter Cayman Islands-flagged tanker, went aground on coral reef habitat three miles south of Tallaboa, Puerto Rico, in waters approximately 10.5 meters in depth (Figure 1).[1] The vessel was carrying over 300,000 barrels of #6 fuel oil. The operator of the T/V MARGARA was Margara Shipping Ltd. and parent company Ernst Jacob (GmbH & Co. KG) and the insurance guarantor is Shipowners Insurance and Guaranty Company (SIGCo) (collectively the "Responsible Parties" or "RP").[2] The United States Coast Guard (USCG) determined that the incident represented a substantial threat of release of oil and, in order to prevent a spill, directed that response actions be taken.[3] The vessel was ultimately refloated and removed from the grounding location on April 28, 2006 without discharging oil into the environment.

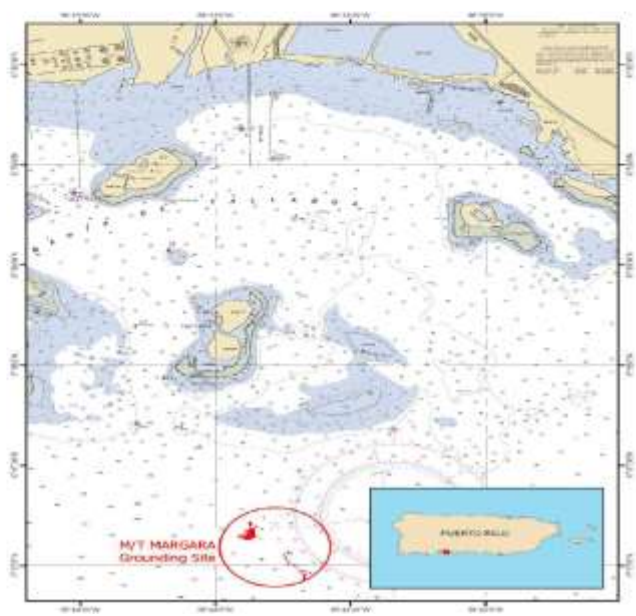

Figure 1: T/V MARGARA site relative to Bahía de Tallaboa in southern Puerto Rico.

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[1] Commonwealth of Puerto Rico, Department of Natural and Environmental Resources (PRDNER) and U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (NOAA) Notice of Emergency Restoration Action for T/V Margara Incident - April 27, 2006 (Nov. 5, 2006)(hereinafter Notice of Emergency Restoration); See also Continental Shelf Associates, Emergency Restoration Strategy: *M/T Margara* Grounding Offshore South Coast of Puerto Rico at 1-3 (Sep. 2006) and National Pollution Funds Center, OSLTF Claim No. M06017-OC01 Determination at 3-4 (Feb. 8, 2019)(hereinafter Primary Restoration Claim Determination).

[2] United States Coast Guard Vessel Certificate of Financial Responsibility to Margara Shipping Ltd for the vessel Margara (Dec. 3, 2003) and Application (Nov. 25, 2003); see also Primary Restoration Claim Determination at 3. The RP was represented in cooperative natural resource damage assessment activities by Independent Maritime Consulting, Ltd (IMC) and Continental Shelf Associates (CSA). See May 31, 2006 PRDNER Letter to IMC Regarding *T/V Margara* Incident Emergency Restoration Needs, July 18, 2006 CSA Letter to USACE, and Notice of Emergency Restoration at 1. Norwegian Hull Club, the RP's hull insurance company, also cooperated in the natural resource damage assessment and paid for some injury assessment activities. Primary Restoration Claim Determination at 5.

[3] Primary Restoration Claim Determination at 3-4, 18-19; see also Notice of Emergency Restoration at 1.

The general path of the vessel is shown in Figure 2. According to the extraction graphics provided to the Trustees by Alexakos and Simpson, Inc.[4]., on May 10, 2006, the bow of the T/V MARGARA was pointing approximately 220º True while aground at 0030 on April 27, 2006 (initial grounding site) (Location 1). During response actions[5], the vessel was rotated approximately 90 degrees by tug boats attempting to free it until it was pointing about 141º True at 1300 on April 27, 2006 (Location 2). However, this instead resulted in grounding the vessel in a different location further westward as evidenced by the berm along the western edge of Location 2 (Figure 3). Later that day, the decision was made by the Captain of the T/V MARGARA and the Federal On-Scene Coordinator (FOSCR) to attempt to free the vessel using a combination of vessel power and tug assist. This response operation did free the vessel for a short period of time (Location 3) before the vessel was re-grounded in Location 4. Eventually the vessel was freed from Location 4 and impacted the bottom around Location 5 before being moved to deeper water.

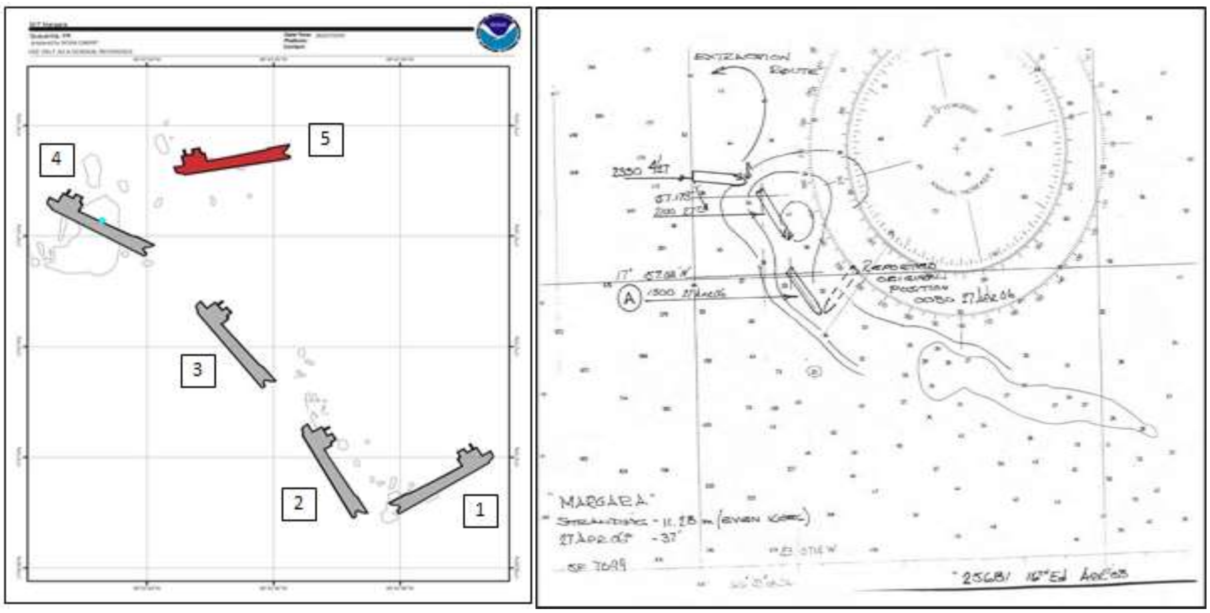

Figure 2: Maps with positions of T/V MARGARA during grounding and removal. The map on the left shows the approximate T/V MARGARA path during removal with coral reef impact areas from Figure 1 outlined in the background. Location 1 indicates the initial grounding site. Location 2 shows how the vessel was rotated during removal causing additional effects in the South Region. Locations 3-5 show the path of the vessel after it was freed (Location 3) and subsequently re-grounded in the North Region (Locations 4-5). Extraction graphics on the right provided by Alexakos and Simpson, Inc. on May 10, 2006 based on data collected on the bridge during the incident.

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[4] Mr. Paul Simpson was aboard the T/V MARGARA during a portion of the extraction in support of the RP.

[5] "Response" (or "remove" or "removal") are defined to mean "containment and removal of oil or a hazardous substance from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, and public and private property, shorelines, and beaches, as defined in section 1001(30) of OPA (33 U.S.C. 2701(30))." 15 C.F.R. § 990.30.

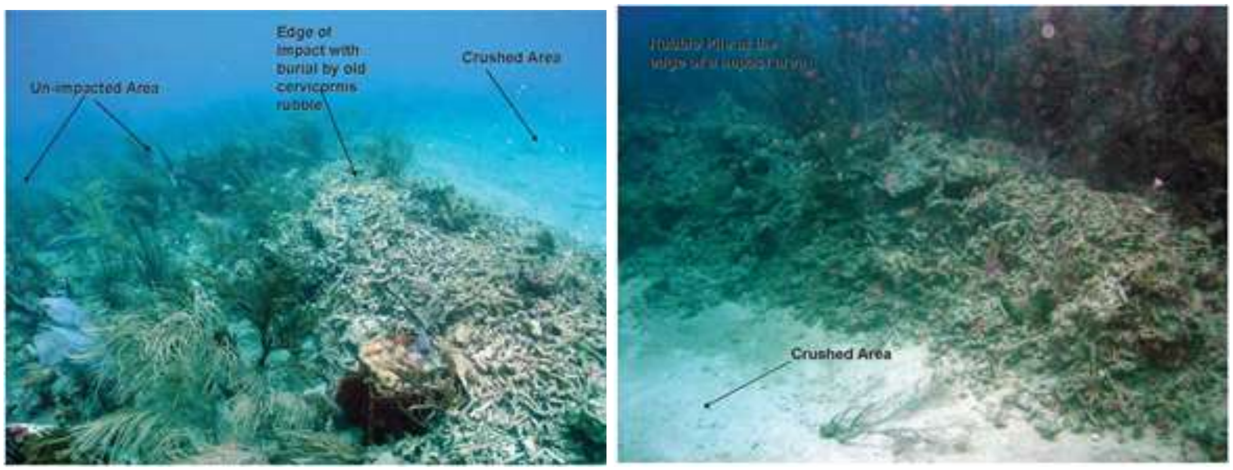

Figure 3: Photos of the rubble berms running north to south along the western edge of the impacts in the South Region created by the rotation and westward movement of the vessel during removal. Photos taken by NOAA Restoration Center in 2006.

In the period immediately following the Incident, the Trustees (see Section 1.5) mapped the site using an underwater mapping system that involved divers communicating via an underwater wireless communications system and surface buoys with GPS. This first effort provided a rough outline of the "site", i.e., the area directly affected by the grounding and the response actions that led to the physical impacts on the reef. Additional mapping efforts allowed the Trustees to reconstruct the sequence of response activities outlined in Section 1.1 and identify locations where coral was affected.

Figure 4 shows more detail on the movement of the T/V MARGARA during response actions. The initial grounding was at Site 146[6]. After being rotated 90 degrees by the tugs, the vessel was moved to the west, affecting Sites 144 - 145 and Sites 147-151. The rotation of the vessel and western movement during the removal created a berm of rubble and coral (dead, loose and/or broken) that ran north to south along the western edge of the impacts in the South Region (Figure 3). In order to promptly remove the vessel from its grounded state, and prevent an oil spill, the vessel's master and the United States Coast Guard made the decision to attempt to free it using a combination of vessel power and tug assist (Figure 2, Locations 3-5).

[6] Here "site" refers to discrete portions of the overall T/V Margara Incident site with damaged coral reef resources, whereas "T/V MARGARA Incident site" refers to the entire of the geographic area damaged by the T/V MARGARA Incident.

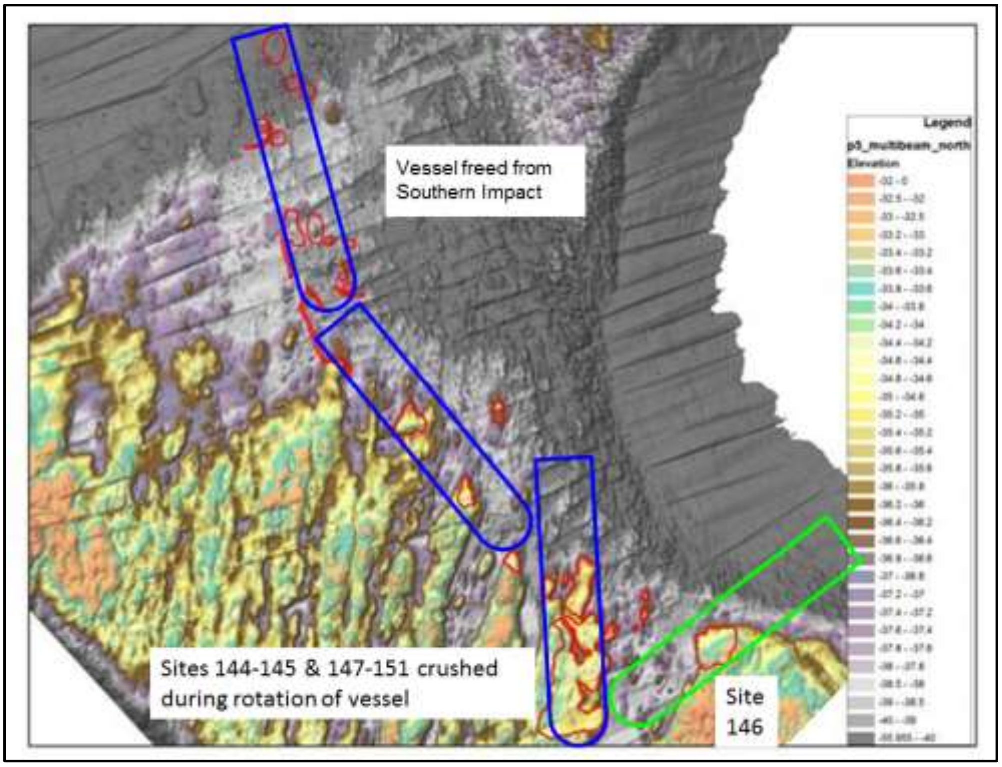

Figure 4: Multibeam image of the impacts to coral reefs (outlined in red) in the South Region showing approximate location of T/V MARGARA during the initial grounding (green polygon) and movement of vessel during extraction (blue polygons) based on extraction graphics provided by Alexakos and Simpson, Inc. in Figure 2. Site 146 (red polygon under the green polygon) was only impacted by the initial grounding while Sites 144-145 and Sites 147-151 (red polygons in Location 2) were affected by rotation of the vessel during response.

The total direct impact area from the T/V MARGARA grounding includes (1) the initial grounding site (Location 1, Site 146), which was not impacted by response actions, (2) impacts to the South Region (Location 2, Sites 144-145 and 147-151), (3) a deeper Central Region impacted by prop wash (off the stern of the vessel in Location 2 Figure 2 and the top left of Figure 4) and (4) the North Region (Locations 4 and 5 in Figure 2). A total of approximately 6,755 m^2 was directly impacted by response actions. Site 146, the area of the initial grounding, is not part of the areas that were impacted by response actions and is therefore not included in this estimate or in subsequent damage assessment. The additional impacts caused by rubble movement during Hurricane Dean that were reported in the Primary Restoration Plan are also not included in this estimate. The Trustees determined that impacts in the southern impact site, northern impact site, and central prop wash site are part of the same occurrence or series of occurrences having the same origin resulting in the substantial threat of oil discharge.

1.2 NATURAL RESOURCE DAMAGE ASSESSMENT TIMELINE

The Trustees' complete natural resource damage assessment (NRDA) for the T/V MARGARA Incident consists of a phased approach, including Emergency Restoration, Primary Restoration, and Compensatory Restoration.[7] Therefore, the comprehensive restoration plan for the T/V MARGARA Incident is described

[7] Emergency Restoration includes actions needed to reduce injuries and prevent unnecessary future losses of injured natural resources. Primary Restoration includes actions undertaken to return injured natural resources and services to baseline conditions. Compensatory restoration includes actions taken to

through a combination of two documents. The "Final Primary Restoration Plan and Environmental Assessment for the 2006 T/V Margara Grounding, Guayanilla, Puerto Rico" (also referred to as the Primary RP/EA), describes actions needed to return injured areas to baseline condition and services. This document, "Phase II of the Comprehensive Plan for the 2006 T/V MARGARA Incident Natural Resource Damage Assessment: Compensatory Restoration Plan and Environmental Assessment" (also referred to as the Final Compensatory RP/EA) describes actions needed to compensate for interim losses of natural resources and services that occur from the date of injury until recovery.

2006-2008: Emergency Restoration

Emergency Restoration actions were undertaken at the site between 2006 and 2008 to prevent or minimize future or ongoing injuries at the site. These Emergency Restoration actions were undertaken as early as possible to stabilize viable corals dislodged during the Incident which were not expected to survive without reattachment. These early efforts allowed for the reattachment of almost 9,500 soft corals, hard corals, and coral fragments, 955 *Acropora cervicornis* fragments, removal of approximately 55 gallons of anti-fouling paint and contaminated substrate, and stabilization of medium to large pieces of reef. However, Emergency Restoration was neither intended nor designed to address all potential restoration actions that might be needed at the site. A more detailed description of the Emergency Restoration actions undertaken at the site is included in Section 3.3.

2008-2013: Injury Assessment and Recovery Monitoring

Following the Emergency Restoration phase, the Trustees notified the RP that Primary Restoration at portions of the site would be necessary to allow for recovery. The RP representatives strongly disagreed with this assessment and countered that natural recovery would occur without additional intervention. In an effort to validate the Trustees assessment and help reach an amicable agreement with the RP, the Trustees monitored the Incident site from 2008 through 2013, including areas of unconsolidated rubble, areas of consolidated hard substrate, emergency restoration structures (as described in Section 3.3 below), and reference sites, including surrounding reef and a nearby vessel grounding site from an unrelated incident, in order to assess coral recruitment and recovery. This monitoring provided the quantitative data to demonstrate to the RP that Primary Restoration was "necessary to return the physical, chemical, and/or biological conditions necessary to allow recovery or restoration of the injured natural resources." 15 C.F.R. 990.53(b)(3)(ii). The data collected showed that coral recruitment and recovery in large areas of the Incident site with unconsolidated rubble was not successful and recovery in these areas would be significantly and continuously inhibited by rubble movement caused by wave energy (Viehman et al., 2018). Therefore, the Trustees determined that Primary Restoration was necessary to stabilize the unconsolidated rubble and rebuild topographic complexity at the Incident site. See Sections 3.2 and 3.5 below for further details.

2013-2016 Primary Restoration Planning

During this time, the Trustees developed a phased restoration planning approach for the T/V MARGARA Incident NRDA. The Trustees first described this phased restoration planning approach in the March 13, 2013 Notice of Intent to Conduct Restoration Planning (see Section 1.6). The Trustees further described their phased restoration planning approach in the September 20, 2014 Draft Primary Restoration RP/EA and May 9, 2015 Final Primary Restoration RP/EA. The Trustees took a phased approach to restoration planning in order to scale Compensatory Restoration planning requirements (using the Resource Equivalency Analysis model described in Section 3.6) based on a shorter recovery period that results from

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compensate for interim losses of natural resources and services that occur from the date of injury until recovery. See 15 C.F.R. Part 990.

the implementation of Primary Restoration as compared to natural recovery. Implementation of the Primary Restoration Plan directly impacts the quantification of required compensatory restoration because it allows the Trustees to determine a date when recovery can begin in the areas of the Incident site where unconsolidated rubble would otherwise preclude, or indefinitely delay, recovery.

At the time of publication of this document, implementation of the Final Primary Restoration RP/EA will be under way at the Incident Site to stabilize unconsolidated rubble and restore the topographic complexity that had been present within the footprint of the impact area. If Primary Restoration were not conducted at the T/V MARGARA Incident site, the Trustees would have to scale recovery based on the time frame of no action/natural recovery. Based on the monitoring done in 2008-2013 described above and set forth in further detail in Section 3.5 below, the presence of unconsolidated rubble in some areas of the Incident site would cause natural recovery to extend into perpetuity (Viehman et al., 2018) and increase the scale of Compensatory Restoration requirements by approximately 30%. Therefore, the Trustees chose to phase restoration planning.

2006-2014 Cooperative Injury Assessment & Negotiations with the Responsible Party

The Responsible Party (RP) for the T/V MARGARA Incident Ernst Jacob (GmbH & Co KG), owner of Margara Shipping Ltd., cooperated with the Trustees' NRDA for the T/V MARGARA Incident by performing and funding Emergency Restoration actions. The RP and its hull insurance company, Norwegian Hull Club, continued to cooperatively participate in NRDA activities with the Trustees beyond the Emergency Restoration phase until approximately May 2014 when the Trustees learned from the hull insurance company that the RP was insolvent. Input from the RP was considered by the Trustees in the development of the Final Primary RP/EA and initial efforts to evaluate Compensatory Restoration alternatives. Due to the RP's termination of participation in NRDA activities in 2014 because of insolvency, the Trustees presented an interim claim for Primary Restoration to the Guarantor identified on the RP's Certificate of Financial Responsibility, Shipowners Insurance and Guaranty Company (SIGCo)[8], in April 2017; however, the Guarantor did not pay or provide binding assurance they would reimburse the Trustees' assessment costs, implement the plan, or pay the Trustees' estimate of the costs of implementation. See Section 1.8 for further details regarding the Trustees' coordination with the RP.

2016-2019 Oil Spill Liability Trust Fund Primary Restoration Claim Adjudication Process

The Trustees initially filed an interim Oil Spill Liability Trust Fund (OSLTF) claim for the first phase, Primary Restoration damages, with the National Pollution Fund Center (NPFC) in December 2016 and then subsequently, in September 2017 after attempting to settle the interim claim with the Guarantor. In July 2019, the NPFC funded the Trustees' interim claim for Primary Restoration. Preparation for implementation of the Primary Restoration Plan is underway at the time of publication of this document.

2019 to Present: Complete Compensatory Restoration Planning

As soon as the Trustees learned that Primary Restoration would be funded by the OSLTF in 2019, the Trustees were able to estimate coral recovery at the Incident site and scale Compensatory Restoration, as further discussed in Section 3.6 below. This Compensatory RP/EA is intended to compensate the public for interim losses to the coral reef ecosystem accruing from the time of the Incident to the time of recovery to baseline. The Final Compensatory RP/EA will be the Trustees' final plan for the T/V MARGARA Incident NRDA.

[8] See infra fn 2.

1.3 **PROPOSED ACTION**

The Trustees (see Section 1.5) publicly proposed their Preferred Alternative for compensatory restoration in October 2020 and have prepared this Final Compensatory RP/EA to select the compensatory restoration to be used to compensate the public for interim losses to coral reef resources caused by the T/V MARGARA Incident. That restoration will take place through coral propagation to directly replace lost coral resources and restore degraded and impacted coral reefs. The Preferred Alternative selected by the Trustees is more thoroughly described in Section 5.

1.4 **PURPOSE AND NEED**

Purpose: The purpose of the proposed action is to provide Compensatory Restoration for interim losses to the coral reef ecosystem from the 2006 T/V MARGARA Incident in Guayanilla, Puerto Rico.

Need: The restoration actions identified in this Final Compensatory RP/EA are needed to compensate the public for lost coral reef resources at the T/V MARGARA Incident site that were not able to be recovered during Emergency and Primary Restoration phases of the NRDA. The Preferred Alternative will compensate for interim losses.

In keeping with the focus of this plan, this Final Compensatory RP/EA provides summarized information regarding:

- the environmental consequences of the T/V MARGARA Incident;
- the objectives of Compensatory Restoration for the T/V MARGARA Incident;
- the restoration alternatives considered for meeting these objectives in developing this plan;
- the trustees preferred Compensatory Restoration project;
- the monitoring needed to determine if corrective actions are required; and
- the corrective actions that will be undertaken to meet restoration goals.

The Trustees' selected Preferred Alternative includes all activities appropriate to the planning, design, construction, corrective actions, monitoring, oversight and evaluation of restoration actions.

This document also serves, in part, as the Federal Trustee's compliance with the National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321, *et seq.*, as applicable to restoration planning.

1.5 NATURAL RESOURCE TRUSTEES AND AUTHORITIES

This Final Compensatory RP/EA has been developed by Natural Resource Trustees, the Puerto Rico Department of Natural and Environmental Resources (PRDNER) of the Commonwealth of Puerto Rico and the National Oceanic and Atmospheric Administration (NOAA) of the United States Department of Commerce.

NOAA, as the lead federal agency, and PRDNER each act as a Natural Resource Trustee pursuant to the Oil Pollution Act of 1990 (OPA), 33 U.S.C. § 2701 *et seq.*, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. § 300.600, and Executive Order (EO) 12777, 56 Fed. Reg. 54757 (Oct. 18, 1991). As a Trustee, each agency is authorized to act on behalf of the public to assess and recover natural resource damages to compensate for the natural resource injuries and service losses caused by the T/V MARGARA Incident, including the costs to plan and implement actions to restore natural resources and resource services injured or lost as a result of the Incident. NOAA is the federal lead trustee for purposes of NEPA compliance. Hereafter, PRDNER and NOAA are collectively referred to as "the Trustees".

PRDNER has further authority to address the harm caused by this Incident pursuant to Law 147 of the Commonwealth of Puerto Rico (Law 147). Law 147 provides for the protection, conservation and management of coral reefs in state waters. The Act empowers the PRDNER Secretary to take the needed strategies to grant such protections and conservation, including the establishment of agreements that will promote the achievement of the purposes of the Law. It also empowers the Secretary to take all needed actions against parties responsible for vessel groundings in order for them to repair the impact inflicted to the system and restore the reef.

In developing this Compensatory Restoration plan, the Trustees have acted in accordance with the natural resource damage assessment regulations issued pursuant to OPA. These regulations are set forth at 15 C.F.R. Part 990 (hereafter, "NRDA regulations"). The restoration alternatives considered, including the Preferred Alternative selected in this plan, were identified and evaluated based on technically valid, reliable and cost effective methods, and based on the technical expertise and restoration experience of the Trustees and information provided by other scientists and experts consulted.

1.6 TRUSTEE DETERMINATION SUPPORTING DEVELOPMENT OF RESTORATION PLAN, 15 C.F.R. §§ 990.40-.45 (SUBPART D)

The Trustees issued a Notice of Intent to Conduct Restoration Planning (NOI) for this Incident on March 13, 2013. That Notice was posted to PRDNER's website and also published in *Primera Hora* on April 19, 2013. That Notice documented the Trustees' determination to proceed with development of a formal restoration plan for this Incident, in accordance with the provisions of 15 C.F.R §§ 990.42 and 990.44, and that such planning would address the need for, as well as the type and scale of, restoration actions appropriate to compensate the public for interim resource injuries and losses.[9]

1.7 OIL POLLUTION ACT AND NATIONAL ENVIRONMENTAL POLICY ACT INTEGRATION

The National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321, *et seq.*, and the regulations guiding its implementation at 40 C.F.R. Part 1500[10], apply to restoration actions that federal natural resource trustees plan to implement under OPA and other federal laws. NEPA and its implementing regulations outline the responsibilities of federal agencies and provide specific procedures for environmental documentation necessary to demonstrate compliance. Generally, when it is uncertain whether a contemplated action is likely to have a significant effect on the quality of the human environment, federal agencies will begin the NEPA planning process by preparing an Environmental Assessment (EA). The EA may undergo a public review and comment period so that federal agencies may consider public input prior to making a determination. Depending on whether an impact is considered significant, the federal agency will either

[9] Note, the Trustees previously published a Notice of Emergency Restoration on November 5, 2006 determining that the Trustees had jurisdiction pursuant to 15 C.F.R § 990.41 and to conduct emergency restoration pursuant to 15 C.F.R § 990.26(a).

[10] This EA is being prepared using the 1978 CEQ NEPA Regulations. NEPA reviews initiated prior to the effective date of the 2020 CEQ regulations was September 14, 2020. This review began on May 30, 2019 and the agency has decided to proceed under the 1978 regulations.

develop an environmental impact statement (EIS) or issue a finding of no significant impact (FONSI).

The Trustees integrated the OPA and NEPA processes in this Final Compensatory RP/EA, as more fully described in Section 1.9. Integration of the EA into this document allows the Trustees to provide for public involvement under both statutes concurrently. This approach is recommended under 40 C.F.R. § 1500.2(c), which provides that federal agencies should "[i]ntegrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively." Thus, this document serves, in part, as the agencies' compliance with NEPA.

This Final Compensatory RP/EA complies with NEPA by 1) describing the purpose and need for restoration action in Section 1.0, "Introduction: Purpose and Need for Restoration"; 2) addressing public participation in this process in Section 1.9, "Public Participation"; 3) summarizing the current environmental setting in Section 2.0, "Affected Environment"; 4) identifying alternative actions in Section 4.0, "Restoration Planning Process"; and 5) analyzing environmental consequences in Section 6.0, "Environmental Consequences." Furthermore, as the second phase of the Trustees' comprehensive plan for the T/V MARGARA Incident NRDA, the Trustees hereby incorporate by reference the first phase of the comprehensive plan for the T/V MARGARA Incident titled, "Final Primary Restoration Plan and Environmental Assessment for the 2006 T/V Margara Grounding, Guayanilla, Puerto Rico" (May 2015).

1.8 COORDINATION WITH THE RESPONSIBLE PARTY AND GUARANTOR

The NRDA regulations under OPA require trustees to invite the responsible parties ("RPs") under the statute to participate in the natural resource damage assessment process. Although RPs may contribute to the process in many ways, the authority to make determinations regarding injury and restoration rests solely with the Trustees.

One of the RPs for the T/V MARGARA Incident is Ernst Jacob (GmbH & Co KG), owner of Margara Shipping Ltd. Ernst Jacob was formally invited to participate in the Emergency Restoration on May 31, 2006, as provided in 15 CFR § 990.14(c), and did cooperate with the Trustees by performing and funding Emergency Restoration actions.[11] Ernst Jacob and its hull insurance company, Norwegian Hull Club, cooperatively participated in natural resource damage assessment activities beyond the Emergency Restoration phase until approximately May 2014 when the Trustees learned from the hull insurance company that the RP was insolvent. This cooperation and coordination between the parties helped avoid duplicative assessment activities, allowed for timely information sharing, allowed for joint field efforts and discussions among the parties' technical representatives, and made the process more cost-effective. Input from the RP was considered by the Trustees in the development of the Final Primary RP/EA and this Final Compensatory RP/EA. The Trustees learned of the RP's declared insolvency during drafting of the Primary RP/EA for the T/V MARGARA Incident. Due to the RP's termination of participation in natural resource damage assessment activities as a result of their declared insolvency in 2014, the Trustees presented an interim claim for Primary Restoration to the Guarantor identified on the RP's Certificate of Financial Responsibility, Shipowners Insurance and Guaranty Company, in April 2017. Because the Guarantor did not settle the Trustees' interim claim for Primary Restoration, the Trustees filed an interim Oil Spill Liability Trust Fund (OSLTF) claim for Primary Restoration damages with the NPFC in September 2017. In July 2019, the Trustees and the NPFC settled the interim claim to fund Primary Restoration.

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[11] See infra fn 2.

1.9 PUBLIC PARTICIPATION

Section 1006(c)(5) of OPA requires the Trustees to involve the public in the restoration planning process (33 U.S.C. § 2706(c)(5)). The NRDA regulations interpret this provision as requiring that Trustees provide the public with the opportunity to comment on proposed restoration plans, and that any public comments received be considered prior to adopting a final plan (15 C.F.R. Section 990.55(c)). The Trustees believe that public involvement and input is essential to an effective restoration planning process. Affording opportunity for public comment is also consistent with all applicable Commonwealth and federal laws and regulations, including NEPA and its 1978 implementing regulations at 40 C.F.R. Parts 1500-1508.

The Trustees published a Notice of Intent to Conduct Restoration Planning on March 13, 2013 for the T/V MARGARA Incident.[12] The NOI identified the Incident and the Trustees involved, provided general information on the natural resource injuries and losses for which restoration might be required, and identified some types of restoration that were thought to be feasible based on initial discussions with various representatives of the public including the Commonwealth, local governments and institutions, private organizations, academic experts, and RPs and their representatives. The Trustees used information from those discussions to develop Primary and Compensatory Restoration Plans as part of the comprehensive plan for the T/V MARGARA Incident NRDA. The Draft Primary RP/EA was made available for public review on September 20, 2014, and the Final Primary RP/EA (incorporating public comments) was published in May 2015. The Primary RP/EA explained to the public that natural resource damage assessment for the T/V MARGARA Incident would be phased into Primary and Compensatory Restoration plans because scaling of the Compensatory restoration project is dependent upon the final Primary Restoration claim approved by the NPFC. This Final Compensatory RP/EA describes the Compensatory Restoration Preferred Alternative for the T/V MARGARA Incident.

On October 9, 2020, the Trustees published a notice of availability for the Draft Compensatory RP/EA in English and Spanish on NOAA's and DNER's websites and in Spanish in *Primera Hora*, a paper of local circulation. The Draft Compensatory RP/EA was initially available for public review and comment for 30 days. The Trustees extended the public review and comment period through December 14, 2020 at the request of the Responsible Parties. The Trustees considered comments received during the public comment period before adopting this Final Compensatory RP/EA for the T/V MARGARA Incident. Accordingly, pursuant to the changes noted below, the Trustees' now select for implementation the Preferred Alternative first proposed in the Draft Compensatory RP/EA for the T/V MARGARA Incident. The Final Compensatory RP/EA is the Trustees' final restoration plan for the T/V MARGARA natural resource damage assessment.

1.9.1 Summary of Public Comments on the Draft Compensatory RP/EA

The Trustees provided opportunities for the public to comment, as described above. During the comment period, the Trustees received a total of nine individual submissions from private citizens, nongovernmental organizations (NGOs), academic institutions, and representatives of the Responsible Parties. Comment summaries and the Trustees' responses to comments are provided in Section 8 of this document.

1.9.2 Summary of Key Changes Made from the Draft Compensatory RP/EA

After considering the public comments received, the Trustees revised the Draft Compensatory RP/EA to

[12] Note, the Trustees also published public notices on November 5, 2006 when it published the Notice of Emergency Restoration and October 30, 2007 when it published a Notice of Emergency Restoration - Mid-Course Correction for the T/V Margara Incident.

prepare this Final Compensatory RP/EA. In addition to minor editorial, grammatical, and technical revisions to improve clarity, the Trustees made a small number of substantive changes. These are summarized below.

Most notably, the Trustees reclassified portions of the site which had been considered "Majority Unconsolidated Rubble" into two new categories: "Unconsolidated Rubble Requiring Primary Restoration" and "Rubble Not Requiring Primary Restoration." This reclassification, as well as the resultant impact on recovery delay and scaling of the necessary restoration is detailed further in Sections 3 and 8 of this document, as well as the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident Using Resource Equivalency Analysis Models" (available in the Administrative Record). In addition, as a result of the changes to the Restoration Scaling, the implementation period for Compensatory Restoration was changed from ten to nine years.

