Osborne Tire Reef
Restoration Plan
Fiscal Year 2023-24

Office of Resilience and Coastal Protection
and
Division of Waste Management
Florida Department of Environmental Protection
2024

Osborn Tire Reef Restoration Plan

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1.0 Executive Summary

The Osborne Tire Reef, a site located off the coast of Broward County, is the location of over 1 million used tires bound for disposal that were placed predominantly between two coral reefs tracts in the 1970s for fishery enhancement purposes. Since the early 2000s, the state and its partners have embarked on restoration efforts to remove tires from the Osborne Tire Reef. More recently, the state began funding projects to remove and relocate stony coral (also known as scleractinian coral) colonies from tires to natural coral reef habitat to facilitate tire removal efforts and restore portions of Florida's Coral Reef in Broward County. In response to the large number of tires remaining on the ocean bottom and continued potential for impacts to natural reef habitat, the 2023 Legislature enacted the Restoration of Osborne Reef Act (Act) (Chapter 2023-126, Laws of Florida). This Act required the Florida Department of Environmental Protection (DEP) to submit a Status Report on tire removal efforts (completed Dec. 1, 2023; DEP 2023; **Appendix A**) and develop a Restoration Plan (Plan) for the impacted reef (due July 1, 2024). The Status Report provided a detailed description of the status of the Osborne Tire Reef, tire removal progress and all associated restoration efforts to date.

This Plan is provided to address the following bill requirements:

> *By July 1, 2024, the Department of Environmental Protection shall develop a comprehensive coral reef restoration plan for Osborne Reef[1] to be commenced, subject to appropriation by the Legislature, upon the completion of the cleanup and tire removal project. At a minimum, the restoration plan must include a preliminary plan for the restoration of the existing reef, the restoration of any nearby natural reefs that were destroyed by the tire installation, the shifting of resources from tire retrieval to reef restoration, and coordination with other coral reef restoration projects and resources.*

The goal of this Plan is to remove all visible tires and restore coral reef habitat in areas that were most likely to have been damaged by the Osborne Tire Reef. A multi-stage approach was developed by the DEP and its contractor to accomplish several objectives and develop this Plan. Stage 1 was a sonar-based survey and geographic information system (GIS) product to map tires on the seafloor (2024 Tire Survey). Stage 2 was an in-water survey to assess the number and condition of tires on reef habitat, severity of tire-related impacts to reef substratum and fauna, the level of entrapment in hardbottom structures and the degree of encrustation by reef organisms (2024 Recon Survey). Stage 3 provides a preliminary plan for the restoration of the existing reef and the restoration of any nearby natural reefs that were destroyed by the tire installation, as required by the Act. This includes a strategy to remove tires from coral reef habitat and conduct biological restoration (coral outplanting).

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[1] The term "Osborne Reef" refers to an artificial reef adjacent to the Osborne Tire Reef installation though they are not officially associated with each other. This Plan is developed on the assumption that it is not the goal of this Act to restore Osborne Reef. Rather, the priority habitat for tire removal and restoration in this Plan is the coral reef. Tires adjacent to or in contact with Osborne Reef will be targeted for removal. Coral outplanting to this artificial reef may be considered if necessary, and if time and budget allow.

The 2024 Tire Survey indicated that tires were spread beyond what was expected, across all four reef complexes (**Figure 1**). To reduce the risk of further damage to the reef, this Plan was developed to expand DEP-lead efforts of tire removal to coral reef habitat. This Plan provides prioritizations for selecting the reef areas for tire removal, considerations and recommendations for removing tires from reef habitat, and requirements and recommendations for relocating stony coral colonies attached to tires prior to tire removal. This information may be used to develop a Request for Proposals, acquire permits and select a contractor to conduct this work. Contractors would be responsible for developing plans to remove tires from reef habitat and to remove and relocate stony coral colonies from reef tires based on the requirements and recommendations set forth in the Plan.

Biological restoration in this Plan (coral outplanting) was developed to focus on returning lost stony coral function to reef areas identified as likely having suffered the greatest impacts from tires. Acreages of reef impact and priority areas for biological restoration were identified using a grid-cell system and high-density tire locations. By comparing benthic survey data over several years, target coral species and densities were selected for biological restoration. Lastly, recommended methods for outplanting stony corals, octocorals and sponges are also provided.

This Plan also describes the estimated total and annual (by fiscal year) budgets of the various activities outlined in this Plan and the approximate timelines to obtain relevant permits, set up agreements and contracts, and remove tires from coral reef and sand habitat. Based on future appropriations, the current tire removal project managed by DEP's Division of Waste Management (DWM) will continue concurrently with implementation of this Plan and expand to include the full extent of the tire distribution in sand and reef habitats. The DEP Office of Resilience and Coastal Protection (ORCP) will lead all coral-related transplantation, restoration and monitoring initiatives.

Using data from tire surveys conducted in 2019 and 2024, there are an estimated 521,000 unburied and visible tires. Estimates do not include tires that are fully buried or located outside the survey areas. It is estimated that there are 429,000 tires in sand and, at most, 92,000 tires in contact with coral reef habitat. Tire removal from all habitats (coral reef habitat and sand habitat) and biological restoration (coral outplanting) is anticipated to take 14 fiscal years from July 1, 2024. Removal of tires from coral reef habitat only and the associated biological restoration could begin no sooner than July 1, 2025, and would take nine fiscal years. The estimated cost per year for all components of the restoration ranges between $6 and $13 million (**Figure 2**). Estimated costs for each individual component total are approximately $78 million for tire removal from sand, $19 million for tire removal from coral reef habitat and $40 million for biological restoration for a grand total of $137 million. All estimated costs are derived from similar work previously completed in the area and would be subject to competitive solicitation. It would be the responsibility of contractors to propose the comprehensive set of methods required for coral removal from tires and removal of tires from the coral reef habitat, tire disposal at the Port Everglades, and biological restoration in the pre-determined grid cells in accordance with this Plan and any associated permits.

Several other restoration efforts, being led by various agencies and organizations, are taking place concurrently along Florida's Coral Reef. These restoration efforts, including any overlap and synergies with this Plan, are outlined in this report.

Figure 1. Locations of tires distributed across all reef complexes (methods and results of the 2024 Tire Survey are in **Appendix B**). The majority of tires have been removed from the Tire Abatement Permit Area (pink polygon) as part of the current tire removal project.

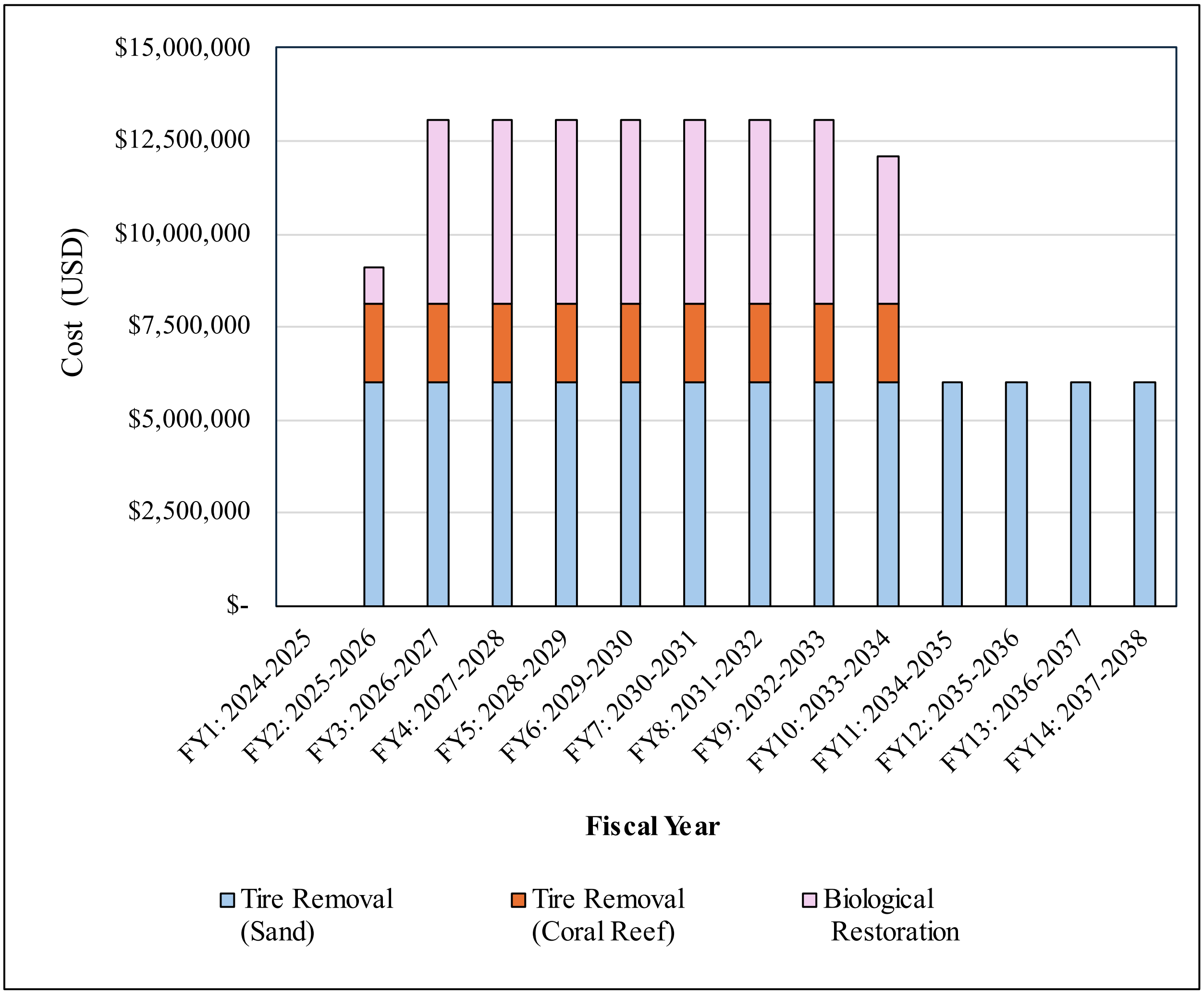


Figure 2. Estimated costs of tire removal (from sand and coral reef habitat) and biological restoration per fiscal year.

2.0 Goals and Objectives

The goals of this Plan are to remove all visible tires from coral reef habitat, thereby preventing future damage from the Osborne Tire Reef, and to restore reef by outplanting corals to reef habitat where the most damage has likely occurred.

