DRAFT
RESTORATION PLAN AND
ENVIRONMENTAL ASSESSMENT
FOR THE 2009 LNG-C MATTHEW GROUNDING
GUAYANILLA, PUERTO RICO

Large colonies of *Orbicella faveolata* (listed as Threatened on the Endangered Species list) damaged by the LNG-C MATTHEW grounding on December 15, 2009. Photo courtesy of NOAA

Prepared by:

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and
the National Oceanic and Atmospheric Administration

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1.0 INTRODUCTION: PURPOSE OF AND NEED FOR RESTORATION

1.1 DESCRIPTION OF THE INCIDENT & RESPONSE ACTIVITIES

On December 15, 2009, the 289 meter LNG/C MATTHEW struck coral reef habitat off the south coast of Puerto Rico near Guayanilla. The vessel was freed with assistance of local tug boats but, during extraction, the vessel was pushed at the bow and swung from side-to-side causing additional damage to the reef before finally being extracted. While there was no release of oil, the grounding, its subseequent movement and/or subsequent actions undertaken to remove the vessel to prevent a significant oil spill (collectively, the Incident) injured and destroyed coral species and impacted the coral reef structure and ecosystem directly destroying over 3,000 m^2 of the living coral reef.

The impacted site is located northeast of the entrance channel to Guayanilla Bay just south of Cayo Maria Langa (Figure 1). The impact is a spur-and groove reef area, varying in depth from 8-12 meters with scattered deeper sand, coral and rubble depressions. The site habitat supported a diverse assemblage of soft corals, sponges, and hard corals, including Staghorn coral (*Acropora cervicornis*), a threatened species under the Endangered Species Act.

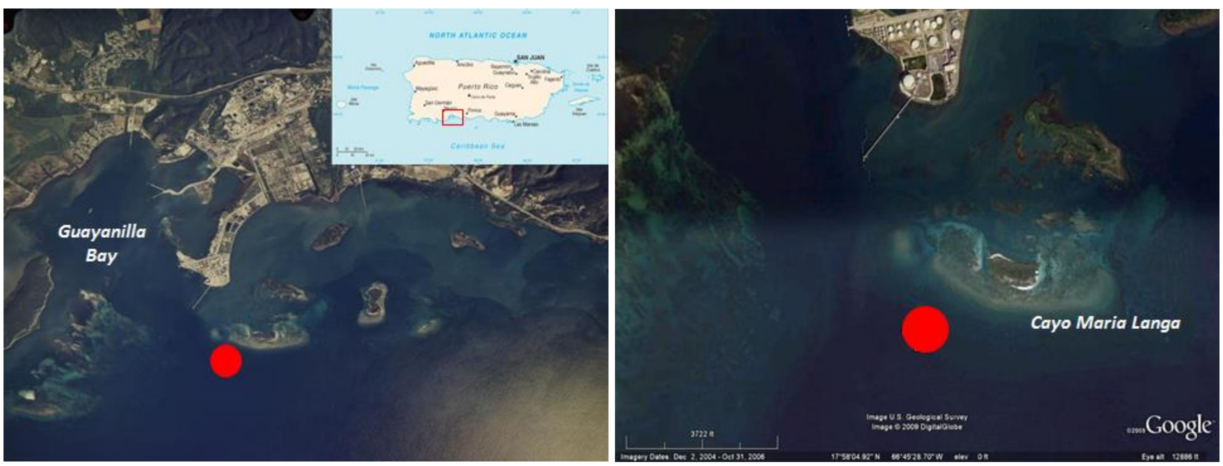

Figure 1: LNG-C MATTHEW grounding site (red dots) relative to Guayanilla Bay (on left) and Cayo Maria Langa (on right) in southern Puerto Rico.

The LNG-C MATTHEW Incident caused significant injuries to coral resources, other reef biota, and reef habitat over a large area (Figure 2). The grounding of the vessel, its subsequent movement and actions undertaken to remove the vessel in order to prevent a significant oil spill caused or contributed to damage to coral reefs. An estimated 3,047 m^2 of reef suffered either a complete loss of biota and topographic relief or suffered intense damage resulting in high mortality (>90%) to corals. There were also several isolated patches of damage with less severe impacts (<30 corals damaged/area) outside of the main impact site.

Emergency restoration actions began immediately following the grounding and lasted through 2010. These efforts included creating numerous small to large individual installations or modules, with dislodged reef framework and corals attached or embedded using a cement mixture. These installations were anchored with varying lengths of rebar driven into consolidated substrate. These actions were able to save approximately 7,000 corals and to address some of the restoration needed at the site to avoid further losses. The emergency restoration actions were intended and designed to address most of the potential restoration actions that might be needed at the site.

Monitoring to assess the success and stability of the restoration, survival of reattached corals and coral recruitment at the site was initiated in 2010. Data from this effort have shown that the restored areas are stable with only minor scouring. There was high survival for the reattached hard corals, but the reattached octocorals did not fare as well. Coral recruits, especially octocorals, in the restored areas are surviving and recovery appears to be proceeding.

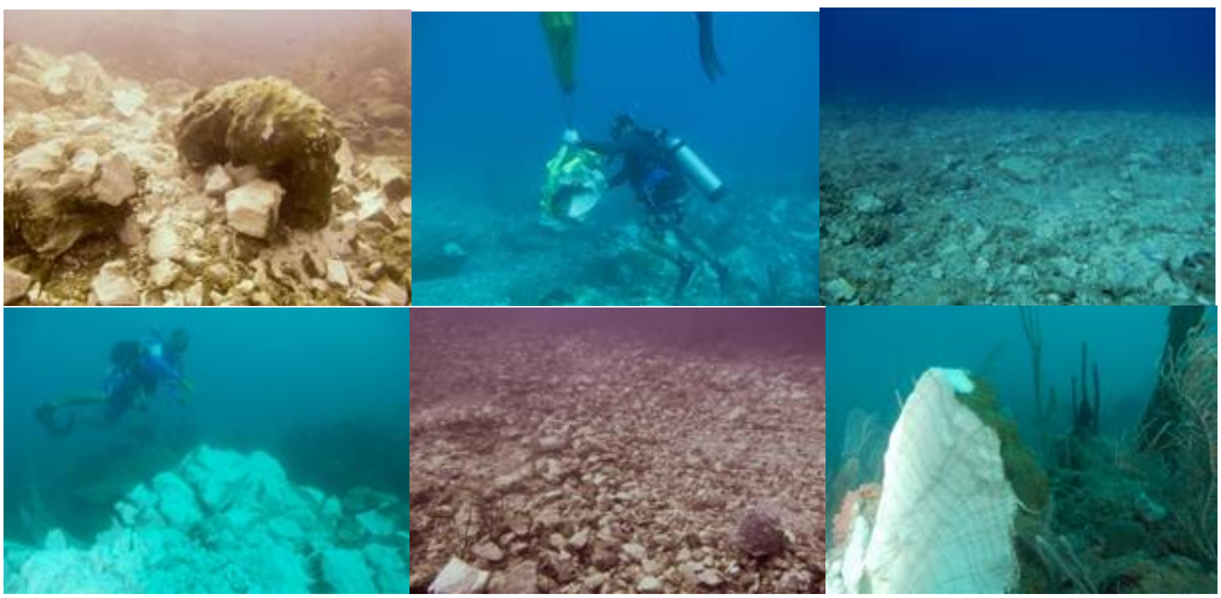

Figure 2: Photos of impacted areas at the LNG-C MATTHEW site. Photos taken by NOAA Restoration Center in December 2009.

1.2 PROPOSED ACTION

The Trustees (see Section 1.4) are proposing to compensate for interim losses to coral reef resources caused by the LNG-C MATTHEW grounding by implementing active coral propagation and restoring coral reefs that are damaged in the future from physical impacts like orphan groundings and storm damage. The Trustees have prepared this Draft Restoration Plan and Environmental Assessment (Draft

RP/EA) for public review to select the additional restoration needed to compensate for the interim losses to the coral reef ecosystem .

1.3 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 2009 LNG-C Matthew Grounding in Guayanilla, Puerto Rico.

Need: The restoration actions identified in this Draft RP/EA are needed to compensate for lost coral reef resources at the LNG-C MATTHEW grounding site that were not able to be recovered during Emergency Restoration. The preferred alternatives would help compensate for interim losses.

Prior to the LNG-C MATTHEW grounding, the impacted reef site was topographically complex, with high and low relief areas providing habitat to multitudes of fish and marine invertebrates. After the grounding, the majority of the impacted site was left at uniform level with very little or no topographic complexity within the impacted areas. Emergency Restoration actions at the site included the reattachment of live corals and medium to large rubble and returning topographic complexity within the site to a condition comparable to that in the reference area. These actions helped restore some of the original topographic complexity and were able to save approximately 7,000 corals, but over 72,000 corals were crushed and damaged beyond repair as a result of the Incident. It will take decades or longer for some of these species to recover. The Puerto Rico Department of Natural and Environmental Resources and the National Oceanic and Atmospheric Administration have determined that compensatory restoration is needed for interim losses at the LNG-C MATTHEW site.

The preferred alternatives include all activities appropriate to the planning, design, construction, monitoring, oversight and evaluation of restoration performance.

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

- the environmental consequences of the LNG-C MATTHEW Incident;
- the objectives of compensatory restoration at the LNG-C MATTHEW grounding site;
- the restoration alternatives considered for meeting these objectives in developing this plan;
- the monitoring that would be needed to determine the success of the identified compensatory restoration actions.

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

1.4 NATURAL RESOURCE TRUSTEES AND AUTHORITIES

This Draft RP/EA has been developed by 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.

PRDNER and NOAA 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, 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 for the natural resource injuries and service losses caused by the LNG-C MATTHEW 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 damage inflicted to the system and restore the reef.

In developing this 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, and the preferred restoration 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.

1.5 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 June 17, 2013**.** That Notice was posted to http://drna.pr.gov/notice-of-intent-to-conduct-restoration-planning-lngc-matthew-incident/ and also published in *Primera Hora* on June 27, 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 .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.

1.6 NATIONAL ENVIRONMENTAL POLICY ACT

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, 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 preparing the 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 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 Draft RP/EA, as more fully described in Section 1.8 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 the National Environmental Policy Act (NEPA).

This Draft 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 1.8, "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 of Preferred Alternative."

1.7 COORDINATION WITH THE RESPONSIBLE PARTY

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

The RPs for the LNG-C MATTHEW Incident are Suez LNG Shipping and Hoegh LNG Fleet Management. The RPs were invited to participate in the conduct of emergency restoration, as provided in 15 C.F.R §§ 990.14(c), and did cooperate with the Trustees by performing and funding the emergency restoration actions. The RP has cooperatively participated in natural resource damage assessment activities beyond the emergency restoration phase as well. This cooperation and coordination between the parties have helped avoid duplicative assessment activities, allowed for timely information sharing, allowed for joint field efforts and discussions among the parties' technical representatives, and have made the process more cost-effective. Input from the RP was considered by the Trustees in development of this Draft RP/EA.

1.8 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 state and federal laws and regulations, including NEPA and its implementing regulations at 40 C.F.R. Parts 1500-1508.

The NOI published on June 17, 2013 served to first inform the public of the Trustee's' intention to develop a formal restoration plan for the LNG-C MATTHEW Incident. The NOI identified the grounding event 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 discussions with various representatives of the public including the Commonwealth, local governments and institutions, private organizations, academic experts, and RP representatives. The Trustees used information from those discussions to develop a Draft RP/EA describing and proposing the further compensatory restoration actions for the LNG-C MATTHEW site.