The Trustees also clarified their history of frequent visits to the site and their familiarity with site characteristics and recovery progression, or lack thereof, in the years since the 2012 joint survey conducted with RP representatives. Other changes include (1) added language clarifying that the initial impact site, or Site 146, was not included in injury calculations; (2) more details added to project descriptions and analysis to include information on *Ramicrusta* macroalgae, coral microfragmentation techniques, acclimation of ex-situ corals to water temperature and conditions, increased specificity for outplant coral species, and inclusion of additional herbivore species (such as Caribbean King Crab); and (3) language recognizing the emergence of Stony Coral Tissue Loss Disease and experimental treatments to heal from or prevent infection to corals.

The Trustees also included information on the 2021 Photomosaic, which was originally conducted to assist with Primary Restoration site planning. Lastly, the Trustees included new calculations of coral outplant sizes, to more accurately reflect experience in Puerto Rico in the past several years. As a result of the changes to the Restoration Scaling mentioned above and the adjusted outplant sizes, the number of corals required for Compensatory Restoration was changed from 98,108 outplants over ten years in the Draft Compensatory RP/EA to needing to outplant 86,206 corals over nine years in the Final Compensatory RP/EA.

1.10 ADMINISTRATIVE RECORD

In accordance with 15 C.F.R. § 990.45, the Trustees have established an Administrative Record (AR) of the NRDA for this Incident. The AR contains records documenting decisions and information relied upon by the Trustees in the NRDA process for the T/V MARGARA Incident, including those supporting the prior Emergency Restoration actions at the site and the Primary and Compensatory Restoration Actions to be undertaken. It may be used in future administrative or judicial review of Trustee actions to the extent such review is provided by Federal or State law.

The AR is available online at https://www.diver.orr.noaa.gov/web/guest/diver-admin-record?diverWorkspaceSiteId=6204

2.0 AFFECTED ENVIRONMENT

This section provides general information on the environmental physical, biological, and cultural/human use environments in which the Incident occurred and that may be affected by alternative restoration actions identified in this Final Compensatory RP/EA. The physical environment includes coral reefs off of Guayanilla, along the southwest coast of Puerto Rico. The biological environment includes a wide variety of tropical marine organisms including corals, fish, shellfish, and other marine invertebrates, including several endangered or threatened species. The cultural/human uses in the area include fishing, recreation, and tourism.

2.1 PHYSICAL ENVIRONMENT

The T/V MARGARA Incident site is situated along the outer portion of a submerged carbonate platform, south of Bahia de Tallaboa on the south coast of Puerto Rico in coral reef habitat (NOAA, 2002a). Water temperatures in this area range from 24–30^{o} C. Depths along the upper shelf in this area range from emergent reefs inshore to > 30 meters along the shelf edge. Tidal ranges in Puerto Rico are less than 1 meter. Coral reef formations in the area are a combination of patch reefs and spur-and-groove reef formations built by scleractinian corals over thousands of years. Patch reefs are isolated raised platforms formed by corals while spur and groove formations are elevated ridges of reef formed by corals separated by deeper channels which have sand or rubble on the bottom. Scleractinian corals, also known as hard or stony corals, are the primary reef builders on coral reefs. At the T/V MARGARA Incident site, the shallowest reefs are around 10 meters deep, and the depth of the channels between the reefs averages 12-15 meters. The geological composition of the reef consists of a hard calcium carbonate mantle formed by coral that is on average 20 cm thick overlying loose relic scleractinian fossils of the staghorn coral, *Acropora cervicornis* like the crust of an apple pie holding in the viscous center. The coral reefs affected by the T/V MARGARA Incident in this area ranged from 10-15 meters deep and supported an epifaunal assemblage dominated by soft and hard corals and sponges (Figures 5 and 6).

Figure 5: Photos of un-impacted reef adjacent to the T/V MARGARA site. Photos taken by NOAA Restoration Center in 2008.

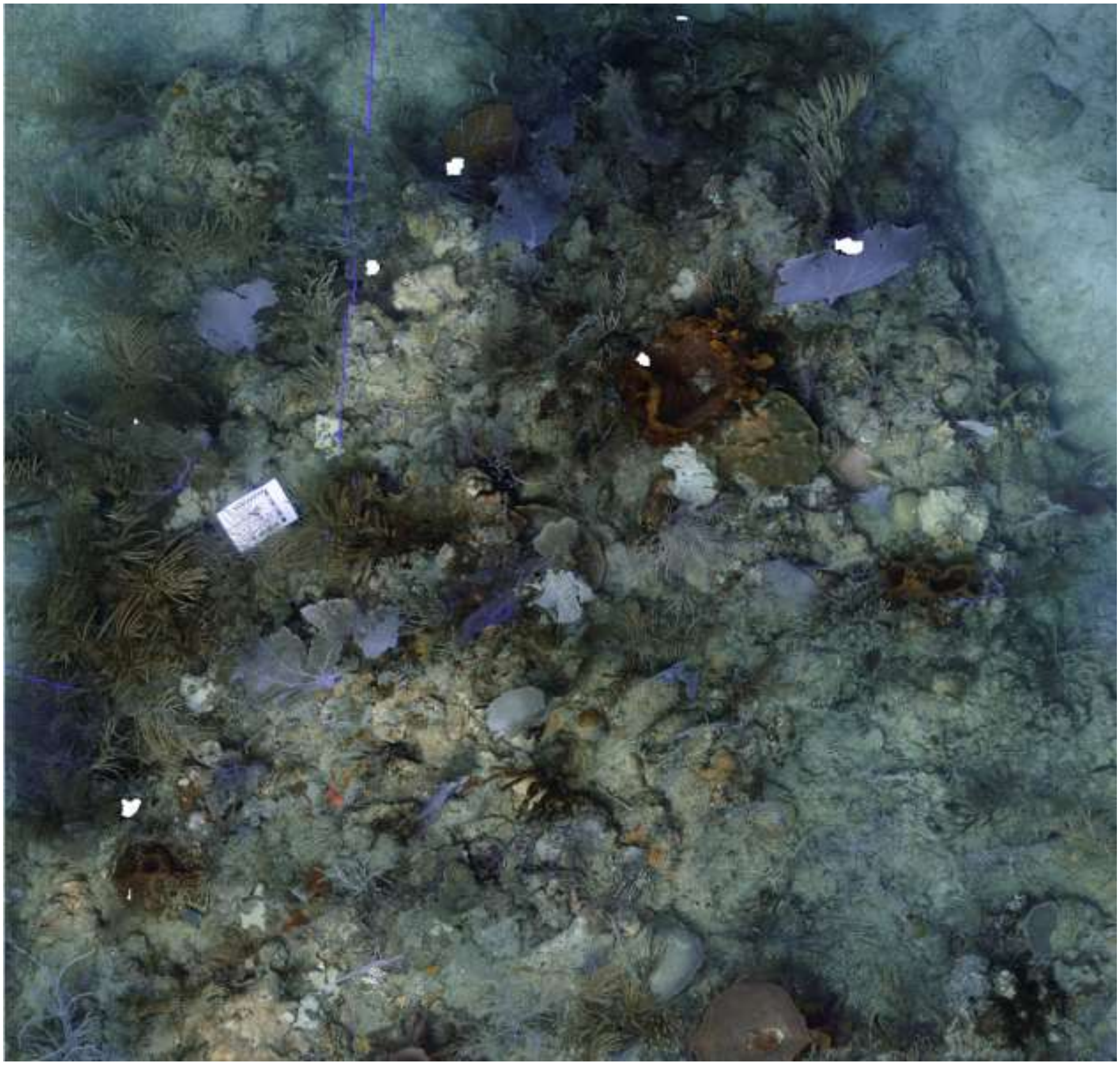


Figure 6: Photomosaic images of un-impacted reef adjacent to the T/V MARGARA site in 2021. Photomosaic images collected by Sea Ventures, Inc.

The coral reefs along the south coast of Puerto Rico are influenced by trade winds, swells, strong currents, hurricanes, and westward-moving terrigenous sediment (derived from land) plumes derived from upland run-off. This area is exposed to easterly trade winds that average 15–20 knots and seas that average 2–3 meters. Swells associated with hurricanes can reach over 6 meters. High sediment influx, turbid water conditions, and re-suspension of fine grained terrigenous sediments are common. In-water visibility typically ranges from 10–15 meters but can fluctuate from less than 2 meters after heavy rains and storms to approximately 30 meters on the clearest days.

2.2 BIOLOGICAL ENVIRONMENT

Coral reefs like those along the south coast of Puerto Rico, including at the T/V MARGARA Incident site, are some of the most biologically diverse ecosystems in the world. Coral reefs provide habitat, spawning and nursery grounds for many marine organisms and fish species, and they are considered hotspots of marine biodiversity (Cesar et al., 2003). The structure of these reefs are built slowly over thousands of years by Scleractinian corals that grow, on average, 1 cm per year or less (Gladfelter et al., 1978; Highsmith et al., 1983; Hubbard and Scaturo, 1985; Huston, 1985; Edmunds, 2007; Crabbe, 2009). The heterogeneous topographic relief afforded by these reefs provide habitat for multitudes of fish and marine invertebrates (UNEP, 2004).

Over the last few decades, coral reefs in the Caribbean have changed dramatically (Hughes 1994, Wilkinson 2008, Jackson et al. 2014). Corals and the multitude of organisms associated with them have suffered a massive decline due to cumulative factors like hurricanes, disease outbreaks, bleaching, pollution, and overfishing (Hughes 1994; Wilkinson 2008, Jackson et al. 2014). The Caribbean-wide mass mortality of one of the keystone species *Diadema antillarum* (long spined sea urchin) in the early 1980's resulted in increased algal abundances that limit coral recruitment and can smother existing corals (Lessios, 1995). Globally, these threats are exacerbated by immediate physical impacts due to ship groundings (like the T/V MARGARA Incident), vessel anchoring, and storm damage from large swells. These immediate physical impacts can be dramatic and have long-lasting effects on the reef structure and associated biological communities. The trend of coral reef decline in the Caribbean and the rest of the world over the last few decades makes what remains of coral reef resources even more valuable, and increases the need and urgency for their restoration and conservation.

Natural resources in the area of the T/V MARGARA Incident include several coral species that are listed as "Threatened" under the Endangered Species Act (ESA). These species include *Acropora cervicornis*, *Orbicella faveolata, Orbicella franksi, Orbicella annularis*, *Dendrogyra cylindrus*, and *Mycetophyllia ferox*. *A. cervicornis* and elkhorn coral (*Acropora palmata*) were once the dominant reef building coral species in the Caribbean. Over the last few decades, these species have declined more than 90% in abundance throughout the region (Bruckner, 2002). In 2006, both species were listed as "Threatened" under the ESA (71 FR 26852, May 9, 2006; NOAA, 2015a). In 2014, five additional coral species from the Caribbean were listed as "Threatened" under the ESA (79 FR 53851, September 10, 2014). These include *O. faveolata, O. franksi, O. annularis, D. cylindrus,* and *M. ferox.*

2.3 CULTURAL and HUMAN USE ENVIRONMENT

Coral reefs like those along the south coast of Puerto Rico, including at the T/V MARGARA Incident site, are also among the most economically valuable ecosystems on earth, providing vital ecosystem services to humans. Coral ecosystems are a source of food; protect coastlines from storms and erosion; provide habitat, spawning and nursery grounds for economically important fish species; provide jobs and income to local economies from fishing, recreation, and tourism; and are a source of new medicines, and of great cultural importance in many areas (Cesar et al., 2003). Coral reefs are an integral part of Puerto Rico's economy, culture, recreation and tourism. Coral reef ecosystems in Puerto Rico and their associated biological communities generate a multitude of ecological, social, and economic benefits for millions of people throughout Puerto Rico (Burke and Maidens, 2004; NOAA, 2018). Coral reef ecosystem services afforded to Puerto Rico include shoreline protection; spawning, nursery, and feeding habitat for an array of commercial fishery species; beach sand nourishment; and support billions of dollars in tourism revenue (Moberg and Folke, 1999; Harborne et al., 2006; Brander et al., 2007; Estudios Técnicos, Inc., 2007). Fisheries related to coral ecosystems in Puerto Rico range from artisanal subsistence fishing, commercial fisheries, aquaculture, recreational fishing, the aquarium/marine ornamental trade, and the curio and fashion industries. Fish like snapper and grouper and invertebrates like lobsters and octopus that grow and live on coral reefs are a significant food source and a very important recreational resource in terms of participation and economic value for people in Puerto Rico (UNEP, 2004).

3.0 ASSESSMENT OF INJURIES TO NATURAL RESOURCES

This section summarizes the Trustees' assessment of the injuries to the reef and associated resources at the Incident site and of the likelihood of recovery of these resources. This information provides the basis for the Trustees' development of the Compensatory Restoration actions selected in this Final Compensatory RP/EA. The Trustees, or their contractors, have visited the site every year since the Incident occurred in 2006, and have taken into account the observations during these site visits in their assessment of the injuries and restoration needed at the T/V MARGARA site.

Corals are known to be sensitive to physical destruction, breakage, and disruption from vessel groundings, propwash, vessel anchoring and cable dragging (Precht el al., 2001; NOAA, 2002b; Rinkevich, 2005). The vessel groundings during removal of the T/V MARGARA generated massive forces on individual corals and reef substrate. Corals typically have a shear strength of 12-81 meganewtons/m^2 (Chamberlain, 1978), and the impact from the vessel movement during response actions crushed and broke thousands of corals. The physical impact from the vessel hull repeatedly striking the reef during response actions, combined with propwash from tug actions to move the vessel, destroyed or severely altered large areas of reef.

3.1 DELINEATION OF PHYSICALLY INJURED SITE

3.1.1 2006-2007 Mapping

In the time period immediately following the Incident, the site was mapped by RP representatives (with Trustee oversight and participation) using an underwater mapping system that involved divers surveying the site by triangulating positions with series of acoustic transceivers connected to GPS marked surface buoys and communicating with a surface team via an underwater wireless communications system. Areas were designated as "impacted" if divers observed evidence of recently broken corals with exposed white skeleton, hull paint, piles of broken corals and rubble, breakage, and/or flattened reef. This effort resulted in the map in Figure 7.

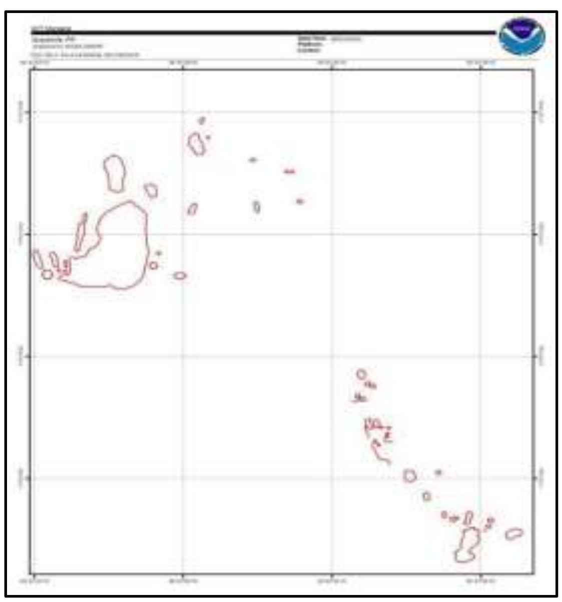


Figure 7: First map of the coral reef areas impacted by the T/V MARGARA Incident. Data were collected in 2006 by divers using an underwater acoustic mapping system and surface buoys with GPS. Areas outlined in red indicate impacted coral reef.

This first effort provided a rough outline of the "site" which encompasses the area of coral reef affected by the grounding and the response actions that lead to the physical impacts on the reef. Since the site consisted of numerous individual impacts over a large area from a series of occurrences having the same origin (the Incident), a more comprehensive and systematic approach to mapping the site's features was necessary. After considering a number of options, the Trustees selected to use Multibeam SONAR[13] technology with 0.5 m resolution to map the site bathymetry. This method was the most comprehensive, yet still cost-effective, approach available using technology available at time. In November 2006, the Trustees arranged for NOAA's Navigation Response Team (already in the area for other work) to conduct the multibeam effort at the site. Trustee and RP divers who had a high degree of site familiarity (from multiple months of Emergency Restoration and other assessment work) then used a combination of the original 2006 maps overlaid on the multibeam charts to develop a consensus set of impact boundaries (Figure 8) and determined the area impacted by response actions for the North, Central and South Regions (Table 1). Areas of impact were interpreted from acoustic images to separate out the deeper areas that were not impacted and the shallow reefs areas that were impacted.

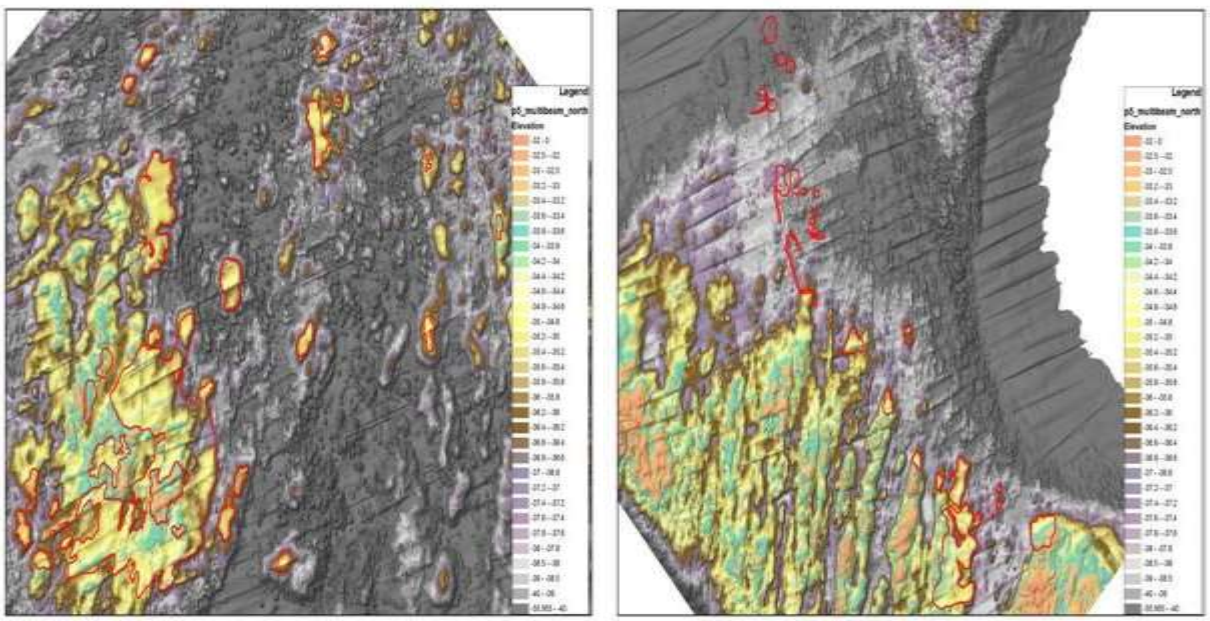


Figure 8: Multibeam images of the T/V MARGARA site with impacted areas delineated in red. The North Region is on the left. Central and South Regions are on the right.

3.1.2 Classification and Delineation of Impact Types

The multiple mapping efforts ultimately produced well-defined impact areas in the North, Central and South Regions. During a 2008 joint technical meeting between RP and Trustee technical representatives who had

[13] Multibeam sonar is an active sensor that utilizes acoustic energy to collect measurements of seafloor depth. Multibeam sensors pulse the bottom with a series of acoustic soundings normal to the track of the vessel and record the reflected echoes in an orientation parallel to the vessel track. This produces a swath of data (representing the width of the track) that, depending on specific sensor and mission requirements, is normally several times the water depth. Like other acoustic sensors, multibeam sonar data are normally collected in a series of transect lines with sufficient overlap to avoid gaps in coverage (NOAA 2004).

extensive site familiarity, these areas were further delineated into Hard Substrate, Majority Unconsolidated Rubble, and Partially Impacted classifications using information and data from diver surveys and multibeam surveys (Table 1). Classifying areas of the site in this manner helped the Trustees evaluate recovery potential, guided Primary Restoration actions, and determined recovery rates within the different areas of the Incident impact site. The classifications were done cooperatively with input from Trustee and RP technical representatives to maximize cost-effectiveness and cooperation, as recommended in 15 C.F.R. § 990.14(c). The delineations represent the consensus bottom type classifications after the Incident (Figure 9).

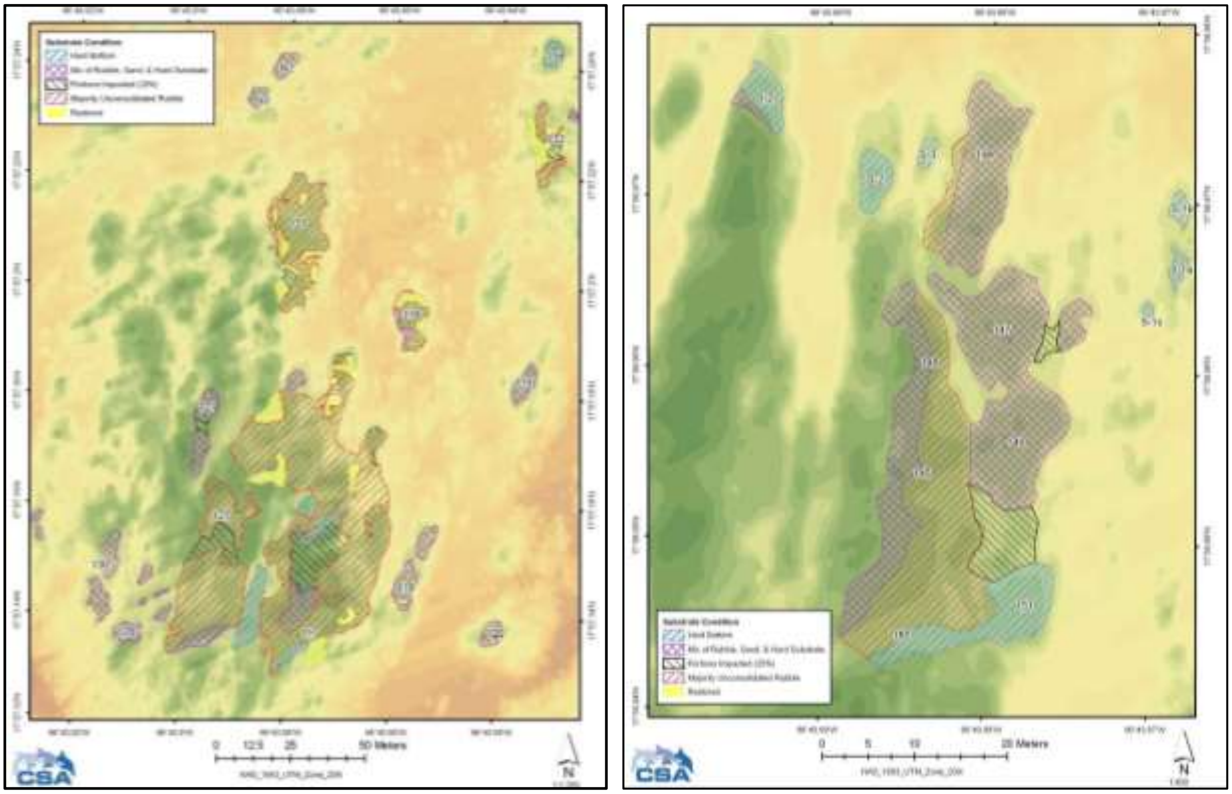


Figure 9: Substrate classification maps for the T/V MARGARA site. The North Region is on the left, and the South Region is on the right. Maps produced by Continental Shelf Associates (2008).

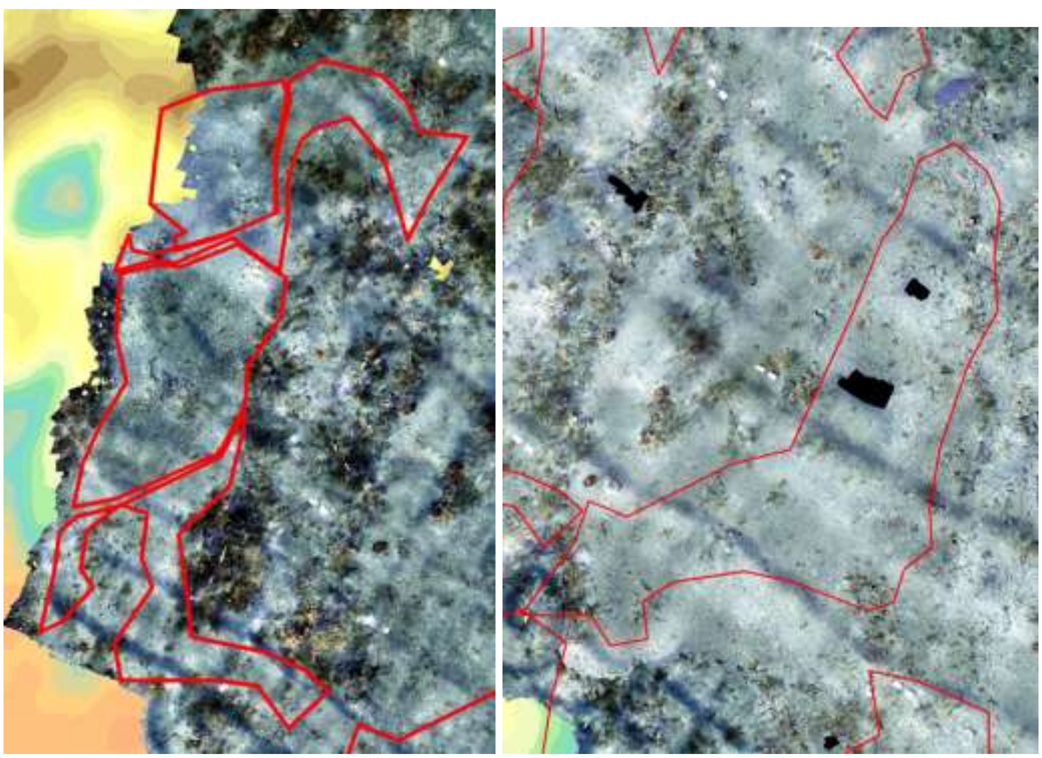
Table 1: Impact Area by Site Region and Injury Classification

Location	Injury Classification	Percent of Corals Impacted	Area (m^2)
North Region	Hard Substrate	100%	1,890
	Unconsolidated Rubble Requiring Primary Restoration	100%	1,471
	Rubble Not Requiring Primary Restoration	100%	2,169
Central Region	Partially Impacted	25%	174
South Region (Impacted by Response Actions)	Hard Substrate	100%	761
	Unconsolidated Rubble Requiring Primary Restoration	100%	191
	Rubble Not Requiring Primary Restoration	100%	99
		Total	**6,755**

In areas classified as "Hard Substrate", the underlying reef structure was considered to still be relatively intact post-Incident even though there was a complete loss of coral biota. Recovery of corals in these areas is considered likely to occur over time due to 1) minimal amounts of rubble that could mobilize and damage or smother recruits during high wave energy events such as storms, 2) lack of sediment to inhibit or smother recruits, and 3) the presence of cryptic reef spaces for coral recruitment.

The areas originally classified as "Majority Unconsolidated Rubble" on the substrate classification maps (Figure 9) were of critical concern. These areas were characterized by large amounts of small pieces of rubble (noted in diver surveys) that had been and would continue to be remobilized during high energy events. Viehman et al. (2018) showed that coral recruitment in these areas was not successful, and recovery in these areas would be significantly and continuously inhibited by the movement of rubble. This is discussed in more detail in Section 3.5. In 2012, a joint survey identified 1,662 m^2 within the 3,930 m^2 of "Majority Unconsolidated Rubble" that needed Primary Restoration in order to start recovery. As a result, the Trustees considered the remaining 2,268 m^2 as Rubble Not Requiring Primary Restoration. Photos from some of the areas identified as Unconsolidated Rubble Requiring Primary Restoration can be seen in Figure 10. Primary Restoration is focused on restoring these areas by stabilizing the rubble.

Figure 10: Photos of Unconsolidated Rubble Requiring Primary Restoration at the T/V MARGARA site on top. Photos by NOAA Restoration Center, December 2008.



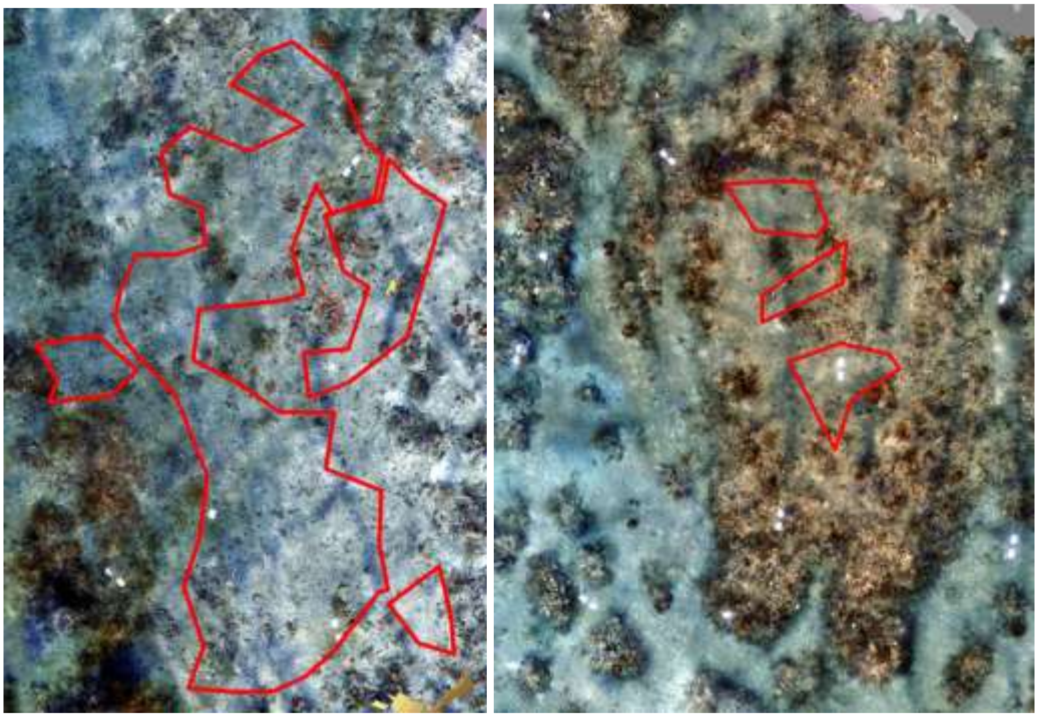


Figure 11: Photomosaic images from the T/V MARGARA site in 2021. Red polygons mark rubble areas identified as Unconsolidated Rubble Requiring Primary Restoration. Areas outside of the polygons are either Hard Substrate, Restored Areas, Unimpacted Areas or Rubble Not Requiring Primary Restoration. Photomosaic images collected by Sea Ventures, Inc.

Joint field surveys between Trustee representatives and the RP consultants found 100% of the coral colonies were impacted (destroyed, missing, or dislodged) within the North and South Regions of the site (Table 1). Impacts in the Central Region were from propwash from the tugboats and vessel during response actions, and not the hull of the vessel; this propwash resulted in a partially impacted area where not all of the corals were dislodged. Within this Central Region, assessment dives were conducted by Trustee representatives and the RP consultants to assess the degree of injury, and both parties agreed that coral colonies were not impacted to the same degree as the other regions. Based on post-dive field agreement between the Trustee representatives and the RP consultants to maximize cost-effectiveness and cooperation, as recommended in 15 C.F.R. § 990.14(c), this region was characterized to have an impact to 25% of the coral colonies (Table 1). Recovery of these areas is viewed as likely to occur over time since the integrity of the reef was still intact.

In 2021, between the publishing of the Draft Compensatory Restoration Plan and the completion of this document, the Trustees completed diver-based collection of large area imagery and partially processed an underwater Photomosaic (e.g., Structure from Motion) of portions of the site for purposes of Primary Restoration implementation planning. While intended to support primary restoration and not new site wide delineation and mapping, the imagery was reviewed and compared against existing delineations as it became available (Figures 11 – 13). After adjustment for known spatial positioning errors, the 2008 and 2012 delineations were found to be qualitatively consistent with the site condition shown in the 2021 photomosaic. Because of its relevance to understanding the current site condition the imagery is being shared with the Responsible Parties as it is being processed and is also being added to the Administrative Record.

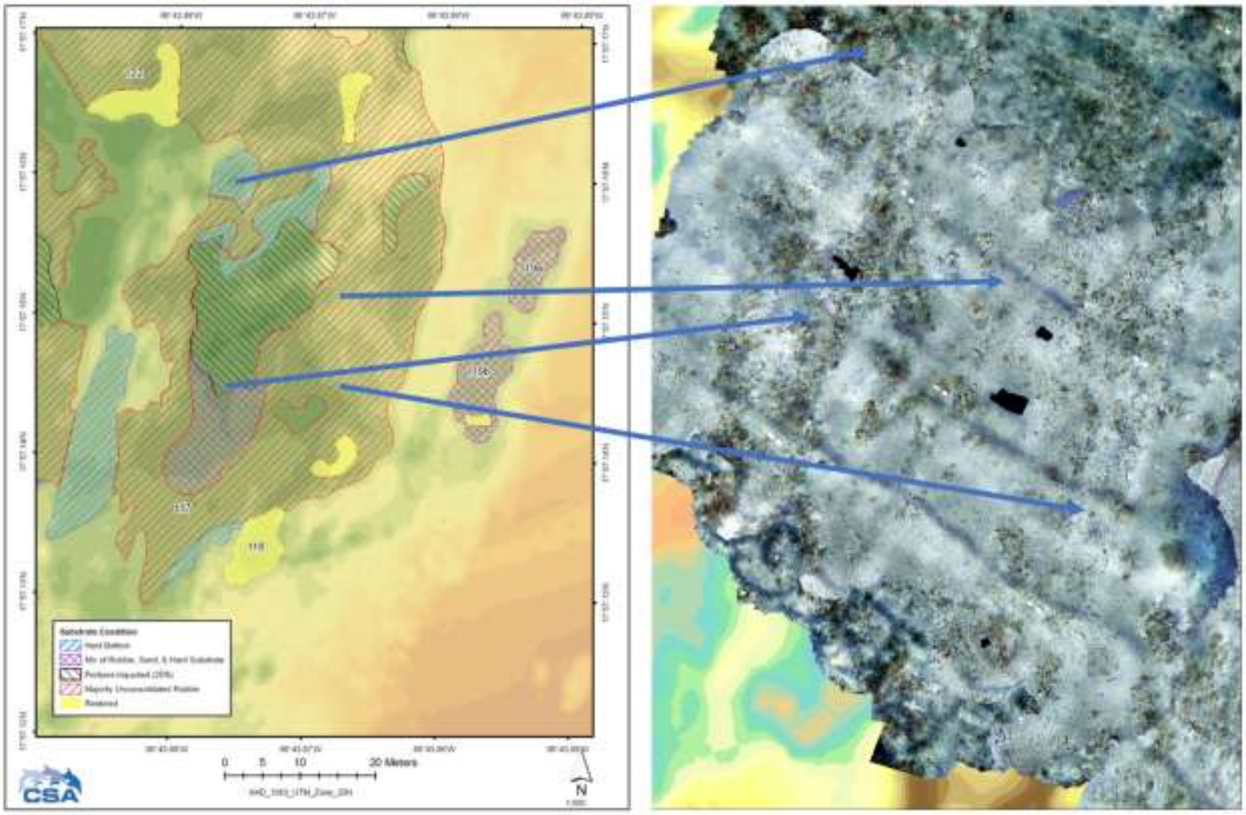


Figure 12: Comparison of Substrate Classification Maps and Photomosaic images from the T/V MARGARA site in 2021. The modest recovery shown is consistent with the recovery periods calculated by the Trustees. Photomosaic images collected by Sea Ventures, Inc.