To achieve these goals, this Plan:

A. Identifies the spatial scale and current distribution of tires (Objective A);
B. Identifies the current levels and types of tire related damage to reef habitat, the condition of tires (i.e., the degree of burial or entrapment), degree of encrustation from coral reef organisms and the potential for additional impacts (Objective B); and
C. Develops a plan to remove tires from reef habitat and restore impacted reef (Objective C).

A multi-stage approach was developed by the DEP and its contractor (Olsen Engineering) to accomplish these objectives and develop this Plan.

1. **Stage 1 (Objective A)**. A tire survey using sonar and an artificial intelligence (AI) GIS product was developed in 2024 (2024 Tire Survey) that, combined with the sonar-based seafloor survey in 2019 (2019 Tire Survey; see Status Report, **Appendix A**), provided a more complete map of the current distribution and abundance of tires. Results of the 2024 Tire Survey are in **Appendix B** (CSA, 2024).

2. **Stage 2 (Objective B)**. An in-water study (2024 Recon Survey) was developed in April 2024 to assess the number and condition of tires on reef habitat, severity of tire related impacts to reef substratum and fauna, the level of entrapment in hardbottom structures and the degree of encrustation by reef organisms. Detailed methods and results are provided in **Appendix C** (Coastal Eco Group [CEG]).

3. **Stage 3 (Objective C)**. This Plan is designed to guide removal of tires from reef habitat and restore impacted reef. This Plan developed the following methods and data analysis to accomplish this objective, including:

    a. Developing methods for coral removal from tires and tire removal from coral reef habitat;
    b. Estimating acreages of tire-impact and subsequent number of coral colonies needed (by species) for biological restoration; and
    c. Developing locations and methods for biological restoration of coral reef habitat.

3.0 Background

Florida's Coral Reef is an ecologically valuable natural resource that benefits Floridians and visitors in a multitude of ways:

- Healthy, resilient coral reefs safeguard against extreme weather, shoreline erosion and coastal flooding.
- According to the U.S. Geological Survey (see Storlazzi et al., 2019), Florida's Coral Reef annually provides more than $655 million in flood protection benefits to people, property and jobs, increasing to over $1 billion during severe storm events.
- The reef provides essential fisheries habitat for species that are valuable to commercial and recreational fisheries, which in turn attract Floridians and tourists who bolster Florida's economy.

It is critical that the reef is resilient and healthy, but the future of Florida's Coral Reef is increasingly being threatened. Pollution, warming ocean temperatures, ocean acidification and many other threats contribute to reef degradation. In addition, stony coral tissue loss disease has significantly impacted the populations of more than half of Florida's 45 reef-building coral species, including those listed under the ESA. Government, private and nonprofit entities continue to address environmental stressors impacting the reef, but Florida's coral species are unable to recover without assistance. Without continued bold and aggressive action, we will lose critical functions and benefits of the reef.

Florida's Coral Reef extends for over 350 miles in southeast Florida, from the Dry Tortugas in Monroe County north to the St. Lucie Inlet in Martin County (**Figure 3**). Several state and federally managed areas exist throughout Florida's Coral Reef, including the Kristin Jacobs Coral Reef Ecosystem Conservation Area Aquatic Preserve (Coral ECA), which was established as an ECA in 2018 and designated an Aquatic Preserve in 2024. Stretching for over 105 miles, from the St. Lucie Inlet in the north to the northern boundary of Biscayne National Park in the south, the Coral ECA includes Broward County, in which the Osborne Tire Reef is situated. The Osborne Tire Reef, an artificial reef composed of tires in the 1970s, was intended to serve as fishery enhancement habitat. Increasing fishing pressure on recreationally and commercially important species (e.g., grouper and snapper) had created a demand for additional coral reef habitat, where fish could reproduce and grow. Reports and studies at the time (1960s and early 1970s) recommended the use of tires for artificial reef construction since they were abundant, inexpensive and easy to handle (Stone and Buchanon, 1970). The abundance of used tires had also created demand for useful methods of tire disposal (Stone et al., 1974). To meet these needs, the state of Florida and the U.S. Army Corps of Engineers (USACE) issued permits in the early 1970s for tires to be deployed offshore Broward County. Additional history is set forth in the Status Report on tire removal efforts (**Appendix A**).

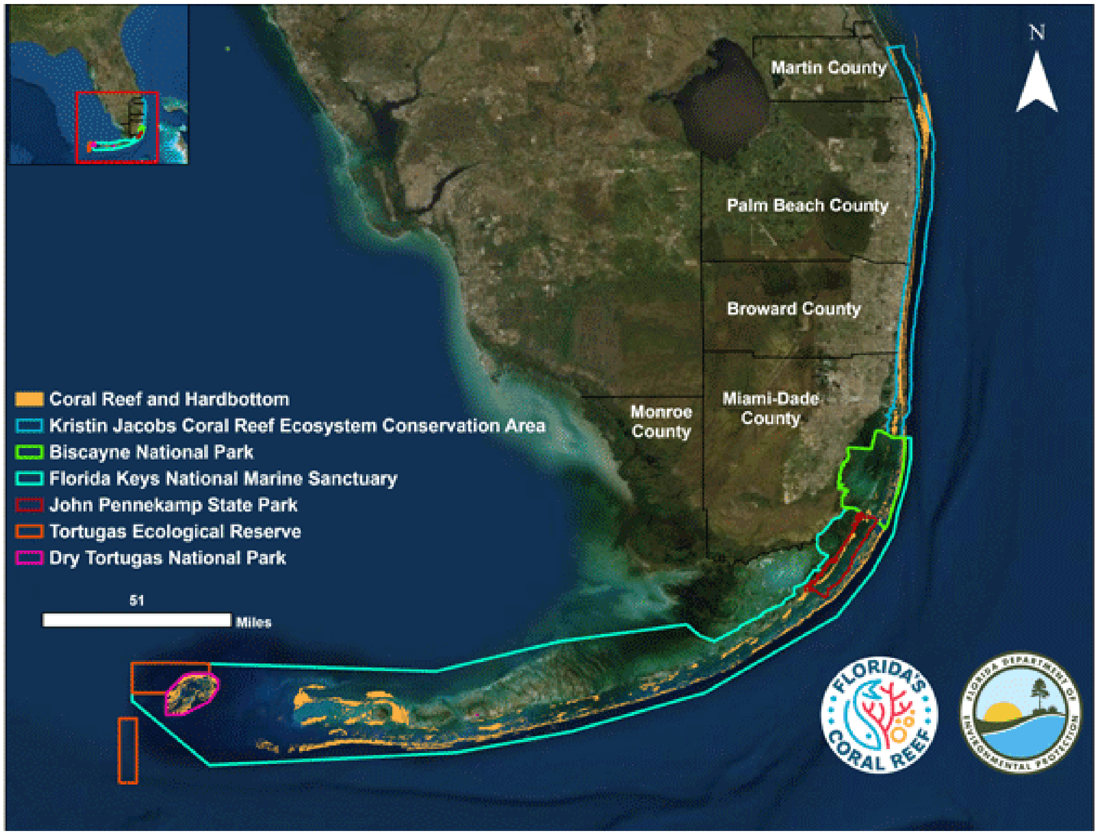


Figure 3. The extent of Florida's Coral Reef including State and Federally managed areas. See the inset legend for the location of the Kristin Jacobs Coral Reef Ecosystem Conservation Area Aquatic Preserve (northernmost section of Florida's Coral Reef).

The reef system in Broward County is composed of multiple linear reef complexes running parallel to shore (Moyer et al. 2003; Banks et al. 2007; Walker et al. 2008). These complexes are often grouped into four broad complexes, referred to as Nearshore Ridge, Inner Reef, Middle Reef and Outer Reef (**Figure 4**). Water depth and vertical relief increase from the Nearshore Ridge through to the Outer Reef. Differences in water depth and vertical relief along with changes in structural complexity influence benthic community composition across the four reef complexes. Communities in the area are generally characterized by the presence of macroalgae, sponges, octocorals and stony corals, including several stony coral species currently listed as Threatened under the federal Endangered Species Act (ESA). Unconsolidated sand is the main habitat between the Middle and Outer Reefs and to the east of the Outer Reef. Numerous artificial reefs (e.g., barges, memorial reefs and large concrete structures known as "ero-jacks") are located in these offshore sand features. The Osborne Tire Reef was originally sited within this reef matrix, in sand habitat between the Middle and Outer Reefs, but numerous factors have served to redistribute the tires over time. Due to poor record keeping and lack of monitoring, the actual number of tires deployed remains unknown, estimates of between 1 and 2 million tires have been put forth (Raymond, 1979; Sherman and Spieler, 2006), and these tires now encompass a far broader area and range of habitats than originally intended.

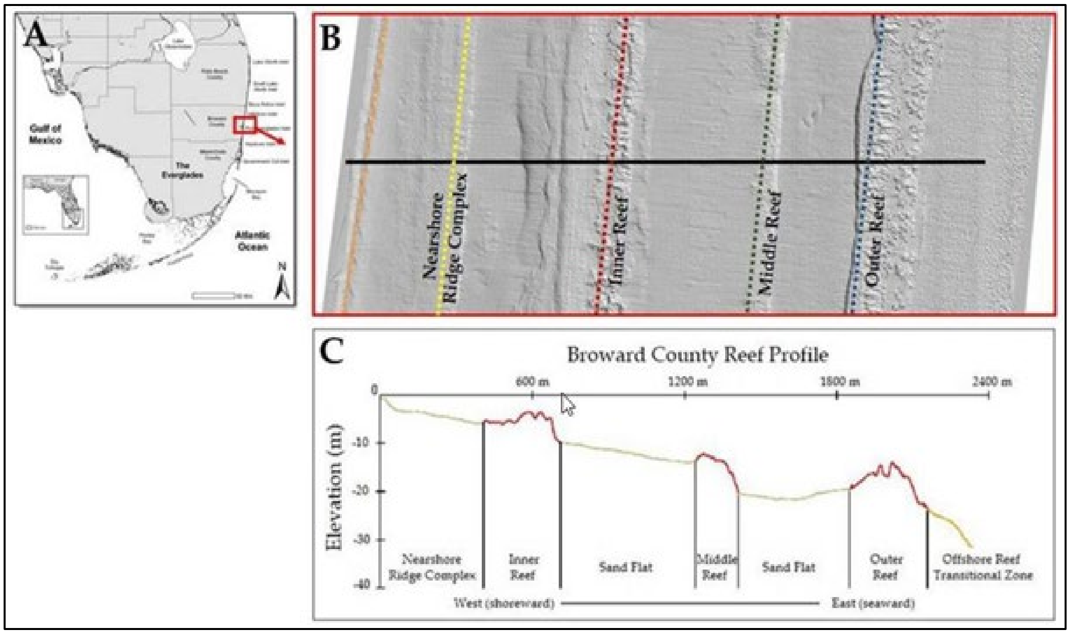


Figure 4. View of the southeast Florida coastline (Source: Walker et al. 2008). (A) Area of Broward County that corresponds to (B), the sea floor bathymetry. The black line in (B) shows the location of a bathymetric profile illustrated in (C) showing the Nearshore Ridge and Inner, Middle and Outer Reefs.