The Trustees are making this Draft PRP/EA available for 30 days to afford the public an opportunity to review and comment on the proposed compensatory restoration plan for the LNG-C MATTHEW site. The Trustees will consider comments received during the public comment period before adopting a Final RP/EA selecting compensatory restoration actions for the LNG-C MATTHEW site. A summary of the comments received, and the Trustees' responses thereto, will be included in the Final RP/EA. The Trustees will provide an additional opportunity for public review in the event that the Trustees decide to make significant changes to the Draft RP/EA based on the public comments received.

The deadline for submitting written comments on this Draft RP/EA is specified in a notice published by the Trustees in "*Primera Hora*", a newspaper of general circulation in Puerto Rico, announcing the availability of this document for public review and comment. Public comments will be maintained in record in the Administrative Record (described in Section 1.9). Written comments on this plan are to be sent by mail or email to:

Sean Griffin,
NOAA Office of Habitat Conservation, Restoration Center
260 Guard Rd, Aguadilla, PR 00603
Email: Sean.Griffin@noaa.gov

1.9 ADMINISTRATIVE RECORD

In accordance with 15 C.F.R. § 990.45, the Trustees have established an Administrative Record (AR) of the natural resource damage assessment for this Incident. The AR contains records documenting decisions and information relied upon by the Trustees in the natural resource damage assessment process for the LNG-C MATTHEW Incident, including the prior emergency restoration actions at the site. 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://casedocuments.darrp.noaa.gov/southeast/matthew/admin.html

It is also available for public review at the office of PRDNER; Division of Recreational and Sport Fishing, Bosque del Nuevo Milenio, Calle Guaralcanal, Rio Piedras, PR 00926.

Additional information and documents, including any future draft restoration plans, any final restoration plans, and other restoration planning documents, will be included in the AR as they are developed and completed by the Trustees.

2.0 AFFECTED ENVIRONMENT

This section provides general information on the environment setting in which the Incident occurred and that may be affected by restoration actions identified in this Draft RP/EA. It includes information on the physical, biological and cultural/human use environments in the vicinity, including those that may be affected by restoration actions described in this Draft RP/EA. The physical environment includes coral reefs off of Guayanilla, Puerto Rico 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.

2.1 PHYSICAL ENVIRONMENT

The LNG-C MATTHEW site is situated at the shelf edge of a carbonate platform just outside of Guayanilla Bay and south of Cayo Maria Langa on the south coast of Puerto Rico and is designated as coral reef habitat (NOAA, 2002a). Water temperatures in this area range from 24^{o}- 30^{o}C. Depths along the upper shelf in this area range from emergent reefs inshore down to 30+ meters along the shelf edge. Coral reef formations in the area are spur-and-groove reef formations built by Scleractinian corals over thousands of years. Scleractinian corals are also known as hard or stony corals and they are the primary reef builders in the ocean. The upper part of these reefs is around 8 meters deep, and the depth of the sand channels between the reefs averages 10-15 meters deep and the sand channels are 1 – 2 meters wide between the spurs. The coral reefs affected by the LNG-C MATTHEW Incident within this setting ranged from 8 - 12 meters deep and supported an epifaunal assemblage visually dominated by soft and hard corals and sponges (Figure 3).

Figure 3: Photos of un-impacted reef adjacent to the LNG-C MATTHEW site. Photos by NOAA Restoration Center, December, 2009.

The coral reefs along the south coast of Puerto Rico are influenced by trade winds, swells, strong currents, hurricanes and westward-moving terrigenous sediment plumes from run-off. This area is exposed to easterly trade winds that average 15-20 knots and seas that average 2-3 meters at the site. The area is also exposed to hurricanes and associated swells that 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 LNG-C MATTHEW 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, 0.5 cm per year. The heterogeneous topographic relief afforded by these reefs provides habitat for multitudes of fish and marine invertebrates.

Over the last few decades there has been a decline in coral reefs due to bleaching, disease outbreaks (on both corals and other species) and increased algal cover. Many of these conditions have been linked to anthropogenic stressors such as greenhouse gas emissions (which has led to increases in seawater temperatures, ocean acidification and storm frequencies); and increased levels of nutrients, contaminants and sedimentation as a result of dredging, coastal development, pollution, agriculture and other land based sources of pollution (LBSP). Overfishing, increases in LBSP and the Caribbean-wide mass mortality of *Diadema antillarum* in the 1980's has also resulted in increased algal abundances that limit coral recruitment and can smother existing corals. These threats are exacerbated by physical impacts due to ship groundings (like the LNG-C MATTHEW Incident), anchoring, and storms; such 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 coral reef resources more valuable, and increases the need and urgency for their restoration and conservation.

Injured resources at the LNG-C MATTHEW site include the Staghorn coral, *Acropora cervicornis*. *A. cervicornis* and *A. 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 Endangered Species Act (ESA). In 2014, five additional coral species from the Caribbean were listed as "Threatened" under ESA. These include *Orbicella faveolata, O. franksii, O. annularis, Dendrogyra cylindrus,* and *Mycetophillia ferox*. All of these species are present near the LNG-C MATTHEW site. Six out of the seven threatened Caribbean coral species under the ESA were impacted at the site. *Acropora palmata* was not observed to be impacted.

2.3 CULTURAL and HUMAN USE ENVIRONMENT

Coral reefs like those along the south coast of Puerto Rico, including at the LNG-C MATTHEW 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, 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 & Maidens, 2004). Coral reef ecosystem services afforded to Puerto Rico include shoreline protection, spawning, nursery, and feeding habitat for an array of commercial fishery species and support billions of dollars in tourism revenue (Moberg & 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. The fish 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 PHYSICAL INJURIES TO RESOURCES

This section summarizes the Trustees' assessment of the physical injuries to the reef and associated resources at the grounding site and of the likelihood of recovery of these resources without further action or intervention. This information provides the basis for and has informed the Trustees' development of the restoration actions considered as well as those proposed in this Draft RP/EA.

3.1 DELINEATION OF PHYSICALLY INJURED SITE

Immediately following the Incident, personnel from NOAA and DNER took the first initial measurements of the site using the fish bone method with transect tapes and GPS and overlaying the area onto Google Earth (Figure 4). A multibeam image of the area was created by the University of Puerto Rico to provide an overview of the site to help identify areas the Trustees may have overlooked during their initial dives (Figure 4).

Shortly afterwards, a joint mapping effort was cooperatively undertaken by the Trustees' and RP's technical representatives in December, 2009 to map the impacted areas and get an estimate on the extent of the damage. Detailed maps were generated using Aquamap (an underwater GPS system). As a result of this effort, the Trustees identified 3,047 m^2 of reef that suffered either a complete loss of biota and topographic relief or suffered intense damage resulting in high mortality (>90%) to corals. There were also several isolated patches of damage with less severe impacts (<30 corals damaged/area) outside of the main impact site. (Figure 5).

Prior to Emergency Restoration, a photomosaic of the entire impacted site was stitched together by personnel from the University of Miami (Figure 6). Imagery was collected by several divers using multiple Go-Pros. This provided a comprehensive image of the entire impact. This image was also used during Emergency Restoration. It provided a visual map for divers working on the site. While on the vessel, they were able to discuss and visually explain with the photomosaic areas that had been completed, needed additional attention or had not been addressed. The divers could point on the map to specific reef spurs that needed more work either reconstructing topography or stabilizing loose corals; or the divers could identify grooves where live corals were still buried and needed to be removed for reattachment elsewhere before they were smothered.

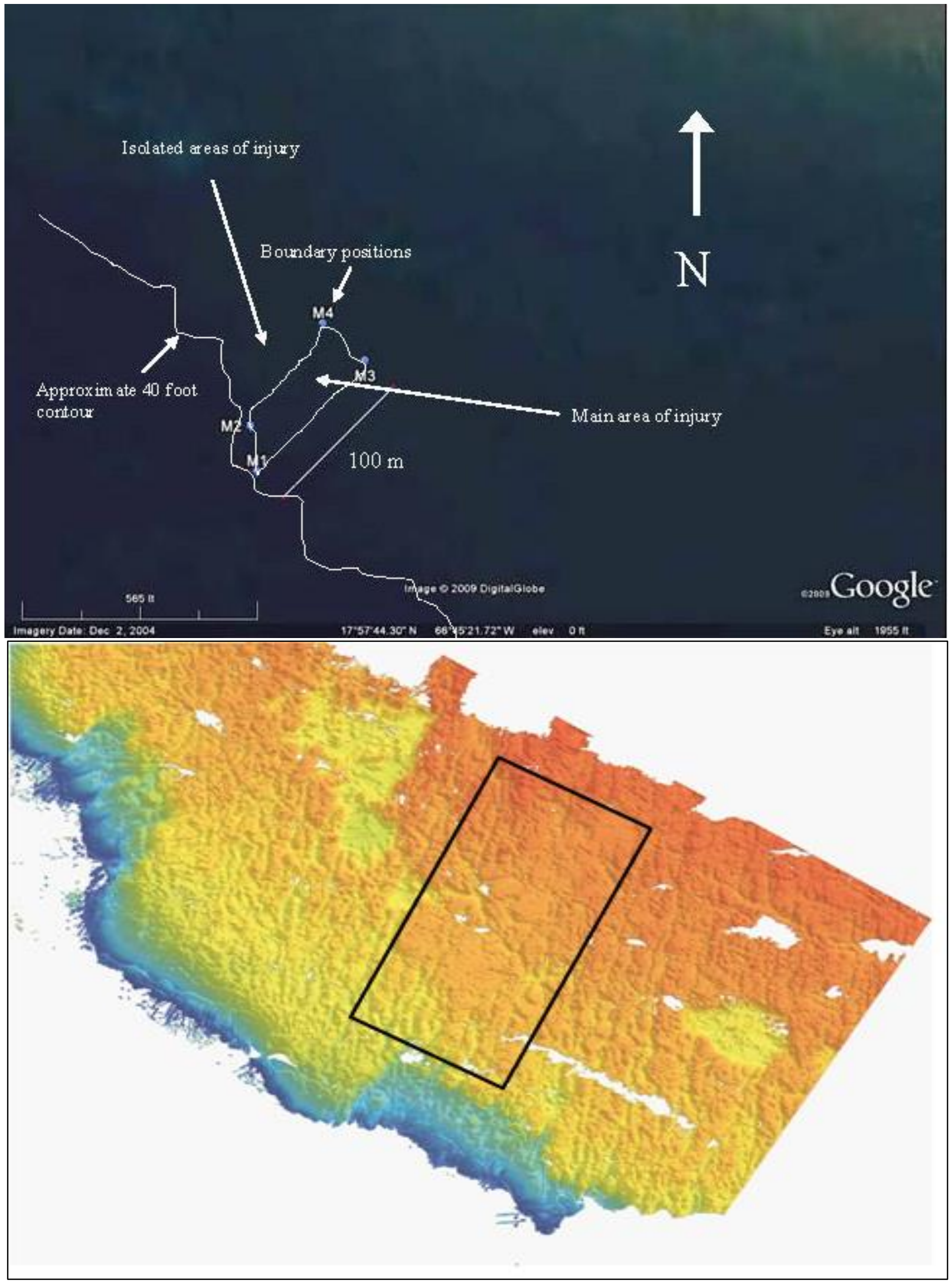

Figure 4: Initial mapping of the LNG-C MATTHEW impact site using GPS (on the top) and multibeam imagery (on the bottom). Multibeam imagery was provided by the University of Puerto Rico. The black rectangle on the multibeam which appears to have less relief than the surrounding areas represents the approximate location of the LNG-C MATTHEW grounding. The shelf edge can be seen where the depth drops from 13 meters to over 30 meters (in blue).