3.2 LOST TOPOGRAPHIC COMPLEXITY

Based on comparison to nearby reference reefs, prior to the T/V MARGARA Incident, the impacted reef site was topographically complex, with high and low relief areas and a combination of patch reefs and spur-and-groove reef formations as described in Section 2. After the Incident, the tops of the patch reefs and spurs were flattened to a uniform level with very little or no topographic complexity within individual impact areas. In order to estimate topographic complexity, measurements were performed to measure the Rugosity Index (RI). RI is the ratio between the total length of a chain and the length of the same chain when molded to a reef surface (Aronson et al., 1994; Knudby and LeDrew, 2007). A perfectly flat surface has an RI of 1. Higher numbers indicate a greater degree of architectural complexity. Measurements focus on the structural complexity of the reef substrate and do not include octocorals. Measurements using a 10m chain were conducted in the reference areas surrounding the impact and compared with measurements in the rubble fields created by the T/V MARGARA Incident. Rugosity measurements were during bi-annual fish and benthic monitoring events at the site since 2012 have shown that the average difference between the highest and lowest areas in the rubble fields is approximately 10 cm, with a range of 3–25 cm. In contrast, the mean relief difference in adjacent unimpacted reef areas was 50 cm with a range of 15–100 cm. The difference in the topographic relief values between the reference areas and impacted areas indicate that the impacted areas have been flattened relative to the surrounding reference reef (considered a proxy for the pre-Incident condition of the impacted reef). The heterogeneous topographic relief of a reef provides critical habitat for fish and marine invertebrates. Damaged spur-and-groove reef habitat and high relief areas will not recover to their original community structure without substantial restorative engineering and proactive restoration to encourage reef development (Precht el al., 2001; NOAA, 2002b; Rinkevich, 2005).

Primary Restoration, fully described in the first phase of this comprehensive planning effort for the T/V MARGARA Incident NRDA, to begin implementation in 2021, will stabilize unconsolidated rubble and restore topographic complexity that had been present prior to the Incident. Should the outcome of the first phase of the Trustees restoration planning for the site been to select the "No Action/Natural Recovery" alternative rather than the Preferred Alternative, a substantially different scale of Compensatory Restoration would have been required, hence the phased approach to restoration planning.

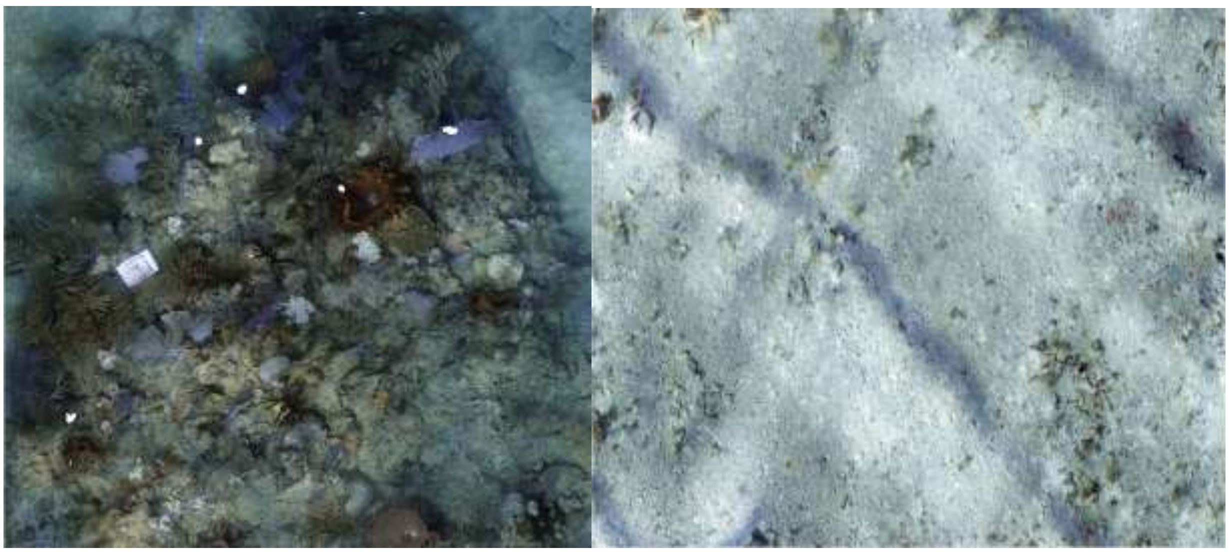


Figure 13: Images comparing unimpacted reef (left) adjacent to the T/V MARGARA site with impacted reef near Site 158 (right). Photomosaic images collected in 2021 by Sea Ventures, Inc.

3.3 DIRECT BIOLOGICAL LOSS

To determine the extent of the coral loss at the T/V MARGARA Incident site, 10 m^2 belt transects were conducted underwater by coral scientists using SCUBA in un-impacted reference reef areas adjacent to the site (Figures 14 and 15). A total of 32 transect surveys of 320 m^2 were surveyed by both Trustee and RP representatives during two field events (October 2006 and May 2008). Results from the second set of surveys in 2008 with both the RP and Trustees were similar to the previous data in 2006 (collected by the Trustees); and both the Trustees and RP representatives agreed that this transect dataset was an accurate description of the coral populations at the site. Data recorded from the belt transects included the coral species present and their respective size class in 10 cm increments[14]. This data was used to estimate pre-Incident coral densities, species diversity, and size distributions. Transects were conducted in the three regions that were impacted: the North Region, the South Region, and the Central Region damaged by propwash that was deeper and just north of the South Region (Table 2). Coral densities in the North Region averaged 8.5 scleractinians/m^2 and 16.2 octocorals/m^2 (octocorals are commonly referred to as soft corals). Coral densities in the South Region averaged 6.6 scleractinians/m^2 and 19.5 octocorals/m^2. In the Central Region, average coral densities were 3.5 scleractinians/m^2 and 12.6 octocorals/m^2. The average density of

[14] Data collected during the 2008 surveys subdivided the smallest size classes up into 0-5cm and 6-10cm, whereas the 2006 survey considered 0-10cm as one size class. The merged data set proportioned the 2006 data equally between the two classes.

corals per m^2 and the total area of impact were then used to calculate the total number of corals impacted by the T/V MARGARA Incident (Table 3). Using this data and approach, the Trustees calculated that over 165,000 corals were impacted as a result of the T/V MARGARA Incident.

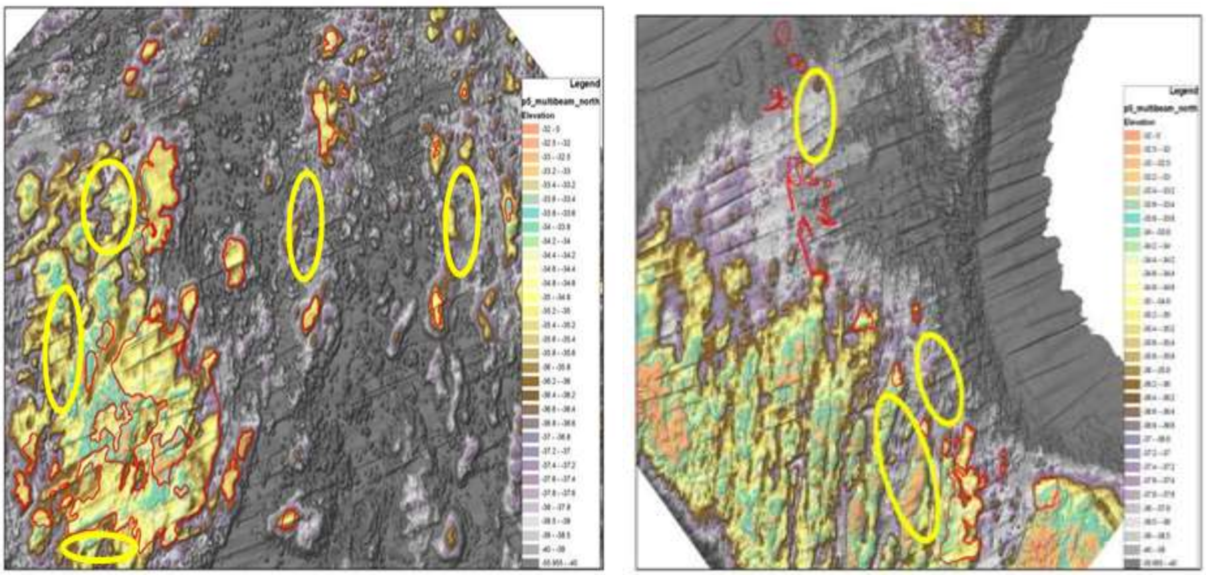


Figure 14: Multibeam images of the T/V MARGARA site showing location of reference transects (yellow polygons) adjacent to the T/V MARGARA site (impacted areas delineated in red).

Figure 15: Photos of un-impacted reef adjacent to the T/V MARGARA site where reference transects were conducted. Photos taken by NOAA Restoration Center in 2008.

Table 2: Density of Corals in Reference Areas near the Three Different Regions at the T/V MARGARA Site. Standard error is included for the densities.

Transect Location	Size of Impact (m^2)	# of 10 m^2 Reference Transects	Density of Scleractinians/m^2	Density of Octocorals/m^2
North Region	5,530	21	8.5 +/- 1.9	16.2 +/- 4.3
Central Region	174	5	3.5 +/- 2.5	12.6 +/- 5.0
South Region	1,051	8	6.6 +/- 2.7	19.5 +/- 4.6

Table 3: Total Number of Corals Impacted by Site Region and Type of Impact as a Result of the T/V MARGARA Incident.[15]

Location	Impact Size (m^2)	Scleractinians Impacted	Octocorals Impacted	Total Corals Impacted
North Region *Hard Substrate*	1,890	16,108	30,588	46,696
North Region *Unconsolidated Rubble Requiring Primary*	1,471	12,537	23,807	36,344
North Region *Rubble Not Requiring Primary*	2,169	18,486	35,103	53,589
Central Region *Hard Substrate*	174	616	2,189	2,805
South Region *Hard Substrate*	761	5,042	14,811	19,854
South Region *Unconsolidated Rubble Requiring Primary*	191	1,266	3,717	4,983
South Region *Rubble Not Requiring Primary*	99	656	1,927	2,583
Total Impact	6,755	54,712	112,142	166,854

3.4 EMERGENCY RESTORATION AND MID-COURSE CORRECTION

After injuries to coral reef resources were identified during the initial dives at the site, in 2006, the Trustees determined that Emergency Restoration actions, as defined by 15 C.F.R. § 990.26, were necessary to prevent additional injury and minimize continuing losses of natural resources at the Incident site. The Trustees developed an Emergency Restoration Plan in cooperation with the RP. The Trustees posted a Notice of Emergency Restoration Action on November 5, 2006 pursuant to 15 C.F.R. § 990.26 to provide public notice of these Emergency Restoration actions. That notice summarized the Trustees' jurisdiction pursuant to 15 C.F.R. § 990.41, the basis for undertaking emergency actions, the actions planned, and the status of implementation of those actions. A copy of the announcement can be found in the AR. These Emergency Restoration operations were initiated in May 2006 and completed in March 2007.

The Trustees' first inspections of the site began in May 2006 and continued through the end of July 2006.

[15] A more detailed breakdown of corals impacted by species and size classes can be found in Appendix A.

Numerous reconnaissance and assessment dives were required to determine the extent of the injury at the site. These surveys revealed thousands of square meters of diverse reef habitat to be severely impacted by the Incident, including response actions to prevent a substantial threat of an oil spill. Impacts included destruction, crushing, breaking, dislodging or burying of many species of soft corals, sponges, and hard corals, including staghorn coral (*A. cervicornis*). Fracturing of reef substrate was observed in some areas. Large numbers of dislodged, broken and buried corals were observed in addition to substantial amounts of rubble (Figure 10). Antifoulant paint remnants with toxic constituents covered some reef areas. Loose and buried reef biota were at risk of imminent loss due to further movement or burial, remobilization of rubble, and potential hurricanes in the 2006 season. The Trustees determined a variety of actions were urgently needed to minimize continuing or prevent additional injury to natural resources, including biological stabilization and reattachment. Specific actions included repositioning, righting, and collection of displaced hard and soft corals and "live rock" fragments; temporarily placement of displaced corals; reattachment of cached biota and associated reef substrate to rescue as many organisms as possible; localized containment or stabilization of rubble; moving grounding-associated rubble from berms; and removal/disposal of antifoulant paint from reef substrate.

The 2006 Emergency Restoration actions began with the caching of corals suitable for reattachment throughout May and June 2006. This involved moving corals from areas where they were at risk and continuing to be harmed, such as if they were upside down or buried, to a safer location for temporary storage until they could be reattached. The primary field work was initiated by the RP in July 2006 under Trustee oversight and was completed in March 2007. This work resulted in reattachment of almost 9,500 pieces of soft corals, hard corals, and coral fragments; 955 *A. cervicornis* fragments; removal of approximately 55 gallons of anti-fouling paint and contaminated substrate; and stabilization of medium to large pieces of reef. Reattached biota were tagged and mapped relative to on-site reference markers to facilitate future monitoring.

Hurricane Dean passed to the south of Puerto Rico as a Category 5 hurricane during August 2007. The Trustees conducted post-storm surveys of the 2006–2007 Emergency Restoration at the site on August 30, 2007 and again with RP representatives on September 4–6, 2007. These surveys revealed that waves and currents generated by the storm caused some impacts to the Emergency Restoration and moved the rubble (that was created by the Incident) injuring previously unimpacted reefs.

Conditions revealed by post-Dean surveys included:

- Large quantities of loose rubble across multiple sites re-mobilized and swept through the site, resulting in observable injuries to some of the corals that had been reattached during the Emergency Restoration.
- Some previously reattached corals were dislodged and needed reattachment.
- A large number of reattached corals suffered excessive scouring at their base and needed stabilization.
- Two of four *A. cervicornis* restoration sites suffered heavy loss of reattached fragments as a result of loose rubble sweeping through these areas. Approximately 225 *A. cervicornis* fragments were salvaged and needed reattachment.
- Exposure of additional antifoulant hull paint that had previously been buried by rubble.
- Of the restoration structures being monitored, 15% of the restoration structures were missing, 30% became unstable and had to be subsequently reattached, and the remaining 55% remained intact.
- Lost mooring buoys

The Trustees determined, pursuant to 15 C.F.R. § 990.26(a), that mid-course corrective actions were needed for the earlier Emergency Restoration actions to meet their restoration objectives and to prevent additional losses at the site. Notice of the mid-course correction (a second Emergency Restoration event) was posted October 30, 2007, and a copy of the announcement can be found in the AR. This second round of

Emergency Restoration operations were implemented during the fall of 2007 through the spring of 2008.

The following corrective actions were determined to be feasible, likely to minimize continuing or prevent additional injury, cost-reasonable and were implemented by the RP in coordination with and under the oversight of the Trustees:

- All prior coral reattachments were checked and re-secured or relocated, as needed.
- Monitoring stations that had been damaged or dislodged by the storm were reestablished (not all of the stations were found, however).
- Loose corals were reattached in place or moved to more secure sites for reattachment.
- At *A. cervicornis* sites, fragments were reattached to new or existing attachment points, and loose rubble was removed or secured.
- Limited rubble stabilization, using cement and incorporating the rubble into the individual installations or modules. This did not address the majority of rubble that needed to be stabilized during Primary Restoration.
- Removal of additional exposed antifoulant hull paint.
- Damaged moorings were replaced.

Approximately 10,500 corals were reattached and saved during the Emergency Restoration (Table 4). The size class distribution of the corals saved during the Emergency Restoration were similar to the sizes of the impacted corals (Figure 16). The species and size class distributions of both the impacted corals and corals saved during Emergency Restoration is valuable information for creating a Resource Equivalency Analysis for this Incident which is described in Section 3.6.

Table 4: Number of Corals Impacted by the T/V MARGARA Incident and Saved During Emergency Restoration.

	Corals Impacted	Corals Saved During Emergency Restoration	Percent Saved During Emergency Restoration
Scleractinians	53,285	4,247	8%
Acropora	1,427	955	67%
Octocorals	112,142	5,328	5%
Total	166,854	10,530	6%

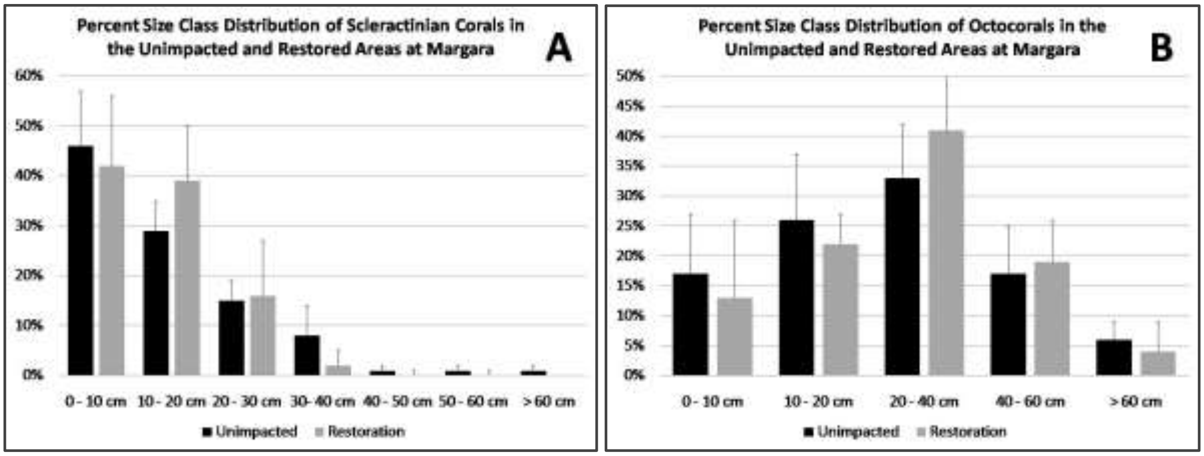


Figure 16: Percent size class distribution of scleractinians (Graph A) and octocorals (Graph B) in the un-impacted reef adjacent to the T/V MARGARA Incident site (black bars) and in restored areas after Emergency Restoration (gray bars).

3.5 SITE RECOVERY

In order to characterize the recovery potential at the site, coral recruitment monitoring was conducted by the Trustees from 2008 - 2013 to track the appearance of newly settled corals and their survival. Monitoring sites were established in unconsolidated rubble fields, in consolidated hard substrate areas, on Emergency Restoration structures, in the surrounding un-impacted reef at the T/V MARGARA Incident site, and at the nearby T/V SPERCHIOS Incident site (a 2005 grounding site with little to no loose rubble and where the impacted site was and remained consolidated hard substrate/pavement). The T/V MARGARA and the T/V SPERCHIOS Incidents occurred within six months of each other. This monitoring provided site specific data from the T/V MARGARA Incident site that was necessary to support the Trustees' Primary Restoration claim (NOAA, 2015b) that restoration was needed in the rubble fields so that corals would be able to recover. These results were published by Viehman et al. (2018), and the data was used to calculate site specific recruitment periods for each species needed for the Resource Equivalency Analysis models used to scale Compensatory Restoration discussed in Section 3.6. The recruitment period refers to the time needed for a sufficient number of surviving coral settlers to recruit to the site to either match or surpass the mean adult density that had been there previously or that exists in the reference area. This takes into account both recruitment rates and survival of those recruits.

The recruitment monitoring data from 2008 through 2013 showed that coral recruit densities in the rubble fields at the T/V MARGARA Incident site were limited by little to no survival of the coral recruits (Figures 17 and 18). Survival and density of scleractinian and octocoral recruits were lower in the rubble areas than in the Emergency Restoration structures, the reference area, or the pavement (Figures 17 and 18). Scleractinian coral density increased at the hard bottom, consolidated pavement areas at the T/V SPERCHIOS Incident site as recruits survived and grew into larger size classes, and the small (<5 cm) size classes were replaced with new recruits (Figure 17A,C); in contrast to the rubble transects, where scleractinian recruits remained in the small (<5 cm) size class and densities did not increase (Figure 18B). Octocoral densities were significantly higher within the pavement areas than within the rubble. Densities of octocorals at the pavement site increased while the numbers of larger octocorals increased as the octocorals grew. This was in contrast to the rubble areas, where the octocoral density did not significantly increase over time (Figure 18).

The graphs in Figures 17 and 18 show how the T/V SPERCHIOS Incident hard bottom site is recovering with time while the T/V MARGARA Incident rubble fields have limited to no recovery seven years after the T/V MARGARA Incident. There are almost no Scleractinians present in the rubble at the T/V MARGARA Incident site, and the data shows that recovery in the rubble fields at the T/V MARGARA Incident site is not occurring (Viehman et al., 2018). The Trustees, or their contractors, have visited the site every year since the Incident occurred in 2006, and these site visits have not provided any reason to doubt this assessment.

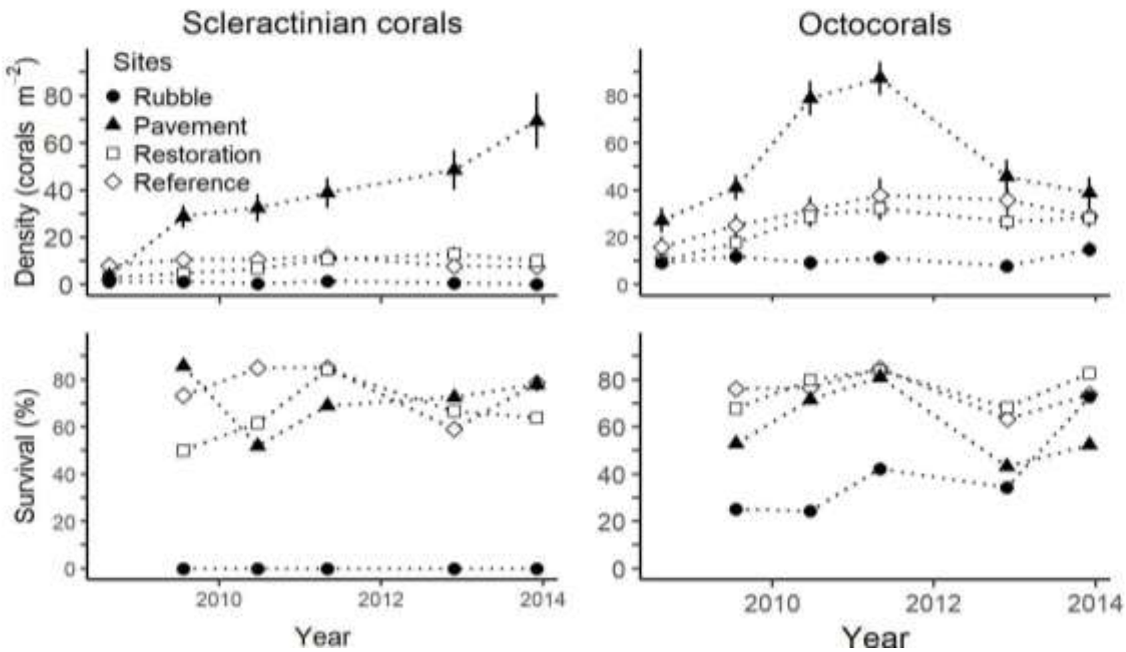


Figure 17: Comparison of coral colonization success between rubble, pavement (hard bottom), restoration and reference sites showing density and survival of recruits. Error bars represent standard error of the mean. Recruit survival represents the percentage of coral recruits that survived from the previous surveys. Figure from Viehman et al., 2018.

As mentioned previously, high relief areas such as spur-and-groove habitat, will not recover to their original community structure without proactive restoration to encourage reef development (NOAA, 2002b; Rinkevich, 2005; Precht et al., 2001). When the reef structure and substrate is broken down into rubble and sand, the reef's ability to recover through natural processes of recruitment is diminished. Loose, broken substrate is dynamic and can be easily moved by storms and current. Settled corals may endure higher sedimentation and increased mortality from overturning and abrasion. Scleractinian corals are not able to recover in these types of habitats (Fox et al., 2003; Cameron et al 2016; Yadav 2016; Viehman et al., 2018; Fox et al., 2019; Kenyon et al. 2020; Ceccarelli 2020). The loss of topographic complexity has serious implications for reef ecosystem recovery, including fish and sea urchin populations that provide valuable services in spur-and-groove habitats (Aronson and Swanson, 1997). Restoration efforts must include re-establishment of the topographic complexity to enhance recruitment and growth of coral species, and indirectly to associated biota, that naturally occur in spur-and-groove habitats.

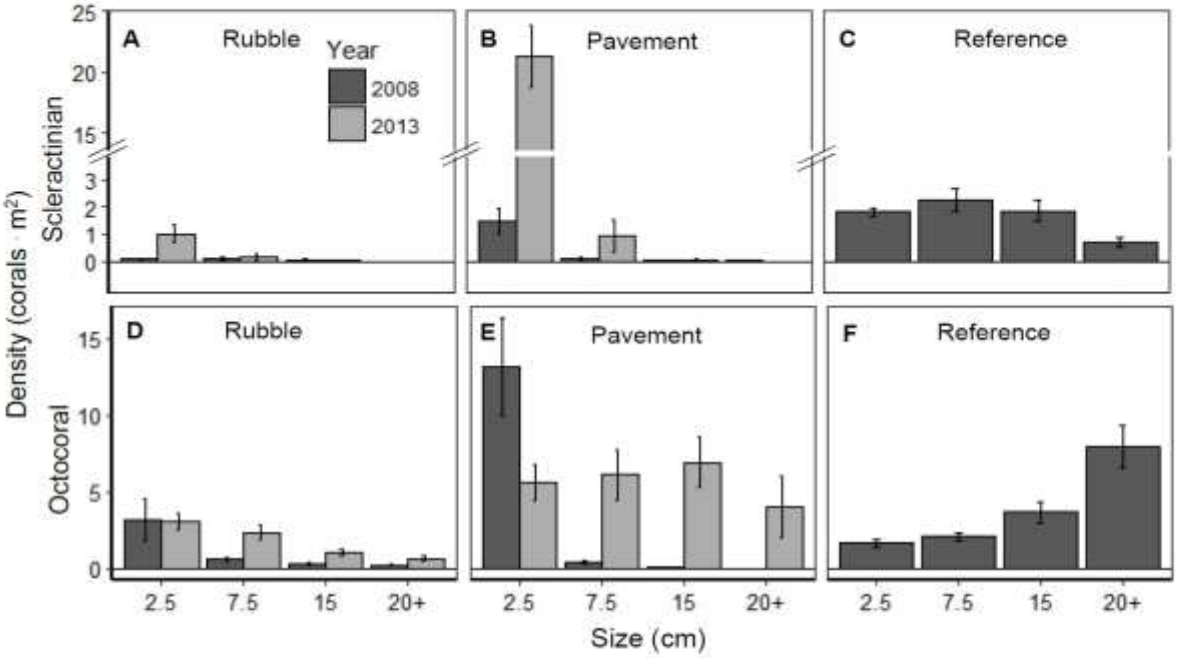


Figure 18: Size-frequency histogram for scleractinian corals (A-C) and octocorals (D-F) at rubble (A,D), pavement (B,E), and reference (C,F) sites in 2008 (rubble, pavement, reference) and 2013 (rubble, pavement). Sizes (cm) are size-class midpoints, Error bars represent standard error of the mean. Figure from Viehman et al., 2018.

Emergency Restoration efforts at the T/V MARGARA Incident site focused on reattaching loose and broken corals, and the Primary Restoration (in progress at the time of publication) will focus on stabilizing rubble and rebuilding topographic complexity. Recovery at the site is dependent upon the successful recruitment of corals and other marine organisms. Many colonies of the slower growing coral species will take decades or centuries to recover to their original size and distribution. Limited recruitment by large reef-building species like *Orbicella* spp. can delay or even preclude the complete recovery of the original coral community (Gittings et al., 1988). Most of the Caribbean scleractinian coral species grow considerably slow, averaging 1 cm/yr or less for most species (Gladfelter et al., 1978; Highsmith et al., 1983; Hubbard and Scaturo, 1985; Huston, 1985; Edmunds, 2007; Crabbe, 2009). Because of the slow recovery rate for many Caribbean coral species, the T/V MARGARA Incident site will take substantial time to recover.

3.6 SCALING OVERVIEW

In planning and scaling compensatory restoration actions under this plan, the Trustees' objective is to provide resource gains that are equivalent or comparable in type, quality and value to the interim resource losses caused by this Incident, after taking into account the effect of prior Emergency Restoration at the site and the substrate stabilization actions in Primary Restoration. The Trustees recognize that it is not possible to directly replace the exact size and species distribution of the corals that were lost during the T/V MARGARA Incident.

The general framework used for quantifying a compensatory restoration action is referred to as the scaling approach. The OPA NRDA regulations allow Trustees to use a resource-to-resource or service-to-service approach, or a valuation approach. In resource-to-resource or service-to-service scaling, the scale of compensatory restoration is determined by obtaining equivalency between the quantity of discounted services lost due to the injury and the quantity of discounted replacement services provided by compensatory actions. The objective of scaling is to ensure that the quantity of the resources or services provided through restoration will be equivalent to interim losses and thus sufficient to compensate the public for losses. If they are not going to provide the same or comparable services, the service to service methods are not valid. The appropriate method for scaling based on resource-to-resource services is a Resource Equivalency Analysis (REA) method (Julius et.al. 1995; Milon and Dodge, 2001).

For the T/V MARGARA Incident, the Trustees recognized that generalizing losses and restoration relationships across all injured corals would likely result in either under- or overestimating interim coral losses and, therefore, compensatory restoration needs. But, just like with many ecosystems and NRDAs, it would not be cost effective or time efficient to assess every injured resource or habitat component. In order to be cost efficient in our assessment, the Trustees determined that a matrix of independent Resource Equivalency Analyses (REAs) that considered the injuries to and recovery characteristics of impacted coral species themselves would sufficiently represent the complexities associated with the coral reef ecosystem losses at the T/V MARGARA Incident site. This would estimate both the interim coral losses and the scale of restoration needed to restore the same or comparable resources to compensate for those losses. As described in Kolinski et al. (2007) and Viehman et al. (2009), this modified type of REA uses a resource-to-resource method that references the number of organisms lost and the number gained through restoration. This approach examines the size distribution of species and life history characteristics of different corals allowing for comparisons between ecological services. This allows the Trustees to quantify and aggregate losses for multiple species, accounting for the different species injured, the sizes/ages lost, anticipated recovery rates and, similarly, to identify the scale of the restoration required to restore or replace coral species comparable to those lost over time. This method has been used to resolve several NRDA coral cases including the LNG-C MATTHEW and T/V PORT STEWART cases in Puerto Rico, the M/V PARADISE case in Florida, and the M/V CAPE FLATTERY and M/V VOGETRADER cases in Hawaii.

Using this approach, the metric for scaling is a coral colony year (CCY). CCY is not equal to the coral age. Discounted CCY is a proxy for services provided and, in the case of any injury, lost during a one-year period of time by a particular size and type of coral. The services provided by corals include the creation of reef structures that provide fish habitat and shoreline protection from storms and waves. While the initial CCY value is only directly comparable to others within the same size class and species, equivalency between sizes and species can be calculated by utilizing a combination of size weighting and equivalency ratios that are based on the contribution each species has to providing fish habitat and shoreline protection. The key inputs into this analysis are the size distribution for each species and the recovery time after injury or restoration. The analysis also considers discounting and other inputs used in REA, such as recovery delay, recruitment period, species growth rates, time to maturity, and project lifespan. The model then uses the number of corals lost by species and size class to determine the coral colony years lost (CCYL) as the basis for the Trustee's injury quantification. This is described in more detail in the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" in the administrative record.[16] This document has a more detailed summary of each of the REAs and the inputs used to estimate CCYL's.

The injury at the T/V MARGARA Incident site falls into three regions which have different coral community composition (Table 2). The sections of the impact site categorized as Hard Substrate were expected to support coral recruitment immediately after the completion of the Emergency Restoration in 2007, while the sections categorized as Unconsolidated Rubble Requiring Primary Restoration would not be able to support coral recruitment until Primary Restoration is complete (NOAA, 2015b; Viehman et al.,

[16] The "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" can be found in the administrative record available at https://www.diver.orr.noaa.gov/web/guest/diver-admin-record?diverWorkspaceSiteId=6204.

2018). The areas classified as Rubble Not Requiring Primary Restoration showed some limited signs of recovery between 2012 and 2021. Separate REAs were calculated for each site region (North, Central and South) and impact type (Hard Substrate, Rubble Not Requiring Primary Restoration, and Unconsolidated Rubble Requiring Primary Restoration).

For areas that still had an intact reef and hard substrate following the Incident, a recovery delay of 1 year was selected using the assumption that recovery would begin to occur once the Emergency Restoration was completed in 2007, one year after the Incident in 2006.

Following the Incident and subsequent Emergency Restoration, many portions of the site remained unconsolidated rubble. Coral recruitment monitoring data from the areas classified as Unconsolidated Rubble Requiring Primary Restoration showed that these areas were not likely to begin recovery until the rubble is stabilized (NOAA, 2015b; Viehman et al., 2018, NOAA, 2020). Primary Restoration to stabilize the rubble fields so they begin recovery will be started in 2021, at the earliest, fifteen years after the Incident. Therefore, a recovery delay of 15 years was chosen for the 1,662 m^2 of reef classified as Unconsolidated Rubble Requiring Primary Restoration: 1,471 m^2 in the North and 191 m^2 in the South. As of the time of publication of this document, those portions of the site have yet to show any meaningful signs of recovery.