In 2019, DEP contracted a study to map the density and distribution of Osborne Tire Reef tires in sand and coral reef habitats (2019 Tire Survey; CSA, 2019; and see **Appendix A** for a summary of findings provided in the Status Report). Results of the survey indicated that tires were primarily concentrated in offshore waters between Sunrise Boulevard and Hugh Taylor Birch State Park, Fort Lauderdale, approximately 3 to 4 miles north of Port Everglades Inlet (**Figure 5**). However, the scope and scale of the 2019 Tire Survey was limited. To fully delineate the tires, the spatial scale of the tire mapping effort was expanded in 2024 (2024 Tire Survey). The 2024 Tire Survey employed ground-truthed side-scan sonar and multibeam echosounder data combined with an AI/GIS product to map the full, current distribution of tires (CSA, 2024; **Appendix B**). As opposed to the roughly 770 acres of Middle Reef, sand, and Outer Reef habitat found to contain tires in the 2019 Tire Survey, the 2024 Tire Survey documented tires distributed across all four reef complexes and sand habitats within a greatly expanded area totaling over 6,000 acres (**Figure 6**). The vast majority of tires were found to be located within sand channels between and within reef complexes, although substantial accumulations of tires were noted along the margins of reef complexes and, occasionally, on reef habitat.

Using data from the 2019 and 2024 tire surveys and accounting for tires that have been removed during the current tire removal project, DEP estimates that there are approximately 521,000 unburied and visible tires within the surveyed areas. Estimates do not include tires that are fully buried, completely obscured by encrusting reef organisms and located outside of the tire survey areas. It is estimated that there are 429,000 tires remaining in sand habitat and at most 92,000 tires in contact with coral reef habitat (**See Appendix B** for detailed tire quantification methods.)

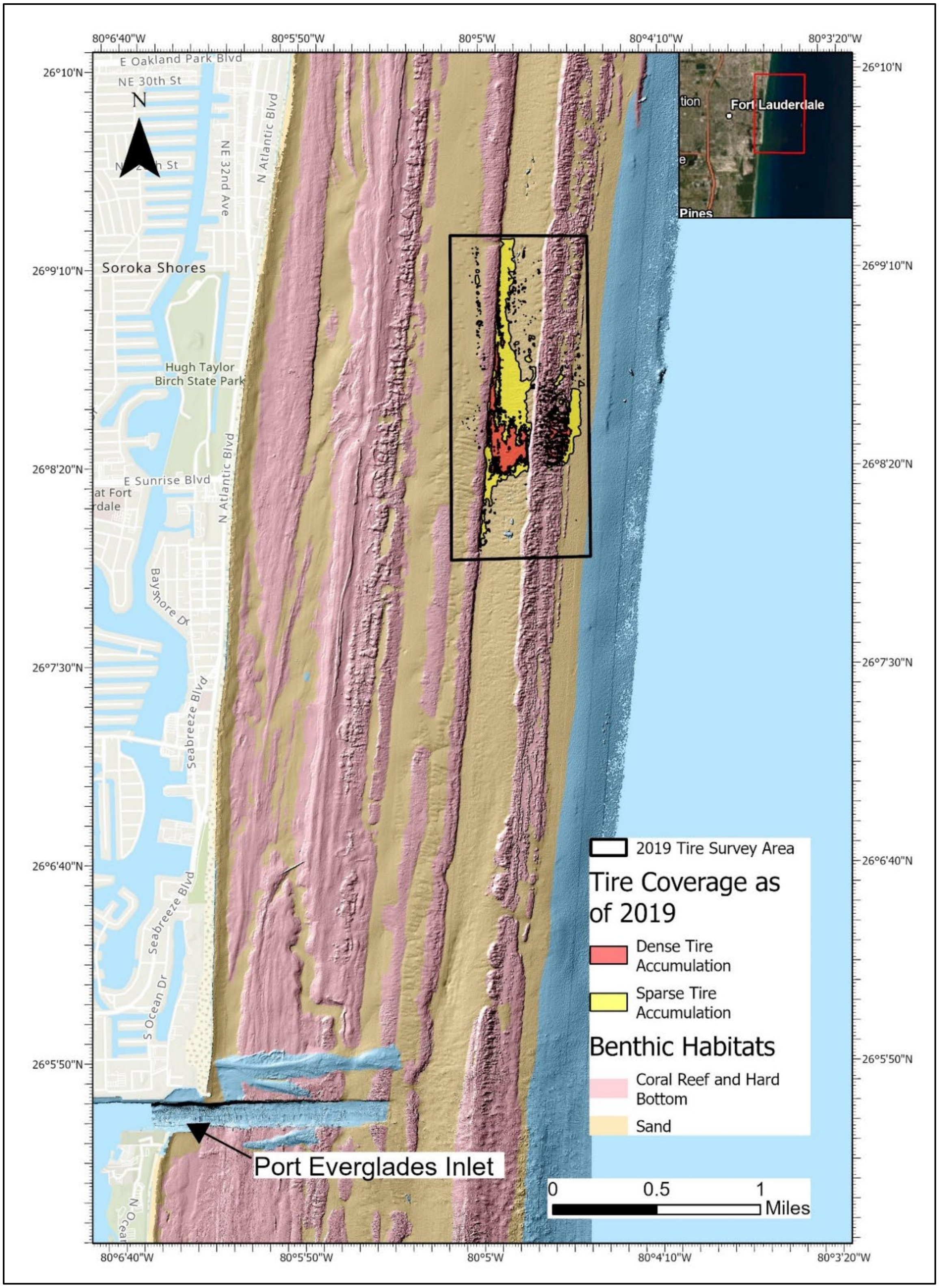


Figure 5. Tire abundance and location in relation to Port Everglades Inlet from the 2019 Tire Survey.

Figure 6. Osborne Tire Reef survey areas for the years 2019 (white box) and 2024 (dotted black box).

DEP contracted an in-water study (2024 Recon Survey; CEG) in April 2024 to assess the number and condition of tires on reef habitat at select locations, the severity of tire related impacts to reef substratum and fauna, and the degree to which tires had been recruited to by sessile reef organisms (e.g., macroalgae, sponges, octocorals and stony corals).

Results from the 2024 Recon Survey study were used to identify dive locations, focusing on the densest accumulations of tires adjacent to coral reef habitat (**Figure 7**). Divers investigated a total of 30 discrete sites, the majority of which had few tires on the actual reef (~87% had between 0 and 10 tires), as tires were found to have aggregated in sand patches and troughs between and within the higher relief coral features (**Image 1a-d**). Many sites (~43%) had accumulations of 11 or more tires in sand areas close to reef habitat, with five of these sites having accumulations of 50 tires or more. Most sites (~77%) were found to contain buried or entrapped (immobile) tires. Sites with loose tires and those with greater densities of tires in nearby sand patches represent areas with the greatest potential for new impacts. Current impacts to reef substrate and organisms were found to be minor and were isolated to only a few sites and to areas at the sand-reef interface. Sessile reef organisms were found growing on tires at all sites and stony corals were observed attached to tires at 60% (18 of 30) of sites; none of these were ESA-listed stony coral species. However, four sites located in shallow water contained the ESA-listed stony coral species *Acropora cervicornis*, colonies of which were documented growing on the reef in close proximity to mobile tires, indicating a high potential for future impacts. For further information, including field data collection methods, data analysis, results and a photo gallery, see **Appendix C**.

The 2024 Tire Survey effort identified that tires are significantly more broadly distributed than previously thought, ranging over 5 miles from north to south and across the shelf through reef and sand habitat from the Nearshore Ridge out beyond the Outer Reef. While the in-water 2024 Recon Survey documented fewer tires on actual reef habitat (up to 92,000 out of the 521,000 remaining tires in the survey areas), it cannot account for the history of impacts resulting from the dispersal of tires over time. Similarly, dense accumulations of tires documented in sand features between and within reef complexes represent the potential for future dispersal-driven impacts to coral reef. Given the continued threat to reef habitat and organisms posed by existing tires, it is clear that tire removal and the subsequent restoration of historically-impacted areas would considerably benefit the protected coral reef resources within the ECA and Florida's Coral Reef more broadly.