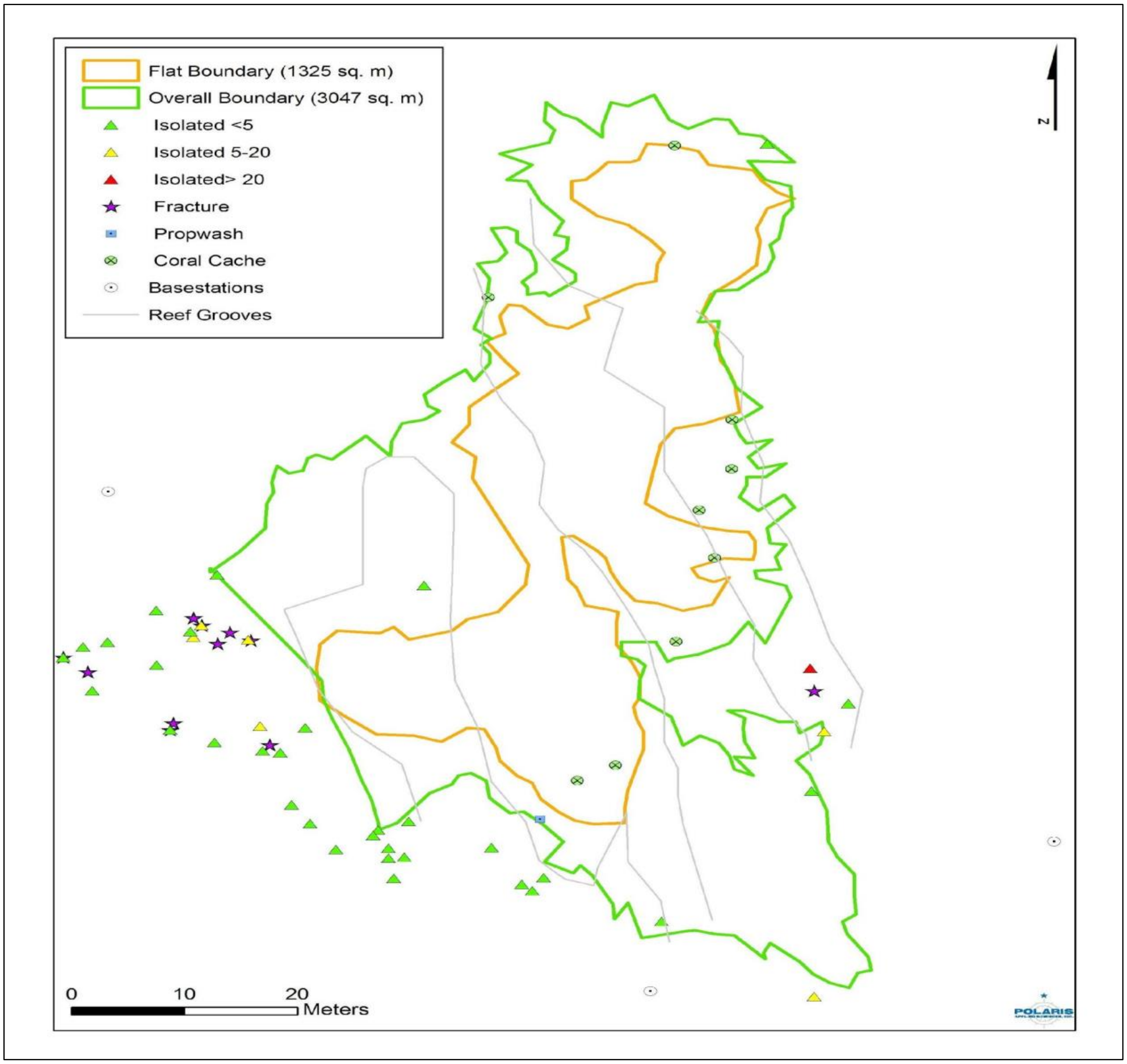

Figure 5: Aquamap of the LNG-C MATTHEW impact site provided by Polaris Applied Sciences, Inc. The area within the yellow polygon was completely flattened by the grounding with 100% loss of coral and topographic relief. The area within the green polygon suffered intense damage resulting in high mortality (>90%) to corals. Triangles represent isolated patches of damage with less severe impacts (green triangles, < 5 corals impacted; yellow triangles, 5-20 corals impacted; and red triangles, 20-30 corals impacted).

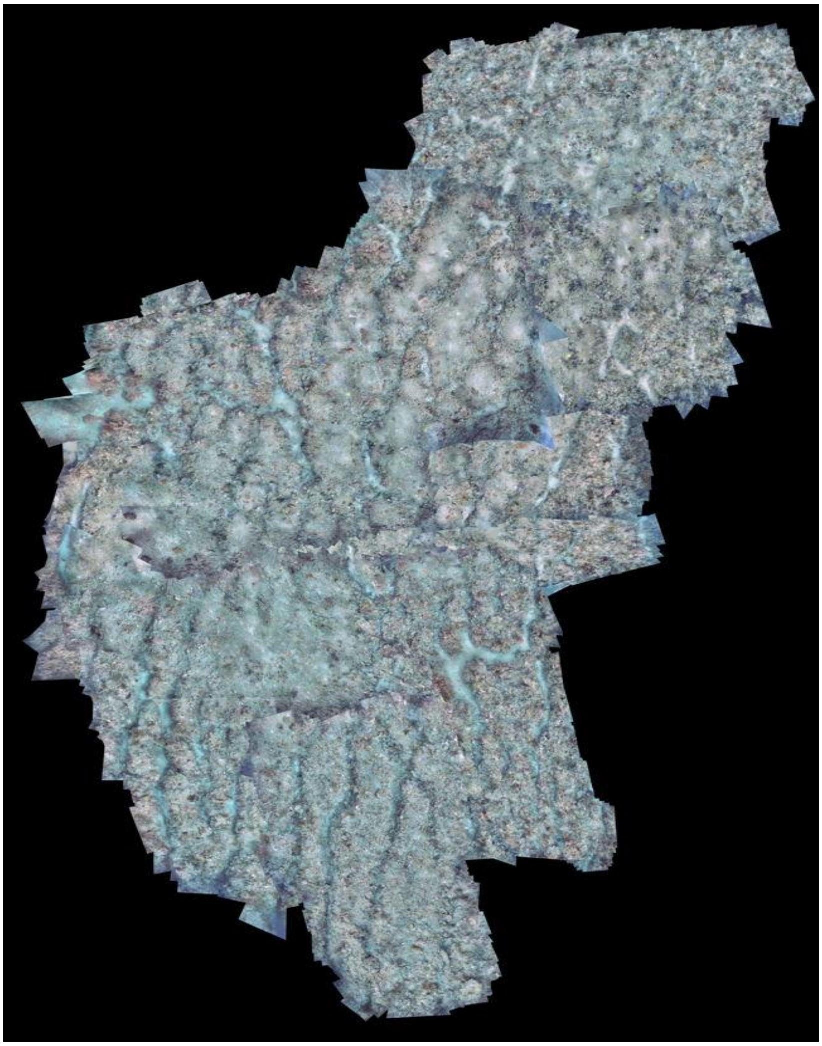

Figure 6: Photomosaic of the LNG-C MATTHEW impact site provided by Art Gleason at the University of Miami.

3.2 LOST TOPOGRAPHIC COMPLEXITY

Prior to the LNG-C MATTHEW grounding, the impacted reef site was topographically complex, with high and low relief areas and spur-and-groove reef formations. After the grounding, the tops of the spurs were flattened to a very uniform level with very little or no topographic complexity especially in areas designated as flat in Figure 5. The sand channels between the grooves were filled with boulders, corals and debris that had broken off during the grounding. High relief areas will not recover to their original community structure without proactive restoration to encourage reef development (NOAA, 2002b; Rinkevich, 2005). Damaged spur-and-groove habitat will not recover rapidly to its former state and may not recover at all without substantial restorative engineering (Precht el al., 2001). Emergency Restoration was designed to restore the topographic complexity that had been present on the tops of the spurs. This was accomplished by removing the broken pieces of reef and corals that had been knocked into the sand channels and bringing them back up onto the tops of the spurs. These pieces were then stabilized using Portland cement, rebar and cement nails. Structures that were created using this method ranged in size from 1 – 20 m^2. Emergency Restoration efforts were able to return rugosity (a measure of topographic complexity) in the impacted areas to within 10% of the unimpacted reference areas adjacent to the site. 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 restored areas throughout the Emergency Restoration.

3.3 DIRECT BIOLOGICAL LOSS

To determine the extent of the coral biota loss at the LNG-C MATTHEW site, 10 m^2 belt transects were performed in un-impacted reef areas adjacent to the site. A total of 15 transects covering 150 m^2 were conducted on October 4, 2010. Five transects were conducted to the east of the site, 5 transects to the north and 5 transect to the west. No transects were conducted south of the site because the shelf edge drops off abruptly to over 30 meters deep. Data recorded in the belt transects included the species present and their respective size class (10 cm increments). This data was used to estimate densities, species diversity and size distributions within the impact. The average density of corals per m^2 and the total area of impact were then used to calculate the total number of corals impacted by the LNG-C MATTHEW Incident. Using this data and approach, the Trustees calculated that just over 72,000 corals were impacted as a result of the LNG-C MATTHEW grounding. Table 1, at the end of this section, has a more detailed breakdown of this estimate by species group. Figure 7 shows the size class distributions of Scleractinians and Octocorals at the site. The species and size class distribution of the impacted corals is valuable information for creating a Resource Equivalency Analysis for this Incident which is described in section 3.5. Approximately 7,000 corals were reattached and saved during the Emergency Restoration. As a result, an estimated 65,000 corals were lost due to the LNG-C Matthew Incident. The Emergency Restoration also prevented additional damage to injured corals and unimpacted areas by stabilizing loose corals and rubble that would have been remobilized during storm events.

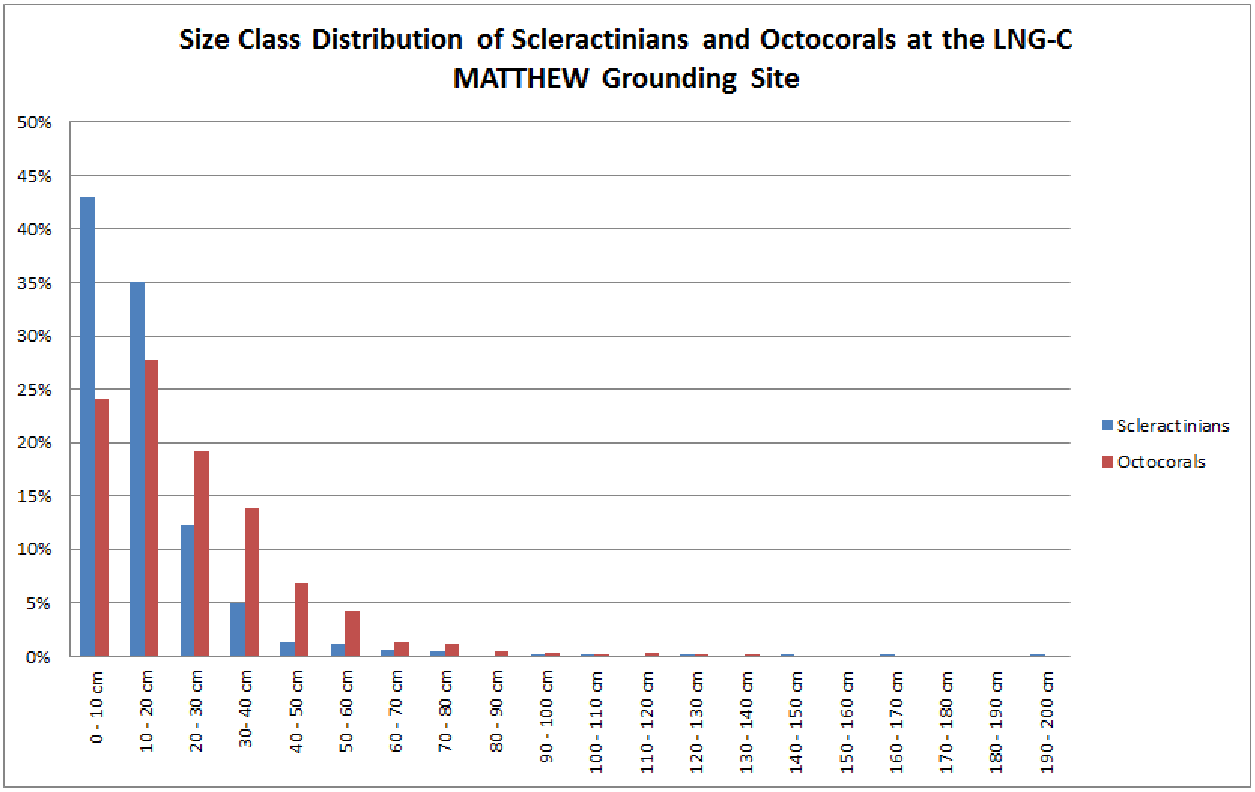

Figure 7: Size class distribution of Scleractinians and Octocorals at the LNG-C MATTHEW grounding site.