Site visits that occurred at least annually between 2012 and 2021 observed that some limited recovery was starting to show in the areas classified as Rubble Not Requiring Primary Restoration. Pinpointing the exact year in which recovery began in these areas would require extensive and expensive data collection, mapping, and analyses of the current recruitment and recovery dynamics at the site. Therefore, in order to maximize cost-effectiveness as recommended in 15 C.F.R. § 990.14(c), the Trustees assigned a recovery begin year of 2012 (corresponding with the joint Trustee/RP site visit & considered to be the earliest reasonable date) and therefore a recovery delay of 6 years for the 2,268 m^2 of reef identified as Rubble Not Requiring Primary Restoration. This included 2,169 m^2 of reef in the North and 99 m^2 in the South. This is a less conservative estimate, because in addition to using the earliest reasonable date, it also assumes that recovery will follow the same rate as the Hard Substrate areas. In reality, recovery in areas with the presence of rubble is likely to take much longer than areas with hard substrate(Fox et al., 2003; Cameron et al 2016; Yadav 2016; Viehman et al., 2018; Fox et al., 2019).

The T/V MARGARA Incident caused substantial injuries to coral resources, other reef biota, and the reef habitat. Based on data and information collected through joint site surveys with the RP, the Trustees calculate the total corals impacted to be 166,854 individual corals (Table 3). This includes different species that are expected to recover at varying rates depending on the size of the coral when it died, recovery delays, recruitment period and growth rates. In total, the Trustees debit model ran nested REAs within each of the site regions and impact types within each site for 52 possible species across 21 size classes for a total of 7,644 potential model runs. For the T/V MARGARA Incident there were 39 scleractinian species evaluated across 8 size classes and 11 octocoral genus evaluated across 5 size classes for a total of 2,569 active model runs. The summary results from the individual Debit REAs in Size Weighted Discounted Coral Colony Years lost per species are presented in Table 5. This is explained in more detail in the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" in the administrative record.

As discussed in Section 3.4, approximately 10,500 corals were saved during the Emergency Restoration (Table 4), and the size distribution of the corals saved during Emergency Restoration was similar to that of the reference areas (Figure 15). The proportion of corals for each species group that were saved during Emergency Restoration was accounted for in the scaling process by a percent credit for each species which was calculated to be 8% for Scleractinians, 67% for Acropora and 5% for Octocorals (Table 4). The CCYLs are subsequently reduced to determine the Trustees requirements for Compensatory Restoration (Table 6).

Table 5: Debit REA Results for Size Weighted and Discounted CCYL by Species, Site Region, and Type of Impact.

	Size Weighted and Discounted CCYL by REA Zone[17]							
Scleractinian Species	**North Primary Rubble**	**North Hard Bottom**	**North No Primary**	**Central Hard Bottom**	**South Primary Rubble**	**South Hard Bottom**	**South No Primary**	**Cumulative CCYL**
Acropora cervicornis	3,886	2,408	3,993	0	0	0	0	10,287
Agaricia lamarcki	216	121	212	22	58	147	24	799
Agaricia spp.	9,805	5,950	9,922	79	1,462	2,683	515	30,416
Colpophyllia natans	1,388	1,340	1,745	0	0	0	0	4,473
Dichocoenia stokesii	918	869	1,141	3	201	524	83	3,739
Diploria labyrinthiformis	1,202	1,184	1,526	12	72	181	29	4,206
Eusmilia fastigiata	443	356	508	0	0	0	0	1,307
Isophyllia spp.	752	686	918	2	31	88	13	2,490
Madracis auretenra	4,653	3,361	5,075	16	0	0	0	13,105
Madracis decactis	4,717	3,352	5,107	18	140	270	50	13,654
Manicina areolata	10	6	11	0	0	0	0	27
Meandrina meandrites	2,553	2,786	3,429	41	50	133	21	9,012
Meandrina jacksoni	684	770	935	0	32	105	15	2,542
Millepora spp.	2,366	1,891	2,705	24	271	673	109	8,038
Montastraea cavernosa	11,523	10,113	13,789	217	1,813	4,954	764	43,174
Mycetophyllia spp.	261	191	286	0	24	55	9	825
Oculina spp.	10	6	10	0	0	0	0	27
Orbicella annularis	4,769	4,327	5,805	17	366	1,081	160	16,525
Orbicella faveolata	5,085	4,215	5,916	63	549	1,446	227	17,502
Orbicella franksi	3,932	3,476	4,723	0	35	83	14	12,264
Orbicella spp.	736	629	869	0	0	0	0	2,233
Porites astreoides	22,696	14,424	23,410	76	1,421	2,706	508	65,240
Porites branneri	33	22	35	0	0	0	0	90

[17] For purposes of legibility, the REA Zones in this table have been abbreviated. North, Central, and South refer to the Regions of the Site. "Primary Rubble" refers to areas categorized as Unconsolidated Rubble Requiring Primary Restoration. "Hard Bottom" refers to areas categorized as Hard Substrate. "No Primary" refers to areas categorized as Rubble Not Requiring Primary Restoration.

Porites porites	800	529	839	0	0	0	0	2,167
Pseudodiploria spp.	3,546	2,853	4,067	127	726	1,899	300	13,517
Scolymia spp.	11	7	11	0	4	7	1	40
Siderastrea radians	0	0	0	0	77	184	30	291
Siderastrea siderea	7,504	6,289	8,778	124	659	1,541	258	25,152
Stephanocoenia intersepta	630	413	658	35	108	245	42	2,130
Unidentified Scleractinian	527	390	581	0	18	34	6	1,557

Table 5 (continued): Debit REA Results for Size Weighted and Discounted CCYL by Species, Site Region, and Type of Impact.

	Size Weighted and Discounted CCYL by REA Zone							
Octocoral Genus	**North Primary**	**North Hard Bottom**	**North No Primary**	**Central Hard Bottom**	**South Primary**	**South Hard Bottom**	**South No Primary**	**Cumulative CCYL**
Briareum	6,370	3,316	6,070	27	1,168	1,919	394	19,264
Eunicea	21,111	13,442	21,792	249	3,566	7,177	1,305	68,641
Gorgonia	21,675	17,067	24,603	341	4,399	10,884	1,766	80,735
Muricea	22,595	12,689	22,166	138	3,077	5,341	1,060	67,066
Plexaura	105,695	70,080	111,004	1,515	18,647	38,644	6,907	352,492
Plexaurella	10,678	8,174	11,961	149	1,612	3,816	634	37,024
Pseudoplexaura	106,100	72,231	112,714	1,048	14,205	29,912	5,299	341,510
Pseudopterogorgia	71,698	37,620	68,531	537	11,202	18,140	3,757	211,484
Pterogorgia	6,330	3,726	6,327	102	822	1,499	289	19,094

Table 6: Size Weighted and Discounted CCYL by Species for the T/V MARGARA Incident Before and After Credit for Emergency Restoration.

Scleractinian Species	Size Weighted and Discounted CCYL	Credits		Scleractinian Species	Size Weighted and Discounted CCYL	Credits	
		ER Credit %	Post-ER Credit CCYL			ER Credit %	Post-ER Credit CCYL
Acropora cervicornis	10,287	67.0%	3,395	*Orbicella* spp.	2,233	8.0%	2,055
Agaricia lamarcki	799	8.0%	735	*Porites astreoides*	65,240	8.0%	60,021
Agaricia spp.	30,416	8.0%	27,983	*Porites branneri*	90	8.0%	83
Colpophyllia natans	4,473	8.0%	4,115	*Porites porites*	2,167	8.0%	1,994
Dichocoenia stokesii	3,739	8.0%	3,440	*Pseudodiploria* spp.	13,517	8.0%	12,436
Diploria labyrinthiformis	4,206	8.0%	3,870	*Scolymia* spp.	40	8.0%	36
Eusmilia fastigiata	1,307	8.0%	1,202	*Siderastrea radians*	291	8.0%	268
Isophyllia spp.	2,490	8.0%	2,291	*Siderastrea siderea*	25,152	8.0%	23,140
Madracis auretenra	13,105	8.0%	12,057	*Stephanocoenia intersepta*	2,130	8.0%	1,960
Madracis decactis	13,654	8.0%	12,562	Unidentified Scleractinian	1,557	8.0%	1,432
Manicina areolata	27	8.0%	25	**Octocoral Genus**			
Meandrina meandrites	9,012	8.0%	8,291	*Briareum*	19,264	5.0%	18,301
Meandrina jacksoni	2,542	8.0%	2,338	*Eunicea*	68,641	5.0%	65,209
Millepora spp.	8,038	8.0%	7,395	*Gorgonia*	80,735	5.0%	76,698
Montastraea cavernosa	43,174	8.0%	39,720	*Muricea*	67,066	5.0%	63,713
Mycetophyllia spp.	825	8.0%	759	*Plexaura*	352,492	5.0%	334,868
Oculina spp.	27	8.0%	24	*Plexaurella*	37,024	5.0%	35,173
Orbicella annularis	16,525	8.0%	15,203	*Pseudoplexaura*	341,510	5.0%	324,434
Orbicella faveolata	17,502	8.0%	16,102	*Pseudopterogorgia*	211,484	5.0%	200,910
Orbicella franksi	12,264	8.0%	11,283	*Pterogorgia*	19,094	5.0%	18,140

4.0 RESTORATION PLANNING PROCESS

4.1 OVERVIEW

The goal of restoration under OPA is to make the environment and the public whole through the identification and implementation of restoration actions that are appropriate to restore, rehabilitate, replace or acquire natural resources or services equivalent to those injured or lost due to unlawful discharges of oil or actions taken in response to the substantial threat of such discharges. The NRDA regulations direct that this goal be achieved by returning injured natural resources to their baseline condition, and by compensating for any interim losses of natural resources and services during the period of recovery to baseline (15 C.F.R. Part 990). The Trustees developed a phased restoration planning approach for the T/V MARGARA Incident NRDA because Compensatory Restoration could not be scaled (using the Resource Equivalency Analysis models described in Section 3.6) until the scope and timing of Primary Restoration was known. Implementation of the Primary Restoration Plan directly impacts the quantification of required Compensatory Restoration since it allows the Trustees to determine a date when recovery can begin in the areas of the Incident site with unconsolidated rubble.

Primary Restoration, fully described in the first phase of this comprehensive planning effort for the T/V MARGARA Incident NRDA, to begin implementation in 2021, will stabilize unconsolidated rubble and restore some topographic complexity that had been formerly present within the footprint of the impact area. Should the outcome of the first phase of the Trustees restoration planning for the site have been to select the "No Action/Natural Recovery" alternative rather than the Preferred Primary Restoration Alternative, a substantially different scale of Compensatory Restoration would have been required, hence the phased approach to restoration planning. As described in the Primary Restoration RP/EA, results of monitoring done in 2008-2013 (described in Section 3.5), and ongoing observations from the site, the continued presence of unconsolidated rubble would not allow natural recovery to occur and substantially increase the compensatory restoration requirement. The exact increase in the restoration requirement is dependent on a number of factors that are situationally specific, but for informational purposes the Trustees hypothetically assumed no recovery at some portions of the site and the compensatory restoration requirement increased by ~30%[18]. In addition to avoiding an increased Compensatory Restoration requirement, Primary Restoration allowed the Trustees to provide direct credit (in the form of a decrease in restoration requirements) for the ~1,550 coral colonies that will be added to the site as part of the Primary Restorations biological enhancement (Section 5.4.3).

Thus, restoration planning involves two phases: Primary Restoration and Compensatory Restoration. The Trustees first described this phased restoration planning approach for the T/V MARGARA Incident natural resource damage assessment in its March 13, 2013 Notice of Intent to Conduct Restoration Planning. The Trustees further described their phased restoration planning approach to complete the T/V MARGARA Incident NRDA in the May 9, 2015 Final Primary Restoration RP/EA. The scope of Primary Restoration at the site was not known until the USCG NPFC completed their adjudication of the Trustees claim on May 30, 2019. At that time planning for compensatory restoration could begin in earnest.

This Final Compensatory RP/EA will focus on restoration to compensate for any interim losses of natural resources and services. The NRDA for the T/V MARGARA Incident will be complete when the Trustees' make the Final Compensatory RP/EA publicly available.

The Trustees overall goal for restoration for this Incident is the restoration of corals that can provide

[18] Based on recalculating the CCYL requiring compensation assuming "No Recovery" in the South and North Unconsolidated Rubble Areas.

equivalency to those that were lost as a result of the impact, and to ensure those coral services will exist into the future. The Trustees have approached restoration planning with the view that the injured natural resources are part of an integrated coral reef ecosystem and that restoring corals will allow other injured natural resources to recover as well. The Trustees also recognize that restoration actions should be consistent with local and national coral reef conservation and community objectives. Alternatives were considered more favorably if they were complementary across multiple community development plans/goals, local and national planning strategies, resource agencies priority setting documents, and species recovery plans.

In developing this Final Compensatory RP/EA, the Trustees considered a range of alternatives to determine the most appropriate to meet the Trustees objectives and to offset interim losses of natural resources and services.

4.2 RESTORATION SELECTION CRITERIA

Consistent with the NRDA regulations (15 C.F.R. § 990.54), the following criteria were used to evaluate restoration project alternatives and identify the restoration actions proposed for implementation:

The extent to which each alternative is expected to meet the Trustees' restoration goals and objectives: The goal of Compensatory Restoration for the T/V MARGARA Incident is to the maximum extent practical replace coral services and species that were lost as a result of the impact, and to ensure those coral services will exist into the future.

The likelihood of success of each restoration alternative: The Trustees consider technical factors that represent risks to successful project implementation, project function, long-term viability, and sustainability of a restoration action. Alternatives with uncertain outcomes or lack of a proven track record in Puerto Rico are considered less viable. The Trustees also consider whether long-term maintenance of project features is likely to be necessary and feasible; projects that are self-sustaining and only require short-term maintenance are considered more favorably. Projects with proven local success are also considered more favorably.

The extent to which each alternative will avoid collateral injury to other natural resources as a result of implementing the alternative: Restoration actions should not result in significant additional losses of natural resources and should minimize the potential to adversely affect surrounding resources (including endangered species) during implementation. Restoration actions with less potential to adversely impact surrounding resources are generally viewed more favorably. Compatibility of a restoration action with the other uses is also considered.

The extent to which each alternative benefits more than one natural resource or service: This criterion addresses the interrelationships among injured natural resources, and between natural resources and the services they provide. Projects that provide benefits to more than one resource and/or yield more beneficial services overall, are viewed more favorable.

The effect of each alternative on public health and safety: Restoration actions that would negatively affect public health or safety are not appropriate.

The cost to carry out the alternative: If after evaluation of the above criteria, more than one restoration alternative is considered equally beneficial, then the benefits of an action relative to its cost become a factor in evaluating restoration alternatives.

The NRDA regulations give the Trustees discretion to prioritize these criteria and to use additional criteria, as appropriate. In developing this Final Compensatory RP/EA, the first criterion listed above has been a primary consideration, because it is critical to ensuring that restoration will compensate the public for the resource injuries and losses attributed to this Incident. The evaluation of restoration alternatives using these criteria involves a balancing of interests in order to determine the best way to meet the restoration objective.

Thus, for this plan the Trustees have prioritized the criterion and established *The extent to which each alternative is expected to meet the Trustees' restoration goals and objectives* and are using it as a first tier screening criteria for restoration alternatives. The nexus of the benefits of the restoration alternative relative to the injuries is used as a first tier screen of restoration alternatives (Section 4.4).

Additionally, due to the complexity of restoring coral reefs, the limited availability of resources/expertise in some regions, complexities with assessing benefits to certain project types, and the regional restoration success the Trustees are also considering three additional restoration selection criteria in order to ensure that the selected project(s) have both quantifiable benefits and are reasonably expected to be available and successful in Puerto Rico.

Timeliness to achieve results: Ability to implement the project and achieve results within a reasonable time frame.

Availability of projects: Some proposed restoration projects may already have adequate funding through other sources, are no longer available, or would require significant resources commitments to be viable.

Ability to quantify and scale natural resource benefits to the injured resources: To adequately scale restoration to resources lost, the Trustees need to be able to quantify and scale restoration efforts using a Resource Equivalency Analysis.

NEPA also requires the Trustees to evaluate the "No Action" alternative, which for compensatory restoration equates to "No Compensation." Under this alternative, the Trustees would take no further action to compensate for interim losses associated with the evaluated natural resources and the public would not be made whole for interim losses.

4.3 IDENTIFICATION OF APPROPRIATE RESTORATION ALTERNATIVES

From shortly after the time of the Incident the Trustees have been gathering information on potential compensatory restoration alternatives from regional resource managers and regulators; coral restoration literature and other restoration practitioners; regional non-governmental organizations; informed members of the public; and the RP. Potential project ideas were varied but could generally be grouped into the following restoration alternatives:

- Enhancement of Corals and Coral Reef Ecosystems
    - *This alternative includes projects or activities that would directly enhance corals or other elements of the reef ecosystem. Potential projects could include or incorporate coral propagation and propagation of other keystone species such as herbivores like sea urchins and parrotfish. Potential projects could be considered both as independent actions and integrated activities to maximize success.*

- Restoration of Existing and Future Impacts to Coral Reefs

- *This alternative would include projects or activities that would restore* other *coral reefs that have been physically impacted (e.g., small boat groundings) but where restoration would otherwise not occur. Potential projects could include the restoration at historic or future physical impact sites where resources are otherwise not available to improve recovery and/or conduct emergency restoration.*

- Prevention of Future Physical Impacts to Coral Reefs
  - *This alternative encompasses projects or activities that might prevent future physical harm to coral reefs, such as from vessel groundings, anchoring on reefs, and marine debris. Potential projects could include improved aids to navigation, improved nautical charts, improvements to pilotage systems for commercial vessels, and removal of marine debris that is harmful to or threatens to harm coral resources.*

- Elimination and Reduction of External Reef Stressors
  - *This alternative would include projects or activities that would decrease other external reef threats and stressors, such as from pollution, climate change, and overfishing. Potential projects could include implementation of Best Management Practices to reduce land-based sources of pollution, improving Marine Protected Area effectiveness, and implementation of projects to promote reef resilience.*

- Restoration of Associated Habitats
  - *This alternative would include projects or activities that would restore habitats commonly associated with coral reefs (but not the reefs themselves) and/or habitats that support that same fish species as coral reefs. Potential projects could include mangrove restoration, seagrass restoration, and coastal wetlands restoration.*

- Construction of Artificial Reefs
  - *This alternative would include projects or activities that place clean, terrestrial-based material and/or structures in non-coral areas to promote rugosity, fish habitat, and in some cases coral recruitment. Potential projects could include placement of ReefBalls™, EcoReefs™, limestone boulders, and/or other structures in sand bottom areas.*

- No Action

4.4 FIRST TIER SCREENING OF POTENTIAL COMPENSATORY RESTORATION ALTERNATIVES

In developing this Final Compensatory RP/EA, the Trustees screened this initial list of alternatives against the "nexus" to the injury represented in the Compensatory Restoration goal as a criterion to both narrow the restoration alternatives to those that were most appropriate for consideration as well as to identify viable projects within those alternatives. This screening included comparison of the potential restoration actions available in the vicinity of the injury caused by the T/V MARGARA Incident for which the public is to be compensated. The ability of an alternative or project to successfully restore the same or equivalent biological resources is a primary criterion. In Table 7, the Trustees rated each potential restoration alternative based on its relationship to that primary criterion, according to the following four ratings:

1) **First Order Nexus** – Project type directly provides the same coral species groups as were lost due to the injury.
2) **Second Order Nexus** – Project type indirectly provides the same resource services and/or directly provides similar resource services as were lost due to the injury.
3) **Third Order Nexus** – Project type only provides resource services that are comparable and/or similar to those lost due to the injury.
4) **No Nexus** – Project type does not provide any of the same resource services as were lost due to the injury, and does not provide any that are comparable or similar.

Because sufficient project opportunities exist under alternatives with a First and Second Order Nexus in the vicinity of the biological losses caused by the T/V MARGARA Incident, the Trustees eliminated alternatives with a Third-Order Nexus or No Nexus from further consideration in the development of a restoration plan, except for the No Action Alternative.

It should be noted at the time of Trustee's initial screen of potential compensatory restoration alternatives, the techniques used as part of "Enhancement of Corals and Coral Reef Ecosystems" were not well established and its viability as an alternative was unclear. Significant progress in the field occurred in the years immediately following, and subsequent evaluation found it to be a viable potential restoration alternative.

Table 7: Primary Criterion (First Tier) Screening of Potential Compensatory Restoration Alternatives.

Potential Compensatory Restoration Alternative	Order of Nexus	Rationale for Ranking
Enhancement of Corals and Coral Reef Ecosystems 1) Asexual Coral Propagation 2) Sexual Coral Propagation 3) Sea Urchin Propagation 4) Parrotfish Propagation	1st	Many project types in this alternative (i.e., coral propagation) could directly replace many of the same coral species and services that the Trustees are seeking to restore.
Restoration of Existing and Future Impacts to Coral Reefs 1) Restoration to physical impacts	1st	Many project types in this alternative (restoration to physical impacts) could directly provide many of the same resources and services that the Trustees are seeking to restore.
Prevention of Future Physical Impacts to Coral Reefs 1) Improving Aids to Navigation 2) Improved Pilotage	2nd	Many project types in this alternative (grounding prevention actions) have the ability to indirectly protect some of the same biological resources that were lost.
Elimination and Reduction of External Reef Stressors 1) Prevent erosion and sedimentation 2) Reduce nutrient loads	2nd	Projects within this alternative have the potential to indirectly restore biological resources through the reduction of land-based and other sources of pollution.
Restoration of Associated Habitats 1) Seagrass Restoration 2) Mangrove Restoration	3rd	Restoration of associated habitats, while beneficial, has a less direct linkage to restoration of the biological resources (coral reefs) lost as part of this incident than some of the other alternatives.
Construction of Artificial Reefs 1) Limestone Boulders 2) Ecoreefs™ 3) Reefballs™	3rd	While artificial reefs can mimic some of the structural characteristics of reefs, they do not provide a means to restore the biological resources for which the Trustees are seeking to restore.

4.5 SECOND TIER SCREENING – EVALUATION OF COMPENSATORY RESTORATION ALTERNATIVES

Having identified the types of restoration actions most likely to meet the Trustees' Compensatory Restoration goals and strength of the alternative's "nexus" for the biological losses (i.e., the corals lost) at the T/V MARGARA Incident site, the Trustees began reviewing specific project opportunities within the alternatives selected in section 4.4 for further consideration. Specifically, only projects that had a 1st or 2nd order of Nexus in Table 7 were analyzed further in this section. The Trustees then narrowed the available projects based on the remaining Restoration Selection Criteria previously mentioned in section 4.2 (Criteria a-d listed below) and the additional criteria deemed important by the Trustees (Criteria e-h):

a) Likelihood of the project's success in achieving the Compensatory Restoration goal
b) The extent to which each alternative will avoid collateral injury to natural resources as a result of implementing the alternative
c) The extent to which each alternative benefits more than one natural resource or service
d) The effect of each alternative on public health and safety
e) The cost to carry out the alternative
f) Ability to implement the project and achieve results within a reasonable time frame
g) Availability of projects
h) Ability to quantify and scale natural resource benefits to the injured resources

The Compensatory Restoration alternatives that were analyzed by the Trustees are described further below, together with a summary of the Trustees' evaluation of each alternative's ability to meet the Compensatory Restoration objectives for the injured reef resources at the T/V MARGARA Incident site.

- **Enhancement of Corals and Coral Reef Ecosystems**

  - **Project Title: Asexual Coral Propagation and Restoration**
    Project Summary: The restoration of previously degraded reef sites (as a result of bleaching, disease, or other mortality events) through the outplanting of a diverse mix of corals propagated in coral nurseries. There is a long history of this type of work in Puerto Rico; however, at many sites the success of coral propagation has been directly related to whether the propagated and outplanted corals become overgrown by excessive growth of macroalgae, including fleshy algae and *Ramicrusta* spp. There has been a significant increase in the invasive red encrusting calcareous algae, genus *Ramicrusta*, which is spreading throughout coral reefs in Puerto Rico (Williams and Garcia Sais, 2020). *Ramicrusta* has become the dominant substrate on many coral reefs, reaching as high as 60% cover in some places. *Ramicrusta* grows quickly and overgrows and smothers coral and other sessile organisms. *Ramicrusta* is considered a "detractor", as it is chemically defended against herbivorous fishes. Sea urchins, however, consume and significantly decrease *Ramicrusta* cover and are currently the only known organisms that eat and significantly reduce *Ramicrusta* abundance. Although site selection can help avoid algal overgrowth, there is a growing consensus that coral propagation work is most successful when coupled with activities that prevent excessive algal growth on restored reefs, such as early site maintenance while corals are maturing and incorporating herbivores to increase the survival of corals while growing in the nursery and when outplanted to the reef. As such the Trustees are including those activities within this alternative.
    Selection Criteria Analysis: This project is a viable alternative for directly restoring the biological and physical impacts that resulted from the incident. Previous experience with this type of work suggests that meaningful results can be achieved in a reasonably short period of time relative to coral reef natural recovery. The Trustees have identified a reasonable mix of coral species that represent different morphologies that can be grown in land based and in-situ nurseries and outplanted onto reefs. Additionally, using asexual fragmentation (including the microfragmentation of slow growing scleractinian coral species that are foundation species critical to reef accretion) has been shown to significantly reduce the growout time relative to other techniques. While not every species impacted is viable for restoration, the mix of available species will provide similar services to those

that were lost, and scaling to adjust for equivalency is viable. Early site maintenance and herbivore additions will increase survival and maximize success. Given the widespread use of this technique in Puerto Rico and the broader Caribbean, more efficiencies are being found and costs are stabilizing at reasonable levels. Based on the analysis above the Trustees find that this alternative has a high likelihood of success, can achieve results over a relatively short period of time, and is directly scalable.

- **Project Title: Sexual Coral Propagation**
  Project Summary: This work is similar in its goal to the approach described above, and these corals would be used to restore previously degraded reef sites with a diverse mix of corals. In this application, the corals used for restoration would be sourced from sexually produced coral gametes to produce larvae to seed coral reefs rather than propagated asexually in coral nurseries. Sexual propagation would involve the collection of multiple corals of the same species, coral spawning, and subsequent crossing of gametes from different corals to produce coral larvae. That larvae would then be transferred into tanks or similar vessels, and settled onto artificial seeding units. Seeding units would be kept in a controlled environment during the coral's early life history phase (30-60 days) before being planted on the reef for subsequent grow-out. This work has the benefit of being able to replace a broader set of species and provide a more diverse genetic lineage. However, the success rate for sexual propagation is much lower than for asexual propagation, due to natural early life history processes, and the time period to reach maturity from a recruit versus an asexually propagated coral is significantly longer (10-20 years for sexually propagated corals, depending on the species, versus 3-5 years for asexually propagated corals).
  Selection Criteria Analysis: The major benefit of this technique is that more of the species directly impacted by the Incident can be restored and that the corals placed on the reef will represent unique individuals rather than genetic clones from asexual reproduction. Unfortunately, much of this work is still in the methods development phase and, while a promising technique for long term reef restoration, the extended duration of benefits return combined with low early life history survival make it a more challenging technique to consider for the Trustees needs with this Incident. Experimental work is underway to reduce early life history mortality and potentially speed growth, and if those challenges are overcome this method has the potential to be an even more viable restoration tool. This technique also relies on corals' natural reproductive cycle, which means that for many, but not all, species the parent coral(s) only produce gametes once per year, potentially further extending the project duration. Costs for this technique are generally the same or higher then asexual propagation. Based on the analysis above, the Trustees find that this alternative has a moderate likelihood of success and is directly scalable, but the project will take an extended period of time to achieve results.

- **Project Title: Sea Urchin Restocking**
  Project Summary: Lack of suitable recruitment habitat and algal overgrowth remains a significant issue on Caribbean coral reefs, and natural herbivory is not keeping algal overgrowth under control at many sites. As mentioned previously, there is a significant increase in the invasive encrusting red calcareous algae, *Ramicrusta* spp. on the majority of reefs in Puerto Rico (Williams and Garcia-Sais 2020). *Ramicrusta* grows quickly and overgrows and kills corals and other benthic organisms. At the moment the only known organisms that eat and significantly reduce *Ramicrusta* abundance are sea urchins. Sea urchins are a key source of this natural herbivory, but are no longer present in sufficient numbers at many sites. Growing sea urchins in aquaria, or sourcing from other reefs, and transplanting them onto coral reefs to increase herbivory is now more frequently

considered as a management and restoration action, and is now being used at scale in Hawaii. While increased herbivore populations can reduce algal overgrowth and increase the availability of recruitment habitat, that by itself does not return coral services. Robust natural coral recruitment and subsequent survival, is a necessary precursor to using this technique to increase coral populations.

Selection Criteria Analysis: Sea urchins are an important keystone herbivore on coral reef ecosystems in the Caribbean and development of techniques to restore/restock them are improving. However, in the Caribbean many reef sites are no longer seeing the robust natural recruitment that would be necessary to allow this technique to address the restoration goals of restoring corals themselves without augmentation with coral propagation. It is theoretically possible to model increased recruit survival based on the action to stock sea urchins and indirectly scale the benefit; however, because of the lack of natural recruitment, its likelihood of success as a standalone effort is only moderately likely, and the time period to achieve a benefit would be very long.

- **Project Title: Parrotfish Restocking**

  Project Summary: Lack of suitable recruitment habitat and algal overgrowth remains a significant issue on Caribbean coral reefs, and natural herbivory is not keeping up at many sites. Parrotfish are a key source of this natural herbivory, but are no longer present in sufficient numbers at many sites. Propagation of parrotfish to increase herbivory on coral reefs could increase the availability of recruitment substrate for corals. While increased herbivore populations can reduce algal overgrowth and increase the availability of recruitment habitat that by itself does not return coral services. Robust natural coral recruitment, and subsequent survival, is a necessary precursor to using this technique by itself to increase coral populations.

  Selection Criteria Analysis: Parrotfish are important keystone herbivores on coral reef ecosystems. Unfortunately, this work is still early in the experimental phase and has not yet proven to be viable at the scale. Like the sea urchin work described above, this work would not be solely sufficient to address the restoration goals of restoring corals themselves without augmentation with coral propagation. This project type is also difficult to scale directly as a stand-alone project because the work is still experimental, and the necessary data to consider survival and density to see improvements to coral health or survival is not available. However, it is theoretically possible to model increased recruit survival based on the action to stock parrotfish and indirectly scale the benefit. Based on the analysis above, while Trustees believe this project could be scalable in an indirect way because of the lack of natural recruitment and its experimental nature, its likelihood of success is low and the time period to achieve a benefit would be very long.

- **Restoration of Existing and Future Impacts to Coral Reefs**

  - **Project Title: Restoration to Physical Impacts**

    Project Summary: As noted earlier in this document, in the aftermath of physical impacts to coral reefs (orphan vessel groundings, anchor damage, and storm damage), the response and restoration to reattach corals and stabilize reefs damaged during orphan groundings and/or storm events is important and has the potential to reduce long term damage.

    Selection Criteria Analysis: While this project is a viable alternative for preventing otherwise avoidable losses to coral reefs, the need for such a project has diminished substantially. Historically, NOAA and PRDNER found themselves with more physical impacts to coral reefs in Puerto Rico then they had resources to address and as such had considered this viable alternative to compensate for impacts to coral reefs from other incidents. However, over the course of the last ~5 years, the rate of vessel groundings and anchor damage incidents with coral impacts requiring restoration decreased, while at the same time the resources available to address these incidents increased. Additionally, after the 2017 Hurricanes Irma and Maria impacts to Puerto Rico, NOAA and PRDNER were successful in securing FEMA funds for emergency response, restoration, and assessment. While it is possible that needs will arise again in the future, at the current time the reduced rate of severe impacts and the increased availability of funds create significant uncertainty in when and if resources would be needed in the future.

- **Prevention of Future Physical Impacts to Coral Reefs**

  - **Project Title: Improving Aids to Navigation**
    Project Summary: Projects that can reduce the impact and/or prevent in whole or in part future incidents have been considered in the past as compensatory restoration and are appropriate to consider in this case as an error in navigation is believed to have been in part the cause of this Incident. Restoration alternatives that would improve navigation through improved or repositioned aids to navigation can theoretically reduce or prevent future groundings.
    Selection Criteria Analysis: While these alternatives have the potential to indirectly protect coral resources from future damage, it is important to understand the baseline navigation condition, the historic trends of vessel impacts, and the opportunities for improvement. An analysis conducted by the Trustees in 2008 found that Port of Guayanilla had a vessel impact of significance every 3.4-5 years. Another incident occurred in late 2009, 3 ½ years after the T/V MARGARA Incident and at the time the Trustees were actively considering potential improvements as Compensatory Restoration. In 2009, the United States Coast Guard (USCG) conducted a "waterways assessment" in the area to identify navigational aid deficiencies and identified a series of opportunities to improve aids to navigation. Unbeknownst to the Trustees until after the fact, the USCG then implemented the recommended changes with public funds. These projects are no longer available as compensation for this Incident and have likely contributed, along with improved pilotage (discussed below), to a substantial reduction in vessel impacts in the area over the last 10 years.

  - **Project Title: Improved Pilotage**
    Project Summary: In addition to aids to navigation (discussed above), pilotage is an important part of some harbors' navigation infrastructure. Projects or alternatives that would improve inadequate pilotage (funding major operational gaps that limit service) could improve a harbor's navigation infrastructure and potentially prevent some future incidents.
    Selection Criteria Analysis: While these alternatives have the potential to indirectly protect coral resources from future damage, it is important to understand the baseline navigation condition, the historic trends of vessel impacts, and the opportunities for improvement. At the time of the T/V MARGARA Incident, the lack of a dedicated all weather pilot boat required a pilot station (point of pilot embarkment) that was inside the reef line and, in addition to some of the aids to navigation limitations (discussed above), was contributing to the background rate of vessel groundings. The acquisition of a new all-weather pilot boat was identified as a need shortly after the incident and representatives of

the Norwegian Hull Club (the hull insurer for the T/V MARGARA) took steps to acquire one for consideration as compensatory restoration during the restoration planning process for this case. The Norwegian Hull Club did ultimately acquire a pilot boat (and provided additional financial support to fill an operational funding gap) to support the ports of Guayanilla, Tallaboa, and Ponce. This Hull Club was also the insurer for LNG MATTHEW that grounded in Guayanilla in 2009 and they ultimately chose to offer the acquisition and funding support as partial compensation for that incident. When that pilot boat (and a second backup vessel purchased with local funds) were put in full service, it allowed the pilot station to be moved outside the reef line and has led to significant decrease in vessel impacts in the area over the last 10 years. This project is no longer available as compensation for this Incident.