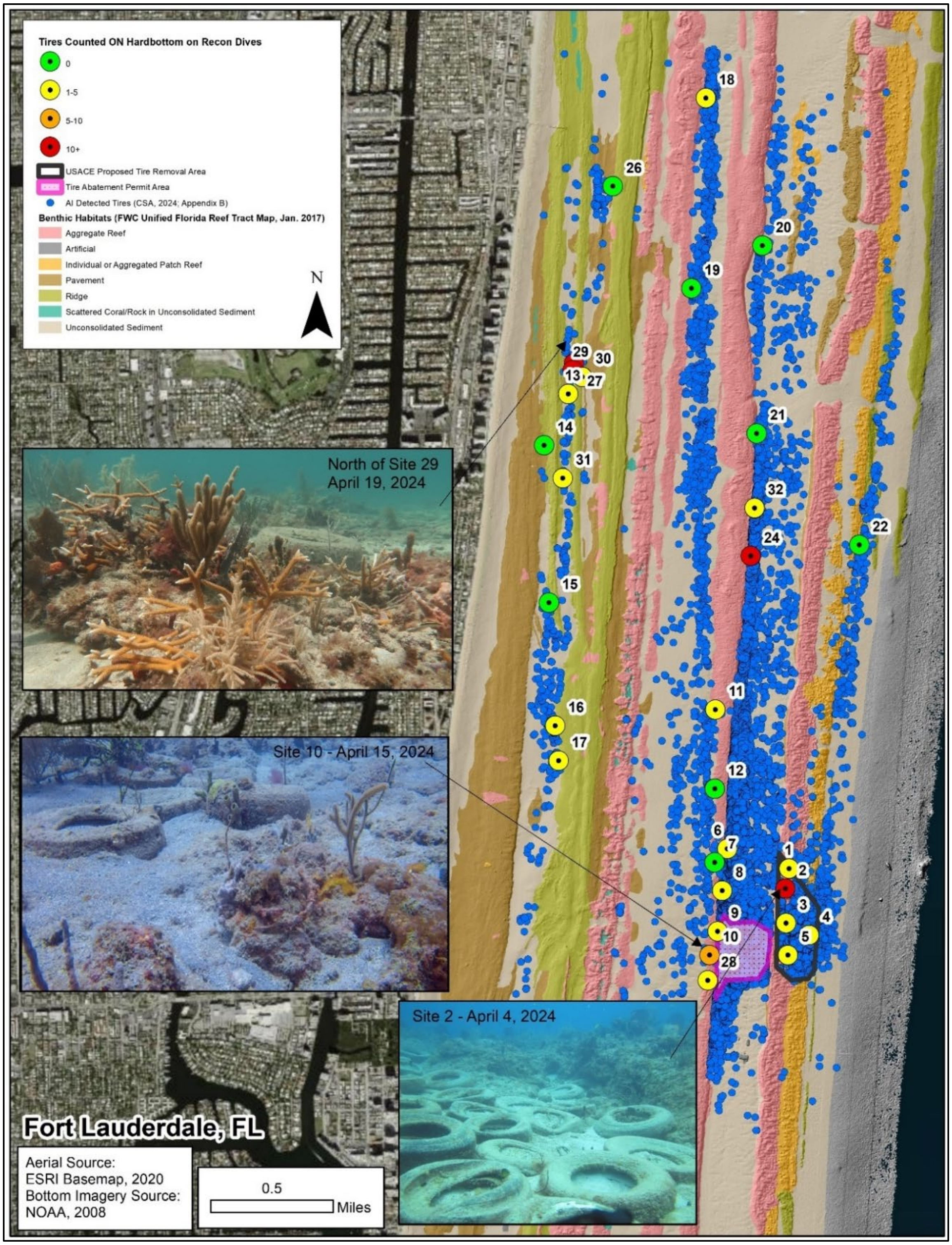


Figure 7. 2024 Recon Survey dive locations depicted among the AI-detected tire locations on the coral reef habitat offshore of Broward County, Florida with georeferenced example habitat images.

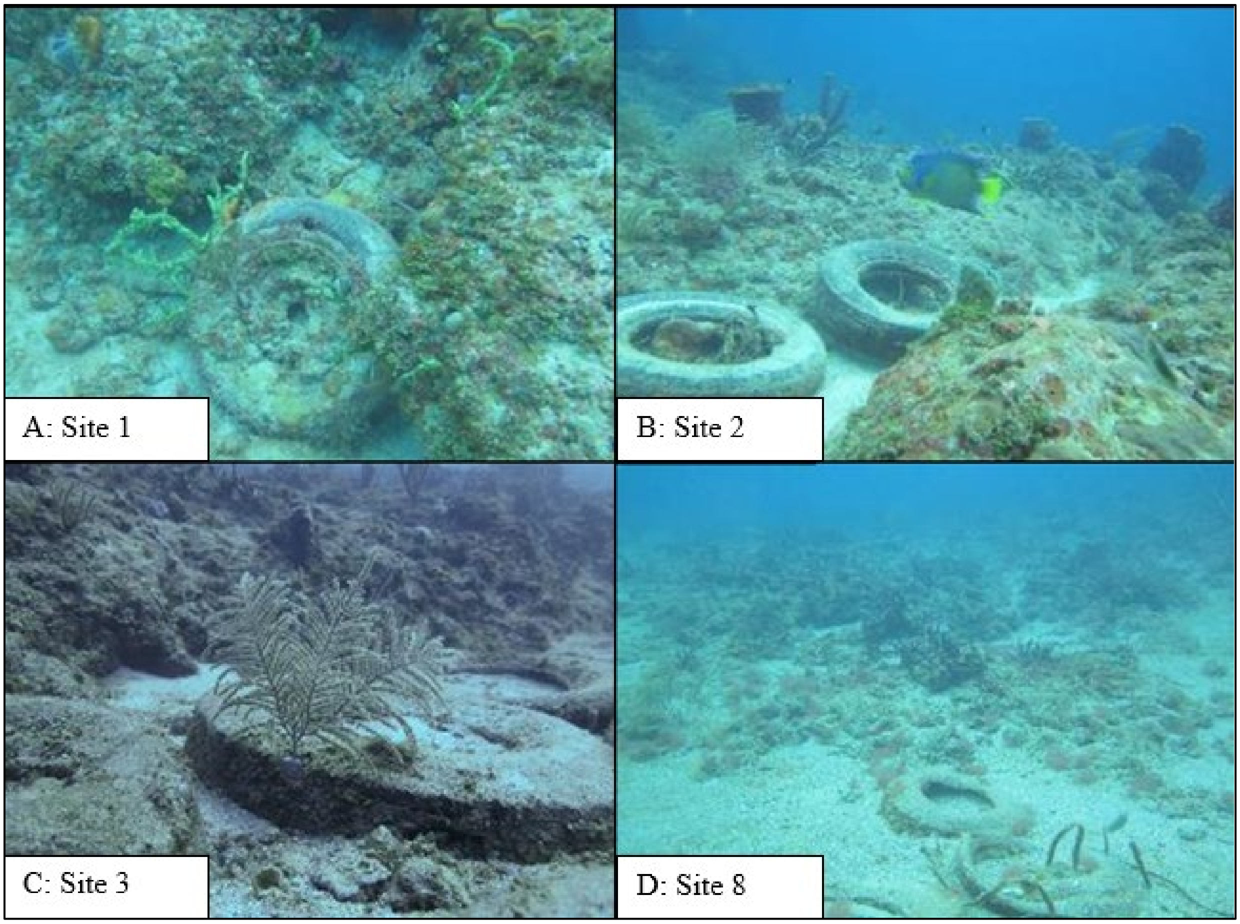


Image 1. Representative photos of tires aggregated in sand patches and troughs between and within the higher relief coral features. (A) Sites 1, (B), Site 2, (C) Site 3 and (D) Site 8, from the April 2024 recon dives (photographs by Coastal Eco Group [CEG]).

4.0 Coral Relocation, Tire Removal and Biological Restoration

Efforts will continue to focus on removing tires and debris associated with the tire deployment from sand habitat and could be expanded to include removal from coral reef habitats and biological restoration to offset impacts resulting from decades of tire dispersal. As detailed in the following sections, these activities would be closely coordinated with and carried out alongside the DEP DWM, who currently oversees the removal of tires from within Tire Abatement Permit Area (**Figure 1**). In the current project, a contractor is removing and relocating corals growing on tires before the tires are removed from the sand habitat.

As the 2024 Tire Survey has shown, the vast majority of tires are located in sand channels between and within reef complexes well beyond the original Osborne Tire Reef area. The current tire abatement project and permit could be expanded to cover all sand habitat containing tires. Doing so would reduce or eliminate the threat to nearby coral reef habitat and to any restoration efforts undertaken. Additional permits and contractors will be needed to remove tires found on reef habitat. **Section 4.1** describes how prioritization of tire removal from reef habitat was determined and provides best management practices for removing tires from reef habitat and relocating corals colonies from tires to which they have attached. In limited instances, some tires may not be removed from reef habitat, as doing so would result in significant additional impacts.

The 2024 Recon Survey documented varying degrees of recent, site-specific tire related impacts to reef habitat and organisms, but such surveys are incapable of uncovering the full, historic extent of impacts. Given the length of time that tires have been in the environment and the extent to which they have dispersed since deployment, a sizeable portion of coral reef habitat within the current distribution of tires has been impacted. For this reason, the biological restoration effort aims to offset putative tire-related reef damage and lost functions by outplanting organisms to reef areas identified as likely having suffered the greatest impacts. **Section 4.2** below describes in detail how reef impact areas were identified, the number of stony coral colonies to outplant was developed and reef areas for restoration were selected.

4.1 Tire Removal from Reef Habitat

To conduct a complete restoration, tires would be removed from coral reef habitat to prevent further damage to the reef and to safeguard reef restoration efforts. Prioritizations for selecting reef areas to clear, considerations and recommendations for removing tires from reef habitat, and requirements and recommendations for relocating stony corals colonies attached to tires prior to tire removal are provided below. Tire removal contractors would be responsible for developing plans to remove tires from reef habitat based on their experience and the recommendations and requirements in **Sections 4.1.1** and **4.1.2**. Coral relocation contractors would be responsible for developing plans to remove and relocate stony coral colonies from reef tires based on the requirements and recommendations set forth in **Section 4.1.3**. All plans would require approval by DEP in addition to requisite permits.

4.1.1 Prioritization of Coral Reef Habitat for Tire Removal

Recommended reef complex and directional prioritizations for tire removal are based on the current distribution of tires in the broader area and on environmental and logistical considerations relating to the risks posed by future tire movement, the timing of restoration activities and the efficiency of contracted tire removal. The 2019 and 2024 Tire Surveys found that tire densities are greatest in the Outer Reef and decline in the inshore direction, and that tires tend to be denser in the southern portions of the Outer and Middle Reefs and in the northern portions of the Inner Reef/Nearshore Ridge (**Figure 6**). These patterns, coupled with the logistical ease of working within the same depth contour, suggest that reef complexes should be fully cleared of tires starting at the Outer Reef and moving sequentially inshore as each complex is cleared (i.e., from the Outer Reef to the Middle Reef and then to the Inner Reef/Nearshore Ridge). Additionally, it is recommended that tire removal start in the south and work north when removing tires from the Outer and Middle Reefs and start in the north and work south when removing tires from the Inner Reef/Nearshore Ridge. In addition to removing the densest aggregations of tires first, this directional procedure has the benefit of clearing areas selected for biological restoration early in the tire removal process for each reef complex (see **Section 4.2.1** for information on reef areas selected for restoration). The described process and timing for tire removal may vary based on availability and development of appropriate specialized equipment needed to recover tires at greater depths.

Figure 8 (discussed in **Section 4.2.1**) depicts a grid of cells superimposed on a map of the current distribution of tires as documented during the 2024 Tire Survey. These cells provide a systematic and manageable way to remove tires from the great expanse of reef habitat within the distribution of dispersed tires. It is therefore recommended that contractor(s) clear cells of tires sequentially, in the manner described previously (i.e., by reef complex and direction within reef complex). To allow restoration activities to progress in an efficient manner and to prevent the repopulation of reef habitat with tires from nearby sand features, reef habitat tire removal contractor(s) should coordinate with DEP to ensure, as is practical, that sand habitat within cells immediately adjacent to cells containing reef habitat are cleared of tires at similar times.

4.1.2 Environmental Considerations for Tire Removal from Coral Reef Habitat

Along with stony corals, the coral reef community within the distribution of dispersed tires is characterized by an abundance of delicate soft corals and large barrel sponges, organisms which can easily be damaged by divers and equipment (Wever, 2022). Further, the 2024 Recon Survey discovered that tires, when present in the reef habitat, tended to be buried or entrapped, suggesting that indelicate removal could result in sedimentation and, in some cases, structural damage to the reef (see **Appendix C**). The following considerations and recommendations are intended to help the tire removal effort be as efficient as possible while avoiding injury to the reef habitat and biota.