3.4 SITE RECOVERY

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 el 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. This type of habitat is favorable for soft coral aggregations that compete with new hard coral settlers (Fox et al. 2003). The loss of topographic complexity has serious implications for reef recovery and fish and sea urchin populations in spur-and-groove habitats. Restoration efforts must include re-establishment of the topographic complexity to enhance recruitment and growth of coral species that naturally occur in spur-and-groove habitats (Aronson and Swanson, 1997).

Emergency restoration efforts at the LNG-C MATTHEW site focused on reattaching loose and broken corals, stabilizing rubble and substrate, and rebuilding topographic complexity. Because of the successful and comprehensive nature of the emergency restoration, the Trustees feel that additional primary restoration is not required at the site. While restoration efforts at the site were comprehensive, recovery at the site still depends on the successful recruitment of corals and other marine organisms. It will take decades or centuries for many of the slower growing coral species to recover to their original size and distribution, and some species may never recover. Limited recruitment by large reef-building species like *Orbicella* spp. and *Dedrogyra cylindrus* can delay or even preclude the complete recovery of the original coral community (Gittings et al., 1988). Growth rates for the majority of Caribbean coral species are also considerably low, averaging 0.5 cm/yr for most species (Highsmith et al., 1983; Hubbard and Scaturo, 1985). Because of the slow recovery rate for many Caribbean coral species, the LNG-C MATTHEW site will take time to recover.

3.5 SCALING OVERVIEW

It is not possible to replicate the exact size and species distribution of the corals lost during the LNG-C MATTHEW Incident. Different coral species have different functional values within each reef habitat. In planning and scaling compensatory restoration actions under this proposed plan, the Trustees' objective is to provide resource or service 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.

The general framework used for scaling 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 in some instances 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 (or resource proxies) lost due to the injury and the quantity of discounted replacement services (or resource proxies) provided by compensatory actions. Where planned restoration actions are going to provide the same or comparable resources or services, 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 make the public whole. Resource-to-resource or service-to-service techniques are usually rooted in the Habitat Equivalency (HEA) or a Resource Equivalency Analysis (REA) method (Julius et.al. 1995; Milon and Dodge, 2001). The HEA method is generally used where the resource injury and/or the restoration action can (i) be generalized into categories (e.g. Marsh) that represent their overall habitat services and functions and (ii) where the overall services per unit of injury (% service loss) or restoration (% service gain) and rate of recovery (shape and time) can be applied uniformly over a discrete area of injury or area of restoration. Thus, in the case of oil impacting a salt marsh, the area of injury usually has a dominant plant species (e.g. *Spartina alterniflora*) that serves as habitat for and provides an array of services to variety of other resources. Injury assessment data (such as on degree and duration of oiling) are often used to attribute a degree of service loss for areas with similar oiling as well as predict an overall recovery timeframe for that area. Even in this relatively simple model, site specific differences in plant density, marsh edge, drainage channels, and other factors may need to be taken into account.

A coral reef is a significantly more complex ecological system than a marsh. From site to site, reefs may be highly variable in terms of structure, rugosity, core species, species assemblages, and species diversity. Each reef "habitat" may also have many different core species of various sizes/ages. Further, each coral species present is itself both a specific living resource and a feature that helps define a reef's particular characteristics and services as habitat to other dependent natural resources. One square meter of reef can easily contain more than 20 individual stony or octocorals plus numerous other species (algae, sponges, invertebrates, crustaceans, small fish, etc.) that help comprise and/or rely upon the reef ecosystem. Depending on the type and degree of impacts and environmental setting, some individual resources may have the potential to recover relatively quickly (in years) while others (i.e. large and/or rare corals) may have very long recovery horizons (decades to centuries) or may never recover at all.

For the LNG-C MATTHEW Incident, the Trustees recognized that generalizing losses and restoration relationships across all injured corals would likely result in under- or over-estimation of interim coral losses and compensatory restoration needs. The Trustees determined a model comprised of a matrix of independent Resource Equivalency Analyses (REAs) that considered the injuries to and recovery characteristics of each core reef component (by species class) would better represent the complexities associated with the coral reef losses at the LNG-C MATTHEW site and provide a better estimate of both the interim coral losses and the scale of restoration needed to restore the same or comparable resources or services to compensate for those losses. As described in Kolinski et al. (2007) and Viehman et al. (2009), this modified type of Resource Equivalency Analysis (REA) uses a resource-to-resource method that references the number organisms lost and the number gained through restoration. This approach examines the size distribution of species or functional groups of different corals and allows for comparisons between ecological services. This method allows the Trustees to quantify and aggregate losses across species, taking into account the different species injured, the sizes/ages lost, anticipated recovery rates and, similarly, to identify the scale of the proposed restoration required to restore or replace coral species comparable to those lost over time.

Using this approach, the metric for scaling is a coral colony year (CCY). A CCY is not equal to the coral age. CCY is a proxy for services provided and/or, in the case of any injury, lost during a one-year period of time for a particular size and type of coral. While the initial CCY value is only directly comparable to others within the same size/species group, equivalency between sizes and groups can be gained by utilizing a combination of a linear size and service weighting. The key inputs into this analysis are the size/species distribution and the recovery time. The analysis also considers discounting and other inputs used in REA, such as relative function, time to maturity, and project lifespan.

The LNG-C MATTHEW Incident caused significant injuries to coral resources, other reef biota, and the reef habitat. Based on data and information collected through joint site surveys, the Trustees calculate the total corals impacted to be just over 72,000 individual corals (Table 1). This includes different species groups (Massive, Brooders, Acropora, Branching, Octocorals, *Psuedopterogorgia* spp.) that are expected to recover at varying rates depending on the size/age of the coral when it died, recruitment and growth rates. This range can vary from a couple years to a couple hundred years depending on the species and size class. Prior to Emergency Restoration, there was an estimated 142,122 CCY lost (CCYL). Approximately 7,000 corals were saved during the Emergency Restoration. The final estimated number of corals that were lost after the LNG-Matthew Incident was 65,000 which represents an estimated 111,601 CCYL (Table 1 and Appendix A).

Table 1: Number of corals impacted in the LNG-C Matthew Incident by species group*.

Species Group	Total Corals Impacted	Estimated Coral Colony Years Lost (CCYL) prior to Emergency Restoration	Estimated CCYL after credit for Emergency Restoration
Massive	14,648	77,596	60,525
Brooders	10,644	9,918	9,025
Acropora	41	22	0
Branching	1,402	3,164	2,879
Octocorals	35,894	44,690	32,624
Psuedopterogorgia spp.	9,446	6,750	6,547
Total	**72,073**	**142,141**	**111,601**

* See Appendix A for a more detailed list of impacted species, size classes, service weighting ratios, growth rates, etc.

4.0 RESTORATION PLANNING PROCESS

4.1 OVERVIEW

The goal of restoration planning 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 OPA regulations direct that this goal be achieved by returning injured natural resources to their baseline condition, but for the incident, and by compensating for any interim losses of natural resources and services during the period of recovery to baseline. Thus, as noted previously, restoration planning may involve two components: primary restoration and compensatory restoration. The Trustees believe that because of the successful and comprehensive Emergency Restoration performed at the LNG-C MATTHEW site, primary restoration will not be necessary. This Draft RP/EA will focus on compensatory restoration and compensating for any interim losses of natural resources and services..

The Trustees have approached restoration planning with the view that the injured natural resources are part of an integrated coral reef ecosystem and that the coastal waters of Puerto Rico represent the relevant geographical area for siting restoration actions. The Trustees also recognize restoration actions should be consistent with local community objectives. Alternatives were considered more favorably if complementary with other community development plans/goals, local planning strategies, resource agencies priority setting documents, and species recovery plans.

In developing this Draft RP/EA, the Trustees have considered the need for and a range of alternatives appropriate to meet the goals of compensatory restoration under OPA including the scope and scale of compensatory restoration required to offset interim losses of natural resources and services.

4.2 RESTORATION SELECTION CRITERIA

Consistent with the NRDA regulations, 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 LNG-C MATTHEW site is to provide resources and services comparable to any residual losses from the resource injuries caused by the Incident. Future management of the restoration site is also considered because management issues can influence the extent to which a restoration action meets its objective.

The cost to carry out the alternative: The benefits of an action relative to its cost are a major factor in evaluating restoration alternatives. Factors that can affect and potentially increase the costs of implementing a restoration alternative can include project timing, access to the restoration site (e.g., with heavy equipment or for public use), acquisition of state or federal permits, acquisition of the land needed to complete a project, measures needed to provide for long-term protection of the restoration site, and the potential liability from project construction. The cost of monitoring sufficient to document restoration performance is a necessary component. Total project costs, and the potential availability of matching funds, if any, can also be considered.

The likelihood of success of each restoration alternative: The Trustees consider technical factors that represent risk to successful project implementation, project function, long-term viability and sustainability of a restoration action. Alternatives susceptible to future degradation or loss, such as due to subsidence or erosion, are considered less viable. The Trustees also consider whether difficulties in project implementation are likely and whether long-term maintenance of project features is likely to be necessary and feasible.

The extent to which each alternative will avoid collateral injury to 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 affect surrounding resources during implementation. Restoration actions with less potential to adversely impact surrounding resources are generally viewed more favorably. Compatibility of a restoration action with the surrounding land use and potential conflicts with endangered species are also considered.

The extent to which each alternative benefits more than one natural resource or service: This criterion addresses the interrelationships among 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 favorably.

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

The NRDA regulations give the Trustees discretion to prioritize these criteria and to use additional criteria, as appropriate. In developing this Draft RP/EA, the first criterion listed above has been a primary consideration, because it is critical to ensuring that restoration will make the public whole 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.

NEPA and the NRDA regulations required the Trustees to evaluate the "No Action" alternative which for compensatory restoration equates to "No Compensation." Under this alternative, the Trustees would take no action to compensate for interim losses associated with the evaluated natural resources.

4.3 IDENTIFICATION OF APPROPRIATE RESTORATION ALTERNATIVES

Throughout the restoration planning process for this Incident, the Trustees gathered information on appropriate potential compensatory restoration alternatives from regional resource managers and regulators; coral restoration literature and 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 is comprised of projects or activities that would directly enhance corals or other elements of the reef ecosystem. Potential projects could include coral transplantation, propagation of corals for transplantation, translocation and propagation of other key stone species such as Diadema antillarum (long spiny sea urchin).*

- Restoration of Existing and Future Impacts to Coral Reefs
  - *This alternative would include projects or activities that would restore coral reefs that have been impacted but where restoration would otherwise not occur. Potential projects could include the restoration at historic, orphan grounding site to improve recovery, emergency restoration of corals harmed by future orphan groundings and/or storm events.*

- Prevention of Future Physical Impacts to Coral Reefs
  - *This alternative encompasses projects or activities that would be likely to 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, sea grass 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 ALTERNATIVES

In developing this Draft 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 biological losses (i.e. the corals lost) caused by the LNG-C MATTHEW 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 2, the Trustees rated each potential restoration alternative based on its relationship to that stated goal, according to the following four ratings:

First Order Nexus – Project type directly provides same resource services as were lost due to the injury.