- **Elimination and Reduction of External Reef Stressors**

    - **Project Title: Prevent Erosion and Sedimentation**
      Project Summary: Land-based sources of sediment runoff are known issues for coral reefs in the Caribbean. Projects or alternatives that reduce erosion on land are known to improve nearshore water quality, which is likely beneficial to nearshore coral reefs. Such improvements in water quality will, in theory, reduce the presence of sediment on the reef allowing better coral recruitment to take place in addition to decreasing stress on existing corals.
      Selection Criteria Analysis: There is a broad range of projects that would be available under this category; however, no quantitative data are available to directly tie specific reductions (units of reduced sediment into nearshore waters) to specific improvements in individual coral survival, recruitment, or mortality prevention. Therefore, it is not currently possible to scale this type of alternative using Resource Equivalency Analysis. In addition to the difficulty of scaling for this alternative, it has a similar challenge as other alternatives discussed above (e.g., Sea Urchin Restocking and Parrotfish Restocking) where the primary benefit would come from new coral recruits rather than changes in reef sediment. As discussed earlier, in the Caribbean many reef sites are no longer seeing the robust coral recruitment that would be necessary to allow this technique to address the restoration goals of restoring corals themselves without augmentation with coral propagation. Based on the analysis above, the Trustees find that this alternative has a moderate likelihood of success in achieving the goals in a moderate amount of time; however, the alternative is not currently scalable.

    - **Project Title: Reduce Nutrient Loading**
      Project Summary: Land-based sources of nutrients (both point and nonpoint source) are known issues for coral reefs in the Caribbean. Projects or alternatives that reduce nutrient inputs from land-based sources are known to improve nearshore water quality which is likely beneficial to nearshore coral reefs. Such improvements in water quality will in theory will reduce the presence of algae on the reef allowing better coral recruitment to take place in addition to decreasing overgrowth stress on existing corals.
      Selection Criteria Analysis: There is a broad range of projects that would be available under this category; however, no quantitative data are available to directly tie specific reductions (units of reduced nutrients into nearshore waters) to specific improvements in individual coral survival, recruitment, or mortality prevention. Therefore, it is not currently possible to scale this type of alternative using Resource Equivalency Analysis. In addition to being difficult to scale, this alternative has a similar challenge as other alternatives discussed above (e.g., Sea Urchin Restocking, Parrotfish Restocking, and Prevent Erosion and Sedimentation) where the primary benefit would come from new coral recruits. As

discussed earlier, in the Caribbean many reef sites are no longer seeing the robust recruitment that would be necessary to allow this technique to address the restoration goals of restoring corals themselves without augmentation with coral propagation. Based on the analysis above, the Trustees find that this alternative has a moderate likelihood of success in achieving the goals in a moderate amount of time; however, the alternative is not currently scalable.

During the preparation of this Compensatory Restoration Plan, Stony Coral Tissue Loss Disease (SCTLD) has become an emerging issue in the region. While experimental treatments are being developed to attempt to heal infected colonies or prevent infection, at this time, there is not enough information available to effectively predict the benefit of or to scale this type of restoration work. While this may become a potential viable technique in the future, at this time disease transmission would be difficult to predict and to scale because there are still a significant number of unknown factors that vary widely between regions (e.g., species susceptibility, survival rates of treated corals, how many treatments are necessary, and short- and long-term reinfection rates). The Trustees will continue to monitor the progress of this disease and may need to employ adaptive management techniques to ensure maximum potential for project success. This may include, but is not limited to, treating outplanted corals to increase survival, using different coral species that are less susceptible to SCTLD, focusing propagation efforts on resilient genotypes, or other techniques which may become available in the future.

In order to formalize the alternatives analysis above, the Trustees established the following alternatives analysis rubric. The summary of this is captured in Table 8.

- **Project Availability** is first used to determine if an alternative advances further in evaluation. Alternatives that have regionally available viable projects are noted as such and advance in consideration; alternatives that do not are eliminated from further consideration.
- **Likelihood of Success** draws upon the sections above and qualitatively considers if a project is likely to have a low, moderate, or high likelihood of success.
- **Timeliness to achieve results** draws upon the sections above and qualitatively considers if the relative time frame it would take to achieve results. The alternatives that could achieve results over the shortest period of time are categorized as such and the actions that would take the longest period of time are categorized as such. Alternatives that fall in between those two groupings were categorized as having a moderate timeliness.
- **Scalability of the project benefit/result to injury** using a REA is necessary. Alternatives are then categorized by their ability to be "Directly" scaled (the action results in measure(s) that can be directly scaled), "Indirectly" scaled (the direct result of the action(s) cannot be scaled using the REA, but a secondary effect can be), or "No" (techniques for scaling are not available with current resources).
- In addition to the above, the Trustees did not see any evidence that the projects described above would result in any collateral injury, nor are any believed to pose any threats to public safety. Given that all would have equal scoring, those criteria are not shown in Table 8.
- All of the alternatives are considered to provide benefits to multiple resources. Given that all would have equal scoring, that criterion is not shown in Table 8.

The Trustees used the evaluation criteria presented in Section 4.2, the nexus analysis in Table 7, the alternative review and analysis in Section 4.5, and selection criteria summary in Table 8 to select the Preferred Alternative. One alternative was found to best address all of the selection criteria and emerged as the best candidate for addressing the losses caused by this Incident. *Enhancement of Corals and Coral Reef Ecosystems using Asexual Coral Propagation and Restoration* combined with the incorporation of herbivores to increase the survival of corals, can effectively restore previously degraded reef sites and provide compensatory for interim lost services resulting from the T/V MARGARA Incident.

In regards to *the cost to carry out the alternative*, none of the alternatives with available projects were prohibitively more expensive than the others. The Preferred Alternative is likely the most cost-effective given its widespread use as a conservation management tool in the region.

Section 5.0 describes the Preferred Alternative selected by the Trustees and provides additional information regarding the Trustees' evaluation of this alternative. Consistent with the role of this document as an Environmental Assessment under NEPA, Section 6.0 presents the information related to and the Trustees' evaluation of potential effects of the Preferred Alternative in this setting.

Table 8: Trustees' Evaluation of Additional Criteria for Potential Compensatory Restoration Projects that have Nexus to the Injury. If projects were not available or had a low likelihood of success, the other criteria were not evaluated for that project.

Restoration Alternatives and Project Title	Project Availability	Likelihood of Success	Timeliness to achieve results	Scalability
	No *Yes*	*Low* *Moderate* *High*	*Long* *Moderate* *Short*	*No* *Indirectly* *Directly*
Enhancement of Corals and Coral Reef Ecosystems				
Asexual Coral Propagation w/ Algal Growth Reduction Activities	Yes	High	Short	Directly
Sexual Coral Propagation	Yes	Moderate	Long	Directly
Sea Urchin Propagation (standalone)	Yes	Moderate	Long	Indirectly
Parrotfish Propagation	Yes	Low	Long	Indirectly
Restoration of Existing and Future Impacts to Coral Reefs				
Restoration to Physical Impacts	No	N/A	N/A	N/A
Prevention of Future Physical Impacts to Coral Reefs				
Improved Pilotage	No	N/A	N/A	N/A
Improving Aids to Navigation	No	N/A	N/A	N/A
Elimination and Reduction of External Stressors				
Prevent Erosion and Sedimentation	Yes	Moderate	Moderate	No
Reduce Nutrients	Yes	Moderate	Moderate	No
No Action (natural recovery only)				
No Action	N/A	Low	N/A	N/A

5.0 COMPENSATORY RESTORATION PLAN FOR ECOLOGICAL LOSSES - SELECTED ACTION

5.1 PREFERRED ALTERNATIVE FOR COMPENSATORY RESTORATION

In Section 4, the Trustees evaluated a series of potential restoration alternatives and selected the Preferred Alternative to compensate for the interim coral losses caused by the T/V MARGARA Incident. The Preferred Alternative is *Enhancement of Corals and Coral Reef Ecosystems using Asexual Coral Propagation and Restoration*. This alternative satisfies the OPA evaluation criteria and meets the Trustees goals of restoration of corals that can provide equivalency to those that were lost as a result of the impact and to ensure those coral services will exist into the future. Additionally, this type of project has also been identified as a jurisdictional priority in Puerto Rico (The Commonwealth of Puerto Rico and NOAA Coral Reef Conservation Program, 2018) and is listed as a priority in the Recovery Plan for Acroporids in the Caribbean (NOAA, 2015a). The Preferred Alternative is described in this subsection. The Trustees' compensatory scaling analysis for the alternative is included in subsection 5.5.

5.2 ENHANCEMENT OF CORALS AND CORAL REEF ECOSYSTEMS USING ASEXUAL CORAL PROPAGATION AND RESTORATION

Coral reefs have suffered declines throughout the entire Caribbean and the globe over the last few decades (Bruckner, 2002) which has led to the classification of several species as "Threatened" under the Endangered Species Act in 2006 and 2014 (71 FR 26852, May 9, 2006; 79 FR 53851, September 10, 2014, NOAA, 2015a). In response to these declines and to physical impacts, such as ship groundings and coastal construction projects, new techniques for reef restoration and recovery have been developed and are now in use around the world (Rinkevich, 2005). In fact, restoration efforts in some areas have already succeeded at creating restored self-sustaining reefs. For example, a pilot project conducted by NOAA (with funds separate from this case) at a small portion of the T/V MARGARA Incident site (where the rubble had been previously stabilized with cement) demonstrated that coral restoration (in this case using asexual fragments of *A. cervicornis*) could efficiently restore degraded reefs (Figure 19) (Griffin et al., 2015).

Figure 19: Photos showing the creation of self-sustaining thickets using *A. cervicornis* outplants from a coral nursery in Guayanilla, Puerto Rico. The photo on the left was taken by NOAA's Restoration Center in 2006 prior to restoration actions that occurred between 2006 and 2011. The photo on the right was taken in 2015 by NOAA's Restoration Center.

In addition to the pilot project discussed above, coral propagation efforts around the world have advanced dramatically over the last 20 years (Goergen et al., 2020). Techniques have been developed to propagate both slow growing coral species through micro fragmentation and faster growing coral species through macro fragmentation. Micro fragmentation based propagation involves growing very small (<1 cm) groups of coral polyps into small (2-4 cm) fragments in land based aquaria and the subsequent use of fusion to create larger colonies from multiple fragments (Forsman et al., 2015; Page, 2013). This method takes advantage of several life history traits of corals to boost growth rates. Cutting these corals into small fragments stimulates an exponential increase in the fragments' surface area growth compared to larger fragments or colonies (Page, 2013). Corals also respond to fragmentation by increasing coral tissue growth to promote healing. Corals grown in the land-based nurseries can be acclimated to the in-water nurseries prior to outplanting to increase their overall survival. These micro fragments (grown ex-situ or in-situ) can then be transplanted onto structures or dead coral heads in a mosaic pattern with a few centimeters between each fragment (Forsman et al., 2015). Fragments then grow to fill in the empty space between each other and fuse together in just a few years. Coral fragments can grow over (i.e., re-skin) a previously dead coral head (or similar artificial structure) that would otherwise have taken 50 to 100 years to grow (Forsman et al., 2015). Using micro fragmentation, the Trustees expect to be able to restore for the ESA-listed corals *O. faveolata, O. annularis* and *O. franksi* (Star corals) along with other slower growing coral species including *Montastraea Cavernosa* (another Star coral) and Brain corals (*Colpophyllia natans*, *Pseudodiploria clivosa, Pseudodiploria strigosa*, and *Diploria labyrinthiformis*) that were impacted by the Incident. Micro fragmentation is the most efficient technique at this time for coral species that grow slowly.

For faster growing coral species including *A. cervicornis, A. palmata, A. prolifera,* and *D. cylindricus*, macro fragmentation is a viable alternative. Macro fragmentation is typically conducted using in-situ coral nurseries located in the ocean. Corals are cut into 5 - 10 cm fragments and mounted on one of several types of nursery structures to promote growth and survival (Figure 20). Typically after one to two years in a nursery, the corals are large enough (Figure 21) so they can be either transplanted back onto the reef or fragmented to create new corals to restock or expand the nursery (Edwards and Gomez, 2007; Edwards, 2010; Johnson et al., 2011; Griffin et al., 2012; Goergen et al., in press). Using this method, corals are raised in nurseries and then transplanted to restore degraded reefs or to assist in population enhancement of coral species that were once prevalent but have declined in recent decades because of disease outbreaks and/or bleaching events. While in the nursery, genetic clones are often grown together on the same structure; however, when they are outplanted to the reef, corals of different genotypes are clustered together to mimic how they would have been found at the site prior to the incident. Maximizing genetic diversity both helps increase long-term resilience as well as maximize natural sexual reproduction potential, as many of the species typically used in restoration are not self-fertilizing (Lirman et al., 2010).

One of the primary limitations to the success of past restoration efforts has been that algae, predators, and nuisance species can outcompete the propagated corals (NOAA, 2019). As such, in order to limit mortality and ensure restoration success, it is important that projects also include components to address competition in addition to just planting corals. In addition to proactive site preparation and ongoing maintenance, herbivores, such as sea urchins, can be used to increase survival of corals both while in the nursery and when outplanted. Sea urchins are algal grazers and increase the survival of corals on the reef and in aquaria by enhancing herbivory, reducing algal cover, and increasing coral survival, recruitment rates, and growth (Edmunds and Carpenter, 2001, Chiappone et al., 2003; Carpenter and Edmunds, 2006; Idjadi et al., 2010; Williams, 2017; Craggs et al., 2019).

Figure 20: Photos showing examples of different methods for growing corals in nurseries. A line nursery is on the top left, a coral tree on the top right, benthic structures on the bottom left and micro fragments in tanks on the bottom right. Photos by NOAA Restoration Center.

Figure 21: ***Acropora palmata*** **colonies ready for harvest in a nursery in Puerto Rico. Photo taken by Sea Ventures, Inc. in 2020.**

5.2.1 Approach to Restoration

While the Trustees have selected *Enhancement of Corals and Coral Reef Ecosystems using Asexual Coral Propagation and Restoration* as the Preferred Alternative, the success or failure of the restoration depends heavily on the specific approach taken to restoration implementation. For this project, the Trustees are proposing the following step-wise approach that will maximize success by minimizing mortality.

5.2.2 Restoration Project Components

Coral reef restoration works best when done as part of an integrated project that restores a mix of coral species within the same site and ideally where multiple sub-sites or plots can be located geographically proximate to each other. The integration of multiple species and multiple plots within a site promotes synergistic ecological effects found on natural reefs such as robust fish and invertebrate populations which in turn help maximize site resilience (NOAA, 2019). For this effort, the Trustees are proposing to outplant multiple species of corals in a series of restoration plots that will be located at several sites around Puerto Rico. The multiple coral species used will represent the representative species used in restoration on Puerto Rico reefs, genotypes that survived previous disease and bleaching outbreaks, and species that can be successfully produced using existing coral propagation techniques. As currently envisioned, each plot will receive approximately 3,000 coral outplants (or clusters of micro-fragments for some species). Plots will be augmented with herbivores and ongoing site maintenance to reduce mortality of coral outplants. Exact number of plots within a site and the size of plots will vary depending on site conditions such as existing coral densities and benthic habitat conditions. The number of plots restored in total will be determined by looking at the restoration credit associated with each plot relative to the outstanding compensation required (Section 5.4.4). The anticipated plot structure is presented in Table 9. Species compositions may vary between sites depending on depth or other environmental factors and the Trustees may need to substitute some species for others as an adaptive management measure.

Table 9: Restoration Project Components.

Restoration Scenario		**Species Mix**	***Plot Mix Components***
Target Outplants p/plot	3,000	*Acropora palmata*	35%
Necessary Project Components	Site Preparation Coral Outplanting Algae Control Site Maintenance	*Acropora cervicornis*	20%
		Star corals	15%
		Brain corals	15%
		Dendrogyra cylindrus	15%

5.2.3 Identification of Target Reef Restoration Sites

Section 5.4.4 identifies that ~29 restoration plots similar to those described in 5.2.2 will be necessary as part of the Compensatory Restoration. Generally, the Trustees anticipate each restoration site will contain 5-10 restoration plots and therefore 4-6 restoration sites will need to be identified. At the outset of the restoration efforts, a series of reef systems in coastal Puerto Rico will be evaluated as potential sites for execution of this compensatory restoration project. These sites will be geographically separated from each other to minimize the impact of external factors and reduce the risk that an unexpected event could impact more than one site.

The following general guidelines taken from the Coral Restoration Consortium's "Guide to Coral Reef Restoration" (Goergen et al., in press) will be applied when selecting reefs for restoration:

Presence of species - Sites with current or recent past presence of the species to be outplanted.

Depth - Within the depth range of the species and similar to the depth of the nursery.

Substrate type - Consolidated hard substrate will provide a stable surface for attachment. Rubble can be harmful to outplants if mobilized. Avoid areas where the benthic materials are rounded, as this may indicate regular reanimation. Where boring fauna are common, substrates should be tested for strength.

Water quality - Good water clarity, flow, and low inputs of land-based runoff. Avoid areas with large temperature fluctuations.

Connectivity - Consider how the site is connected to others around it, as the goal of restoration is generally to create breeding populations and the resulting larvae will need somewhere to settle.

Accessibility - Choose sites within easy reach of nursery to reduce costs and increase efficiency. Sites further away may warrant an additional nursery to be installed closer to the area of interest.

Human impact - Avoid areas that are likely to be impacted by damaging human activities such as coastal construction, diving, fishing, trap deployment, and anchoring.

If the site has not previously had restoration activities, nearby small-scale pilot projects may be conducted to confirm site viability.

5.2.4 Mapping of Reef Sites and Selection of Sub-sites for Restoration

Once restoration sites are identified, they will be mapped and assessed in detail to identify a series of 5-10 plots where the Compensatory Restoration will be focused within the site. While there will be multiple plots within a site, it is expected that they will be restored over the course of the project using a rolling approach to restoration implementation. For example, a site with 6 sub-site plots might have two plots restored during the first three years of the project and two more plots restored subsequently, continuing until all sub-plots are restored. This approach generally has a higher degree of success, allows for adaptive management of future efforts based on past successes and failures, and allows some sites to be completed while other efforts are still on-going.

Once a potential sub-site plot has been selected for restoration, it will be necessary to test and prepare a site prior to outplanting (Section 5.2.6). Once prepared, a sub-section of the plot will be initially restored to confirm site suitability and survival before the subsequent portions of the plot are restored.

5.2.5 Development of Coral Nurseries

Once target reef sites are selected, in-situ (in water) and ex-situ (aquaria-based) coral nurseries will be established (or existing sites expanded) to provide the source corals for restoration. These nurseries will house genetically diverse coral broodstock that includes genotypes that have survived previous bleaching events and multiple disease outbreaks. Broodstock will be sourced from existing programs, damaged/loose corals of opportunity on nearby reefs, and in some cases sourced from donor colonies. Broodstock will then be fragmented asexually using either micro or macro fragmentation techniques, depending on the species, and grown out for restoration. It is anticipated that in-situ nurseries will need to be established near or directly adjacent to each restoration site to restore the plots within that reef site. Those in-situ nurseries will be augmented with one or more ex-situ nurseries that will provide corals for multiple restoration sites. Ex-situ nurseries are generally constructed along a bay, canal, marina or other protected portion of the coast, but can also utilize inshore warehouse space if an adequate water supply is available. Ex-situ nurseries typically consist of a series of shallow tanks, filtration systems, and lab space. Ex-situ nurseries should be designed to be resilient to storms. Nurseries will be deconstructed at the end of the project or otherwise transferred to another entity.

5.2.6 Site Preparation

Prior to outplanting corals to a reef sub-site, the substrate will be prepped by removing marine debris and invasive and nuisance species, such as thick mats of fleshy algae, turf algae, *Palythoa* spp. and *Ramicrusta* spp., or any other peyssonnelid algae, from the reef. *Palythoa* is an organism that creates “mats” on available substrate and is a fierce competitor for space on the reef, readily overgrowing corals and preventing settlement of coral recruits (Ladd et al., 2019). By removing these species, the growing corals will not have to expend as much energy fighting for reef space. Debris, predators or disease may need to be physically removed by divers from a site prior to outplanting, and herbivores may be added to a site prior to coral outplanting to help remove algae. Recent studies have shown that the introduction of sea urchins will significantly reduce algal cover within the first month (Williams, 2021). Any combination of these actions may be needed to prepare a site so that corals will survive once outplanted, and the specific actions needed will vary between sites.

5.2.7 Coral Outplanting

After a reef site plot has been prepared as described in the previous section, clusters of corals will be outplanted to the site. The number of corals per cluster will vary by species. Each species of stony coral being restored as part of the Compensatory Restoration Plan has different rates of growth, husbandry requirements, and production rates during the nursery process; therefore, restoration of a plot will be accomplished over a period of time rather than all at once. While the process for restoring each species will generally follow the same path, the time and labor during each step of the process can vary considerably from one species to another. As each of the species chosen for restoration play a different role in the ecological function and heritage of the reef system, it is important that they are all included in the strategy.

All coral restoration projects experience some degree of mortality and loss. While mortality can be minimized with focused site preparation, incorporation of grazers, and diligent maintenance, it cannot be eliminated. As such, when working to achieve a specific restoration goal (in this case, compensating for a specific amount of Discounted CCYL) the most cost-effective strategy is to plant the number of corals needed to achieve the Discounted Coral Colony Years Gained (CCYG) goal plus the number of corals that are expected to be lost due to mortality. Taking this approach, the number of surviving corals should be sufficient to achieve the restoration goals without the need for costly replants. As such, the output from the Trustees REA already factors expected mortality during the time period the restoration plot is establishing itself.

After a plot's outplanting is complete, it takes a period of time for the plot to establish and for the outplanted corals to have stabilized in their new environment. Typically, most restoration related mortality happens within this period of time as the corals become acclimated and reach sexual maturity (NOAA, 2019). While this period of time can extend out as long as a decade in some environments and for some species, the Trustees are assuming only a 5 year period of time for site establishment.

While some level of coral mortality is expected, predicting mortality incidence and rates at different sites can be challenging. Previous experience with restoration in Puerto Rico and elsewhere has shown that mortality is site dependent, which is why site selection is important and why initially only a small portion of a plot is restored. It is also known that diligent maintenance and the presence of grazers can reduce mortality (NOAA, 2019). Recent large-scale restoration planning efforts in Florida (Mission: Iconic Reefs) have assumed 65% mortality for coral outplants (NOAA, 2019). Because the Preferred Alternative includes a full suite of activities to minimize mortality (e.g., site preparation, grazers, and ongoing restoration plot maintenance; see Section 5.2.8) and because of the history of successful NOAA and PRDNER coral restoration efforts at many sites in Puerto Rico, the Trustees make the assumption that mortality will be 10% per year for the first five years until the site is fully established consistent with section 5.3.1 (NOAA et al., 2018; NOAA et al., 2019; NOAA et al., 2020). Projects that do not incorporate measures to minimize mortality should consider higher mortality estimates.

5.2.8 Addition of Grazers and Site Maintenance

In Puerto Rico and elsewhere, the previous success of coral restoration has been directly influenced by whether the propagated corals are overgrown by excessive algal growth, suffer predation, are physically damaged, or succumb to a disease outbreak. As such, large scale coral restoration is best coupled with activities that prevent excessive algal growth on restored reefs and address other site problems before they result in mortality. These activities can include ongoing site maintenance while plots are establishing themselves and incorporating herbivores such as sea urchins.

In addition to site selection, one of the most effective ways to ensure coral restoration success is to ensure the presence of herbivores, in particular the sea urchin *Diadema antillarum*, that help naturally control algae. These once dominant species declined in the 1980s and have been very slow to naturally recover to Caribbean reefs since many sites have not recovered to pre-die off densities (Lessios et al., 1984). While the first choice is to select restoration sites with high urchin densities, that is often not possible. In that case, augmentation or transplantation of sea urchins to the restoration site is prudent and effective. Fortunately, urchins can be grown in aquaria, and in some cases sourced from other reefs, and transplanted to restoration sites to increase herbivory.

A component of this alternative will be to rear multiple sea urchin species including *Diadema antillarum*, *Echinometra* sp., and *Tripneustes ventricosus* along with the herbivorous Caribbean king crab (*Maguimithrax spinosissimus*) and transplant them to the reef to naturally remove algae and increase survival and growth rates of the coral outplants. It is important to note here that the Trustees did not select propagation of sea urchins as a stand-alone project for compensatory restoration because, by itself, the work would not address the restoration goals of replacing corals. This is the same reasoning that coral propagation without addressing site preparation, algal grazing, nuisance species removal, and site maintenance would not likely achieve restoration goals. Coral propagation, on the other hand, can be done in conjunction with sea urchin/herbivore propagation to increase survival rates for the coral outplants that are put out on the reef. This also decreases the overall maintenance required at a site, since surveyors will not have to go out as frequently to remove algae around outplanted corals. Without taking a holistic approach to site restoration, coral mortality could be substantially higher and even greater contingencies for corrective action would be necessary.

In addition to augmentation with sea urchins/herbivores to control algae growth, coral mortality can be minimized with regular maintenance of the restored sites during the plot establishment period. Routine maintenance at each site is a necessary step towards successful restoration of reef function, structure, and diversity (Edwards and Gomez, 2007; Edwards, 2010; NOAA, 2019; Goergen et al., in press). Maintenance at the restoration sites will increase the survival of the outplants and directly influence the ability to meet the performance criteria outlined in Section 5.5 of this Restoration Plan.

Maintenance activities may include, but are not limited to:

- Removal of algae, (predators) corallivores, invasive and nuisance species, and debris.
- Treatment and/or removal of diseased corals
- Augmentation with a small number of additional corals or herbivores to a site for areas that have patchy but not widespread mortality.
- Reattaching and/or stabilizing loose colonies or broken fragments.

Maintenance trips are typically needed more frequently (every 30-60 days) during the first year after outplanting and then taper off as time goes on (4 times per year) and are not planned past the completion of the plot establishment period of 5 years. Maintenance is different from corrective actions. Corrective actions are required when monitoring identifies mortality (or other site issues) that could affect the ability to meet the performance criteria of the project and therefore require more substantial intervention.

5.3 PERFORMANCE CRITERIA, MONITORING AND CORRECTIVE ACTIONS

5.3.1 Performance Criteria

The Trustees have determined that ~29 restoration plots implemented as described in Section 5.2 will be sufficient to address the interim losses associated with the T/V MARGARA Incident. The criteria for success of the coral propagation work is to show survival of these plots minus the expected losses from mortality. One approach to evaluating project success is through a straight count of the total numbers of surviving tagged corals; however, previous projects have shown that as a site matures this can be exceedingly difficult because individual outplants may be hard to relocate (Goergen et al., 2020). In some cases, a straight count of tagged corals might suggest a site in need of corrective action (because of missing or dead corals), yet site wide surveys would show a healthy maturing site even if some outplant movement or change in coral species composition has occurred. This is especially common with alternatives such as this one where the majority of coral outplants are branching in nature. As such, the best approach for determining if a site is successful and meeting the performance criteria is to monitor both survival of individual colonies as well as any change in overall percent cover.

The Trustees will assume that survival of a coral outplant for 5 years is a proxy for long term survival since it has been shown that an outplant will be sexually reproductive and reach full function in 3 - 5 years (NOAA, 2019). Therefore a plot will be determined, as part of monitoring, to have met its performance criteria if the following objectives are met.

- Percent coral cover within a restoration plot as measured at time of outplant completion does not decrease below the expected 5 year mortality rate of 40.95% (i.e., for a site with 20% coral cover post-outplanting and an expected annual mortality rate of 10% for 5 years would not have cover decrease to less than 11.8% at year 5)[19]
- Presence of an individual species does not decrease by more than 40.95%
- At least 59.05% of the coral outplants that use micro fragmentation are fused together.

Plots within a site or between sites that were completed within the same year may be considered together in these calculations if higher than expected survival within one plot is necessary to offset for lower than expected survival at another site.

5.3.2 Monitoring

Effectiveness monitoring, or how well a coral restoration project is able to meet the desired goals, can take up to 5 years to properly determine the survival of outplants (Goergen et al., 2020). After 5 years, outplanted corals (using the techniques proposed here) are typically sexually mature and established on the reef (NOAA, 2019). The fate of the corals after this point in time generally are not related to their status as restored corals and have more to do with overall reef condition. Monitoring is required both to determine if a site meets its Performance Criteria but also if an interim corrective action is necessary to address site issues before failure occurs.

Monitoring methods will be consistent with the Coral Restoration Consortium's (CRC) "Coral Reef Restoration Monitoring Guide" (Goergen et al., 2020). Monitoring will consist of both roving diving surveys that evaluate overall condition within the entire restoration plot as well as permanently established sub-plots (representing a minimum of 20% of the overall plot as recommended by NOAA, 2019) that will

[19] This approach may need to be modified (or considered on a species by species approach) for plots that have an extended outplanting period.

serve to calculate trends in survival, growth, and mortality. Permanent monitoring sub-plots will be monitored using 3D photo-mosaics (an underwater image of the entire plot), fixed monitoring stations, and verification transects. The monitoring schedule in Table 10 which was adapted from the "Coral Reef Restoration Monitoring Guide (Goergen et al., 2020) will be implemented within each plot.

Sub-plot monitoring using photomosaics and tagging a subset of outplanted corals will enable the Trustees to determine if mortality is exceeding projected thresholds for a specific site and if any corrective actions are needed. New techniques may become available over the course of this project to make outplanting, corrective actions and monitoring more efficient and help meet performance criteria. Additional monitoring techniques will be evaluated by the Trustees as they become available and integrated into the project if they are found to be effective.

As noted in the previous section, restoration projects in all habitats, including coral reefs, experience some degree of mortality and loss. Although the Trustees factor a set value for mortality into the coral outplant requirements for specific sites, it can be difficult to accurately predict how mortality will vary from site to site and over time. Thus, the site monitoring allows evaluation of whether coral survival rates are within the expected range, or if a site is trending towards higher than expected mortality. Monitoring is intended to detect early warning signs that restoration goals are not being met and help determine what corrective actions may need to be implemented (Goergen et al., 2020). Sometimes those interventions can be minor in nature; however, at some sites more directed interventions in the form of corrective actions will be necessary to address the source of mortality and/or transplant additional corals or sea urchins to offset the mortality to ensure that the restoration project meets performance goals.

Table 10: Monitoring Schedule for Restoration Sites

Methods	Schedule	Objective
Baseline Monitoring	Pre-restoration	Pre-baseline surveys to map the site for planning logistics, determine what site preparation is needed, and how many of each coral species and sea urchins/herbivores will be outplanted. Photomosaics and transects will be used to determine coral community composition prior to restoration.
Pre-restoration Baseline Survey	7-14 days before outplanting	Identify any potential disease, bleaching, debris, water quality or predation issues prior to outplanting. These surveys can help reduce mortality by removing any problems or choosing to delay outplanting until conditions are more favorable.
Immediate Survey	7-14 days after outplanting	Identify any potential transport, handling, or predation issues. These surveys can help identify immediate problems that may require maintenance or lead to early corrective actions.
Initial Survey	Within 3 months after outplanting	Implementation monitoring to determine how well the initial phase of restoration was designed and executed and assess the effectiveness of outplanting methods.
Annual Surveys	Annually for 5 years	Effectiveness monitoring to assess whether restoration goals are met. How well did the treatment design meet the restoration goals and how successful is the project based on these goals. This includes photomosaics and transects to monitor coral survival, growth and health.
Post Disturbance Surveys	As soon as possible after or during any major natural or man-made events	This includes but is not limited to surveying for disease or bleaching during a disease outbreak or bleaching event and assessing damage from physical impacts. This can help identify any corrective actions needed after or during such an event like treating or removing diseased corals or stabilizing broken ones.

5.3.3 Corrective Actions

Corrective actions will need to be conducted when monitoring shows that a site is not projected to meet performance criteria outlined in section 5.3.1. While regular site maintenance can address minor issues, formal corrective actions typically require dedicated funding and the mobilization of additional resources to complete the work.

As outlined in earlier sections, the Trustees expect 10% mortality per year over a 5 year plot establishment period and the ultimate performance criteria are based on this metric. If at any monitoring time step a restoration plot sees more than double the expected mortality for that period (overall and species by species), or any other trend that could suggest performance criteria will not be met, the corrective actions will be considered.

Potential corrective actions could include, but are not limited to:

- Major debris, predator, sponge, disease and/ or algae removal
- Transplanting additional sea urchins to outplant sites to reduce algae and increase survival of coral outplants
- Outplanting additional corals to a site to replace corals that died or promote thicket formation for the branching corals
- Reattaching and/or stabilizing a significant number of colonies or fragments that broke free
- Outplanting a significant amount of micro-fragments to a site to ensure colony fusion

Based on the Trustees' experience with coral propagation efforts in Puerto Rico over the last 15 years, 10% of restored sites needed corrective actions. Mass mortalities within the restored sites (not seen in the adjacent reef) were typically the result of excess corallivore predation, disease, bleaching, storms, or debris. Therefore, the Trustees estimate that 10% of the restoration work conducted during Compensatory Restoration will require corrective actions. Execution of a corrective action within a restoration plot will reset the plot establishment period, the performance criteria and the monitoring for the affected restoration plot.

5.4 COMPENSATORY CREDIT

The method of calculating the expected benefits (credits) of the Preferred Alternative is similar to how the injury (debits) is calculated and relies on the same underlying principles (Discounted CCY) discussed in Section 3.6. The purpose of this section is to describe how the post-Emergency Restoration credit Discounted CCYL for each species will be offset with Compensatory Restoration (Table 6). A detailed description of the approach outlined below can be found in the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" in the Administrative Record.

5.4.1 Functional Equivalency

As noted in Section 3.6, the Trustees' scaling approach is based on the principle that the morphology and life history characteristics of different coral species result in differences in the types and degrees of functions provided to the coral reef ecosystem and the resources that depend on that ecosystem. Some coral species significantly contribute to building the overall reef structure, while others are more cryptic in nature and do not. Some species have a morphology that provides shelter and refuge for many associated reef species, while others do not. Similarly, no two reefs are the same, nor is it possible for a restoration project to restore the exact sizes, species distribution, and reef profile that existed pre-impact.

To reflect these differences in the functional values provided by different coral species within the reef ecosystem, the Trustees' REA model incorporates a "Functional Weighting Factor" that serves as a scaling ratio applied to normalize the injury or benefit (i.e., the calculated CCYs) across the different species. This scaling ratio is applied to both the number of corals lost due to an incident and the number of corals gained through compensatory projects.

Without a scaling ratio to adjust for the different functions provided by different coral species within the reef ecosystem, all corals would be treated as the same in the scaling analysis, with restoration of corals scaled on a one-to-one basis to corals lost regardless of the different service functions provided by different species. In this case, treating all corals impacted as functionally equal to the corals used for restoration would substantially increase the compensation required. Therefore, a means of weighting functions among different species is needed to determine an appropriate compensatory scale for many otherwise viable compensatory restoration projects because the mix of species to be restored by the restoration project did not exactly match the mix that was lost. The equivalency ratio for each species allows the different species to be converted into a single metric - "corals" - while preserving that some species contribute significantly more to reef function than others. This also ensures that rare corals are not simply exchanged for more common corals on a one-to-one basis in scaling restoration-based compensation.