Working in sensitive coral reef habitat in varying depths, currents, and visibility will be challenging, and divers must maintain neutral buoyancy or work in sand patches to avoid impacts. Sand patches, troughs, and flats can serve as staging areas for equipment and removed tires, where large enough to accommodate these items. Different reef areas will have their own unique conditions and communities, and contractors should familiarize themselves with each site before commencing work. Cached tires should be bound so that they remain in stable formations and should be removed from the water before any high-energy wave events (i.e., storms). Offloading tires brought to the surface by divers may be easier, especially at deeper depths, if the vessel is moored to a stationary point that avoids hardbottom.

The standard tire removal procedure should be to carefully lift tires from the reef and relocate them to sand habitat where the sediment trapped within can be removed. From there, they can be cached in secure bundles and then raised to vessels on the surface using lift bags. While all tires will have some degree of sediment trapped inside them, some tires will be loose on the reef while others will be buried or entrapped. Further, over half of the tires will likely have organisms growing on them (e.g., sponges, octocorals and/or stony corals). Each of these scenarios will require a different approach to tire removal. The standard approach can be used for loose tires free of biota. Buried tires will need to be excavated before being relocated, and care should be taken to avoid releasing sediment on the reef. Entrapped tires should be assessed carefully before removal is attempted. Substrate damage should be kept to an absolute minimum and, depending on the degree of tire entrapment and the amount of damage that would result from its removal, some tires may need to be left in place. Small hand tools such as chisels, levers or drills can be used to dislodge tires if the level of entrapment is minor. Regarding tires with attached fauna, all colonies of ESA-Listed stony coral species (regardless of size) and colonies of non-Listed ESA stony coral species greater than or equal to 5 cm in maximum dimension will need to be relocated before tires can be removed. Stony coral relocation requirements and recommendations are described in greater detail in the following section.

4.1.3 Stony Coral Relocation from Tires - Requirements and Recommendations

The 2024 Recon Survey of reef sites with relatively dense accumulations of tires found stony corals growing on tires at more than half of the sites investigated. While no ESA-listed species were attached to tires, occasionally they were found in close proximity to tires. To minimize impacts to reef organisms resulting from the removal and disposal of tires, stony coral colonies meeting the following criteria must be removed from tires prior to tire removal and disposal.

- All colonies of ESA-Listed coral species, if present, (regardless of colony size) shall be removed from tires and relocated to appropriate natural habitat. A current list of local ESA species is presented in **Table 1**.

- All non-ESA-Listed stony corals greater than or equal to 5 cm in maximum dimension that exhibit no signs of disease and have not been colonized by bioeroding sponges shall also be removed from tires and relocated to appropriate natural habitat.

Table 1. ESA-listed stony coral species as of June 1, 2024.

Common Name	Scientific Name
Elkhorn coral	*Acropora palmata*
Staghorn coral	*Acropora cervicornis*
Lobed star coral	*Orbicella annularis*
Mountainous star coral	*Orbicella faveolata*
Boulder star coral	*Orbicella franksii*
Rough cactus coral	*Mycetophyllia ferox*
Pillar coral	*Dendrogyra cylindrus*

Contractors responsible for stony coral removal from tires must have experience in coral relocation and be able to identify local species of coral, coral diseases and *Cliona* sp. overgrowth. They also must obtain an FWC Special Activities License (SAL) and abide by the conditions contained within the permit, including FWC's Coral and Octocoral Mitigation Relocation Recommendations and Protocols for the Management of In-Water Nurseries, Coral Transport and Coral Outplanting.

Exposed tires should be thoroughly searched for coral colonies prior to their removal. It is recommended that removal and relocation be conducted before the tire removal effort. Once located, divers will manually dislodge colonies from tires. Appropriate tools include putty knives, paint tools (5-in-one tool or paint scraper) or other thin-bladed tools with beveled edges. Chisels with thin blades may be tested, but they are generally too thick-bladed to use (i.e., can cause fragmentation of the coral colony). The use of power tools or heavy pry bars should be avoided unless absolutely necessary.

Care should be taken to minimize impacts to colonies. Rubber gloves should be worn and changed as needed while handling corals to minimize mucous removal, abrasion, and disease transmission. Every effort should be made to remove colonies from tires without fragmenting them (i.e., to remove colonies in whole condition), although some fragmentation is expected, particularly for colonies with flat growth forms. If a colony fragments during dislodgement, viable fragments should be collected and re-attached at the receiver site (i.e., all fragments from the same broken colony shall be kept together and reconstructed within 0 - 5 mm from one another – like puzzle pieces – and reattached at the receiver site).

Once detached, colonies may be relocated to temporary cache holding areas. Colonies may be held in these secure locations for a few days, though the aim should be to transplant colonies from temporary holding areas to receiver sites within the fewest number of days after removal as possible. Care shall be taken to minimize impacts to colonies while at holding sites (e.g., colonies shall not be layered within baskets/buckets and baskets/buckets shall be of appropriate material—no metal shall come in contact with live coral surfaces). Further, only colonies of the same species should be held together, and colony tissue touching should be avoided. If a vessel will be used to transport colonies (as opposed to divers relocating colonies underwater to nearby sites), then dislodged colonies should be lifted to the boat using buoyed baskets/buckets.

Coral colonies may be relocated to nearby reef habitat, provided tires have been sufficiently removed from that area. If not directly relocated to receiver sites in adjacent habitat, relocation sites will be selected by the contractor, in consultation with the DEP, based on depth, substrate type, and location on a reef (ledge, shelf, etc.) (van Woesik et al., 2021). The contractor may also consider using temporary offshore coral nurseries until permanent receiver sites are identified. If authorized, stony coral colonies removed from tires may be donated to restoration/research practitioners. Colonies should be transported to their respective receiver sites and attached to the benthos as quickly as is practicable. The aim should be to attach all colonies removed from tires or from temporary holding areas to their respective receiver sites the same day they are transported; however, if the number of colonies or sea state/weather conditions do not allow for same day transplantation, then colonies may be cached in a safe, secure location at receiver sites. Attachment of all cached colonies should be the priority over the next available field days.

Care should be taken to prevent injury to colonies while transporting them to selected receiver sites (temporary or permanent). If a vessel is used to transport colonies (as opposed to divers relocating them underwater to nearby sites), then colonies should be stowed in a cooler on board the vessel to keep them cool, damp and out of the sun during transport. The amount of time colonies should only be kept in coolers (out of the water) should be minimized (e.g., less than six hours). Only small colonies should be layered within coolers. When layering, a protective barrier (e.g., sheet of bubble wrap) should be used to separate colonies to prevent abrasion.

It is recommended that, once at receiver sites, colonies be attached and grouped in such a manner as to create regionally-appropriate species mixtures and densities (potentially using historical data from the Broward County Marine Biological Monitoring Program). Care should be taken to place corals at appropriate distances from naturally occurring or previously transplanted colonies in order to promote colony growth, tissue re-colonization and plating (e.g., approximately 0.5 to 2 meters apart). Prior to attachment, the surface to which the colony will be attached and the coral colony (underside of the colony) should be prepared. Fouling organisms (mostly algae) and sediment should be removed from contact surfaces so that the adhesive used (e.g., epoxy of concrete) can form a solid bond between the colony and the substratum. Wire brushes and/or chisels and chipping hammers may be used to prepare surfaces, but care should be taken to avoid injury to living coral tissue and reef organisms during surface preparation. An adhesive with a proven track record (e.g., Portland type II cement and carbonate sand, epoxy, mixtures of type II cement, carbonate sand and molding plaster, etc.) should be used to attach colonies. Different mixtures and mixture ratios may be needed and used for different sized colonies (small, large, very large, etc.). It is critical that the adhesive used be brought as closely to the edge of the living tissue as possible and cover all exposed skeleton as practicable to reduce the opportunity for bio-eroding organisms to invade. However, extreme care should be taken to minimize contact between the adhesive and live coral tissue. Any adhesive that comes into contact with live coral surfaces should immediately be removed before it becomes imbedded/entrained in tissue mucous or polyp calices.

Best management practices should be followed to ensure the successful relocation and survival of coral colonies. In addition to those described above, relocated stony coral colonies should be assessed within two weeks of transplantation to determine attachment success. Any relocated colonies found to be loosely attached and unattached during the assessment should be reattached using the methods described above. Additionally, coral colony removal and relocation efforts should be discontinued during periods of elevated water temperatures or during bleaching events (typically in August and September) (see FWC's Protocols for the Management of In-Water Nurseries, Coral Transport, and Coral Outplanting for specific guidance). Outplanted colonies will need to be monitored per FWC SAL requirements. Reef restoration contractors will be responsible for developing monitoring plans for stony coral outplants that meet SAL requirements. These plans should be coordinated with DEP.