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.

Third Order Nexus – Project type only provides resource services that are comparable and/or similar to those lost due to the injury.

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 existed under alternatives with a First- and Second Order Nexus in the vicinity of the biological losses caused by the LNG-C MATTHEW Incident, the Trustees dropped alternatives with a Third-Order Nexus or No Nexus from further consideration in development of a restoration plan.

Table 2: Trustees 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	1st	Many project types in this alternative (active coral propagation) in this alternative could provide many of the same services that were seeking to restore.
Restoration of Existing and Future Impacts to Coral Reefs	1st	Many project types in this alternative (restoration to physical impacts) in this alternative could provide many of the same services that were seeking to restore.
Prevention of Future Coral Reef Physical Impacts	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	2nd	Projects within this alternative have the potential to restore biological resources (though indirectly) through the reduction of land-based and other sources of pollution.
Restoration of Associated Habitats	3rd	Restoration of associated habitats while beneficial has a less direct linkage to restoration of the biological resources lost as part of this incident than some of the other alternatives.
Construction of Artificial Reefs	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 ALTERNATIVES

Having identified the types of restoration actions most likely to meet the compensatory restoration goal for the biological losses (i.e. the corals lost) at the LNG-C MATTHEW site, the Trustees began reviewing the specific project opportunities that were consistent with the alternatives selected in section 4.4 for further consideration. The Trustees then narrowed the available projects under each broad alternative based on the following factors:

- Ability of the project to meet the OPA Restoration Selection Criteria
- Ability to implement the project within a reasonable time frame.

- Strength of the project's "nexus" to the injured resources.
- Likelihood of the project's success in achieving the compensatory restoration goal.
- Extent to which the project limited disruption to existing resources.
- Ability to scale the project using scientifically defensible means and assumptions

Through that process, projects that did not meet many or all of the above criteria were dropped from further consideration for use as Compensatory Restoration. The following restoration alternatives, and associated projects, emerged as the best candidates for addressing the outstanding biological losses caused by this Incident:

1) **Enhancement of Corals and Coral Reef Ecosystems**

   - **Active Coral Propagation** – Cultivating corals in nurseries and outplanting to coral reefs in Puerto Rico that have been either impacted by physical impacts or have lost corals in the past to disease or bleaching events.

2) **Restoration of Existing and Future Impacts to Coral Reefs**
   - **Restoration to Physical Impacts –** Reattach corals and stabilize reefs damaged during orphan groundings and/or storm events.

The Trustees evaluated these alternatives further using the criteria listed in this section and ultimately found that for the outstanding coral reef injuries from this incident that the Active Coral Propagation and Restoration to Physical Impacts alternatives were most closely aligned with the compensatory restoration goals for the biological losses caused by this Incident. The proposed compensatory restoration alternative presented in Section 5.0 summarizes the Trustees evaluation of the alternatives considered, the basis for the Trustees' choice of the preferred compensatory alternatives and the reasons these were favored over the non-preferred alternatives.

5.0 PROPOSED RESTORATION PLAN FOR ECOLOGICAL LOSSES

The restoration projects proposed to compensate for ecological injuries from the LNG-C Matthew grounding are identified in subsection 5.1. Subsection 5.3 describes the other project alternatives that were considered but not selected.

5.1 PREFERRED ALTERNATIVES FOR COMPENSATORY RESTORATION

The Trustees are proposing to approve two compensatory restoration projects to compensate for the interim coral losses caused by the LNG-C MATTHEW Incident. The preferred restoration actions are (1) Active Coral Propagation and (2) Restoration to Physical Impacts to restore and enhance corals and coral ecosystems in Puerto Rico. Both of these actions have been identified as jurisdictional priorities in Puerto Rico and are listed as priorities in the Draft Recovery Plan for Acroporids in the Caribbean (NOAA, 2015). A combination of the two alternatives has been proposed since Restoration to Physical Impacts relies on restoration to unplanned incidents. While it is not possible to predict exactly where these incidents will occur and their magnitude, the Trustees can use data going back to 2009 to estimate approximately how many will occur each year. By balancing this alternative with Active Coral Propagation, the Trustees can ensure that a certain amount of compensatory restoration is completed each year rather than rely on unplanned events. It gives the Trustees the opportunity to balance restoration efforts depending on the number and severity of incidents each year. The preferred restoration alternatives and proposed project actions are described in this subsection, together with a summary of the Trustees' evaluation of those alternatives, and the basis for selecting these projects. The Trustees' compensatory scaling analysis for each project is included in subsection 5.2 while subsection 5.3 describes the other alternatives considered by the Trustees, including the "No Action" alternative, together with the reasons they were not preferred in this proposed plan.

5.1.1 Active Coral Propagation

Both *A. cervicornis* and *A. palmata* have suffered dramatic declines throughout the entire Caribbean over the last few decades (Bruckner, 2002) which led to the inclusion of these species as "Threatened" under the Endangered Species Act in 2006. As a result of this decline, adult populations typically have low densities and low genetic diversity, resulting in a reduction in sexual reproduction and genetic connectivity for this genus. Most of the remaining populations are isolated from each to reproduce sexually making recovery difficult for these species. The life history traits of this genus (fast growth rates and highly successful asexual reproduction through fragmentation) has shown these species to be good candidates for coral propagation in the Caribbean (Highsmith, 1982; Lirman et al., 2010). As these populations continue to decline, proactive intervention is becoming increasingly warranted (Edwards and Clark, 1998). The clustering of corals with different genotypes during outplanting will increase the chances for sexual reproduction of these species in the field. The establishment of "reproductive thickets" may help increase connectivity in some areas (Lirman et al., 2010) and outplanting efforts in some areas have already succeeded at creating self-sustaining thickets (Griffin et al., 2015).

This project alternative represents active coral population enhancement for ESA-listed corals *A. cervicornis, A. palmata, O. faveolata, D. cylindricus* and other potential species. It would include continuation and expansion of existing coral nurseries in Puerto Rico, establishment and maintenance of additional coral nurseries in Puerto Rico, and active outplanting from each nursery to restore degraded reefs throughout the region. Based on the success of active coral propagation efforts in Puerto Rico and elsewhere, the Trustees believe an expanded, long term coral population enhancement represents a viable and appropriate alternative to compensate for coral losses caused by the LNG-C MATTHEW Incident in Puerto Rico.

Every year, corals are broken during storm events or ship groundings. These coral fragments can settle back on the reef and grow into new asexual recruits, or they are swept off the reef into sand and seagrass beds where they have low rates of survival (Lirman, 2000). Each year, there are thousands of these fragments that are lost to abrasion and burial by sediment in less ideal habitats. There is a significant opportunity here to save some of these fragments and use them for creating coral nurseries in Puerto Rico. Fragments can be brought into nurseries and used as broodstock for the nursery. There is virtually no real take from the environment since these fragments would have otherwise perished if left where they were. In some cases (usually to increase genetic variability in the nursery) fragments can be collected from healthy donor colonies. The donors usually recover in 3-6 weeks and show no additional mortality or disease after the fragment is removed (Lirman et al., 2010). Collected fragments are either transported underwater to nearby nurseries or placed in bins with seawater on board a vessel if they need to be transported by boat to the nursery sites. The seawater is changed regularly and the bins remain shaded during transit.

Figure 8: Photos showing a typical 5' x 10' line nursery set up (left) and a tree (right). Photos by NOAA Restoration Center.

Once at the nursery site, collected coral fragments are mounted on a variety of structures to promote growth and survival. Traditional methods included blocks, wire cages, and A-frames, but nurseries throughout the region are switching over to floating nurseries which include "Floating Underwater Coral Arrays" (FUCAs), Horizontal Line Nurseries (HLN) or Tables, or Trees (Figure 8). Floating nurseries have been shown to promote higher survival and growth rates compared to their benthic counterparts (Griffin et al., 2012; Hernández-Delgado et al., 2014). There is less disease due to the lack of predators on line nurseries and better water circulation. Line nurseries are also more durable during storm conditions and have withstood swells of at least 20 feet. Because of the low maintenance required for line nurseries, operational funds can focus on outplanting and nursery expansion.

Typically after one year in a nursery, a coral fragment has grown enough so that it can be either transplanted back onto the reef or fragmented to create new corals for the nursery to either restock or expand the nursery. Under this alternative, corals would be raised in nurseries and transplanted to restore reefs damaged by physical impacts (Figure 9) or to assist in population enhancement of coral species that were once prevalent but have declined in the recent decades because of disease outbreaks and/or bleaching events. During outplanting, corals with different genotypes will be clustered together to increase the chances for sexual reproduction of these species in the field (Lirman et al., 2010). A subset of outplanted corals will be monitored at each site for success by looking at survival, growth, and expansion. During the first year, monitoring will focus on survival and growth while longer term monitoring (3+ years) will focus on expansion of thickets through fusion and asexual reproduction along with effects on the reef community (fish biomass and percent cover of benthic organisms). A final monitoring plan will be developed by the Trustee Council prior to implementation of the Active Coral Propagation alternative.

Figure 9: Photos showing results of restoration using *A. cervicornis* outplants from a coral nursery at the T/V MARGARA grounding site in Guayanilla, Puerto Rico. The photo on left was taken by NOAA's Restoration Center in 2006 prior to restoration. The photo on the right was taken in 2015 by NOAA's Restoration Center.

The following general guidelines will be applied when selecting outplanting sites:

1) Suitable reef habitat and/or historic presence of the species (in recent decades).
2) Healthy environment for the given region
3) Part of restoration following physical impacts.

4) Increase genetic diversity at sites where there is low genetic diversity to increase chances of sexual reproductive success

5) Not within any permitted marine and coastal construction areas (i.e. dredging, beach nourishment projects, etc.).

This alternative allows for direct replacement of coral resources like those that were lost as a result of the Incident. This sort of project is also listed as one of the priorities in the Draft Recovery Plan for Acroporids in the Caribbean. The Trustees acknowledge that not all coral species that were lost would be able to be replaced as part of this alternative, but this project is proposed in combination with "Restoration to Physical Impacts" which will allow for restoration to a wider assemblage of coral species. Subsection 5.2 describes how this is addressed in scaling of the proposed actions.

5.1.2 Restoration to Physical Impacts

Physical impacts from hurricanes, vessel groundings, anchors, and marine debris are major threats to coral reef health and integrity and present a direct disturbance to the coral environment that can completely alter a reefs structure and function. U.S. Caribbean reefs are impacted annually by 1-2 major hurricanes, 1-2 large ship groundings, 100's of small boat groundings, and tons of derelict fishing gear. Many of these US Caribbean impacts occur each year in Puerto Rico, but often there is no viable responsible party or the impact is a result of a natural event. After these acute disturbances, injured corals and fragments are subject to abrasion, scour, and sedimentation which ultimately result in death if they are not stabilized. Unchecked, these damages can result in additional reef loss and instability, reducing coastal protection, causing economic impact to local fisheries, and eliminating key tourist attractions on which many coastal economies depend. However, if dislodged fragments can be collected and stabilized shortly after physical impact then, the probability of survival increases substantially (Edwards and Gomez, 2007).

This alternative would provide support for emergency response and restoration capability to respond to such incidents. Such a project would have the resources available to respond immediately to reef impacts in order to stabilize corals and loose substrate, implement emergency restoration and monitor long term effects. Each year thousands of corals would be saved that would have otherwise been lost due to physical impacts. Stabilizing these colonies not only directly saves the injured corals but also prevents further damage to unimpacted reefs when loose corals and debris are mobilized during storms or swells.