To compensate for the interim coral losses caused by the T/V MARGARA Incident, the Trustees are proposing a Compensatory Restoration project that features propagation of corals like *Acropora palmata, A. cervicornis, Dendrogyra cylindrus, Orbicella* spp., *Pseudodiploria* spp. and *Diploria* spp. that can be successfully produced using existing coral propagation techniques in exchange for injury to a wide variety of coral species lost. At present, coral propagation techniques are not available to reproduce all of the species that were lost. The scaling ratio allows for an appropriate, weighted adjustment for differences in functional values among coral species, which serves to equalize benefits and losses and helps prevent under- or over-compensation in scaling compensatory restoration.

In order to address the functional difference between different species, the Trustees first identified two of the primary functions that coral reefs provide as Fisheries Habitat and Wave Protection. Considering these two primary functions, the Trustees then conducted a literature review to assess each coral species commonly found in the Caribbean on: 1) the degree to which the species contributes to Reef Accretion; 2) the Maximum Size Potential of the coral; and 3) the species Sexual Reproduction Strategy. Using the objective measures above, the Trustee devised a scoring rubric that can be used to evaluate the relative contribution a species has towards reef function. The rubric and associated scores for each measure can be found in the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" in the Administrative Record.

Ultimately the scores were used to develop an Equivalency Ratio between 0 and 1 to normalize the species by species Discounted CCYL into a common unit. Table 11 shows the application of the Equivalency Ratios against the post-Emergency Restoration Credit Discounted CCYL. After the crediting of the Emergency Restoration, there is an outstanding loss of 504,348 Equivalency Weighted Discounted CCYL.

Table 11: Application of Equivalency Ratios and CCYL Outstanding

	Credits	Equivalency Analysis	
Scleractinian Species	**Post-Emer. Rest. Credit CCYL**	**Ratio**	**CCYL Outstanding**
Acropora cervicornis	3,395	1.00	3,395
Agaricia lamarcki	735	0.67	493
Agaricia spp.	27,983	0.50	13,991
Colpophyllia natans	4,115	1.00	4,115
Dichocoenia stokesii	3,440	0.83	2,855
Diploria labyrinthiformis	3,870	1.00	3,870
Eusmilia fastigiata	1,202	0.50	601
Isophyllia spp.	2,291	0.33	756
Madracis auretenra	12,057	0.67	8,078
Madracis decactis	12,562	0.33	4,145
Manicina areolata	25	0.33	8
Meandrina meandrites	8,291	0.83	6,882
Meandrina jacksoni	2,338	0.83	1,941
Millepora spp.	7,395	0.50	3,698
Montastraea cavernosa	39,720	1.00	39,720
Mycetophyllia spp.	759	0.50	379
Oculina spp.	24	0.83	20
Orbicella annularis	15,203	1.00	15,203
Orbicella faveolata	16,102	1.00	16,102
Orbicella franksi	11,283	1.00	11,283
Orbicella spp.	2,055	1.00	2,055
Porites astreoides	60,021	0.50	30,010
Porites branneri	83	0.33	27
Porites porites	1,994	0.67	1,336
Pseudodiploria spp.	12,436	1.00	12,436
Scolymia spp.	36	0.33	12
Siderastrea radians	268	0.50	134
Siderastrea siderea	23,140	1.00	23,140

Stephanocoenia intersepta	1,960	0.83	1,627
Unidentified Scleractinian	1,432	0.50	716
		Sub-Total	209,027

Table 11 (Continued): Application of Equivalency Ratios and CCYL Outstanding

Octocoral Genus	**Post-ER Credit CCYL**	**Ratio**	**CCYL Outstanding**
Briareum	18,301	0.17	3,111
Eunicea	65,209	0.17	11,086
Gorgonia	76,698	0.33	25,310
Muricea	63,713	0.17	10,831
Plexaura	334,868	0.17	56,928
Plexaurella	35,173	0.33	11,607
Pseudoplexaura	324,434	0.33	107,063
Pseudopterogorgia	200,910	0.33	66,300
Pterogorgia	18,140	0.17	3,084
		Sub-Total	**295,320**
	Total CCYL Outstanding		**504,348**

5.4.2 Restoration Crediting Approach

The goal of the coral propagation work is to produce enough surviving corals to offset the 504,348 CCYL caused by the T/V MARGARA Incident. The method of calculating the expected benefits (credits) of a particular type of restoration is very similar to how the injury (debits) is calculated and relies on the same underlying principles. A project is considered to have provided the required compensatory restoration when credits (Weighted Discounted CCYG) are equal or greater than the debits (Weighted Discounted CCYL).

For this effort, the Trustees are proposing to outplant multiple species of corals in a series of restoration plots that will be located at several sites around Puerto Rico. The coral species used will represent both the species composition typically used in restoration on Puerto Rico reefs and species that can be successfully produced using existing coral propagation techniques. The Trustees currently estimate that each plot will receive approximately 3,000 coral outplants (or clusters of micro-fragments for some species). Table 9 in Section 5.2.2 shows the proposed species composition within each plot for which credits will need to be established.

To model the required Compensatory Restoration using this REA, it is necessary to model the benefits (in CCYG) that will be gained from each coral species that will be included in the project in the same way that CCYL was modeled for each species (and size class) that was impacted. In order to do that in this case, the

Trustees considered the CCYG that would be generated from a single outplant of each species. Then knowing the relative species composition within a restoration plot, the Trustees could determine the total number of restoration plots that would be necessary to compensate for the injury from the T/V MARGARA Incident.

In order to calculate the CCYG gained from each species included as part of the Preferred Alternative, the following inputs are needed:

- Coral size at time of outplanting or cluster formation.
- Year of outplanting
- Time for fusion or cluster formation to complete.
- Time period for site establishment.
- Annual mortality during site establishment.
- Equivalency ratio for selected species.

The necessary inputs to effect this calculation and the calculation steps are outlined in the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" in the Administrative Record. The results of the calculations per restoration species and plot are outlined in Table 12.

Table 12: CCYG Per Coral Species and Plot.

Restoration Scenario			Species	Mix/ Plot
Target Outplants/ Plot	3,000		*Acropora palmata*	35%
Necessary Project Components	Site Preparation Coral Outplanting Algae Control Site Maintenance		*Acropora cervicornis*	20%
			Star corals	15%
			Brain corals	15%
			Dendrogyra cylindrus	15%
Species	**Corals Required**	**CCYG/ Coral**	**CCYG/ Species**	**CCYG/ Plot**
Acropora palmata	1,050	3.50	3,678	17,020
Acropora cervicornis	600	9.63	5,780	
Star corals	450	6.94	3,123	
Brain corals	450	6.94	3,123	
Dendrogyra cylindrus	450	2.92	1,314	

5.4.3 Credit from Primary Restoration Biological Additions

A component of the Primary Restoration at the site is a modest amount of biological enhancement to the structures that will be placed in order to maximize the likelihood of site recovery. As part of this work ~1,200 clusters of *Acropora cervicornis* and ~350 colonies of other scleractinian corals (*Orbicella faveolata* and others available from a nearby donor site) will be outplanted on or near the Primary Restoration structures. The corals available are expected to average ~33 cm and ~15 cm respectively and available for outplanting in 2023. While the purpose of this work is to assist site recovery, the Trustees will also provide Compensatory Restoration credit for these corals. Credit of 15,284 Weighted CCYG is provided using the same approach outlined earlier in this section and in the "Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models" in the Administrative Record.

5.4.4 Compensatory Restoration Requirements

The CCYG per plot can then be used to calculate how many plots are necessary to offset the CCYL outstanding after crediting for Emergency and Primary Restoration. The number of plots and the number of corals by species necessary for the Compensatory Restoration from the T/V MARGARA Incident are in Table 13. The Trustees' scaling calculated that 86,206 corals will need to be outplanted to the reefs of Puerto Rico consistent with the parameters outlined in this document to compensate for the outstanding losses from the T/V MARGARA Incident.

Table 13: T/V MARGARA Incident Compensatory Restoration Requirements

CCYL Impacted	504,348
CCYG from Primary Restoration	15,284
CCYL Requiring Compensation	489,063
CCYG Per Restoration Plot	17,020
Number of Restoration Plots	28.7
Species Mix	Corals Required
Acropora palmata	30,172
Acropora cervicornis	17,241
Star corals	12,931
Brain corals	12,931
Dendrogyra cylindrus	12,931
Total Outplants Required	86,206

5.5 RESTORATION IMPLEMENTATION AND ESTIMATED COST

The implementation of the Preferred Alternative, *Enhancement of Corals and Coral Reef Ecosystems Using Asexual Coral Propagation and Restoration*, is estimated to cost approximately $29,397,476. A more detailed analysis of implementation project tasks and budget estimates for each element may be found in the T/V MARGARA Incident Compensatory Restoration Implementation Plan and Budget Narrative (available in the Administrative Record). Following publication of this document and preceding implementation of Compensatory Restoration, the Trustees will prepare a detailed budget to be available in the Administrative Record.

5.6 SUMMARY

The implementation of the Preferred Alternative, *Enhancement of Corals and Coral Reef Ecosystems using Asexual Coral Propagation and Restoration* will meet the Trustees overall goal for Compensatory Restoration to restore coral reefs that can provide equivalency to those that were lost as a result of the impact and to ensure those coral services will exist into the future.

This alternative allows for replacement of the equivalent coral resources as those that were lost as a result of the Incident based on the Trustees' evaluation of the alternatives in Section 4 and the ability of the Preferred Alternative to compensate for the injury. Additionally, projects similar to this alternative are a jurisdictional priority in Puerto Rico (The Commonwealth of Puerto Rico and NOAA Coral Reef Conservation Program, 2018) and projects such as this are also shown as a priority in the Recovery Plan for Acroporids in the Caribbean (NOAA, 2015a).

The Trustees expect it will take approximately 9 years[20] to complete the outplanting of 86,206 corals at ~29 restoration plots across 4-6 restoration sites. The first year of the project will create coral nurseries with sufficient capacity to sustain the requirements of this plan for the following 8 years, during which almost 11,000 corals per year will be outplanted. The first year of the project will create enough coral nursery capacity to meet the requirements of this plan and will be followed by 8 years of outplanting almost 11,000 corals per year. As with any project, a sound adaptive management strategy is key to long term success. Lessons learned in the early years of the project will be incorporated into later efforts which could modify the actual restoration scenario that is implemented. Having multiple nursery locations operating both in and out of the water will ensure that corals will be produced for outplanting regardless of any unforeseen circumstances that may affect production or survival in a given area. New techniques may become available during the project that could improve propagation and outplanting.

[20] Not including additional time for monitoring, corrective actions, and achievement of performance criteria.

6.0 ENVIRONMENTAL CONSEQUENCES

This section of the document specifically addresses the factors and criteria that federal agencies are to consider in evaluating the potential significance of the impacts of proposed actions and their alternatives in terms of both context and intensity for NEPA purposes. The previous analyses were provided in the context of OPA. In the case of site-specific restoration projects, as outlined in this Final Compensatory RP/EA**,** the appropriate context for considering the significance of the action is local, meaning coral reefs in Puerto Rico, as opposed to national or worldwide. The Trustees worked cooperatively with federal and state agencies, municipalities, and non-governmental organizations as well as the general public that was affected by the grounding to identify and screen a broad range of restoration alternatives. This process and the alternatives carried forward for further consideration are described in Sections 4 and 5. In this section, the Trustees evaluate the potential for environmental consequences that could result from restoration actions associated with both the Preferred and the No Action Alternatives.

The Preferred Alternative consists of rearing corals and sea urchins/herbivores in aquaria and in-situ nurseries and transplanting them onto degraded reef areas. Corals are typically attached using epoxy, cement, concrete nails, or other mechanical devices (e.g., plastic cable ties). Generally, transplanted corals are attached either directly to the reef or to a small base that can be affixed to the sea floor. Outplanting will use field-tested methods in a manner that results in only minor temporary adverse effects with a net overall beneficial effect to the corals and coral reefs in Puerto Rico, as described below.

The Preferred Alternative would enhance coral reefs and coral populations, reduce algal cover, and increase coral survival, as described further below. The Preferred Alternative would increase reef habitat function and topographic complexity at multiple sites. The Preferred Alternative would restore coral reefs and increase their services and benefits to other resources and to the public in Puerto Rico. The enhanced and increased reef habitat resulting from the Preferred Alternative would provide improved areas for fish, lobster and other marine species to feed and seek protection. Aesthetic and recreational benefits to humans are also possible for divers and fishermen in Puerto Rico.

Under the No Action Alternative, nothing will be done to compensate the public for losses incurred by the T/V MARGARA Incident.

6.1 SCOPE OF THE NEPA ANALYSIS

This section describes the potential impacts of the Preferred Alternative (asexual coral propagation) as well as the No Action Alternative. In particular, this section analyzes the potential direct, indirect, and cumulative ecological, social, and economic impacts associated with the two alternatives.

The following definitions were generally used to characterize the nature of the various impacts:

Short-term or long-term impacts: These characteristics are determined on a case-by-case basis and do not refer to any rigid time period. In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period. Long-term impacts are those that are more likely to be persistent and chronic.

Direct or indirect impacts: A 'direct' impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a proposed action and may occur later in time or farther removed in distance but still be a reasonably foreseeable outcome of the action. For example, a direct impact of erosion on a stream might include sediment-laden waters in the vicinity of the action, whereas an 'indirect' impact of the same erosion might lead to lack of fish spawning habitat and result in lowered reproductive rates of native fish spawning in the downstream stream reach.

Minor, moderate, or major impacts: These relative terms are used to characterize the magnitude of an impact. 'Minor' impacts are generally those that may be perceptible but, in their context, are not amenable to measurement because of their relatively minor character. 'Moderate' impacts are those that are more perceptible, and typically, more able to be quantified or measured. 'Major' impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in Council on Environmental Quality (CEQ) regulations (40 C.F.R. § 1508.27) and, thus, warrant heightened attention and need to conduct an EIS to fulfill the requirements of NEPA.

Adverse or beneficial impacts: An 'adverse' impact is one having unfavorable or undesirable outcomes on the man-made or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single action may result in adverse impacts on one environmental resource and beneficial impacts on another resource.

Cumulative impacts: The CEQ regulations implementing NEPA define 'cumulative' impacts as the "impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." 40 C.F.R. § 1508.7. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time within a geographic area.

6.2 SUMMARY OF IMPACTS OF THE PREFERRED ALTERNATIVE

The environmental and socio-economic impacts of the Preferred Alternative are largely beneficial. The actions to be implemented will increase populations of an ESA-listed and other coral species, further enhancing their recovery. These effects, in turn, will contribute to improving the overall quality of the coral reef environment in Puerto Rico, allowing for increased populations of corals and other benthic invertebrates, improved habitat for fish and other marine organisms; and other benefits for a variety of federally threatened and endangered species. Similar coral restoration projects have been underway in Puerto Rico and the broader US Caribbean at a scale similar to that proposed here with no substantial observed adverse effects. As with any coral restoration action, there are certain activities (e.g., use of small vessels, anchoring, placement of nursery structures on the seafloor, and coral tissue contact with cement and epoxy) that may have short-term adverse effects, such as the potential for debris, isolated mortality, and increased turbidity. These effects are minimized by following best management practices (BMPs) and utilizing trained and experienced restoration practitioners. Any effects that do occur are expected to be localized and of very limited duration.

As with all restoration projects, sound evaluation criteria, performance goals, adaptive management, and appropriate risk considerations are key. For example, studies are currently in progress to evaluate the target coral densities in potential restoration sites to maximize success. Results from these studies will be incorporated into the outplant site selection plan. Further, outplanting site selection should reduce location-based sources of risk to the extent possible. Should a site perform poorly due to local environmental conditions, an alternate site would be identified for restoration work. The project would manage risk of failure by using multiple independent oceanic nurseries and outplanting corals to different reef locations, in order to maximize work windows, decrease exposure of corals to localized stressors, and provide overall redundancy. Disadvantages of in-water coral nurseries include exposure to hurricanes, predators, diseases, extreme weather events, and tampering or inadvertent damage by the fishermen and boaters. Careful planning, monitoring, outreach, and education on fishing and anchoring issues and careful nursery site selection can decrease these risks.

The Preferred Alternative will provide beneficial socio-economic impacts to the local community. Both recreational and commercial fisheries in Puerto Rico have the potential to indirectly benefit as the proposed project will improve habitat that many economically important species of finfish and invertebrates rely on during various life stages. The project will likely directly employ local divers and scientists and hire local businesses to implement restoration actions. Additionally, the increased reef health in the area has the potential to indirectly increase recreational and tourism use of the reef which subsequently will provide income to local dive operators, restaurateurs, hotels, shops, and others.

6.3 IMPACTS OF PREFERRED ALTERNATIVE AND NO ACTION ALTERNATIVE

The Trustees evaluated the potential for the Preferred and the No Action Alternatives to impact the following: the biological environment (fisheries, vegetation, wildlife, and endangered and threatened species), the physical environment (air and noise pollution, water quality, geological and energy resources, and contaminants), the cultural and human use environment (environmental justice, recreation, traffic, and cultural resources), and cumulative impacts.

6.3.1 Biological Environment

Fisheries

<u>Preferred Alternative:</u>
The Preferred Alternative for restoration would occur within areas designated as Essential Fish Habitat (EFH), including coral reefs and live/hard bottoms, which are designated EFH by the Caribbean Fishery Management Council for species managed under the Spiny Lobster, Queen Conch, Reef Fish, and Coral Fishery Management Plans; and sand/shell substrate, which is designated EFH for species managed under the Queen Conch and Reef Fish Fishery Management Plans. However, the Trustees do not believe that these restoration actions would have an adverse impact on EFH as designated under the Magnuson-Stevens Fishery Conservation and Management Act, as amended and reauthorized by the Sustainable Fisheries Act (Public Law 104-297) (Magnuson Stevens Act), 16 U.S.C. §§1801 et seq. An abbreviated EFH consultation was completed with the National Marine Fisheries Service (NMFS) on April 3, 2018. Based on prior consultations for similar restoration activities, NMFS Southeast Regional Office (SERO) concurred that the Preferred Alternative will not have a net adverse impact on EFH.

Vessels and companies contracted for this work would be required to have all the insurances and USCG certifications to minimize and be able to respond to any spills or release of lubricants. The vessels used would likely range from 30-70’ in length. It is common for seas in Puerto Rico to reach over 6–8 feet. Coastal mangroves and nearshore seagrass beds in the area are protected from offshore swells by coral reefs. Wakes from the vessels would not exceed typical background conditions, so no adverse impact on coral reefs, mangroves, or seagrasses is expected in the project area.

During the active restoration phases of the Preferred Alternative, short-term, minor, direct, and very localized adverse impacts that could occur include impacts to adjacent coral reefs by anchoring vessels or increases in turbidity within and near the project sites during restoration. These effects would be minimized by 1) setting up temporary moorings so vessels would not need to anchor, and 2) using a sludgy stucco-like cement mixture to attach coral colonies to minimize plumes, although some temporary, localized increase in turbidity could still occur. Increases in turbidity may adversely affect coral, fish, and filter feeders in the local area, by clogging gills, increasing mucus production, and smothering organisms found on reefs in the vicinity. Effects on mobile fish and invertebrates would be temporary/negligible since these organisms would likely leave the local area temporarily and return after project completion. Increased noise levels due to vessel traffic would also cause mobile fish to leave the area until operations end. The EFH would be beneficially impacted by the accelerated recovery and enhancement of reef services that would be achieved through the proposed restoration actions, including through increased survival of coral recruits and by preventing additional injuries and losses to reef organisms from rubble mobilization during storm events. The restored reef would serve as habitat for prey species and provide a nursery for the larvae and juvenile stages of many managed species.

No Action**:**
The Trustees believe that the No Action Alternative would have a net adverse impact on EFH as designated under the Magnuson-Stevens Fishery Conservation and Management Act, as amended and reauthorized by the Sustainable Fisheries Act (Public Law 104-297) (Magnuson Stevens Act), 16 U.S.C. §§1801 et seq. EFH would be adversely impacted by a lack of recovery and reduction of reef services that will occur if no action is taken to restore impacted reefs. This includes little to no survival of coral recruits and additional injuries and losses to reef organisms from rubble mobilization during storm events.

Vegetation and Wildlife

Preferred Alternative:
The Preferred Alternative would not have a net adverse effect on vegetation and wildlife. There is no vegetation present at any of the sites. Any wildlife such as marine mammals or sea turtles that may be present in the area during restoration activities are mobile enough that they would only experience short term, minor adverse impacts since they would move out of the way of any restoration activity. There is adequate habitat adjacent to the area so they would have plenty of space for refuge during operations. Removing algae and debris and placing sea urchins will alter vegetation and wildlife at project sites but is expected to have a net-positive impact on vegetation and wildlife populations.

No Action: The Trustees do not believe that the No Action Alternative would have a net adverse effect on vegetation and wildlife. There is no vegetation, except algae, present at any of the sites, but the No Action Alternative would not benefit wildlife either.

Endangered and Threatened Species

Endangered and threatened species that are known to occur on reefs in Puerto Rico are listed in Table 14. Many of these species, including staghorn (*A. cervicornis*) and elkhorn (*A. palmata*) coral, mountainous star coral (*Orbicella faveolata*), boulder star coral (*O. franksi*), lobed star coral *(O. annularis)*, pillar coral (*Dendrogyra cylindrus)*, rough cactus coral (*Mycetophillia ferox*), green sea turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Scalloped Hammerhead shark (*Sphyrna lewini*), Nassau grouper (*Epinephelus striatus*) and West Indian manatee (*Trichechus manatus*) have been documented on reefs in Puerto Rico. Most species would either be present on the reef or migrate through the area.

Table 14: Federal and State Endangered or Threatened Species in Waters or on Reefs Near Guayanilla, Puerto Rico. T = currently listed as Threatened. E = currently listed as Endangered.

Common Name	Scientific Name	Status
Staghorn coral	*Acropora cervicornis*	T; Critical Habitat
Elkhorn coral	*Acropora palmata*	T; Critical Habitat
Mountainous star coral	*Orbicella faveolata*	T
Boulder star coral	*Orbicella franksi*	T
Lobed star coral	*Orbicella annularis*	T
Pillar coral	*Dendrogyra cylindrus*	T
Rough cactus coral	*Mycetophillia ferox*	T
Green Sea Turtle	*Chelonia mydas*	T; Critical Habitat
Leatherback Turtle	*Dermochelys coriacea*	E; Critical Habitat
Hawksbill Turtle	*Eretmochelys imbricata*	E; Critical Habitat
Roseate Tern	*Sterna dougalii dougalii*	T
West Indian Manatee	*Trichechus manatus*	T
Scalloped Hammerhead	*Sphyrna lewini*	T
Nassau grouper	*Epinephelus striatus*	T

Preferred Alternative:
The proposed activity is expected to have an impact on protected species through noise created by project vessels, habitat perturbation due to human activity while conducting the proposed actions, turbidity that could smother some of the sessile species, physical impact due to contact with divers, use of tools, and unforeseen accidents in the area. Given the constant presence of boats in Puerto Rico waters, the 30-70' boats used during restoration activities should not have vessel noise signatures that exceed levels frequently experienced at these sites. The noise, perturbation, and turbidity generated by the human activity are expected to be temporary and of very short duration. The restoration approach will minimize turbidity by using attachment materials with a composition that lessen this effect. The staff who will be working on the project will be trained on the protocols to minimize accidents that could physically impact sessile protected species. The divers that will participate in the compensatory activities have adequate training to avoid contact with corals.

The general locale where the restoration actions would be sited contains critical habitat for some of these threatened and endangered species. All of these species would benefit from coral restoration at these sites. Additionally the overall (net) long-term effects would be more beneficial to these species and outweigh any of the short-term potential adverse impacts. The Trustees know of no other direct or indirect impacts of the Preferred Alternative on threatened or endangered species, or their designated critical habitats.

The Preferred Alternative falls under the "3Rs Programmatic Biological Opinion (BIOp)" initiated October 18, 2016 by NOAA. The Programmatic Biological Opinion analyzed the potential routes of effects from the activities to be implemented under the Preferred Alternative on all listed species and designated critical habitats under NMFS' purview (i.e., corals and sea turtles) listed at the time. NOAA Restoration Center requested concurrence with NMFS Southeast Protected Resources Division that the Preferred Alternative falls within the scope of the 3Rs Programmatic Biological Opinion on March 26, 2018; and the Protected Resources Division provided concurrence on March 26, 2018.

No Action:
The No Action Alternative would have no adverse effects on ESA species listed in Table 14.

6.3.2 Physical Environment

Air Quality

Preferred Alternative:
Minor temporary adverse impacts to air quality would result from exhaust emissions from vessels used during construction activities; but the amounts of exhaust would be small, and should be quickly dissipated by prevailing winds. There would be no long-term adverse impacts to air quality.

No Action:
There would be no adverse impacts to air quality from the No Action Alternative.

Noise

Preferred Alternative:
Noise associated with the vessels represents a short-term adverse impact during the proposed restoration actions. There is marine life present at the sites, and it is possible that vessels and divers may temporarily disturb marine life in the immediate vicinity, or cause temporary movement of marine life away from the site. Similarly, though many of the restoration sites do not support much, if any, active recreation by humans (fishermen or divers), it is possible that some people may avoid this area during restoration, but as with marine life, such disruption would be limited to the period of restoration implementation activities. There are many substitute sites readily available to divers and fishermen in Puerto Rico. Coral and sea urchin/herbivore propagation, monitoring, and maintenance activities, equipment operation, and vehicle or boat traffic associated with the restoration could result in short-term minor to moderate adverse impacts due to noise in natural areas. For example, while motorized vessels are in use, noise would be created which could be readily apparent and attract attention. Although such changes would not dominate the soundscape and some sounds would be dampened or masked by ambient wave or ship noise, noise generated during the project could detract from user experiences and create audible contrast for visitors in the project areas. While there would be an increase in motorized vessels during restoration activities, long-term minor impacts to ambient noise levels would only occur during monitoring events when motorized vessels conduct follow up visits to the site, which would be a maximum of a few days a year for up to five years.

No Action:
There would be no adverse impacts from noise associated with the No Action Alternative.

Water Quality

Preferred Alternative:
In the short term, the proposed restoration activities might have minor, short term, direct and indirect adverse impacts to water quality by temporarily increasing turbidity in waters within and near the project sites. These effects would be minimized through BMPs that would be employed in undertaking restoration actions but some turbidity could still occur. Implementation of similar past restoration projects have been

shown to have little to no turbidity effects on the adjacent reef. Over the longer term, the proposed restoration actions would accelerate recovery of and enhance coral reefs at the sites.

No Action:
There would be no adverse impacts to water quality from the No Action Alternative.

Geology

Preferred Alternative:
The proposed restoration actions would have a beneficial impact on the reef geology. The proposed restoration actions would have an immediate beneficial effect by increasing topographic complexity to the impacted sites. Corals help stabilize the reef structure and reduce erosion.

No Action:
The No Action Alternative would have no adverse impact on the reef geology in the area.

Energy

Preferred Alternative:
Natural gas and petroleum products are transported by vessels almost daily to facilities in Puerto Rico. The Preferred Alternative would take place outside of the shipping channels intended for transport of these products and in waters too shallow for such vessels to safely travel. None of the proposed restoration actions have the potential to directly or indirectly affect energy production, transport, or infrastructure in Puerto Rico in any way.

No Action:
The No Action Alternative does not have the potential to directly or indirectly affect energy production, transport, or infrastructure in Puerto Rico in any way.

Contaminants

The Trustees have no reason to believe there are any contaminants of concern at the restoration sites. Due diligence will be conducted to explore the possibility that proposed restoration sites are contaminated using available information on locations of outfalls and known contaminant sources.

6.3.3 Cultural and Human Use Environment

Environmental Justice

Preferred Alternative:
None of the proposed restoration activities have the potential to adversely and/or disproportionately affect minority or low-income populations in Puerto Rico, including economically, socially, or in terms of conditions affecting their health. Other coral reef restoration projects have been implemented in Puerto Rico consistent with federal, state and local laws designed to protect and restore the environment with no noted adverse effects. The Preferred Alternative has no unique attributes or characteristics compared to prior projects that would cause additional adverse effects to minority or low-income populations. The proposed activities would help restore an environment that is of benefit to all citizens, populations and groups in Puerto Rico.

No Action:

By taking No Action, injured reef environments that are of benefit to all citizens, populations and groups in Puerto Rico will take a very long time to recover. The lack of meaningful recovery of the reef at the T/V MARGARA Incident site contributes adversely to the economic and social well-being of all citizens, populations and groups in Puerto Rico, although taking no restoration action is not expected to affect their health. The No Action Alternative would likely disproportionately affect low income fishing communities more than other communities as they rely on these reefs as primary source of income and subsistence fishing.

Recreation

Preferred Alternative:
Noise and increased turbidity of surface waters due to construction activities during restoration could have a minor short-term adverse effect on recreational activities by temporarily discouraging and decreasing recreational activities in the vicinity of a site; however, many of the sites proposed for restoration do not currently support much, if any, active recreation. Nonetheless, it is possible that some persons may avoid these areas due to noise during construction and maintenance, but such disruption would be minor and limited to the duration of the restoration activities. There are many other sites readily available in Puerto Rico that are similar or better quality substitute sites for recreation while the restoration actions take place. In the longer term, the proposed restoration actions would be expected to increase and enhance the site's post-incident aesthetics and recreational opportunities for fishermen and divers in Puerto Rico, therefore, providing beneficial impacts.

No Action:
The No Action Alternative could adversely impact recreational opportunities for fishermen and divers in Puerto Rico since degraded coral reefs at the T/V MARGARA Incident site may never recover with No Action. This would result in a reduction in available fishing and diving areas.

Traffic

Preferred Alternative:
The Preferred Alternative would have a minor short-term adverse effect on vessel traffic. There would be an increase in vessel traffic during implementation, monitoring, and corrective actions associated with the restoration activities. There is vessel traffic in the adjacent waters, including large vessel traffic associated with transport of natural gas and petroleum products, but the proposed restoration activities would take place outside of the primary routes, channels and areas used by vessels. Vessels used to implement restoration at the impacted sites would display appropriate dive flags to alert other vessels that other vessel traffic at the site is restricted during restoration. Once restoration activities are complete, any increased vessel traffic and restrictions on other vessel traffic at the restoration site would end. No other effects on traffic in the area are anticipated.

No Action:
The No Action Alternative would have no effect on traffic in the area.

Cultural Resources

There are no known historic sites or significant cultural, scientific or historic resources in the areas that would be affected by the proposed restoration actions. If any archeological artifacts are identified, archeologists from the Cultural Institute of Puerto Rico will be contacted to visit the sites to make a determination that there are areas or resources of cultural or historical significance that would be disturbed by the proposed restoration actions.

6.4 CUMULATIVE IMPACTS

6.4.1 Cumulative Impacts of the Preferred Alternative

Over the last few decades, there has been a drastic decline in coral reefs throughout the world because of overfishing, land based sources of pollution and climate change. As a result, 22 species of coral have been listed as threatened or endangered pursuant to the Endangered Species Act since 2006, seven of which are located in the Caribbean and project area. These effects are magnified in the Caribbean where there is a high human population density in a small oceanic basin with lower coral species diversity, especially on a small island like Puerto Rico with a population of over 3.5 million people. The combination of increased ship traffic in the region and larger vessels coming through the newly widened Panama Canal increase the risk of groundings and oil spills. Bleaching events and disease outbreaks have increased in frequency and intensity. In 2005 alone, it is estimated that the US lost half of its coral reefs in the Caribbean in just one year during a massive bleaching event centered near the USVI and Puerto Rico (Eakin et al., 2010). Any cumulative impacts arising from the Preferred Alternative are expected to result in cumulative beneficial impacts by enhancing coral reefs and coral populations throughout the project area; and accelerating recovery and enhancing the coral reefs at degraded sites, allowing them to provide ecological services sooner and into the future. The effects of compensatory restoration actions, however, would be local and would not be expected to significantly affect the human environment alone or in combination with other activities in its vicinity. It would not result in any change in the larger current pattern, boat traffic, economic activity or land-use in Puerto Rico. The proposed restoration actions would only restore habitat that originally existed and occurred naturally at these locations.

Other known activities in the vicinity of the restoration include commercial shipping lanes, which have routine marine vessel traffic. It is not likely the restoration and commercial marine vessel traffic would have any additive effects on coral reef resources in the area, since the coral reefs are outside of the shipping lanes. Corals produced at the nurseries will be used in nearby areas for other coral recovery and restoration projects, to benefit ongoing coral resource conservation efforts. There are commercial fisheries in the vicinity, for finfish and shellfish (not for corals). The level of this fishing activity has been steady but some preliminary indications are that it may increase at the restoration sites due to potentially higher fish densities at restored sites.

Overall, there are likely to be no significant adverse cumulative impacts from the Preferred Alternative. A net cumulative beneficial impact will likely result from future restoration activities that will be used to compensate for interim losses.

The Preferred Alternative included in this Final Compensatory RP/EA incorporates experience learned through restoration work conducted in Puerto Rico over the last ten years. The Recovery Plan for *A. cervicornis* and *A. palmata* includes coral propagation efforts as a high priority to enable the recovery of these populations (NOAA, 2015a). The restoration alternative selected in this Final Compensatory RP/EA, in combination with additional coral propagation work proposed in the Final RP/EAs for the T/V PORT STEWART and LNG-C MATTHEW will assist in the recovery of these species within the area. The trend of coral reef decline in the Caribbean and the rest of the world over the last few decades make existing coral reef resources even more vulnerable as well as more valuable, increasing both the need and urgency for both compensatory restoration and conservation.

6.4.2 Cumulative Impacts of the Non-Preferred (No Action) Alternative

As mentioned in the previous section, there has been a decline in overall coral reef health across the globe due to overfishing, land-based sources of pollution, and climate change. Deteriorating reef conditions have led to the listing of 22 species of coral as threatened or endangered pursuant to the Endangered Species Act. The No Action Alternative is expected to result in continued cumulative, adverse impacts and would not provide the conditions necessary for recovery of the injured reefs. With No Action, key natural resources and services will take a very long time to recover. The No Action Alternative has an attendant, long-term likelihood of causing further adverse injuries and losses of resources due to future impacts. While the No Action Alternative would not have any adverse effects on air, noise, traffic, energy, cultural resources, vegetation and wildlife, there would be adverse effects on fisheries, endangered species, geology, water quality, recreation and socio-economic factors. The current trend of coral reef decline over the last few decades only adds to the urgency for compensatory restoration and the need to take action at impacted sites.