4.2 Biological Restoration of Coral Reef Habitat

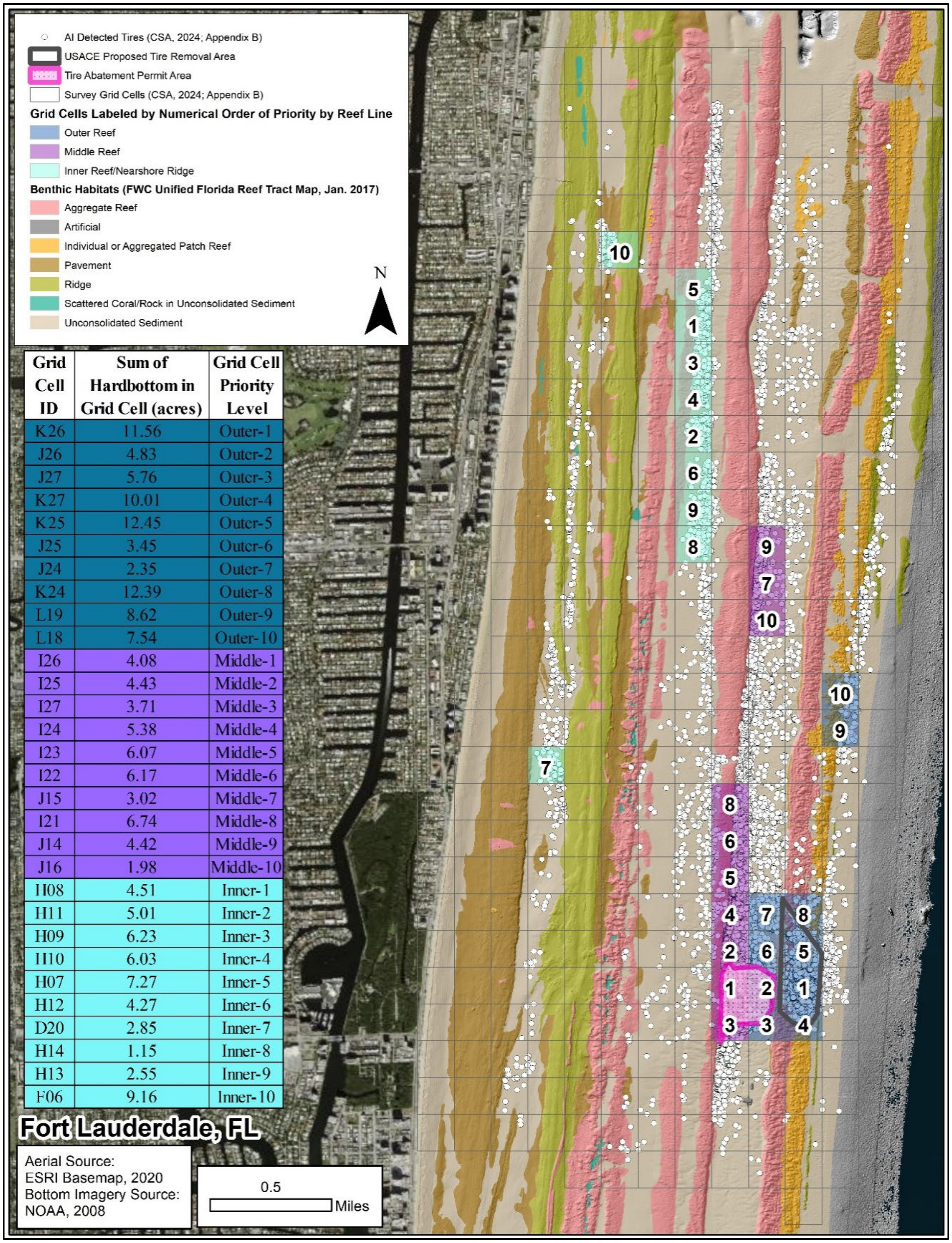
Coral reef restoration will focus on returning lost stony coral function to reef areas identified as likely having suffered the greatest impacts from tires. ESA-Listed stony coral species and species that have suffered the greatest losses to Stony Coral Tissue Loss Disease (SCTLD) are targeted for biological restoration (outplanting); sponges and octocorals may also be outplanted if time and budget allow. The means and methods used to identify impact areas, select restoration areas, and determine the stony coral species and number of coral colonies to outplant for the restoration effort are described in detail in the following sections. Recommended methods for outplanting stony corals, octocorals and sponges are also provided.

4.2.1 Impact Area Identification and Restoration Area Selection

While beneficial, in-water surveys to assess the current interaction between tires and coral reef habitat (e.g., 2024 Recon Survey) cannot account for the history of impacts resulting from the dispersal of tires over time. To overcome this hurdle, the present-day distribution and abundance of tires was used to identify areas of reef most likely to have been impacted as tires dispersed, settled and then likely redistributed. To start, grid cells, each measuring 14.7 acres in area, were used to subdivide the area within the distribution of dispersed tires. **Figure 8** depicts grid cells superimposed on a map of the current distribution of tires as documented during the 2024 Tire Survey. Depending on their position relative to reef complexes and areas of sand, cells could contain one or two habitat types (sand, reef); most tires are currently located within sand habitat between and within reef complexes. The current, mapped density of tires was used to identify cells in each reef complex with the greatest density of tires within and in adjacent cells. A total of 17 cells, 20 cells, and 9 cells were identified in the Outer Reef, Middle Reef and Inner Reef/Nearshore Ridge, respectively. Summing the area of reef habitat within each cell resulted in a total of 246.9 acres of impact, distributed as 46 acres in the Inner Reef/Nearshore Ridge, 101 acres in the Middle Reef and 99.9 acres in the Outer Reef (**Table 2**).

Reef restoration efforts described in **Section 4.2.2** will focus on the grid cells identified above, as they were determined to contain reef habitat that has likely suffered the most tire-related impacts over time. Based on a goal of restoring 10 acres of reef within each reef complex at a ratio of 1 acre per grid cell, the number of grid cells identified above was trimmed to arrive at 10 priority restoration cells for each reef complex (see numbered grid cells in **Figure 8**). Ten acres of restoration per reef complex is recommended because working at this scale is manageable, and because it affords desirable and achievable coral colony densities for restoration. Note that one additional grid cell has been added to the Inner Reef/Nearshore Ridge complex to arrive at 10 cells (10 acres).

Results of this effort revealed several priority grid cells in the Outer Reef within the area that the USACE intends to restore as compensatory mitigation for impacts anticipated from the Port Everglades Deepening and Widening Project (see inset polygon and grid cells 8, 5, 1, and 4 on the Outer Reef in **Figure 8**). This area will only be targeted for tire removal and restoration if the USACE does not restore the reef within ten years from July 1, 2025. Priority grid cells 8, 5, 1 and 4 on the Outer Reef remain in this Plan for planning purposes; however, DEP may identify other grid cells for restoration in the Outer Reef (i.e., reassign cells 8, 5, 1 and 4 to other areas/cells) if needed. **Section 7** provides information on coordination with the USACE and other restoration programs.



Grid Cell ID	Sum of Hardbottom in Grid Cell (acres)	Grid Cell Priority Level
K26	11.56	Outer-1
J26	4.83	Outer-2
J27	5.76	Outer-3
K27	10.01	Outer-4
K25	12.45	Outer-5
J25	3.45	Outer-6
J24	2.35	Outer-7
K24	12.39	Outer-8
L19	8.62	Outer-9
L18	7.54	Outer-10
I26	4.08	Middle-1
I25	4.43	Middle-2
I27	3.71	Middle-3
I24	5.38	Middle-4
I23	6.07	Middle-5
I22	6.17	Middle-6
J15	3.02	Middle-7
I21	6.74	Middle-8
J14	4.42	Middle-9
J16	1.98	Middle-10
H08	4.51	Inner-1
H11	5.01	Inner-2
H09	6.23	Inner-3
H10	6.03	Inner-4
H07	7.27	Inner-5
H12	4.27	Inner-6
D20	2.85	Inner-7
H14	1.15	Inner-8
H13	2.55	Inner-9
F06	9.16	Inner-10

Figure 8. Priority grid cells (each approximately 14.7 ac) showing priority levels for biological restoration of the Osborne Tire Reef distribution survey area. Grid cells are prioritized based on the number of tires on or near coral reef habitat. A label of '1' indicates the highest number of tires within that reef line.

Table 2. Number of colonies to be outplanted to each reef complex. The area of impacts and the percentage of total impacts are also given for each reef complex.

Reef Complex	**Area Impacted** (acre)	**Percent of Total Impact Area** (%)	***Number of Colonies to be Outplanted** (n)
Inner Reef/ Nearshore Ridge	46.0	18.6	18,246
Middle Reef	101.0	41.0	40,222
Outer Reef	99.9	40.4	39,633
Total	***246.9***	***100***	***98,101***

*Calculated by multiplying the total number of colonies to be outplanted (98,100) by the percentage of total impact area (246.9 acres) accounted for by each reef complex.

4.2.2 Stony Coral Based Reef Restoration Recommendations

Reef impact acreages (see **Section 4.2.1**) along with information on recent, historical declines in the abundance of stony corals within Broward County were used to calculate the number of coral colonies needed to offset losses due to historical, tire-related impacts. To account for previous, severe declines in the abundance of some coral species, as well as more recent losses due to SCTLD, a specific suite of stony corals species (ESA-listed species and species most susceptible to SCTLD) present in Broward County were selected for the restoration effort. **Table 5** lists the 10 species selected for biological restoration. Stony coral data from the Broward County Marine Biological Monitoring Program, which surveys corals throughout the county, were used to determine the mean density of these species for the time periods 2003-2008 (historical) and 2019-2021 (current). This dataset represents the most comprehensive and longest time series of data collected within the County and also effectively demonstrates the change in density resulting from the SCTLD outbreak.

Statistical evaluation of these data revealed mean densities of 0.1034 colonies/square meter (m^2) and 0.2016 colonies/m^2 for the historical and current time periods, respectively. Subtracting the current mean density from the historical period resulted in a decrease in mean density of -0.098 colonies/m^2. When multiplied by the total calculated impact acreage (246.9 ac; **Table 2**), leads to 98,101 colonies, the number needed to offset impacts by returning coral related functions to the reef. The total number of colonies to be outplanted would be distributed to the reef complexes proportionally, using the reef impact acreages identified previously (**Table 2** and see **Section 4.2.1**). Doing so would result in a total of 39,633 colonies, 40,222 colonies, 18,246 colonies being outplanted to the Outer Reef, Middle Reef and Inner Reef/Nearshore Ridge, respectively (**Table 2**). Dividing the total number of colonies to outplant within each reef by the 10 acres of reef to be restored (see **Section 4.2.1**), provides the number and density of stony coral colonies to be outplanted to each 1-acre reef area (**Table 3)** within each priority grid cell in each reef complex (see **Figure 8**).

There are numerous ways to assign numbers of colonies to the 10 species selected for use. For planning purposes, the historical representation of each species (2003-2008) has been employed to proportionally assign numbers of colonies to species for biological restoration. For each reef complex, the historical (2003-2008) densities of the species were identified and then converted to relative abundance (percent of total). The relative abundance of each species within a reef complex was then multiplied by the total number of colonies assigned to that reef complex (see **Table 2**) to arrive at the number of colonies to outplant for each species within each reef complex (**Table 4**). This approach has the advantage of being data driven but also the potential to lead to numbers of colonies that may not be available for some species (**Table 5**). The relative abundance of each species within each reef in **Table 4** can be revised at the time of restoration to account for species/colony availability. Stony corals removed from tires and outplanted to nearby coral reef habitat (**Section 4.1.3**) will not count towards meeting restoration needs. Coral colonies may be sourced from in situ (offshore) or ex situ (lab grown) nurseries. It is recommended that FWC genetic management guidelines be followed such that nursery-raised, disease-resistant and thermally-tolerant genotypes corals are outplanted.

Table 3. Restoration priority grid cells and coral colony outplant number and density by reef complex.

Reef Complex	**Number of Priority Cells** (n)	**Area to Restore**			**Number of Colonies**		**Outplant Density**
		Per Cell (ac)	**Total** (ac)	**Total** (m^2)	**Total** (n)	**Per Acre** (n/ac)	(n/m^2)
Inner Reef/ Nearshore Ridge	10	1	10	40,468.6	18,246	1,825	0.5
Middle Reef	10	1	10	40,468.6	40,222	4,022	1.0
Outer Reef	10	1	10	40,468.6	39,633	3,963	1.0

Table 4. Suggested number of colonies to be outplanted for species in each reef complex. Mean historical (2003-2008) density and relative abundance are also provided for each species.