Response to physical impacts is a Jurisdictional Priority in Puerto Rico, an identified capacity gap in that jurisdiction, and a priority element of the draft Acropora recovery plan (NOAA, 2015). Puerto Rico has acknowledged that because of internal limitations and the need for quick and flexible response more robust action on the part of NOAA was necessary to help stem the unchecked and unnecessary coral losses that were occurring after physical impacts. NOAA has started a project that allows the Trustees to address the numerous impacts that were occurring annually, but currently does not have enough resources to address all of the impacts. A notification network along with a form to report grounding incidents has been set up with the US Coast Guard, salvers, and the local communities so that the Trustees are notified immediately of impacts. This has allowed the Trustees to conduct a preliminary assessment quickly after an incident and emergency restoration can be implemented if there is damage to coral resources. Corals are usually stabilized using a combination of cement, rebar, masonry nails, and epoxy. If necessary, limestone can be used to recreate topographic complexity at sites that have been flattened and rubble can be stabilized using cement to increase the survival of coral recruits and allow recovery to begin. Short term monitoring at certain sites (1-3 years) is performed to determine the success of the restoration (survival of reattached corals and stability of structures) while longer term monitoring will focus on reef recovery (benthic cover along with coral recruitment rates and survival).

In evaluating this alternative the Trustees found that it was likely to meet many of our goals for addressing the interim lost services associated with the LNG-C Matthew Incident. It was also found to have similar costs as the "Active Coral Propagation" alternative. The only negative feature identified with alternative was the unpredictable nature of future impacts and the uncertainty when, where, and what impacts would be able to be restored. This uncertainty results in the need for extrapolation from historical impacts in order to determine the credit for these future incidents. The scaling for this work is described in subsection 5.2.

5.2 COMPENSATORY CREDIT

The method of calculating the expected benefits (credits) of the preferred projects is similar to how the injury (debits) is calculated and relies on the same underlying principles (CCY) discussed in Section 3.5. The calculation also takes into consideration credit for Emergency Restoration and other interim restoration actions (pilot Acropora restoration efforts). In this case, the projects are considered to have provided the required compensatory restoration when credits [CCY gained (CCYG)] are equal or greater than the debits (CCYL).

As discussed in Section 5.1, the Trustees are proposing to approve two preferred alternatives focused on active coral propagation and restoration after physical impacts to address the interim losses still outstanding from the Incident after Emergency Restoration was completed. Credits for these actions (CCYG) are estimated by calculating the number of expected surviving outplants created from Active Coral Propagation and the number of corals expected to be saved during Restoration to Physical Impacts and scaling them similarly to how CCYL were determined - based on species, size class, recruitment and growth rates. The CCYG is also discounted annually by 3% for each year after the incident (2009) until when the projects are expected to be implemented.

TheActive Coral Propagation project will be implemented in Puerto Rico in existing nurseries and new nurseries when appropriate sites are identified. Once at full production, each nursery is expected to be able to produce 1,000-2,000 corals for outplanting each year. A certain amount of mortality in outplanted corals is expected before coral growth and natural reproduction (sexual and asexual) can outpace the rate of coral loss. Data from other sites in Puerto Rico indicate that outplant mortality in the first two years is approximately 20%. CCYG for this project is estimated by the number of corals outplanted each year, mortality of the outplants, species and size classes of the outplants, recruitment and growth rates, and year of outplanting. An example of one credit scenario outplanting nursery grown *A. palmata* can be found in Table 3. The final credit (CCYG) will be determined by the actual number of outplants, what species are outplanted, sizes, year of outplanting, etc For this project, the CCYG is discounted 3% each year between when the Project begins and when the corals are outplanted.

Table 3: Example of CCYG estimates for outplanting *A. palmata* from coral nurseries.

Species	Service Weighting Factor	Target Outplant Size (cm)	Years to Full Function (years after outplanting)	Outplant Lifespan (years after outplanting)	Relative Service Function	Project Start Year	Project Year		# of Surviving Corals Outplanted Annually	WCCYG Annually	Total WCCYG
Acropora palmata	0.931	20	1	50	100%	2017	1	2017		0	14,301
							2	2018	1000	3,735	
							3	2019	1000	3,626	
							4	2020	1000	3,521	
							5	2021	1000	3,418	

To estimate credit for Restoration After Physical Impacts, the Trustees evaluated a credit scenario based on historical orphan grounding and storm impact data from Puerto Rico since 2009. Annually, there are more than 50 groundings in Puerto Rico, but not all of them impact coral reefs. The frequency of groundings and storms that impact coral reefs, and the average number of corals available after each impact for reattachment were estimated from this data and could be used to estimate the total number of corals that could be saved each year (Table 4). This data could then be used to estimate the CCYG for this work based on the species, size class, recruitment and growth rates.

Table 4: Frequency of groundings and storms that impact coral reefs in Puerto Rico since 2009 and the average number of corals available for reattachment and CCYG after each impact.

Event	Frequency (per Year)	Average # of Corals/Incident available for Reattachment	Total # of Corals Saved each Year	Total Coral Colony Years Gained (CCYG)*
Small Groundings (<100 corals reattached)	4	40	160	2,159
Medium Groundings (>100 corals reattached)	2	350	700	7,351
Storm damage	1	1,000	1,000	14,554

* The CCYG in this table are based on if restoration was implemented in 2009. CCYG are discounted by 3% each year based on how many years after the Incident the restoration is completed.

Since Restoration to Physical Impacts relies on restoration to unplanned incidents that cannot be predicted, a combination of this work with the active population enhancement efforts are proposed to ensure that sufficient credit is generated over the course of five years. By balancing this program with Active Coral Propagation, the Trustees can ensure that a certain amount of compensatory restoration is completed each year rather than rely only on unplanned events. It gives the Trustees the opportunity to balance restoration efforts depending on the number and severity of incidents each year. At the project outset, the Trustees will identify the expected annual costs to complete both the population enhancement and impact response programs t to achieve at least 111,600 CCYG over 5 years. If the funds identified by the Trustee Council for unplanned incidents are not fully utilized restoring physical impacts, the remaining funds will be used for Active Coral Propagation to ensure that sufficient project credit is generated. Given this combined approach, it is estimated that over 111,600 CCYG will be earned through either outplanting from coral nurseries or saving corals after physical impacts over the course of 5 years to make up for the lost services at the LNG-C Matthew site. The Trustees' current estimate of the projects' costs is $1.6 million. This is the product of a negotiated settlement that took into account all circumstances, including litigation risk. This will cover contract support for vessel and dive operations during propagation, response, restoration and monitoring activities as well as Trustee oversight (contract management, labor, hazard pay and travel for Trustees supervising the projects).

5.3 PROJECT ALTERNATIVES

As described in Section 4.0 and Section 6.0, the Trustees considered a number of alternatives for compensatory restoration:

- Enhancement of Corals and Coral Reef Ecosystems;
- Restoration of Existing and Future Impacts to Coral Reefs;
- Elimination and Reduction of External Reef Stressor;
- Prevention of Future Physical Impacts to Coral Reefs;
- Restoration of Associated Habitats;
- Construction of Artificial Reefs; and
- No Action Alternative

Of these seven alternatives, the first two (as described in Section 4 and Section 6.1) were selected as preferred alternatives because they were the ones deemed most likely to meet the Trustees' purpose and need under NEPA. They are being carried forward for detailed review, along with the "No Action" alternative (as required under NEPA). The remaining four were considered but eliminated from detailed review. Those alternatives and the rationale for not selecting them are evaluated in this section.

5.3.1 Elimination and Reduction of External Reef Stressors

This alternative was dropped from further consideration because, while many high quality restoration projects of that type are capable of meeting many of the Trustees' identified goals, the benefits of these projects to reefs were indirect in nature and the Trustees were not able to identify a suitable technique to scale these benefits (often the reduction of sediments and nutrients) to the biological losses to be restored.

5.3.2 Prevention of Future Coral Reef Physical Impacts

This alternative was also dropped from further consideration because, while there are many opportunities to improve Aids to Navigation and potentially protect coral reefs from future injuries by vessel groundings, the Trustees were not able to identify a suitable technique to scale these benefits to the biological losses to be restored.

5.3.3 Restoration of Associated Habitats (Sea Grass, Mangrove, Wetlands)

Potential projects could include mangrove restoration, sea grass restoration, and coastal wetlands restoration. While these alternatives would include projects or activities that would restore habitats commonly associated with coral reefs and habitats that support that same fish species as coral reefs, they would not directly replace the services that were lost by the coral themselves. Given the lack of nexus to corals, the Trustees could not identify a suitable technique to scale these benefits to the biological losses that needed to be restored.

5.3.4 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 aggregation, and in some cases coral recruitment. Potential projects could include placement of ReefBalls™, EcoReefs™, limestone boulders, and/or other structures in sand bottom areas. While these alternatives could create habitat similar to coral reefs, they are not able to replace the corals themselves that were lost in the incident. They may provide substrate for coral recruitment, but as mentioned previously, many of these species will take decades or even centuries to recover naturally given low recruitment rates and slow growth rates. The preferred compensatory restoration alternative is intended to make up for this loss of service during recovery, not recreate it elsewhere.

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 proposed actions 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 Draft RP/EA**,** the appropriate context for considering significance of the action is local, 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 a broad range of restoration alternatives. This process and the alternatives selected are described in Sections 4 and 5. In this section, the Trustees evaluated the potential for environmental consequences that could result from restoration actions associated with both the Preferred and the No Action Alternatives.

The activities to be undertaken under this Draft RP/EA include stabilizing loose rubble and limestone, reattaching loose coral fragments, and attaching nursery-raised corals to reef areas. Large corals and substrate may be reattached or secured by weight (at placement or as constructed) or by using cement, rebar, concrete, nails, and/or epoxy. The placement, reattachment, and stabilization of smaller coral fragments, individual coral colonies, or nursery-reared corals is typically done using epoxy, cement, concrete nails or other mechanical devices (e.g., plastic cable ties). Generally, transplanted corals are reattached either directly to the reef or to a base, which is affixed to the sea floor. Stabilization and restoration activities conducted would use field-tested methods and be performed 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.

These restoration actions would enhance coral populations and increase coral survival and recovery at impacted sites, and prevent additional damage to reef resources during storm events. The restoration actions would increase reef habitat function and topographic complexity at multiple sites. The preferred restoration alternatives would restore coral reefs and increase their services and benefits to other resources in Puerto Rico. The enhanced and increased reef habitat resulting from these actions would also 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.

6.1 SCOPE OF THE NEPA ANALYSIS

This section describes the potential impacts of the proposed actions (active coral propagation and restoration after physical impacts), 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 be 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 reproduction 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 likely 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 CFR 1508.27), and thus, warrant heightened attention and examination for potential means for mitigation 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 CFR 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 ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS EVALUATION

The environmental and socio-economic impacts of the described restoration actions are largely beneficial. The actions to be implemented will increase populations of an ESA-listed coral species, further enhancing its 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; improve habitat for marine organisms, and other benefits for a variety of federally threatened and endangered species. Similar restoration projects have been underway in Puerto Rico and the broader US Caribbean at a scale similar to that proposed here with no significant adverse effects. As with any restoration action there are certain short term effects that can have some adverse effects (e.g., use of small vessels, anchoring, placement of nursery structures on the seafloor, and coral tissue contact with epoxy etc.) such as the potential for debris, isolated mortality, surface damage and added traffic. These effects are minimized by following best management practices and utilizing trained and experienced practitioners; any effects that do occur however are expected to be localized and of very limited duration.

As with all restoration projects, sound evaluation criteria, performance goals, capacity for adaptive management, and appropriate risk considerations are key. For example, studies are in progress to evaluate the target coral densities in areas to be outplanted at 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; however, should a site perform poorly due to local environmental conditions, an alternate site would be identified. The project would manage risk of failure by using three independent oceanic nurseries, in addition to numerous outplanting locations, in order to maximize work windows, decrease exposure 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.