6.5 CONSIDERATION OF CLIMATE IMPACTS

The Trustees considered the following categories of potential effects related to climate change:

- The Green House Gasses (GHG) emission effects of a proposed action and alternative actions.
- The relationship of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures.

Potential Effect of Proposed Actions on GHG Emissions

Minor adverse direct effects on GHG emissions are expected as a result of the proposed restoration activities. Actions resulting in GHG emissions may include the use of vessels, transport of materials needed for construction, and other activities associated with pre- and post-implementation. These activities have the potential to generate GHG emissions through the use of oil-based fuels and consumption of both renewable and nonrenewable resources.

Potential Effect of Climate Change on Proposed Actions

Despite the high level of uncertainty around climate change effects on restoration, efforts have been made to identify precautionary approaches that consider the range of potential effects. In general, actions that support ecosystem resilience, diversity and connectivity provide the greatest likelihood of safeguarding public investments in light of expected climate change impacts while considering cost effectiveness. Several principles for ensuring that public investments in restoration provide maximum adaptability to climate change have been identified (NOAA OCRM and OHC 2010):

- Prioritize habitat connectivity: Focus on activities that connect habitats to allow for habitat and species migration as climate changes.
- Reduce existing stressors: In the absence of site-specific forecasts of climate change impacts or ecosystem responses, focus on reducing existing stressors such as pollution and habitat fragmentation that hinder the ability of species or ecosystems to withstand climatic events.
- Protect key ecosystem features: Focus management and protection strategies on structural characteristics, organisms, or areas that represent important keystones or trophic functions that are necessary for the overall system.
- Maintain diversity: Identify and conserve a diversity of habitats and species within an ecosystem to provide resilience and a source for recovery.

The Preferred Alternative will work directly to protect keystone species by enhancing populations of coral species like *A. cervicornis* and *A. palmata.* It will help reduce stressors, restore topographic relief and help maintain diversity and habitat connectivity of coral reefs within Puerto Rico by restoring impacted areas to conditions similar to reference areas. These activities will also preserve species diversity that might otherwise be lost if restoration activities were not to occur.

7.0 COMPLIANCE WITH OTHER KEY STATUTES, REGULATIONS AND POLICIES

Oil Pollution Act of 1990 (OPA), 33 U.S.C. §§ 2701, et seq.; 15 C.F.R. Part 990

OPA establishes a liability regime for oil spills or substantial threats of release of oil which injure natural resources and/or the services that those resources provide to the ecosystem or humans. Federal and state agencies and Indian tribes act as Trustees on behalf of the public to assess the injuries, scale restoration to compensate for those injuries and implement restoration. Section 1006(e)(1) of OPA,33 U.S.C. § 2706 (e)(1), requires the President, acting through the Under Secretary of Commerce for Oceans and Atmosphere (NOAA), to promulgate regulations for the assessment of natural resource damages resulting from a discharge or substantial threat of a discharge of oil. Assessments are intended to provide the basis for restoring, replacing, rehabilitating, and acquiring the equivalent of injured natural resources and services.

The OPA regulations provide a framework for conducting sound natural resource damage assessments that achieve restoration. The process emphasizes both public involvement and participation by the responsible party(ies). The Trustees have followed the regulations in this assessment.

***Clean Water Act (CWA), 33 U.S.C. §§ 1251,* et seq.**

The CWA is the principal law governing pollution control and water quality of the nation's waterways. Section 404 of the law authorizes a permit program for the discharge of dredged or fill material into waters of the United States. The U.S. Army Corps of Engineers (USACE) administers the program. Coral restoration projects usually involve placement of materials like limestone and minor disturbances of benthic sediments in jurisdictional waters, and therefore require 404 permits. Under Section 401 of the CWA, restoration projects that involve a discharge into navigable waters must obtain certification of compliance with state water quality standards. The Preferred Alternative does not involve any discharge into navigable waters; therefore, 404 permits and 401 certifications will not be required.

***Rivers and Harbors Act (RHA), 33 U.S.C. §§ 401,* et seq.**

Section 10 of the RHA prohibits the unauthorized obstruction or alteration of any navigable water of the United States. The construction of any structure in or over any navigable water of the United States, the excavating from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters is unlawful unless the work has been authorized by USACE. The authority of the Secretary of the Army to prevent obstructions to navigation in navigable waters of the United States was extended to artificial islands, installations, and other devices located on the seabed, to the seaward limit of the outer continental shelf, by section 4(f) of the Outer Continental Shelf Lands Act of 1953. The Preferred Alternative would require authorization by USACE pursuant to Section 10 of the RHA.

Coastal Zone Management Act (CZMA), 16 U.S.C. §§ 1451,* et seq.*, 15 C.F.R. Part 923

The goal of the CZMA is to encourage states to preserve, protect, develop, and, where possible, restore and enhance the nation's coastal resources. Under Section 1456 of the CZMA, restoration actions undertaken or authorized by federal agencies within a state's coastal zone are required to comply, to the maximum extent practicable, with the enforceable policies of a state's federally approved Coastal Zone Management Program. The Trustees believe that the Preferred Alternative is consistent with the Puerto Rico Coastal Zone Management Program (PR CZMP). The Trustees sought guidance from Puerto Rico regarding the proposed actions and the timing for consistency review under its program. The Puerto Rico Planning Board, in the Office of the Governor, found that (1) restoration of coral reefs is necessary to ensure the health and resiliency of the marine ecosystem within Puerto Rico; (2) that the Restoration Plan is part of a planning process required to design and define the course of action to achieve restoration, recovery and mitigation of the impacted coral reef systems; and that, as such, (3) the plan is consistent with PRCZMP policy number

29, “Objectives and Land Use Policies of the Land Use Plan of Puerto Rico", established to “protect, preserve and restore natural, environmental and cultural resources by preparing and implementing restoration plans for degraded natural, environmental and cultural resources". The Board also confirmed that, prior to performing the Preferred Alternative, NOAA and the PRDNER must continue to coordinate with the Puerto Rico Planning Board to complete consistency reviews of the project-specific implementation activities as part of further regulatory and permitting processes (Letter from Puerto Rico Planning Board to NOAA (S. Willis), April 1, 2015).

Endangered Species Act (ESA), 16 U.S.C. §§ 1531,* et seq., *50 C.F.R. Parts 17, 222, & 224

The ESA requires all federal agencies to conserve endangered and threatened species and their habitats to the extent their authority allows. Under the ESA, the Department of Commerce (through NOAA’s National Marine Fisheries Service), and the Department of the Interior (through the U.S. Fish and Wildlife Service (USFWS)) publish lists of endangered and threatened species. Section 7 of the Act requires federal agencies to consult with these departments to minimize the effects of federal actions on these listed species.

As summarized in subsection 5.2 above, the Trustees believe none of the actions proposed in the Preferred Alternative to restore impacted coral reefs and enhance coral populations are likely to adversely affect threatened or endangered Species or their designated critical habitats. NOAA Restoration Center requested concurrence with NMFS Southeast Protected Resources Division that the Preferred Alternative falls within the scope of their 3Rs Programmatic Biological Opinion on 3/26/18; and the Protected Resources Division provided concurrence on 3/26/18.

***Fish and Wildlife Conservation Act, 16 U.S.C. §§ 2901,* et seq.**

The Preferred Alternative would either encourage the conservation of non-game fish and wildlife, or have no adverse effect.

***Fish and Wildlife Coordination Act (FWCA), 16 U.S.C. §§ 661,* et seq.**

The FWCA requires that federal agencies consult with the USFWS, NMFS and state wildlife agencies regarding activities that affect, control, or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat. The Trustees coordinated with NMFS, the USFWS, and PRDNER (the appropriate state wildlife agency under FWCA). This coordination is also incorporated into compliance processes used to address the requirements of other applicable statutes. The Preferred Alternative described herein would have a positive effect on fish and wildlife resources.

***Magnuson-Stevens Fishery Conservation and Management Act, as amended and reauthorized by the Sustainable Fisheries Act (Public Law 104-297) (Magnuson-Stevens Act), 16 U.S.C. §§ 1801,* et seq.**

The Magnuson-Stevens Act (MSA) provides for the conservation and management of the Nation’s fishery resources within the Exclusive Economic Zone (from the seaward boundary of every state to 200 miles from that baseline). The resource management goal is to achieve and maintain the optimum yield from U.S. marine fisheries. The Act also established a program to promote the protection of Essential Fish Habitat (EFH) in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat. After EFH has been described and identified in fishery management plans by the regional fishery management councils, federal agencies are obligated and other agencies are encouraged to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by such agency that may adversely affect any EFH.

As summarized in section 6.2 above, the Trustees do not believe that the Preferred Alternative would have a net adverse impact on EFH as designated under the Act. An abbreviated EFH consultation was completed with NMFS on 04/03/18. Based on prior consultations for similar restoration activities, NMFS SERO concurred that the Preferred Alternative will not have a net adverse impact on EFH and that no further coordination is needed under the EFH provisions of the MSA. NMFS SERO will not be recommending EFH conservation measures under Section 305(b)(4)(A) of the MSA.

***Marine Mammal Protection Act (MMPA), 16 U.S.C. §§ 1361,* et seq.**
The MMPA provides for the long-term management of and research programs for marine mammals. It places a moratorium on the taking and importing of marine mammals and marine mammal products, with limited exceptions. The Department of Commerce is responsible for whales, porpoises, dolphins, seals, and sea lions. The Department of the Interior is responsible for all other marine mammals. The Preferred Alternative would not have an adverse effect on marine mammals.

***Migratory Bird Conservation Act, 16 U.S.C. §§ 715,* et seq.**
The Preferred Alternative would have no adverse effect on any migratory birds.

Migratory Bird Treaty Act, 16 U.S.C. §§ 703 – 712
The Preferred Alternative would have no adverse impacts on migratory birds under the purview of this Act. No migratory birds would be pursued, hunted, taken, captured, killed, attempted to be taken, captured or killed, possessed, offered for sale, sold, offered to purchase, purchased, delivered for shipment, shipped, caused to be shipped, delivered for transportation, transported, caused to be transported, carried, or caused to be carried by any means whatever, received for shipment, transported or carried, or exported, at any time, or in any manner.

***National Historic Preservation Act (NHPA), 16 U.S.C. §§ 470,* et seq.**
Section 106 of the NHPA requires federal agencies, or federally funded entities, to consider the impacts of their projects on historic properties. NHPA regulations require that federal agencies take the lead in this process, and outline procedures to allow the Advisory Council on Historic Preservation to comment on any proposed federal action. The Trustees are presently unaware of any historic sites or resources that could be affected by the Preferred Alternative.

Information Quality Guidelines Issued Pursuant to Public Law 106-554
Information disseminated by federal agencies to the public after October 1, 2002, is subject to information quality guidelines developed by each agency pursuant to Section 515 of Public Law 106-554 that are intended to ensure and maximize the quality of such information (i.e., the objectivity, utility and integrity of such information). This Final Compensatory RP/EA is an information product covered by information quality guidelines established by NOAA and DOI for this purpose. The quality of the information contained herein is consistent with the applicable guidelines.

Executive Order 13089 (63 Fed. Reg. 32701) - Coral Reef Protection
On June 11, 1998, President Clinton issued EO 13089, Coral Reef Protection, to address impacts to coral reefs. Section 2 of that EO states that federal agency actions that may affect U.S. coral reef ecosystems shall: (a) identify their actions that may affect U.S. coral reef ecosystems; (b) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and (c) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems. Given that this Final Compensatory RP/EA is designed to restore injured coral and coral reef habitat, compliance with EO 13089 is inherent within the Preferred Alternative.

Executive Order 12898 (59 Fed. Reg. 7629) -Environmental Justice
This Executive Order requires each federal agency to identify and address, as appropriate,

disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. EPA and the Council on Environmental Quality have emphasized the importance of incorporating environmental justice review in the analyses conducted by federal agencies under NEPA and of developing mitigation measures that avoid disproportionate environmental effects on minority and low-income populations. The Preferred Alternative will have no adverse effects on any low income or ethnic minority communities.

Executive Order Number 11514 (35 Fed. Reg. 8,693) – Protection and Enhancement of Environmental Quality
An Environmental Assessment is integrated within this Final Compensatory RP/EA and environmental analyses and coordination are taking place as required by NEPA.

Executive Order Number 11988 (42 Fed. Reg. 26,951) – Floodplain Management
The Preferred Alternative has neither bearing on development of nor any other potential to affect any floodplain.

Executive Order Number 11990 (42 Fed. Reg. 26,961) -Protection of Wetlands
The Preferred Alternative will not result in adverse effects on wetlands or the services they provide.

Executive Order Number 12962 (60 Fed. Reg. 30,769) -Recreational Fisheries
The Preferred Alternative will not result in adverse effects on recreational fisheries but would contribute to the enhancement of, and help support, such fisheries.

Regulation 8809, Commonwealth of Puerto Rico
Article 7a in Regulation 8809 of September 9, 2016, *Coral Reef Regulation*, prohibits the extraction, removal, mutilation or in any way destruction or harm to any coral, coral reef or coral community, associated marine system or part of these. Article 7h prohibits the installation, operation or management, without the required permit from the Secretary, artificial reefs, coral nurseries, conduct scientific research or establish restoration programs. NOAA's Restoration Center has had multiple Letters of Agreement (LOA) with PRDNER to conduct work like the Preferred Alternative in this Final Compensatory RP/EA. The current LOA is a 5 year agreement and expires in 2023.

Regulation 6766, Commonwealth of Puerto Rico
Regulation 6766 of 11 February 2004, *Regulation to rule threatened and endangered species of the Commonwealth of Puerto Rico*, prohibits the possession, transportation, take or destruction of threatened or endangered species without a PRDNER's Secretary permit (Article 2.02). The Secretary could provide a permit or authorization letter for activities that will result in the reproduction or survival of the species (Article 5.02). The Preferred Alternative seeks to increase the survival of coral species considered at present threatened. At present, NOAA is authorized to handle coral threatened species through the agreement mentioned in the previous section. Any additional required permit will be discussed and coordinated with PRDNER, as one of the Trustees.

Regulation 6765, Commonwealth of Puerto Rico
Regulation 6765 of 11 February 2004, *Regulation to rule the conservation and management of wildlife, exotic species and hunting activity in the Commonwealth of Puerto Rico*, prohibits the possession, transportation, take or destruction of wildlife without a PRDNER's Secretary permit (Article 2.02). Given that the Regulation and the PRDNER system do not provide a process for this type of activity, an authorization letter must be requested for handling the wildlife. The Preferred Alternative seeks to increase the survival and propagation of coral species, and PRDNER is one of the Trustees seeking the

support of habitat conservation through these actions; so the Trustees do not expect impediments in the process of obtaining such authorization or permit.

8.0 SUMMARY OF PUBLIC COMMENTS ON THE DRAFT COMPENSATORY RP/EA AND TRUSTEE RESPONSES

8.1 Introduction

The public comment period for the Draft Compensatory RP/EA opened on October 9, 2020, and a notice of availability was published in both English and Spanish on NOAA's and DNER's websites and in Spanish in *Primera Hora*, a paper of local circulation. The Trustees extended the initial 30 day public review and comment period and accepted public comments through December 14, 2020.

During the public comment period, the Trustees received a total of nine submissions from private citizens, NGOs, academic institutions, and representatives of the Responsible Parties. Public comments received on the Draft Compensatory RP/EA were reviewed and categorized under the following topics: (1) General Support, (2) Technical Comments, and (3) Comments Beyond the Scope of the Compensatory RP/EA. Similar comments within each topic were grouped together, as appropriate, for which the Trustees prepared a response. The resulting comments and associated responses are provided below. As described below, all comments submitted during the period for public comment were reviewed and considered by the Trustees prior to finalizing the Compensatory RP/EA. All public comments will be included in the Administrative Record. After considering the public comments received, the Trustees revised the Draft Compensatory RP/EA to prepare this Final Compensatory RP/EA. A summary of the edits made between the Draft and Final Compensatory RP/EA, including edits based on public comment, is included in Section 1.9 of this document.

8.2 General Support

Comment 8.2a: Several commenters expressed support for the proposed actions identified in the Draft Compensatory RP/EA for the proposed coral propagation work. One commenter noted that the proposed actions take an active and holistic approach to the proposed restoration and incorporate the best available current methods and resources.

Response: The Trustees for the T/V MARGARA Incident acknowledge their support.

Comment 8.2b: One commenter concurred with the Trustees' estimates for the number, species, and sizes of corals that were impacted by the T/V MARGARA Incident.

Response: The Trustees for the T/V MARGARA Incident acknowledge their agreement.

Comment 8.2c: One commenter concurred with the Trustees' estimates for the amount of credit given for the corals that were saved during Emergency Restoration.

Response: The Trustees for the T/V MARGARA Incident acknowledge their agreement.

Comment 8.2d: One commenter concurred with the Trustees' estimates in the REA for damage and recovery of corals in hard substrate areas.

Response: The Trustees for the T/V MARGARA Incident acknowledge their agreement.

Comment 8.2e: A few commenters expressed support for the Trustees' collaborative efforts to assess and restore the injured natural resources.

Response: The Trustees for the T/V MARGARA Incident acknowledge their support.

8.3 Technical Comments

Comment 8.3a: Legal and technical representatives of the RPs mentioned the recovery delay in the REA and noted that the vessel representatives, and/or the guarantor, should not be responsible for the consequences of that time delay in restoration implementation when it was not under the vessel representative's ability to control.

Response: As detailed further in Section 1.2 of the Final Compensatory RP/EA, the Trustees actively worked with the RP for several years following the Incident. This work included (1) cooperative implementation of Emergency Restoration from 2006 to 2008, (2) cooperative assessment of natural resource injuries and recovery at the site from 2008 to 2013 in order to establish to the RP the need for Primary Restoration, and (3) cooperative planning of Primary Restoration as well as developing alternatives for Compensatory Restoration from 2013 to 2014. In May 2014, legal representatives for the RP informed the Trustees that the owner of the T/V MARGARA, Ernst Jacob, had become insolvent and the RP would no longer be participating in the ongoing assessment. Following the RP withdrawal from participation in the assessment and after receiving the notification of the bankruptcy, the Trustees published a Draft Primary RP/EA in 2014 and completed the Final Primary RP/EA in 2015, presented the claim for Primary Restoration costs to the RP's agent and guarantor in 2017, and submitted a claim to the National Pollution Funds Center (Claim: M006017-OC01) for Primary Restoration costs in 2017. Because Primary Restoration is necessary to stabilize the rubble fields present at the Site, the Trustees could not finalize their determination of damages, nor calculate how much Compensatory Restoration would be needed, until they knew when Primary Restoration would be implemented. Funding for Primary Restoration was approved in 2019 by the NPFC, and implementation will commence in 2021.

Ultimately, there are many individual factors which are incorporated into the Trustees' REA calculations and recovery delay is only one of them. Were it to be excluded from consideration or artificially shortened, the injuries to the natural resources and to the public as a result of the T/V MARGARA Incident would not be appropriately compensated for. As detailed in Section 1.2, Compensatory Restoration is necessary to compensate for interim losses of natural resources and services that occur from the date of injury until recovery of baseline conditions. That recovery to baseline conditions, in turn, is accomplished through Primary Restoration. Implementation of Primary Restoration substantially lowers the required Compensatory Restoration, when compared with the interim losses which would take place under natural recovery.

Comment 8.3b: Legal and technical representatives of the RPs questioned that the Trustees were basing their damage assessment on surveys conducted between 2006 and 2012 and suggested that the Trustees have not revisited the site since 2012.

Response: The Trustees are very familiar with the site. As detailed in Table 15, not only did the Trustees visit the site between 2006 and 2012 to conduct surveys, perform recruitment monitoring, and implement emergency restoration, but the Trustees have also regularly visited the site every year since 2013. Since 2012, the Trustees and/or the Trustees' contractors have visited the T/V MARGARA Incident site more than 100 times. All site visits to date have supported the Trustees' assessments of the site and the Trustees' conclusion that recovery is inhibited in the rubble areas of the site. Site visits in August and September 2021 during the pre-construction photomosaic collection effort for Primary Restoration implementation observed evidence of rubble movement and additional overturned Emergency Restoration structures which will need stabilization during Primary Restoration.

There is a large coral nursery adjacent to the site that was established in anticipation of Primary Restoration and which needs tending on a regular basis (i.e., quarterly). Due to its proximity, visits to this nursery often coincide with visits to the site. Additionally, site surveys have been and will continue to be conducted in preparation for implementation of Primary Restoration. Most recently, NOAA contractors conducted reference transect surveys at the site in the summer of 2020, and Trustee representatives were at the site in January and February of 2021 to prepare the coral nursery to propagate corals needed for Primary Restoration, and again in March 2021 to collect photomosaic imagery of the site for Primary Restoration planning. The Trustees have added language to clarify both site visitation history and awareness of site conditions in Section 3 (Assessment of Injuries to Natural Resources) of the Final Compensatory RP/EA.

Table 15: T/V MARGARA Site Visits by Trustees and/or the Trustees' Contractors Since 2012

Year	Number of Days	Description
2013	48*	Coral nursery work, monitoring and site checks (31 days) Monitoring (17* days)
2014	17*	Coral nursery work, monitoring and site checks (8 days) Monitoring (5* days) Mooring buoy maintenance (4 days)
2015	12	Coral nursery work, monitoring and site checks (11 days) Post hurricane site check (1 day)
2016	6	Coral nursery work, monitoring and site checks (6 days)
2017	22*	Coral nursery work, monitoring and site checks (11* days January/February; 3 days February; 7 days August) Post Hurricane Maria site check (1 day)
2018	6	Coral nursery work, monitoring and site checks (6 days)
2019	11	Coral nursery work, monitoring and site checks (11 days)
2020	13	Collect reference data (4 days) Post-earthquake site check (1 day) Prepare coral nursery for Primary Restoration (8 days)
2021†	29	Collect photomosaic imagery of the T/V MARGARA site for Primary Restoration (20 days) Prepare coral nursery for Primary Restoration (9 days)

***** Multiple sites were visited during these trips

† As of date of publication of Final Compensatory RP/EA

Comment 8.3c: Legal and technical representatives of the RPs questioned the Trustees' assertion that no natural recovery is occurring in the areas designated as Majority Unconsolidated Rubble. In support of this, the commenters pointed to the difference between the original estimate of 3,930 square meters of rubble and the 2012 surveys that identified 1,662 square meters of damaged areas where unconsolidated rubble required active intervention via Primary Restoration. The commenters agreed that there is impeded natural recovery in areas of unconsolidated rubble but suggest that the decrease in the area of damage requiring primary restoration indicates that natural recovery is occurring.

Response: The Trustees acknowledge that limited natural recovery has begun in some areas of the site. However, attributing the difference between the original estimate of 3,930 m^2 of rubble and the 2012 surveys that identified 1,662 m^2 of unconsolidated rubble requiring Primary Restoration as being indicative of recovery is a mischaracterization that paints an incomplete picture of site recovery. The Draft Compensatory RP/EA defined a single area as "Majority Unconsolidated Rubble" (3,930 m^2). However, the Trustees divided the "Majority Unconsolidated Rubble" area in the Final Compensatory RP/EA by separating it into two areas: Unconsolidated Rubble Requiring Primary Restoration (1,662 m^2)

and Rubble Not Requiring Primary Restoration (2,268 m^2). The Trustees agree that the 2012 surveys identified 1,662 m^2 where unconsolidated rubble required active intervention in the form of Primary Restoration. The 1,662 m^2 footprint requiring Primary Restoration is included within the originally estimated area of 3,930 m^2 of rubble. Primary Restoration of this smaller area is intended to stabilize enough of the unconsolidated rubble to allow for overall recovery of site as a whole, including the larger 3,930 m^2 area. However, Primary Restoration has not been completed yet. Repeated damage from rubble mobilization during high-energy events, such as storms, prevents recovery in the areas of Unconsolidated Rubble Requiring Primary Restoration, and limits recovery in areas of Rubble Not Requiring Primary Restoration. Until Primary Restoration is complete any natural recovery is likely temporary given coral's susceptibility to re-injury from mobilized rubble during high-energy events.

The joint field work conducted in 2012 during Primary Restoration planning was not intended to track recovery and recharacterize the overall site but, rather, to identify the areas where Primary Restoration would be most beneficial in supporting recovery of the overall site. Measurements were taken only in the areas targeted for Primary Restoration. Therefore, some of the smaller rubble areas were not captured within this effort. This is because the Trustees realized at the time that not all of the smaller, more isolated rubble areas could be addressed in a cost-effective manner. Accordingly, the Trustees chose to focus Primary Restoration efforts on the larger rubble areas to maximize cost-effectiveness as recommended in 15 C.F.R. § 990.14(c).

The Trustees also acknowledge that between the 2012 joint site visit and the present, some limited recovery has begun in some of the rubble areas not slated for Primary Restoration. This limited recovery includes lower mortality of coral recruits compared to rubble areas requiring Primary Restoration, but this recovery is not as successful as in the hard substrate areas where there is higher survival of coral recruits (Fox et al., 2003; Cameron et al 2016; Yadav 2016; Viehman et al., 2018; Fox et al., 2019). As previously stated, the Trustees, therefore, revised the Final Compensatory RP/EA to separate the injury area previously defined in the Draft Compensatory RP/EA as "Majority Unconsolidated Rubble" (3,930 m^2) into two areas: Unconsolidated Rubble Requiring Primary Restoration (1,662 m^2) and Rubble Not Requiring Primary Restoration (2,268 m^2).

The Trustees consider natural recovery to have already begun in areas of Rubble Not Requiring Primary Restoration, even though recovery here is limited and temporary due to repeated damage from mobilized rubble. However, because pinpointing the precise time when recovery began in these areas would require extensive and expensive data collection, mapping, and analysis of the current recruitment and recovery dynamics at the site, the Trustees revised REA applied a recovery delay of six years for areas of Rubble Not Requiring Primary Restoration. This six-year delay reflects the lagging recovery observed at these areas between 2012 and 2021 while also acknowledging the occurrence of some limited recovery. Yet, without the specific data to quantify the lagging recovery, the Trustees set 2012 as the date for which recovery began for Rubble Not Requiring Primary Restoration. Although this may overestimate recovery, the Trustees determined that a recovery delay of 15 years is not appropriate for these areas since limited recovery was observed. The recovery delay remains 15 years for the areas of Unconsolidated Rubble Requiring Primary Restoration because natural recovery is not occurring there.

Figure 22 displays the difference between a healthy and successful recovery as compared to the August 2021 observations at the Margara Incident rubble fields. Note the presence of a few surviving corals in the rubble fields does not represent successful recovery. Furthermore, observations from August and September 2021 reported signs of recent rubble movement, subsequent burial of corals and coral recruits, as well as movement and flipping of Emergency Restoration structures (Figure 23).

Figure 22: Photo on left showing healthy recovery with numerous surviving coral recruits in 2012 at the T/V SPERCHIOS grounding site six years post grounding. Photo on right showing the lack of any significant recovery in rubble fields in 2021 at the T/V MARGARA site fifteen years after the grounding. Photos by Sea Ventures, Inc.

Figure 23: Evidence of continued burial of corals and recruits by rubble movement and movement of Emergency Restoration structures in 2021 at the T/V MARGARA site. Photos by Sea Ventures, Inc.

Comment 8.3d: Legal and technical representatives of the RPs mentioned that there is no discussion in the Draft Compensatory RP/EA of whether the initial grounding site is excluded from the overall damage estimates or otherwise considered as part of the compensation claim.

Response: The Trustees did not include the initial impact area in their assessment of the damage. The Draft Compensatory RP/EA notes this in the description of and discussion related to Figure 4 in Section 1.1. The Draft Compensatory RP/EA reads, "The total direct impact area from the T/V MARGARA Incident includes (1) the initial grounding site (Location 1, Site 146), which was not impacted by response actions, (2) impacts to the South Region (Location 2, Sites 144-145 and 147-151), (3) a deeper Central Region impacted by prop wash (off the stern of the vessel in Location 2 Figure 2 and the top left of Figure 4), and (4) the North Region (Locations 4 and 5 in Figure 2). A total of approximately 6,755 m^2 was directly impacted by response actions." To provide additional clarity, the Trustees have added the following sentence to the Final Compensatory RP/EA: "Site 146, the area of the initial grounding, is not part of the areas which were impacted by response actions and is therefore not included in this estimate or in subsequent damage assessment."

Comment 8.3e: Legal and technical representatives of the RPs questioned whether some of the damage in the northern impact was likely due to vessel movements from oceanographic conditions or actions of the master and not to planned removal efforts.

Response: The northern site, where the vessel regrounded multiple times during response actions (Figures 2,4), consists entirely of damage ultimately resulting from response efforts taken as part of the removal of the vessel. The National Pollution Funds Center also confirmed this on pages 18-19 of its determination of the Trustees' claim for Primary Restoration.

Comment 8.3f: One of the commenters remarked on the importance of including sea urchins as herbivores in restoration projects in Puerto Rico because there has been a significant increase in the invasive red encrusting calcareous algae, *Ramicrusta*, that is spreading throughout coral reefs in Puerto Rico (Williams and Garcia Sais, 2020). *Ramicrusta* is the dominant substrate on many coral reefs, reaching as high as 60% cover in some places. *Ramicrusta* grows quickly and overgrows and smothers coral and other sessile organisms. The commenter also noted that *Ramicrusta* is considered a "detractor, as it is chemically defended against herbivorous fishes. Other herbivores, such as sea urchins are known to consume and significantly decrease *Ramicrusta* cover." The commenter further noted that "[a]t the moment the only organism that eats and significantly reduces *Ramicrusta* abundance is sea urchins. Therefore, it is necessary to include them in restoration."

Response: The Trustees agree with this statement. Sea urchins have always been included as an integral part of this restoration, and the Trustees have included additional details on *Ramicrusta* in the project summaries for both Asexual Coral Propagation and Sea Urchin Restocking in Section 4.5 of the Final Compensatory RP/EA.

Comment 8.3g: One of the commenters remarked on the project selection criteria for Asexual Coral Propagation on page 44 in the Draft Compensatory RP/EA which says using asexual fragmentation has been shown to significantly reduce the growout time relative to other techniques. The commenter wrote that "the micro fragmentation of slow growing corals, which are the foundation species, reduces the grow out time significantly."

Response: The Trustees agree with this statement, and have added language concerning slow growing corals, as the foundation species, to the project selection criteria in Section 4.5 of the Final Compensatory RP/EA. Micro fragmentation techniques for slower growing corals are included in the Trustees' Preferred Alternative.

Comment 8.3h: One of the commenters remarked on the project selection criteria for Sexual Coral Propagation on page 45 in the Draft Compensatory RP/EA, noting that this type of project will take a longer time to see any changes on the reef.

Response: The Trustees agree with this statement. While Sexual Coral Propagation is a promising technique for long term reef restoration, the extended timeframe for return of benefits combined with low early life history survival make it a more challenging technique to consider for the Trustees' restoration needs resulting from this Incident. As a result, the Trustees did not propose this as the Preferred Alternative in the Draft Compensatory RP/EA, nor select it for implementation in the Final Compensatory RP/EA.

Comment 8.3i: One commenter asked for clarification on why *Diadema* sea urchin propagation as a solo project is categorized as "Long" for the "[t]imeliness to achieve results" category in Table 8 on page 50 of the Draft Compensatory RP/EA. The commenter states that "you start seeing significant reduction in algal cover within a month of restocking *Diadema*. In addition, adult *Diadema* are considered settlement cues for *Diadema* larval settlement (Hunte and Younglao 1988, Forcucci 1994). Therefore, natural recruitment of *Diadema* should occur after populations are increased through restocking efforts."

Response: The "[t]imeliness to achieve results" category in Table 8 refers to the amount of time it will take a project to replace the number of corals lost. Here, it does not refer to the amount of time it will take to restock *Diadema* or to remove algae. For *Diadema* alone, the "[t]imeliness to achieve results" includes the time it takes: (1) to restock the sea urchins to then remove the algae in order to clear space for coral recruitment, and (2) for the corals to then recruit onto the reef, and then (3) for those corals to survive and grow to adult sizes similar to those that were lost. Similar to the Sexual Coral Propagation alternative, while *Diadema* propagation as a stand-alone project is a promising technique for long term reef restoration, the extended timeframe for return of benefits combined with low early life history survival of coral recruits make it a more challenging technique to consider for the Trustees' needs with this Incident. As a result of this, the Trustees did not select sea urchin propagation as a preferred stand-alone restoration project. However, the Trustees do recognize the beneficial impact on coral reef restoration which grazer and herbivore propagation can have, and have included sea urchin propagation as a supplemental component of the Preferred Alternative, *Enhancement of Corals and Coral Reef Ecosystems Using Asexual Coral Propagation and Restoration*, in the Final Compensatory RP/EA.

Comment 8.3j: One commenter agreed with the Trustees' decision to not propagate parrotfish as a restoration alternative stating that "parrotfish are picky eaters. They don't consume all algal types, especially Dictyota, which is one of the most abundant algae on coral reefs."

Response: The Trustees for the T/V MARGARA Incident acknowledge their agreement.

Comment 8.3k: One commenter suggests that the Draft Compensatory RP/EA's plan to propagate *Diadema* or parrot-fish is ill-advised, as they are herbivores that can drastically damage more living coral than is beneficial.

Response: As mentioned in Section 4 of the Final Compensatory RP/EA, the Trustees are not proposing to propagate parrot fish. As for *Diadema*, according to the scientific literature, sea urchins, including *Diadema*, are algal grazers and increase the survival of corals on the reef and in aquaria by enhancing herbivory, reducing algal cover, and increasing coral survival, recruitment rates, and growth (Edmunds and Carpenter, 2001, Chiappone et al., 2003; Carpenter and Edmunds, 2006; Idjadi et al., 2010; Williams, 2017; Craggs et al., 2019, Williams, 2021). As such, *Diadema* would not damage living coral, but would instead benefit growing corals by improving the reef environment by reducing competition with algae and ultimately, increasing coral recruitment, growth, and survival rates.

Comment 8.3l: Legal and technical representatives of the RPs suggested including the Caribbean king crab (*Maguimithrax spinosissimus*) to aid in managing algae overgrowth at restored sites. They further state that their use has shown promise in other Caribbean locations and is an active part of ongoing restoration efforts in the Florida Keys.

Response: The Trustees agree that use of Caribbean king crab is a viable option and have added language to the Final Compensatory RP/EA to indicate that the Preferred Alternative includes both Caribbean king crab and sea urchins as available options for herbivores to aid in managing algae at restoration sites. This was included in Section 5.2.8 in this Final Compensatory RP/EA.

Comment 8.3m: Legal and technical representatives of the RPs suggest that there is some disparity between the amount of corals proposed for outplanting in the T/V MARGARA Draft Compensatory RP/EA and other past cases in Puerto Rico (such as the T/V PORT STEWART and LNG-C MATTHEW) (Table 16), suggesting that the outplants required by the Trustees for this Incident are approximately twice that of the T/V PORT STEWART and LNG-C MATTHEW restoration plans.