Inner Reef/Nearshore Ridge			
Species	**Historical Mean Density** (n/m^2)	**Relative Abundance** (%)	**Colonies to Outplant** (n)
Acropora cervicornis	0.100	60.6	11,053
Dichocoenia stokesii	0.025	14.9	2,719
Pseudodiploria clivosa	0.013	8.2	1,491
Orbicella faveolata	0.011	6.7	1,228
Colpophylia natans	0.010	5.8	1,053
Meandrina meandrites	0.006	3.4	614
Diploria labyrinthiformes	0.001	0.5	88
Eusmilia fastigiata	0	0	0
Orbicella franksii	0	0	0
Pseudodiploria strigosa	0	0	0
Total colonies to outplant on Inner Reef/Nearshore Ridge			*18,246*

Middle Reef			
Species	**Historical Mean Density** (n/m^2)	**Relative Abundance** (%)	**Colonies to Outplant** (n)
Meandrina meandrites	0.103	43.9	17,664
Dichocoenia stokesii	0.075	32.0	12,890
Orbicella faveolata	0.025	10.7	4,297
Pseudodiploria clivosa	0.010	4.2	1,671
Colpophylia natans	0.009	3.9	1,552
Orbicella franksii	0.006	2.7	1,074
Eusmilia fastigiata	0.003	1.5	597
Pseudodiploria strigosa	0.003	1.2	477
Acropora cervicornis	0	0	0
Diploria labyrinthiformes	0	0	0
Total colonies to outplant on Middle Reef			*40,222*

Outer Reef			
Species	**Historical Mean Density** (n/m^2)	**Relative Abundance** (%)	**Colonies to Outplant** (n)
Meandrina meandrites	0.073	35.6	14,103
Dichocoenia stokesii	0.069	33.3	13,211
Orbicella faveolata	0.050	24.3	9,640
Diploria labyrinthiformes	0.006	3.2	1,250
Eusmilia fastigiata	0.006	2.7	1,071
Pseudodiploria clivosa	0.001	0.5	179
Pseudodiploria strigosa	0.001	0.5	179
Acropora cervicornis	0	0	0
Colpophylia natans	0	0	0
Orbicella franksii	0	0	0
Total colonies to outplant on Outer Reef			*39,633*

Total colonies to outplant on all reef complexes	*98,101*

Table 5. Number of colonies to be outplanted for each species.

Species	*Number of Colonies (n)
Acropora cervicornis	11,053
Colpophylia natans	2,604
Diploria labyrinthiformes	1,337
Dichocoenia stokesii	28,820
Eusmilia fastigiata	1,668
Meandrina meandrites	32,381
Orbicella faveolata	15,165
Orbicella franksii	1,074
Pseudodiploria clivosa	3,341
Pseudodiploria strigosa	656
Sum	**98,101**

*Calculated by summing the number of colonies to be outplanted for each species in all three reef complexes (**Table 3**).

4.2.3 Recommended Methods for Outplanting Stony Corals, Octocorals and Sponges

Stony coral colonies will be the priority for outplanting to the 1-acre area in each of the 10 priority grid cells in each reef complex; however, if time and funding allow, octocorals and barrel sponges (*Xestospongia muta*) may also be outplanted. Brief methods (best management practices) for working with each of these groups/species are provided below.

4.2.3.1 Stony Corals

Section 4.1.3 provides detailed recommendations for relocating and attaching stony coral colonies. Specific outplanting methods should be coordinated with DEP. Restoration contractors should also refer to the following documents:

- *Best Management Practices for Coral Relocation and Outplanting Efforts in Light of Stony Coral Tissue Loss Disease*, draft dated Oct. 12, 2023.
- *FWC Coral and Octocoral Mitigation Relocation Recommendations*, dated Jan. 9, 2023.

Outplanted colonies will need to be monitored per FWC SAL requirements. Reef restoration contractors will be responsible for developing monitoring plans for stony coral outplants that meet SAL requirements. Contractors should coordinate with DEP while developing plans.

4.2.3.2 Octocorals

Octocorals may be outplanted as time and budget allow. Outplanting success can be improved by using smaller fragments or colonies (<10 cm) (Linares et al., 2008; Padrão, 2021), cleaning reef surfaces with wire brushes or scrapers to clear them of debris prior to attaching colonies, and by using a two-part epoxy (i.e. Splash Zone A-788, All-fix two-part epoxy) instead of cement as an adhesive. Additionally, a 10 cm deep hole roughly the diameter of a fragment can be drilled in the reef surface to hold a 25 cm long fragment. The base of the fragment can be striped before inserting it into the hole and securing it with epoxy. Species that respond well to striping are *Eunicea flexuosa* and *Antillogorgia acerosa* (Brinkhuis, 2009).

4.2.3.3 Barrel Sponges

Barrel sponges (*Xestospongia muta*) may be outplanted as time and budget allow. Albeit slowly, fragments or large portions of this species will grow and attach to the reef following relocation. Direct, stable contact with the substrate is critical (McMurray & Pawlik 2009), and various methods have been developed to hold barrel sponges in place while they attach, including cages, mesh systems, rope systems, mesh-rope system combinations, and direct mounting on either artificial or natural substrates (Bierwirth et al., 2022). In general, the act of relocating (outplanting) a barrel sponge starts with clearing algae and debris from the identified attachment area using wire brushes and/or scrapers. The sponge, either as a fragment or a large part of an individual (top half or more), can then be secured to the substrate with stainless steel wire or rope/twine, fastened cross-sectionally over the sponge, and anchored at four points using cut or masonry nails. If a large part of an individual (top half or more) is used, then the “base” of the sponge, the point at which it was severed from the donor individual, should be placed on the benthos; after this, wire can be threaded through the tissue and then secured to the anchor points. To allow the sponge time to attach itself, the entire structure should be tight enough to prevent any movement due to water motion. Once the sponge has fully attached to the benthos, the constraining apparatus can be removed to allow sponge to heal from any wire damage (Bierwirth et al., 2022).

5.0 Permitting Considerations

All biological restoration and tire removal methods will need to be compliant with the required permits and licenses from the appropriate regulatory and resource protection agencies. The agencies will vary depending on the scope of the project and permittee. Contractors should become familiar with the agencies and contacts in **Table 6.** Because there is potential for adverse effects to adjacent reef habitat and ESA-listed stony coral species during tire removal from coral reef habitat, the project will require coordination under the National Environmental Policy Act (NEPA) and Section 7 of the ESA. Compliance with the NEPA review process and ESA requires preparation of an Environmental Assessment (EA) and Biological Assessment (BA) and coordination with the National Marine Fisheries Service (NMFS). A SAL from FWC will be required for coral relocation. The SAL application requires detailed information about restoration practices including harvest, holding and relocation/outplanting site coordinates, research hypothesis that may be tested, authorized personnel, funding sources, project title, project summary, associated permits and gear specifications. Outplanting of listed stony corals from a land-based nursery may also require permit authorization from the NMFS.

Table 6. Likely applicable permitting information including agency, permit name and main contact.

<table>
<tr><th>Location</th><th>Activity</th><th>Permits Required</th></tr>
<tr><td rowspan="2">Florida State Waters</td><td>Tire Removal and/or Structure Placement</td><td>Broward County-Environmental Resource License
• Website
• Contact: Aquatic and Wetland Resources Permitting Coordinator AWRLicense@broward.org or 954-519-1454

Florida Department of Environmental Protection (DEP) Environmental Resource Permit (ERP)
o Any activities located on state lands also require sovereignty of submerged lands authorization.
o FDEP Website
o Southeast Florida Contact: DEP Southeast District Office or 561-681-6600

South Florida Water Management District (SFWMP) ERP
o Any activities located on state lands also require sovereignty of submerged lands authorization.
o SFWMD Website
o SFWMP contact: epermit@sfwmd.gov or 561-682-2281

US Army Corps of Engineers (USACE) Regional General Permit SAJ-112
• Application information and instructions
• Permit
• General information contact:
  o Jacksonville Division Office
  o SAJ-RD@usace.army.mil or 904-232-1177
• Contact for Martin, Palm Beach, and Broward County
  ▪ sp@usace.army.mil</td></tr>
<tr><td>Any restoration work with corals</td><td>Florida Fish and Wildlife Conservation Commission (FWC) for a Special Activity License (SAL)
• Website
• Contact: sal@myfwc.com or 850-487-0554</td></tr>
<tr><td>Other considerations:</td><td colspan="2">• Florida permitting resource: Authorization Guidance for Coral Restoration Activities on Florida's Coral Reef
• If your activities may affect a historic landmark or resource: National Historic Preservation Act (NHPA) Section 106 Consultation</td></tr>
</table>

6.0 Integrating Tire Retrieval to Reef Restoration

The DEP will continue to manage tire removal until all visible and removable tires are retrieved from sand and coral reef habitats. Tire removal from sand, tire removal from coral reef habitat, and biological restoration will require different resources, expertise, timelines, and milestones. Subsequently, the costs and approximate timelines for each are discussed in this section. The estimated budget by fiscal year for each project is shown in **Table 7**. Concurrent timelines for all projects and necessary actions are shown in **Table 8**.

Table 7. Approximate annual cost (USD) of each major component for the Osborne Tire Reef Restoration Plan for each Fiscal Year (FY). Estimated costs per year are generally averaged over each FY. An en dash indicates costs for a project component are not likely to be needed.

Fiscal Year	Tire Removal Activities From Sand		Tire Removal Activities From Coral Reef		Biological Restoration	Total Yearly Budget
	Tire Removal	Coral Removal/ Relocation	Tire Removal	Coral Removal/ Relocation		
FY1: 2024-2025	–*	–	–	–	–	–
FY2: 2025-2026	$4,593,380	$1,432,501	$1,920,000	$153,556	**$1,000,000	$9,099,438
FY3: 2026-2027	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY4: 2027-2028	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY5: 2028-2029	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY6: 2029-2030	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY7: 2030-2031	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY8: 2031-2032	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY9: 2032-2033	$4,593,380	$1,432,501	$1,920,000	$153,556	$4,978,820	$13,078,258
FY10: 2033-2034	$4,593,380	$1,432,501	$1,920,000	$153,556	$3,978,820	$12,078,258
FY11: 2034-2035	$4,593,380	$1,432,501	–	–	–	$6,025,882
FY12: 2035-2036	$4,593,380	$1,432,501	–	–	–	$6,025,882
FY13: 2036-2037	$4,593,380	$1,432,501	–	–	–	$6,025,882
FY14: 2037-2038	$4,593,380	$1,432,501	–	–	–	$6,025,882
Sub-Totals	**$59,713,946**	**$18,622,517**	**$17,280,000**	**$1,382,007**	**$39,830,562**	**$136,829,032**
Project Totals	**$78,336,463**		**$18,662,007**			

*DEP has been allocated funds for tire removal and coral removal/relocation during FY1, per Line Item 1807 of the General Appropriations Act. **Some funding should be allocated during FY2 to begin grow-out of corals so that they are ready for outplanting as early as FY3.