Another potential risk with the preferred Active Coral Propagation alternative is that it focuses largely on active propagation of *Acropora* species versus a more diverse species assemblage. While the Trustees ultimately hope to be able to propagate other species in addition to *A. cervicornis* and *A. palmata* in order to have a more diverse restoration project, propagation strategies are not as far developed for other species, and therefore the Trustee's balanced out the Active Coral Propagation with Restoration After Physical Impacts to address a more diverse assemblage of coral species. That said any single species project has the potential for risks that might effect that species more than others (hurricane induced breakage, disease, etc.). These factors are being considered in project design and as such the project will utilize multiple locations and numerous genetic individuals to minimize these risks.

The proposed alternative is viewed as having largely beneficial socioeconomic impacts in the local community. Both recreational and commercial fisheries in Puerto Rico have the potential to indirectly benefit as the proposed projects will improve habitat in the system that many economically important species of finfish and invertebrates rely on during various life stages. The project will likely directly employee local divers and work with business in the local community. Additionally the increased reef health in the area has the potential to indirectly increase recreational and tourism use of the reef which subsequently will result in income to local dive operators, restaurateurs, hotels, shops, etc.

6.3 IMPACTS OF PREFERRED ALTERNATIVE AND NO ACTION ALTERNATIVE

The Trustees evaluated the potential for restoration actions associated with both the Preferred and the No Action Alternatives to impact the following: the biological environment (fisheries, vegetation and wildlife, and endangered species), the physical environment (air and noise pollution, water quality, geological and energy resources, contaminants), the cultural and human use environment (environmental justice, recreation, traffic, and cultural resources) and in Section 5.3, the potential for cumulative impacts.

6.3.1 Biological Environment

Fisheries

Preferred Alternatives:

The preferred alternatives for restoration would occur within areas designated as Essential Fish Habitat (EFH), but 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. Prior to the physical impacts from groundings or storms, these sites provide valuable EFH. However, after being impacted loose unconsolidated rubble is left behind, topography has been destroyed and areas are devoid of biota. This is not EFH. Stabilizing the rubble and re-introducing both topographic features and biota to restore a site's EFH would benefit the surrounding fisheries. 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 6 - 8'+. Mangroves and seagrass beds in the area are protected from offshore swells by coral reefs. Wakes from the vessels would not exceed typical background conditions so they should have no impact on coral reefs, mangroves or seagrasses in the area.

During the active restoration phases of these projects, short-term, minor, direct and very localized adverse impacts that could occur include physical 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 requiring that the contractors set up temporary moorings so vessels won't have to anchor, and using a sludgy stucco-like cement mixture that reduces plumes that would be employed in undertaking restoration actions to maximize the protection of area resources but some increase in turbidity could still occur. Increases in turbidity may 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. Mobile fish and invertebrates would probably not be affected, since these would most likely leave the area, 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 positively impacted by the accelerated recovery and enhancement of reef services that would be achieved through the preferred 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 for a variety of managed fish 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 negatively 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 Alternatives:
The Trustees do not believe that the preferred primary restoration alternative would 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 that may be present in the area during restoration activities are mobile enough that 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.

No Action: The Trustees do not believe that the No Action Alternative would have a net adverse effect on vegetation and wildlife.

Endangered Species

Endangered and threatened species are known to occur on reefs in Puerto Rico are listed in Table 5. Many of these species, including staghorn (*Acropora* cervicornis) and elkhorn (*A. palmata*) coral, mountainous star coral (*Orbicella faveolata*), boulder star coral (*O. franksii*), lobed star coral *(O. annularis)*, pillar coral (*Dendrogyra cylindrus),*rough cactus coral (*Mycetophillia ferox*), green sea turtle (*Chelonia mydas*), Hawksbill turtle (*Lepidochelys kempi*), leatherback turtle (*Caretta caretta*), 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.

Preferred Alternatives:
Given the constant presence of boats in Puerto Rico, the 10-20 meter boats used during restoration activities should not have vessel noise signatures that exceed levels frequently experienced at these sites. Additionally, the general locale where the restoration actions would be sited is critical habitat for these species. These species would benefit from restoration at these sites. Coral survival would increase as a result of stabilization. Rubble stabilization would prevent additional injuries to colonies from mobilization of rubble during storm events that can break, abrade and smother colonies adjacent to the impact site. While it is possible there may be some minor short-term adverse effects to some of these species during primary restoration through sedimentation or from possible physical impact it is not expected. Additionally the overall (net) long-term effects would be much more beneficial to these species and outweigh any of the short-term potential impacts. The Trustees know of no other direct or indirect impacts of the preferred restoration alternative on threatened or endangered species, or their designated critical habitats.

The NOAA Restoration Center completed a Programmatic Consultation on its enhancement and restoration activities in September 2011 (NMFS, 2011). 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 has requested concurrence with NMFS Southeast Protected Resources Division that the Preferred Alternatives fall within the scope of the Restoration Centers Programmatic Biological Opinion on February 16, 2016; and the Protected Resources Division provided concurrence on February 19, 2016.

Table 5: 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 franksii*	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 imbricate*	E; Critical Habitat
Roseate Tern	*Sterna dougalii dougalii*	T
West Indian Manatee	*Trichechus manatus*	E
Scalloped Hammerhead shark	*Sphyrna lewini*	T
Nassau grouper	*Epinephelus striatus*	T

No Action:
The No Action Alternative would have a net adverse effect on ESA species listed in Table 5 that are either present on the reef or migrate through the area as discussed in the previous section. Corals injured during physical impacts would perish and there would be little or no recruitment survival in the rubble areas. Additional injuries can be expected to occur through mobilization of rubble during storm events that can break, abrade and smother colonies adjacent to the impact sites.

6.3.2 Physical Environment

Air Quality

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

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

Noise

Preferred Alternatives:
Noise associated with the vessels represents a short-term adverse impact during the restoration projects. 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 the site does 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 duration of the project. There are plenty substitute sites readily available to divers and fishermen in Puerto Rico. Installation activities, equipment operation, and vehicle or boat traffic associated with the restoration could result in short-term minor to moderate adverse impacts to noise in natural areas. For example, during the use of motorized vessels, 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, these actions could detract from the current user activities or 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 couple days a year for up to ten years.

No Action:
There would be no negative impacts from noise due to the No Action Alternative.

Water Quality

Preferred Alternatives:
In the short term, the planned restoration activities might have minor, short term, indirect impacts by temporarily increase 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

effects on the adjacent reef. Over the longer term, the preferred restoration actions would accelerate recovery of and enhance coral reefs at the sites.

<u>No Action</u>:
There may be long term moderate impacts by increases in turbidity in waters within and near the impact sites as a result of No Action, particularly when sediment in the rubble fields is suspended during storms.

Geology

<u>Preferred Alternatives:</u>
The preferred restoration actions would have a positive impact on the reef geology. Physical impacts can significantly impact reef topography and flatten the reef in many areas. Without restoration, these areas may never recover their original topography. The preferred primary restoration actions would have an immediate positive effect by restoring topographic complexity to the impacted sites.

<u>No Action</u>:
The No Action Alternative would have a negative impact on the reef geology in the area. Physical impacts can significantly impact reef topography and flatten the reef in many areas. With No Action, these areas may never recover their original topography.

Energy

<u>Preferred Alternatives:</u>
Natural gas and petroleum products are transported by vessels almost daily to facilities in Puerto Rico. The preferred restoration activities 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.

<u>No Action</u>:
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. Impacted sites will be investigated extensively as part of preassessment, emergency restoration, assessment surveys used to identify impacted reef areas and identify necessary restoration actions.

6.3.3 Cultural and Human Use Environment

Environmental Justice

Preferred Alternatives:
None of the preferred 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. Coral reef restoration projects have been implemented in Puerto Rico consistent with federal, state and local laws designed to protect and restore the environment. The preferred primary restoration project has no unique attributes or characteristics in that regard. 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, the damaged reef environments that are of benefit to all citizens, populations and groups in Puerto Rico may never recover. The lack of meaningful recovery of the reef contributes adversely to the economic and social well-being of all citizens, populations and groups in Puerto Rico, although it would not expected to impact conditions affecting 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 Alternatives:
Though noise and increased turbidity of surface waters due to construction activities during restoration can have a minor short term effect on recreational activities by temporarily discouraging and decreasing recreational activities in the vicinity of a site; however, many sites 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, 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. In the longer term, the preferred 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.

No Action:
The No Action Alternative could negatively impact recreational opportunities for fishermen and divers in Puerto Rico since the impacted reef may never recover with No Action. This would result in a reduction in available fishing and diving areas.

Traffic

Preferred Alternatives:
The Preferred Alternative would have a minor short term effect on vessel traffic. There would be an increase in vessel traffic during active implementation of 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 preferred 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 mobility at the site is restricted during restoration. Once restoration activities are complete, the added vessel traffic to, from and 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 planned primary restoration actions.

6.4 CUMULATIVE IMPACTS

6.4.1 Cumulative Impacts of the Preferred Restoration 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 included on the Endangered Species List since 2006; seven of which are located in the Caribbean and project area. These effects are magnified in the Caribbean where there is a much higher human population densities in a much smaller oceanic basin with lower coral species diversity, especially on a small island like Puerto Rico with a population over 3.5 million people. The combination of increased ship traffic in the region and larger vessels coming through the newly widened Panama Canal have potential long term adverse impacts from 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, positive impacts by enhancing coral populations throughout the project area, saving corals that would otherwise perish, accelerating recovery and enhancing the coral reefs at impacted sites, allowing them to provide ecological services sooner and into the future. The effects of the compensatory restoration projects, 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 of hydrologic discharge, boat traffic, economic activity or land-use in Puerto Rico. The preferred restoration actions would only restore habitat that originally existed and occurred naturally at these locations.

Other known activities in the vicinity of the restorations 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 actions. A net cumulative beneficial impact will likely result from future restoration activities that will be used to compensate for interim losses.

The Preferred Restoration Alternatives included in this Draft RP/EA are based on 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, 2015). The restoration alternative proposed in this draft RP/EA in combination with additional coral propagation work proposed in the draft RP/EA for the T/V PORT STEWART will assist in the recovery of these species. 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 inclusion of 22 species of coral on the Endangered Species List. The No Action Alternative is expected to result in cumulative, adverse impacts and would not provide the conditions necessary for recovery of the injured reefs. With No Action, key natural resources and services might not ever return to baseline. 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 Non-Preferred 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. Data collected at other sites, and the scientific literature and restoration work conducted in Puerto Rico over the last ten years have shown that rubble areas created by physical impacts will not recover with No Action. 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

For purposes of this analysis, the federal agencies must evaluate two categories of potential effects related to climate change. Under Section 102 of NEPA and the CEQ Regulations for Implementing the

Procedural Provisions of NEPA, 40 C.F.R. §§ 1500-1508, federal agencies should analyze the environmental effects of GHG emissions and climate change when they describe the environmental effects of a proposed agency action. Specifically, federal agencies must consider the following:

- The 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 do have the potential to generate GHG emissions through the use of oil-based fuels and consumption of both renewable and nonrenewable resources. At this point in the planning process, it is not possible to identify potentially GHG-generating activities more specifically.

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 restoration alternatives proposed in this Draft RP/EA will work directly to protect keystone species by enhancing populations of coral species like *A. cervicornis* and *A. palmata.* They will help reduce stressors, restore topographic relief and help maintain diversity and habitat connectivity on coral reefs within Puerto Rico by restoring impacted areas to their previous ecological capacity. These activities will also preserve species diversity that might otherwise be lost if it weren't for the restoration activities.

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 which injure or are likely to 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 beneficial uses of dredged or fill material. The U.S. Army Corps of Engineers 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 discharge or fill activities in navigable waters must obtain certification of compliance with state water quality standards. The proposed Preferred Alternatives don't involve placement of limestone, disturbance of benthic sediments, or involve discharge or fill activities; therefore, 404 permits and 401 certifications will not be required..