Response: While past cases are informative, each incident is independently evaluated based on the size, nature, and extent of injury. Comparing only the size of the impacted sites and the number of corals lost for each of the groundings, the T/V MARGARA Incident was over twice as large as the LNG-C MATTHEW grounding (Table 16). The T/V MARGARA Incident was over ten times larger than the T/V Port Stewart grounding in terms of the number of corals lost and over twenty times larger in terms of the size of the impacted site (Table 16). Considering the nature and extent of injury in addition, impacts to the T/V MARGARA site were structurally much more significant to the reef, creating rubble fields that require stabilization through Primary Restoration in order for recovery to occur. In contrast, there were no significant recovery delays for either the T/V PORT STEWART or LNG-C MATTHEW groundings. In those cases, the damage to the reefs was addressed during Emergency Restoration efforts and did not require further substantial Primary Restoration for recovery to begin.

There are substantial differences between the T/V MARGARA Incident and other past cases in Puerto Rico in terms of the size of the impacted sites, the number of corals lost, the nature and extent of structural damage to the reef, and the need for Primary Restoration before recovery could begin. Because of these factors, the Trustees believe the restoration requirements for the T/V MARGARA Incident are an accurate reflection of the differences between these incidents.

Table 16: Size of Impact and Number of Corals Lost for the T/V MARGARA Incident, LNG-C MATTHEW and T/V PORT STEWART

Incident	T/V PORT STEWART	LNG-C MATTHEW	T/V MARGARA
Total Corals Lost	7,200	72,000	166,854
Size of Impact	512 m^2	3,047 m^2	6,755 m^2

Comment 8.3n: A couple of the commenters state that the Trustees' Draft Compensatory RP/EA proposes too much compensation for the damages to trust resources. These commenters assert (1) that over twice the amount of hard corals are proposed to be outplanted as were lost and that they will be outplanted at a larger average size than the impacted corals; and (2) that larger corals should be outplanted to reduce the number of corals required for compensation by the REA.

Response: The Trustees disagree with these two assertions and understand them to be self-contradictory. The commenters simultaneously express concern about outplants being larger than what was present before the Incident, and recommend that the Trustees outplant even larger corals than the Draft Compensatory RP/EA proposed in order to reduce the number of overall outplants needed. Approximately 166,854 corals were impacted by the T/V MARGARA Incident. The Draft Compensatory RP/EA proposed 95,250 corals to compensate for the corals that were lost (Draft Compensatory RP/EA, Table 13, page 67). This equates to 57% of the number of corals impacted. The Final Compensatory RP/EA proposes 86,206 corals, which amounts to 52% of the number of corals impacted.

The Draft Compensatory RP/EA did not propose outplanting larger corals than those that were lost as a result of the T/V MARGARA Incident. Of the scleractinian corals lost during the T/V MARGARA Incident, 95% were 10 - 40 cm in diameter, and 95% of the octocorals lost were 10 - 60 cm tall (Draft Compensatory RP/EA, Figure 12, page 30). The Draft Compensatory RP/EA proposed outplanting corals in the 15 - 25 cm range (Table 12 in the Draft Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models). Although this is within the lower range of sizes that were lost, the proposed size of coral outplants in the Draft Compensatory RP/EA was based on current best practices from around the Caribbean to maximize project success and not based on CCYG values in the REAs (NOAA, 2019; Goergen et al., in press).

The Trustees have updated the estimated outplant sizes in the REA to more accurately reflect the sizes of corals outplanted in Puerto Rico since 2018 in Table 17 (NOAA et al., 2018; NOAA et al., 2019; NOAA et al., 2020) and in Tables 12 and 13 in the Final Technical Memo for Scaling Compensatory Restoration for the T/V MARGARA Incident using Resource Equivalency Analysis Models. These size estimates are equal to or larger than what other coral restoration practitioners are outplanting from their nurseries. Outplant sizes are the result of multiple factors that include nursery capacities, overloading of the nursery structures, annual coral growth rates, coral mortality, vessel cargo space during transport from nursery to restoration site, hurricane season, and diver handling both in the nursery and outplanting. Corals in the nurseries are pruned and outplanted prior to hurricane season so that there are smaller corals in the nurseries during hurricane season to minimize damage and/or loss during storms. Increasing the size of outplants reduces the number of corals that can be outplanted in a day due to limitations in vessel cargo space and the increased diver interaction time required to outplant larger corals. The larger the outplanted coral, the fewer each diver can carry at a time and the longer it takes to attach each coral. Therefore, while outplanting larger corals may reduce the number of corals needed to meet the REA restoration requirements, it would also significantly increase outplanting costs since more days would be required for outplanting.

Table 17: Size of Coral Outplants in Puerto Rico Between 2018 and 2021 by Species.

	Size of Outplants												
Species	**5 cm**	**10 cm**	**15 cm**	**20 cm**	**25 cm**	**30 cm**	**35 cm**	**40 cm**	**45 cm**	**50 cm**	**55 cm**	**60 cm**	**Ave. Size**
A. cervicornis	198	325	121	371	226	1,081	736	1,398	490	319	50	23	**33 cm**
A. palmata	420	11,349	48	3,126	26	283	5	35	0	0	0	0	**12 cm**
D. cylindrus	38	750	0	60	0	0	0	0	0	0	0	0	**10 cm**

Comment 8.3o: One commenter remarked that "the compensatory coral outplants will also increase the overall prevalence of a regionally threatened species and has positive compensatory value that will likely exceed the pre-grounding conditions."

Response: This may be true for the faster growing *Acroporids* that will be outplanted, but is not true for the other slower growing ESA listed species like *Orbicella* spp. and *Dendrogyra* that are also proposed to be outplanted. The Trustees will not be able to replace the larger colonies of those species lost as a result of the Incident in a reasonable time frame. The proposed alternative includes coral species that can be successfully produced using existing coral propagation techniques. Since the Trustees are not able to propagate all species, the restoration will have to outplant higher numbers of some species than were present at the site before the Incident, while at the same time outplanting lower numbers for others, or not outplanting certain species at all.

Comment 8.3p: One commenter remarked that the annual natural loss of corals in the reference areas at the T/V MARGARA site is likely to range from several percent to over ten percent per year under normal circumstances and this should be addressed in the REA.

Response: According to data collected by the Trustees, this assumption is not correct. During recruitment monitoring, reference surveys were conducted through 2013 at reference transect sites near the impacted areas. More recently, coral transect surveys were collected in July 2020 by NOAA contractors at reference sites near the impacted areas. Both of these survey efforts show no downward change in coral densities when compared with original reference transect surveys conducted in 2006 and 2008, indicating that annual natural loss of corals in the reference areas is minimal. In contrast, other coral reef areas in Puerto Rico have even shown an increase in coral cover since 2006 (Garcia-Sais et. al, 2019).

Comment 8.3q: One commenter mentioned that they had reached out to contractors, including Dr. David E. Vaughan Consulting LLC. They further asserted that, according to Dr. Vaughan, Compensatory Restoration could be completed in 5 to 7 years.

Response: The Trustees believe this reduced time frame is likely too aggressive for the number of corals required in the Final Compensatory RP/EA. It is likely that it relies on overly aggressive assumptions in terms of the time required to grow out the corals, the number of days needed to outplant corals each year, and the manpower necessary to do so.

The first year of work alone requires building the nurseries up to capacity to produce the number of corals that will be needed for outplanting. In following years, Trustees expect to be outplanting just under 11,000 corals a year, which will require an estimated 82 field days per year for outplanting alone. In addition, more field days will be needed for site preparation, nursery and site maintenance, and restoration monitoring. Unfortunately, due to prevailing weather patterns (15 to 20 knot trade winds and 4' to 6' seas, as well as seasonal hurricanes and tropical storms), it is not possible to conduct field work every day of the year in Puerto Rico. These "weather days" must be accounted for when planning a restoration project. Based upon the Trustees' experience in Puerto Rico with the scale of nurseries, associated permitting, capacity and expertise to outplant, the Trustees believe that 9 years is a realistic and achievable pace to meet the restoration goals set forth in the Final Compensatory RP/EA.

Comment 8.3r: One commenter asserted that ten percent mortality of outplants each year for five years, including the 3% discount in the REA, is less than 60 percent survival and more conservative than the estimated mortality for the Mission: Iconic Reefs restoration efforts. They suggest that after the first two years the mortality rate of outplants will be about the same as for naturally-occurring corals. Therefore, they recommend using 10% mortality only in the first two years.

Response: The first assertion, that the mortality rate used by the Trustees is higher than the cited Mission: Iconic Reefs example, is incorrect. In fact, the Mission: Iconic Reefs endeavor (a large-scale restoration planning effort in Florida) took an even more conservative approach to outplant mortality, and considered 10% annual mortality over a 10 year period of time, rather than the 5 years used by the Trustees for the T/V MARGARA Incident. The Trustees consider the ~60% survival estimate to be reasonable and consistent both with the Trustees' previous experience (NOAA et al., 2018; NOAA et al., 2019; NOAA et al., 2020) and with other practitioners in the field. While the Trustees will strive for maximum survival, higher estimates of survival are purely speculative and will not ensure the public is made whole. Moreover, the Trustees acknowledge there is a recent threat that has the potential to significantly increase the mortality rate of affected corals, Stony Coral Tissue Loss Disease. Reefs impacted by SCTLD have shown declines of 50% in coral density (Brandt et al 2021). Given this is a recent threat for Puerto Rico, reported for the first time at the end of 2019 and still spreading westbound, the impact of SCTLD was not included in this assessment.

The second assertion, that after the first two years the mortality rate of outplants will be the same as for naturally-occurring corals, is incorrect. Effectiveness monitoring, or how well a coral restoration project is able to meet the desired goals, can take up to 5 years to properly determine the survival of outplants (Goergen et al., 2020). After 5 years, outplanted corals (using the techniques proposed here) are typically sexually mature and established on the reef (NOAA, 2019). The fate of the corals after this point in time generally are not related to their status as restored corals and have more to do with overall reef condition.

Outplanted coral survival is very site- and species-specific and can vary greatly across regions. The Trustees applied mortality calculations over a 5-year period of time to reflect that even the outplanted corals that eventually perish will provide services for some period of time.

Comment 8.3s: Legal and technical representatives of the RPs questioned the Trustees cost per coral outplant estimates and the cost per corals lost compared to other grounding cases in Puerto Rico and Hawaii.

Response: The Trustees did not use either cost per coral lost or cost per coral outplant as variables to estimate the cost of the Compensatory Restoration in the Draft or Final Compensatory RP/EA. Rather, the Trustees incorporated the actual expected costs of the various components of the restoration project (i.e., labor, vessels and materials needed for setting up the nurseries, maintenance, restoration site preparation, outplanting, and monitoring) to calculate a total cost for execution of the project as a whole. Any references to cost in the Draft Compensatory RP/EA and/or attached supplementals were for general estimation purposes only. Now that the Trustees are publishing the Final Compensatory RP/EA, they have developed detailed cost estimates (based on past, current, and anticipated costs for executing coral restoration in Puerto Rico) for the Preferred Alternative and those details can be found in Administrative Record at https://www.diver.orr.noaa.gov/web/guest/diver-admin-record/6204. It is also important to note that, due to advances in restoration techniques and approaches, the Preferred Alternative for the T/V MARGARA Incident involves restoring a more accurate representation of species impacted than has been possible in the past. This has the additional effect of making cost per coral comparisons with prior cases more difficult.

Comment 8.3t: One commenter recommended outplanting only on the same south coast surrounding Tallaboa for both nexus and cost considerations. They argue that there is no evidence of widespread mortality events that would affect all outplant types in the recent past, and minimal spread of outplant sites of 25 km from the outplant facility will minimize risk of catastrophic loss, maximize output from a single large facility, and reduce costs.

Response: The Trustees do not agree that outplanting solely within 25 km of a single coral nursery is sufficient to minimize risk of catastrophic loss. In 2017, Hurricanes Irma and Maria caused significantly more damage to corals, outplants and nurseries in northeast Puerto Rico than reefs in the southwest of the island (Viehman et al., 2020). Conversely, Hurricanes Matthew and Dean caused more damage to the southwest coast than the northeast coast in 2016 and 2007, respectively. In addition, bleaching events can vary in severity from one side of the island to the other depending on water temperature, resulting in localized mortality which is difficult to predict with certainty (Garcia-Sais et al., 2019). Hurricane damage to coral nurseries in Puerto Rico also varies between regions over the years (NOAA et al., 2018). Therefore, the Trustees concluded that restoration should occur at a number of coastal sites in Puerto Rico in order to minimize the risk of catastrophic loss and maximize the potential for restoration success.

Comment 8.3u: One commenter suggested including *Montastraea cavernosa* as one of the coral species for propagation, as it does well in ex-situ nurseries using micro fragmentation techniques.

Response: The Trustees agree with this recommendation and plan to include *M. cavernosa* in the propagation efforts. The Trustees have added it to the list of coral species for micro fragmentation work in Section 5.2 of the Final Compensatory RP/EA.

Comment 8.3v: One commenter suggested the Trustees also consider using artificial reefs in order to speed up the restoration process. They stated that natural coral reefs take a while to grow and that artificial reefs with the proper materials and proper design could also help for tourism purposes.

Response: The Trustees agree that artificial reefs can speed up the process of replacing some of the services that were lost in cases where reef structure was compromised or destroyed. Limestone boulders, a form of artificial reef, are being used for Primary Restoration at the T/V MARGARA site to replace lost topography that would otherwise take centuries to regrow. As mentioned in Section 4.4 of the Final Compensatory RP/EA, while artificial reefs can mimic some of the structural characteristics of reefs, they do not provide a means to restore the biological resources that were lost during the Incident and for which the Trustees are seeking to restore through Compensatory Restoration. The Preferred Alternative will provide for the restoration of those biological reef resources lost as a result of the Incident and will, in turn, have a positive impact on human uses such as tourism.

Comment 8.3w: One commenter recommended acclimating the corals grown in the land-based nurseries to the in-water nurseries prior to outplanting to increase their overall survival.

Response: The Trustees agree with this recommendation and have included it in the Final Compensatory RP/EA in Section 5.2.

Comment 8.3x: Several commenters identified minor grammatical errors throughout the Draft Compensatory RP/EA.

Response: The Trustees appreciate the suggestions and have made the appropriate corrections throughout the Final Compensatory RP/EA.

8.4 Comments Beyond the Scope of the Compensatory RP/EA

Comment 8.4a: Legal and technical representatives of the RPs questioned the perceived increase in estimated costs for the current restoration when compared to the Trustees' previous settlement offers relating to this Incident.

Response: Any reference to or exploration of positions taken by the Trustees during potential settlement discussions is outside the scope of this Restoration Plan. The primary purpose of this Restoration Plan is to determine what is necessary to address natural resource injuries for which OPA is applicable, and to select restoration projects which will restore, rehabilitate, replace, and/or acquire the equivalent of damages caused by those injuries. As detailed in Section 4.2, Restoration Selection Criteria of the Restoration Plan, the Trustees considered a number of factors in selecting the Preferred Alternative, including cost, and found that "[t]he Preferred Alternative is likely the most cost-effective given its widespread use as a conservation management tool in the region." (Section 4.5).

Comment 8.4b: Legal and technical representatives of the RPs made remarks on both the scale and implementation of the Final Primary RP/EA, suggesting that the Trustees' surveys were outdated and that a survey should be conducted prior to Primary Restoration implementation to avoid any additional harm to the reef.

Response: Primary Restoration was designed in conjunction with RP consultants, Polaris and Continental Shelf Associates, through 2014. The public comment period for the Draft Primary RP/EA closed on October 20, 2014 and no public comments were received. The RPs' technical representative, Polaris, however, provided comments on the Final Primary RP/EA to the National Pollution Fund Center during consideration of the Trustees' Primary Restoration claim.

As detailed in the Trustees' response to Comment 8.3b, above, the Trustees have visited the site multiple times each year since the Incident, continue to do so, and are familiar with current site conditions.

The Trustees fully intend to avoid any collateral injury during Primary Restoration implementation. This is discussed in Section 5.1, Environmental and Socio-Economical Impacts Evaluation, of the Final Primary RP/EA.

Comment 8.4c: Legal and technical representatives of the RPs provided remarks questioning the United States Coast Guard's determination that the Incident represented a substantial threat of release of oil.

Response: The United States Coast Guard's determination that the grounding of the T/V MARGARA represented a substantial threat of release of oil was analyzed in detail in the National Pollution Funds Center's 2019 determination of the Trustees' Primary Restoration claim. Further analysis of that determination is outside the scope of this Restoration Plan.

Comment 8.4d: Legal and technical representatives of the RPs asked about restoration credit for the prior purchase and operation of a pilot boat to improve pilotage system in the area of the Incident, asserting that credit should be applied toward coral damages for either the LNG-C MATTHEW or T/V MARGARA cases.

Response: The Trustees understand that the Norwegian Hull Club, one of the insurers for both the T/V MARGARA and the LNG-C MATTHEW, entered into an agreement with a pilot's association to reimburse the pilots for the purchase of a pilot boat and provide funds for operation of the pilot boat. The Trustees were not party to this agreement. Norwegian Hull Club proposed the purchase and operation of a pilot boat as credit towards compensatory restoration of the T/V MARGARA Incident. However, the Trustees could not calculate compensatory restoration nor consider compensatory restoration alternatives for the T/V MARGARA Incident until site recovery and primary restoration were determined first. Site recovery and primary restoration were not determined until 2019 when the NPFC granted the Trustees' interim OSLTF claim for primary restoration costs. As explained in Section 4.5 of this Compensatory RP/EA, the Norwegian Hull Club subsequently offered the purchase and operation of the pilot boat as compensatory restoration credit for another oil spill incident caused by one of its insured, the LNG-C MATTHEW. Because this project to improve pilotage was already used to compensate for losses associated with another case, it is no longer a viable alternative for the T/V MARGARA Incident.

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APPENDIX A

TOTAL NUMBER OF CORALS IMPACTED BY SPECIES AND SIZE CLASS

	Size Class								
Scleractinians Species	**0 - 5 cm**	**5-10 cm**	**10-20 cm**	**20-30 cm**	**30-40 cm**	**40-50 cm**	**50-60 cm**	**60-70 cm**	**Total**
Acropora cervicornis	171	277	553	210	77	55	55	28	**1,427**
Agaricia lamarcki	66	66	69	3	14	0	0	0	**219**
Agaricia spp.	4,345	3,795	1,865	447	69	0	0	0	**10,521**
Colpophyllia natans	0	55	55	77	0	0	0	55	**243**
Dichocoenia stokesii	173	186	200	55	0	0	0	0	**615**
Diploria labyrinthiformis	28	54	82	3	133	0	0	0	**299**
Eusmilia fastigiata	39	39	77	0	28	0	0	0	**182**
Isophyllia spp.	93	134	146	28	0	0	0	0	**401**
Madracis auretenra	1,047	756	634	291	55	0	28	0	**2,810**
Madracis decactis	1,049	774	668	346	55	0	28	0	**2,920**
Manicina aerolata	28	0	0	0	0	0	0	0	**28**
Meandrina meandrites	272	274	245	136	55	0	0	0	**983**
Meandrina jacksoni	11	11	69	77	0	0	0	0	**169**
Millepora spp.	398	464	373	111	55	28	0	0	**1,428**
Montastraea cavernosa	907	1,043	1,487	980	492	57	0	3	**4,970**
Mycetophyllia spp.	0	55	91	0	0	0	0	0	**146**
Oculina spp.	28	0	0	0	0	0	0	0	**28**
Orbicella annularis	230	243	434	196	190	55	0	69	**1,417**
Orbicella faveolata	301	406	344	388	216	55	28	45	**1,783**
Orbicella franksi	105	146	406	210	160	28	28	0	**1,084**
Orbicella spp.	0	28	77	28	55	0	0	0	**188**
Porites astreoides	2,402	3,827	5,030	1,490	278	55	28	28	**13,138**
Porites branneri	0	28	0	0	0	0	0	0	**28**
Porites porites	199	221	105	55	0	0	0	0	**581**
Pseudodiploria spp.	339	432	768	287	122	0	0	0	**1,947**
Scolymia spp.	41	0	0	0	0	0	0	0	**41**
Siderastrea radians	26	79	0	0	0	0	0	0	**105**
Siderastrea siderea	1,946	1,823	1,213	305	105	3	0	0	**5,396**
Stephanocoenia intersepta	779	314	57	0	3	0	0	0	**1,154**
Unidentified Scleractinian	236	119	77	28	0	0	0	0	**460**
Total	**15,259**	**15,649**	**15,127**	**5,754**	**2,164**	**337**	**194**	**228**	**54,712**

TOTAL NUMBER OF CORALS IMPACTED BY SPECIES AND SIZE CLASS (Continued)

Octocorals	**Size Class**					
Genus	**0-10 cm**	**10-20 cm**	**20-40 cm**	**40-60 cm**	**60-70 cm**	**Total**
Briareum	476	564	1,121	266	0	**2,427**
Eunicea	1,103	1,822	2,201	1,331	139	**6,596**
Gorgonia	559	1,341	1,358	1,134	688	**5,079**
Muricea	1,722	2,931	2,082	1,089	303	**8,128**
Plexaura	5,399	7,359	13,106	4,962	1,394	**32,219**
Plexaurella	191	668	633	667	231	**2,390**
Pseudoplexaura	6,701	8,424	10,261	4,928	1,513	**31,826**
Pseudopterogorgia	3,332	5,110	6,208	4,755	1,799	**21,204**
Pterogorgia	303	878	928	40	123	**2,272**
Total	**19,787**	**29,097**	**37,897**	**19,172**	**6,190**	**112,142**

APPENDIX B

Finding of No Significant Impact

FINDING OF NO SIGNIFICANT IMPACT

PHASE II OF THE COMPREHENSIVE PLAN FOR THE 2006 T/V MARGARA INCIDENT NATURAL RESOURCE DAMAGE ASSESSMENT: COMPENSATORY RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT

Background:

Under the Oil Pollution Act of 1990 (OPA) the Natural Resource Trustee Agencies (Trustees), including the National Oceanic and Atmospheric Administration (NOAA) on behalf of the U.S. Department of Commerce, and the Puerto Rico Department of Natural and Environmental Resources (PRDNER) on behalf of the Commonwealth of Puerto Rico, prepared the Final Compensatory Restoration Plan and Environmental Assessment (Final Compensatory RP/EA) for the 2006 T/V MARGARA Incident. The Final Compensatory RP/EA assesses damages and evaluates compensatory restoration alternatives for natural resource injuries incurred as a result of this grounding.

On or about April 27, 2006, the T/V MARGARA, a 228-m (748-ft) Cayman Islands-flagged tanker carrying over 300,000 barrels of #6 fuel oil, went aground on coral reef habitat three miles south of Tallaboa, Puerto Rico. The grounding and response actions taken to prevent or reduce the threat of a release of oil from the vessel into the environment resulted in injuries to natural resources. The vessel was ultimately refloated and removed from the grounding location on April 28, 2006 without discharging oil into the environment. However, the response efforts to refloat and remove the vessel in an effort to prevent an oil spill injured and destroyed coral species and impacted the coral reef structure and ecosystem across an estimated eight acres of coral reef habitat. Emergency restoration actions undertaken at the site between 2006 and 2008 could not address all physical injuries or conditions at the site caused by the Incident. The Final Primary Restoration Plan/Environmental Assessment that was published in 2015 was developed by the Trustees and identified the additional actions the Trustees proposed to undertake at the site in order to restore lost topographic complexity and address site conditions that impeded natural recovery processes at the site. The Final Compensatory RP/EA is intended to select the compensatory restoration to be used to compensate the public for interim losses to coral reef resources caused by the T/V MARGARA Incident.

Restoration Projects:

The Trustees developed the Final Compensatory RP/EA, which examines and evaluates potential projects to restore natural resources and human uses that were lost due to the spill. As a result of this evaluation, the Trustees selected one restoration project: *Enhancement of Corals and Coral Reef Ecosystems using Asexual Coral Propagation and Restoration* to directly replace lost coral resources.

Public Involvement:

Throughout the Natural Resource Damage Assessment (NRDA) process, the Trustees have made information available to the public. The Trustees sought public input on the Draft Compensatory RP/EA. On October 9, 2020, the Trustees published a notice of availability for the Draft Compensatory RP/EA in English and Spanish on NOAA's and DNER's websites and in Spanish in *Primera Hora*, a paper of local circulation. The Draft Compensatory RP/EA was initially available for public review and comment for 30 days. The Trustees extended the public review and comment period through December 14, 2020 at the request of the Responsible Parties. Public comments received by the Trustees were addressed in preparing the Final Compensatory RP/EA and are summarized in Chapter 8 of the Final Compensatory RP/EA.

Alternatives Considered Under OPA:

The Trustees considered 14 restoration alternatives in developing the Final Compensatory RP/EA: asexual coral propagation, sexual coral propagation, sea urchin propagation, parrotfish propagation, restoration to physical impacts, improving aids to navigation, improved pilotage, prevent erosion and sedimentation, reduce nutrient loads, seagrass restoration, mangrove restoration, and artificial reefs using either limestone boulders, Ecoreefs™ or Reefballs™. The Trustees identified *Enhancement of Corals and Coral Reef Ecosystems using Asexual Coral Propagation and Restoration* as the selected restoration alternative for injuries to coral reef resources. In compliance with OPA NRDA regulations and the National Environmental Policy Act (NEPA), the Selected Alternative was finalized after public review and comment.

Environmental Consequences:

NEPA requires an analysis of the effects of federal actions on the quality of the human environment. NOAA has determined that it is appropriate to combine the final restoration plan and NEPA impacts analysis into one document, and has included an evaluation of alternatives for restoration under both OPA and NEPA in the Final Compensatory RP/EA.

The Companion Manual (January 13, 2017) for NOAA Administrative Order (NAO) 216-6A (April 22, 2016) contains criteria for determining the significance of the impacts of a proposed action. In addition, the Council on Environmental Quality (CEQ) regulations at 40 C.F.R. §1508.27 state that the significance of an action should be analyzed both in terms of "context" and "intensity." The significance of this action is analyzed based on the NAO 216-6 criteria and the CEQ's context and intensity criteria. The criteria listed below are relevant to making a Finding of No Significant Impact (FONSI), and have been considered individually, as well as in combination with the others, and include:

(1) Can the proposed action reasonably be expected to cause substantial damage to the ocean and coastal habitats and/or essential fish habitat as defined under the Magnuson Stevens Act and identified in Federal Management Plans (FMPs)?

> Response: No. As documented in the Final Compensatory RP/EA, and in concurrence with Puerto Rico's Local Action Strategies, Best Management Practices (BMPs) and management plans, the Trustees do not expect the selected project to cause substantial damage to the ocean and coastal habitats and/or essential fish habitat as defined under the Magnuson-Stevens Act. Any short-term and temporary localized impacts (such as potential disturbance of corals by divers or sedimentation from cement) would be minimized or eliminated by the use of BMPs.

(2) Can the proposed action be expected to have a substantial impact on biodiversity and/or ecosystem function within the affected area (e.g., benthic productivity, predator prey relationships, etc.)?

> Response: No. The selected project is not expected to have a substantial impact on ecosystem function and species biodiversity. It would be locally beneficial but not significant regionally. As documented in the Final Compensatory RP/EA the selected project is expected to improve habitat function through outplanting nursery-raised corals and herbivores to the reef. The selected compensatory restoration action would increase coral and herbivore populations at the restoration

sites. Any potential adverse impacts (such as those discussed in (1) above) are expected to be minimal, short term, and localized.

(3) Can the proposed action reasonably be expected to have a substantial adverse impact on public health and safety?

Response: No. The proposed project is not expected to have any impacts, adverse or otherwise, on public health and safety since the restoration staff would all comply with required state and federal dive safety and boating operational protocols.

(4) Can the proposed action reasonably be expected to adversely affect endangered or threatened species, their critical habitat, marine mammals, or other non-target species?

Response: No. Any short-term and temporary localized impacts (such as potential disturbance of endangered species by divers or boat traffic) would be minimized or eliminated by the use of BMPs.

Endangered and threatened species that are known to occur on reefs in Puerto Rico include staghorn (*A. cervicornis*) and elkhorn (*A. palmata*) coral, mountainous star coral (*Orbicella faveolata*), boulder star coral (*O. franksi*), lobed star coral *(O. annularis),* pillar coral (*Dendrogyra cylindrus),* rough cactus coral (*Mycetophillia ferox*), green sea turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Scalloped Hammerhead shark (*Sphyrna lewini*), Nassau grouper (*Epinephelus striatus*) and West Indian manatee (*Trichechus manatus*). Most species would either be present on the reef or migrate through the area.

The proposed activity is expected to have an impact on protected species through noise created by project vessels, habitat perturbation due to human activity while conducting the proposed actions, turbidity that could smother some of the sessile species, physical impact due to contact with divers, use of tools, and unforeseen accidents in the area. Given the constant presence of boats in Puerto Rico waters, the 30-70' boats used during restoration activities should not have vessel noise signatures that exceed levels frequently experienced at these sites. The noise, perturbation, and turbidity generated by the human activity are expected to be temporary and of very short duration. The restoration approach will minimize turbidity by using attachment materials with a composition that lessen this effect. The staff who will be working on the project will be trained on the protocols to minimize accidents that could physically impact sessile protected species. The divers that will participate in the compensatory activities have adequate training to avoid contact with corals.

The general locale where the restoration actions will be undertaken contains critical habitat for some of these threatened and endangered species. All of these species would benefit from coral restoration at these sites. Additionally the overall (net) long-term effects would be more beneficial to these species and outweigh any of the short-term potential adverse impacts. The Trustees know of no other direct or indirect impacts of the Selected Alternative on threatened or endangered species, or their designated critical habitats.

(5) Are significant social or economic impacts interrelated with natural or physical environmental effects?

Response: No. The Trustees do not expect there to be significant adverse social or economic impacts interrelated with natural or physical environmental effects of the proposed project. On the contrary, the selected compensatory restoration project will have only positive impacts in the local community. Both recreational and commercial fisheries in the Guayanilla area have the potential to indirectly benefit as the proposed actions will improve habitat in the system that many economically important species of finfish and invertebrates rely on during various life stages.

(6) Are the effects on the quality of the human environment likely to be highly controversial?

<u>Response:</u> No. During the public review period for the Draft Compensatory RP/EA, the Trustees received no negative public comments regarding the human environment. There is no public disagreement with the proposed coral restoration, and based on past experience with other coral restoration projects, the Trustees expect there would be no uncertainty regarding likely environmental effects from the proposed projects.

(7) Can the proposed action reasonably be expected to result in substantial impacts to unique areas, such as historic or cultural resources, park land, prime farmlands, wetlands, wild and scenic rivers, essential fish habitat, or ecologically critical areas?

<u>Response:</u> No. The Trustees do not expect the proposed project to result in substantial adverse impacts to unique areas or resources, such as historic or cultural resources, parks, wetlands, essential fish habitat, or ecologically critical areas.

(8) Are the effects on the human environment likely to be highly uncertain or involve unique or unknown risks?

<u>Response:</u> No. Outplanting corals and herbivores from nurseries would not pose any uncertain effects or unknown risks to the human environment. These are common reef restoration methods used in the United States and Puerto Rico. The areas in which the projects would be implemented are well known to the project implementers, and none of the project methods that are expected to be used are unique, controversial, or untried.

(9) Is the proposed action related to other actions with individually insignificant, but cumulatively significant impacts?

<u>Response:</u> No. The potential impacts of the selected compensatory restoration actions were assessed and considered relative to other coral restoration actions conducted in Puerto Rico in the last ten years. Prior restoration efforts have shown that a comprehensive approach that includes multiple species of coral and herbivores has the most success over the long term. However, when considered with the other prior coral reef restoration efforts, the selected compensatory restoration actions are unlikely to have any substantial additive effects at the Caribbean ecosystem scale. Therefore the proposed action would not result in a cumulatively significant impact.

(10) Is the proposed action likely to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural or historical resources?

<u>Response:</u> No. The proposed project is not expected to impact any cultural, scientific, or historic resources.

(11) Can the proposed action reasonably be expected to result in the introduction or spread of a non-indigenous species?

<u>Response:</u> No. The proposed project does not involve working with any non-indigenous species.

(12) Is the proposed action likely to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?

> Response: No. Outplanting corals and herbivores from nurseries are common reef restoration methods used in the United States and Puerto Rico. The precedent for using these methods has already been set and has not resulted in significant effects.

(13) Can the proposed action reasonably be expected to threaten a violation of Federal, State, or local law or requirements imposed for the protection of the environment?

> Response: No. Implementation of the proposed project would not require any violation of federal, state or local laws designed to protect the environment. The Trustees also believe none of the actions proposed in the Final Compensatory RP/EA to outplant corals and herbivores to coral reefs in Puerto Rico are likely to adversely affect Threatened or Endangered Species or their designated critical habitats. The Selected Alternative falls under the "3Rs Programmatic Biological Opinion (BIOp)" initiated October 18, 2016 by NOAA. The Programmatic Biological Opinion analyzed the potential routes of effects from the activities to be implemented under the Selected Alternative on all listed species and designated critical habitats under NMFS' purview (i.e., corals and sea turtles) listed at the time. NOAA Restoration Center requested concurrence with NMFS Southeast Protected Resources Division that the Selected Alternative falls within the scope of the 3Rs Programmatic Biological Opinion on March 26, 2018; and the Protected Resources Division provided concurrence on March 26, 2018. The Trustees will ensure that the proposed restoration actions are in compliance with all relevant federal, state and local laws and regulations prior to project implementation.

(14) Can the proposed action reasonably be expected to result in cumulative adverse effects that could have a substantial effect on the target species or non-target species?

> Response: No. The actions proposed in the Final Compensatory RP/EA are expected to result in cumulative positive impacts by improving coral and herbivore populations on coral reefs in Puerto Rico. The effects of the proposed compensatory restoration project, however, are local and are not expected to significantly affect the human environment alone or in combination with other reef restoration projects in its vicinity. It would not result in any change in the larger current pattern of hydrologic discharge, boat traffic, economic activity or land-use in Puerto Rico. The proposed restoration project would only restore habitat that originally existed and occurred naturally at this location.

DETERMINATION

Based upon an environmental review and evaluation in the Final Compensatory RP/EA for the T/V MARGARA Incident, it is determined that implementation of the Selected Alternative in the Final Compensatory RP/EA does not constitute a major Federal action significantly affecting the quality of the human environment under the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969 (as amended). Accordingly, an environmental impact statement is not required for this action.

Christopher Doley

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Chris Doley | Date
Chief, Restoration Center
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