***Rivers and Harbors Act, 33 U.S.C. §§ 401,* et seq.**
The Rivers and Harbors Act regulates development and use of the nation's navigable waterways. Section 10 of the Act prohibits unauthorized obstruction or alteration of navigable waters and vests the U.S. Army Corps of Engineers (USACoE) with authority to regulate discharges of fill and other materials into such waters. Restoration actions that must comply with the substantive requirements of Section 404 must also comply with the substantive requirements of Section 10. This would likely be required for some aspects of the coral propagation work, and would be addressed for project activities prior to implementation as part of the USACoE's regulatory processes.

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 proposed restoration actions are, and can be

performed in a manner, that 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 reef areas impacted by physical impacts 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, environment al and cultural resources". The Board also confirmed that, prior to performing the actions identified in the Restoration Plan, 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 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 this Draft RP/EA 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 has requested concurrence with NMFS Southeast Protected Resources Division that the Preferred Alternative falls within the scope of the Restoration Centers Programmatic Biological Opinion on February 16, 2016; and the Protected Resources Division provided concurrence on February 19, 2016.

***Fish and Wildlife Conservation Act, 16 U.S.C. §§ 2901,* et seq.**
The proposed restoration actions 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 are coordinating with NMFS, the USFWS, and the Puerto Rico Department of Natural Resources (the appropriate state wildlife agency under FWCA). This coordination is also incorporated into compliance processes used to address the requirements of other applicable statutes, such as Section 404 of the CWA. The restoration actions 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 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 subsection 6.2 above, the Trustees do not believe that the planned restoration actions would have a net adverse impact on EFH as designated under the Act. An abbreviated EFH consultation will be completed with NMFS in 2016 prior to completion of the final EA. Based on prior consultations for similar restoration activities, NMFS SERO does not consider impacted sites with loose unconsolidated rubble, no topography and areas devoid of biota to meet criteria for designated EFH.

***Marine Mammal Protection Act, 16 U.S.C. §§ 1361,* et seq.**
The Marine Mammal Protection Act 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, porpoise, seals, and sea lions. The Department of the Interior is responsible for all other marine mammals. The restoration actions described in this plan would not have an adverse effect on marine mammals.

***Migratory Bird Conservation Act, 16 U.S.C. §§ 715,* et seq.**
The restoration actions described in this plan would have no adverse effect on any migratory birds.

Migratory Bird Treaty Act, 16 U.S.C. §§ 703 – 712
The restoration actions described in this plan 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, 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 proposed restoration actions.

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 Draft 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 Draft RP/EA is designed to restore injured coral and coral reef habitat, compliance with EO 13089 is inherent within the project.

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 restoration actions described in this Draft RP/EA have no potential to affect any low income or ethnic minority communities, therefore the Trustees have concluded that such communities would not be adversely affected by the planned restoration actions.

Executive Order Number 11514 (35 Fed. Reg. 8,693) – Protection and Enhancement of Environmental Quality
An Environmental Assessment is integrated within this Draft 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 restoration actions described in this plan have 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 restoration actions described in this plan would not result in adverse effects on wetlands or the services they provide.

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

Regulation 2577, Commonwealth of Puerto Rico
Article 3 in Regulation 2577 of 5 November 1979, *Regulation to control the extraction, possession, transportation and sale of coralline resources in Puerto Rico*, prohibits to take, extract, destroy, transport, possess or sale any live or dead coral within state waters. Article 5.4 of this regulation exempts those activities that have a US Corps of Engineers permit and have an endorsement from the Department of Natural and Environmental Resources. NOAA's Restoration Center has an MOA with PRDNER to conduct the proposed Preferred Alternatives in this Draft RP/EA.

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 restoration activities described in this Draft RP/EA seek to increase the survival of coral species considered at present threatened so the Trustees do not expect impediments in the process of obtaining such authorization or permit.

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 Draft RP/EA seeks to increase the survival and propagation of coral species so the Trustees do not expect impediments in the process of obtaining such authorization or permit.

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APPENDIX A

SUMMARY OF CORALS IMPACTED AND CORAL COLONY YEARS LOST (CCYL) FROM THE LNG-C MATTHEW GROUNDING

Site Name:	LNG-C MATTHEW					
Impact Area (sq. meters)	3,047					
Impact Year	2009	**Discount rate**	3%	**Standardized Coral Size (cm)**	45	

Species Groups	% Service Loss @ Injury	Loss into Perpetuity (TRUE/FALSE)	Annual Growth Rate (cm)	Recovery Delay (Years)	% Addressed by ER	Average Recruitment Delay (Years)	% Relative Value @ Recovery
Massive	100%	FALSE	0.56	0.5	22%	5	80%
Brooders	100%	FALSE	0.488	0.5	9%	3	80%
Acropora	100%	FALSE	10	0.5	100%	5	100%
Branching	100%	FALSE	1.8	0.5	9%	5	80%
Octo Corals	100%	FALSE	1.9	0.5	27%	3	100%
Psd Corals	100%	FALSE	3.7	0.5	3%	3	100%

Results

Species Groups	Total Coral Losses	Outstanding DWCCYL (Prior to ER)	Outstanding DWCCYL (After credit for ER)
Massive	14,648	77,596	60,525
Brooders	10,644	9,918	9,025
Acropora	41	22	0
Branching	1,402	3,164	2,879
Octo Corals	35,894	44,690	32,624
Psd Corals	9,446	6,750	6,547
Total	**72,073**	**142,141**	**111,601**

Number of corals impacted by species and size class

Species Group A

Massive

Species	Service Weighting Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Size Class		**0 - 10 cm**	**10 - 20 cm**	**20 - 30 cm**	**30 - 40 cm**	**40 - 50 cm**	**50 - 60 cm**	**70 cm**	**80 cm**	**90 cm**	**100 cm**	**110 cm**	**120 cm**	**130 cm**	**140 cm**	**150 cm**	**160 cm**	**170 cm**	**180 cm**	**190 cm**	**200 cm**
Avg Size (cm)		5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195
Colpophyllia natans	0.569	20	0	0	61	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichocoenia stokesii	0.375	163	81	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diploria clivosa	0.528	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diploria labyrinthiformis	0.542	41	102	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diploria strigosa	0.556	508	711	386	264	81	0	20	20	0	0	0	0	0	0	0	0	0	0	0	0
Eusmilia fastigiata	0.458	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isophyllastrea rigida	0.292	20	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isophyllia sinuosa	0.292	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Madracis decactus	0.347	630	142	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Madracis pharensis	0.292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manicina areolata	0.181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meandrina meandrites	0.417	122	223	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meandrina memorialis	0.403	20	41	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montastraea annularis	0.931	366	427	203	122	0	61	20	0	0	41	0	0	0	0	0	0	0	0	0	0
Montastraea cavernosa	0.569	853	1,239	548	284	122	41	0	41	0	0	0	0	0	0	0	0	0	0	0	0
Montastraea faveolata	0.847	752	589	345	183	122	102	61	61	0	20	41	0	20	0	20	0	41	0	0	41
Montastraea franksii	0.847	61	122	20	41	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
Montastraea spp.	0.847	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mussa angulosa	0.350	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycetophyllia spp.	0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scolymia spp.	0.222	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siderastrea siderea	0.528	1,341	792	223	142	20	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solenastrea bournoni	0.431	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solenastrea hyades	0.458	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stephanocoenia michilini	0.306	325	305	61	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xestospongia muta	0.500	0	41	102	41	61	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species Group B

Brooders

Species	Service Weighting Factor	Size Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			0 - 10 cm	**10 - 20 cm**	**20 - 30 cm**	**30 - 40 cm**	**40 - 50 cm**	**50 - 60 cm**	**70 cm**	**80 cm**	**90 cm**	**100 cm**	**110 cm**	**120 cm**	**130 cm**	**140 cm**	**150 cm**	**160 cm**	**170 cm**	**180 cm**	**190 cm**	**200 cm**
		Avg Size (cm)	5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195
Agaricia spp.	0.236		2,295	934	223	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porites astreoides	0.264		2,661	2,844	853	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porites colonensis	0.250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siderastrea radians	0.181		508	163	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species Group C

Acropora

Species	Service Weighting Factor	Size Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			0 - 10 cm	**10 - 20 cm**	**20 - 30 cm**	**30 - 40 cm**	**40 - 50 cm**	**50 - 60 cm**	**70 cm**	**80 cm**	**90 cm**	**100 cm**	**110 cm**	**120 cm**	**130 cm**	**140 cm**	**150 cm**	**160 cm**	**170 cm**	**180 cm**	**190 cm**	**200 cm**
		Avg Size (cm)	5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195
Acropora cervicornis	0.889		41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Species Group D

Branching

Species	Service Weighting Factor	Size Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			0 - 10 cm	**10 - 20 cm**	**20 - 30 cm**	**30 - 40 cm**	**40 - 50 cm**	**50 - 60 cm**	**70 cm**	**80 cm**	**90 cm**	**100 cm**	**110 cm**	**120 cm**	**130 cm**	**140 cm**	**150 cm**	**160 cm**	**170 cm**	**180 cm**	**190 cm**	**200 cm**
		Avg Size (cm)	5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195
Dendrogyra cylindrus	0.833		41	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Millepora spp.	0.389		345	264	203	81	41	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porties porites	0.542		203	102	20	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species Group E

Octo Corals

Species	Service Weighting Factor	Size Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			0 - 10 cm	**10 - 20 cm**	**20 - 30 cm**	**30 - 40 cm**	**40 - 50 cm**	**50 - 60 cm**	**70 cm**	**80 cm**	**90 cm**	**100 cm**	**110 cm**	**120 cm**	**130 cm**	**140 cm**	**150 cm**	**160 cm**	**170 cm**	**180 cm**	**190 cm**	**200 cm**
		Avg Size (cm)	5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195
Briareum asbestinum	0.167		1,930	1,686	772	305	81	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eunicea spp.	0.208		1,138	1,422	1,117	691	386	122	20	41	0	0	0	0	0	0	0	0	0	0	0	0
Erythropodium spp.	0.125		1,767	1,584	691	122	61	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gorgonia spp.	0.236		284	427	488	366	386	305	223	142	81	20	20	20	0	0	0	0	0	0	0	0
Muricea spp.	0.250		264	650	589	345	122	61	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Muriceopsis spp.	0.278		0	0	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plexaura spp.	0.250		1,828	2,580	1,645	2,092	873	569	61	203	0	41	0	0	0	20	0	0	0	0	0	0
Plexaurella spp.	0.236		41	102	61	102	142	81	20	0	41	0	0	20	0	0	0	0	0	0	0	0
Psuedoplexaura spp.	0.264		61	81	183	163	102	41	0	41	20	20	0	0	0	0	0	0	0	0	0	0
Pterogorgia spp.	0.292		0	223	102	61	0	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Unknown spp.	0.220		1,524	1,645	975	508	284	264	61	41	20	0	0	20	0	0	20	0	0	0	0	0

Species Group F

Psd Corals

Species	Service Weighting Factor	Size Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			0 - 10 cm	**10 - 20 cm**	**20 - 30 cm**	**30 - 40 cm**	**40 - 50 cm**	**50 - 60 cm**	**70 cm**	**80 cm**	**90 cm**	**100 cm**	**110 cm**	**120 cm**	**130 cm**	**140 cm**	**150 cm**	**160 cm**	**170 cm**	**180 cm**	**190 cm**	**200 cm**
		Avg Size (cm)	5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195
Psuedoptergorgia spp.	0.208		1,097	1,097	1,280	853	467	325	81	142	0	20	0	41	20	0	0	0	0	0	0	0
Palythoa	0.133		2,133	833	589	325	122	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0