Table 8. Shifting of resources and approximate timeline during individual Fiscal Years (FY) to remove tires from coral reef and sand habitat. An en dash indicates a project component would likely not occur.

Fiscal Years	Habitat	Tire Removal/ Disposal	Coral Removal/ Outplanting	Biological Restoration	Other Actions Needed
Fiscal Year 1 (2024-2025)	Sand	√	√	–	• Permit modification to expand the area for tire removal in sand.
	Reef	–	–	–	• Competitively procure services for reef tire removal and obtain permits.
Fiscal Year 2 (2025-2026)	Sand	√	√	–	–
	Reef	√	√	–	• Initiate propagation and grow-out of corals. • Initiate procurement for services for Biological Restoration.
Fiscal Years 3 to 10 (2026-2034)	Sand	√	√	–	–
	Reef	√	√	√	• Finalize procurement of services for Biological Restoration (during FY3) and obtain permits.
Fiscal Years 11 to 14 (2034-2038)	Sand	√	√	–	–

* Maximum number of fiscal years of 14 is dependent final scopes of work and contingent upon appropriations.

6.1 Removal of Tires on Sand Habitat

Based on 2019 and 2024 Tire Surveys (see **Appendices A** and **B**), an estimated 429,000 unburied and visible tires remain in the sand habitat within the surveyed areas. The density of tires remaining in the Tire Abatement Permit Area (**Figures 6** and **7**) as of May 2024 is low and tire removal of visible tires continues through FY1 using existing appropriations. A permit modification is required to expand the current tire removal permit[2] to include all sand habitat where tires are spatially distributed. Permit modification would take up to six months. Once a permit modification is complete, removal of tires from sand habitat is estimated to be completed during FY14 (**Table 8**).

Table 9 shows the estimated costs of individual components associated with tire removal from sand (i.e., coral removal/relocation and tire removal/disposal). DEP is using a conservative estimate (on the higher side) to ensure estimated costs presented in this report would result in complete tire removal. The cost per tire removal is likely to increase substantially from its current amount (approximately $30 per tire) due to increased time and effort to locate and bundle tires at lower densities and in deeper waters (discussed in detail in the Status Report [**Appendix A]**). Cost estimates do not account for fully buried tires, which may be uncovered through the natural movement of sand between the major reef lines. Costs also do not account for inflation. The estimated cost for removing tires from sand is $59,713,946 (**Table 9**).

In addition, the cost for coral removal from tires in sand habitat was estimated at $18,622,517 (**Table 9**). Costs are based on current contractor quotes and similar methods used from the last two fiscal years (summarized in **Appendix A**). Based on the best available information, estimates of the number of corals on tires were obtained using data from the 2024 Recon Survey (**Appendix C**); however, this survey was not designed for this purpose and did not sample the full tire distribution. Costs also do not account for inflation.

The total estimated costs for removing tires from sand and relocating corals from those tires is $78,336,463. This estimate does not include tires on coral reef habitat.

Table 9. Estimated approximate cost (USD) of each individual portion of the Osborne Tire Reef Restoration Plan.

Major Project	Individual Project	Individual Project Cost	Major Project Cost
Tire removal from sand habitat	Coral Removal and Relocation	$59,713,946	$78,336,463
	Tire Removal and Disposal	$18,622,517	

[2] Current tire removal project permit number: 06-0272719-006-EI

6.2 Removal of Tires on Coral Reef Habitat

Based on 2019 and 2024 Tire Surveys (see **Appendices A** and **B**), an estimated 92,000 tires remain in the coral reef habitat within the surveyed area. **Table 8** outlines activities associated with tire removal from coral reef habitat for each fiscal year. DEP would competitively procure vendor(s) and collaborate to procure relevant permits for tire removal from coral reef habitat during FY1. Tire removal from coral reef habitat is expected to occur between FY2 (2025-2026) and FY10 (2033-2034). This timeline is dependent upon appropriate funding and execution of other relevant restoration efforts.

Table 10 shows the estimated costs of individual projects associated with tire removal from coral reef habitat (i.e., coral removal/relocation and tire removal/disposal). Cost estimates for tire removal from coral reef habitat are based on an estimated 92,000 tires currently estimated to be in contact with coral reef habitat evenly divided over nine fiscal years. This tire number was obtained from data collected in the 2019 and 2024 Tire Surveys (see **Appendices A** and **B**). DEP is using a conservative estimate (on the higher side) in this Plan to ensure complete tire removal. Estimated cost for removing tires from coral reef habitat is $17,280,000 (**Table 10**). Current contractor estimates from large-scale restoration and debris removal efforts were used (e.g., DEP's *Clipper Lasco* ship-grounding restoration). The estimated cost for coral removal and relocation from tires to coral reef habitat is $1,382,007 (**Table 10**). Estimates of the number of corals on tires were obtained using data from the 2024 Recon Survey (**Appendix C**); however, this survey was not designed for this purpose and did not sample the full tire distribution. DEP will have a more refined timeline after contractors submit proposals and contracts are finalized. Costs also do not account for inflation. The total estimated costs for removing tires from coral reef habitat and relocating corals from those tires is $18,662,007 (**Table 10**).

Table 10. Estimated approximate cost (USD) of each individual portion of the Osborne Tire Reef Restoration Plan.

Major Project	Individual Project	Individual Project Cost	Major Project Cost
Tire removal from coral reef habitat	Coral Removal and Relocation	$17,280,000	$18,662,007
	Tire Removal and Disposal	$1,382,007	

6.3 Biological Restoration

Table 8 outlines activities associated with biological restoration for each fiscal year. In conjunction with tire removal from coral reef habitat, DEP would procure services for biological restoration during FYs 2 and 3 (2024-2026). It is not necessary to wait until all visible tires are removed before biological restoration takes place. Methods related to biological restoration are detailed in **Section 4.2.**

Table 11 shows the estimated costs of individual components associated with biological restoration of coral reef habitat (i.e., coral outgrowth in aquariums and monitoring of corals). Costs were estimated from other restoration-related initiatives including Mission: Iconic Reefs (see **Section 7**). The number of colonies to be grown and outplanted is 98,100 (for details on how this number was obtained, see **Section 4.2**). The estimated cost for propagation and grow-out in land-based aquaria is $10,076,832 and for transport and outplanting is $19,353,168 (**Table 11**). Some funding should be allocated during FY2 to begin grow-out of corals so that they are ready for outplanting as early as FY3 (**Table 8**). It should be noted that as land-based infrastructure and capacity is expanded under Florida's Coral Reef Restoration and Recovery (FCR3) Initiative (see **Section 7**) and there will be economies of scale that are expected to significantly reduce the overall cost per coral. Costs may also vary depending on availability and complications associated with grow-out of certain species (e.g., *M. meandrites*). Anticipated cost for monitoring of up to 25% of the colonies for up to 1 year (at 1-month, 3-month, 6-month and 1-year periods) is $10,400,562 (**Table 11**). This cost may vary depending on the level of mortality of corals following outplanting. Cost of biological monitoring may vary depending on progress by the USACE's tire removal for compensatory mitigation for the for impacts expected to result from the Port Everglades Deepening and Widening Project (discussed in **Section 4.2.1**). The total estimated costs for biological restoration including propagation, grow-out, outplanting and monitoring of corals is $39,830,562.

Table 11. Estimated approximate cost (USD) of each individual portion of the Osborne Tire Reef Restoration Plan.

Major Project	Individual Project	Individual Project Cost	Major Project Cost
Biological restoration (coral outplanting)	Propagation and Grow-out	$10,076,832	$39,830,562
	Transport and Outplanting	$19,353,168	
	Monitoring	$10,400,562	

As land-based infrastructure and capacity is expanded under Florida's Coral Reef Restoration and Recovery (FCR3) Initiative (see **Section 7**), there will be economies of scale that are expected to significantly reduce the overall cost per coral.

7.0 Overview on other Coral Reef Restoration Projects

To guide resource allocations over the next five years, the DEP and the FWC identified two priorities critical to ensuring successful restoration of Florida's Coral Reef:

1. Building a network of coral nurseries and restoring Florida's Coral Reef. Concurrent with the efforts to address local stressors like water quality and harmful algae, partners must scale up coral propagation and restoration capacity and infrastructure to jump-start wild coral population recovery. To grow new coral at a scale necessary to truly have an impact for Florida's Coral Reef, innovative methods must be developed.

2. Establishing large-scale ecosystem restoration strategy and associated infrastructure necessary to preserve the ecological and structural integrity of Florida's Coral Reef. Recurring funds will support jump-starting a "coral restoration economy," including:

- A skilled workforce for creating, expanding and operating in-water and land-based coral nurseries.
- Transplanting corals to the reef.
- Maintaining and monitoring restoration sites over the years to come.

Florida's Coral Reef restoration community began outplanting coral in the early 2000s to address the significant loss of coral (reef structure) and ecosystem function occurring over the past several decades. Coral restoration started with staghorn and elkhorn coral, and tens of thousands of colonies of both species have been successfully fragmented and outplanted. Recently, the focus of restoration has not only expanded to propagating stony coral tissue loss disease-susceptible species, but also moved beyond coral to focus on the other components of the ecosystem, like sponges and herbivores.

Due in part to the significant loss of Florida's coral cover and thanks to new coordination opportunities, there is an increase in the development of collaborative regional restoration plans, including Florida's Coral Reef Restoration Strategy, the Kristin Jacobs Coral Reef Ecosystem Conservation Area Restoration Plan, National Oceanic and Atmospheric Administration's (NOAA) Mission: Iconic Reefs and the Florida's Coral Reef Restoration and Recovery (FCR3) Initiative, which are discussed below. Other restoration or mitigation related efforts related to this Plan are also discussed below.

Florida's Coral Reef Restoration Strategy

Florida's Coral Reef Restoration Strategy was facilitated by The Nature Conservancy and collaboratively developed and supported by local, state, and federal reef managers and restoration practitioners. By modeling oceanic processes coupled with coral larval connectivity data, sites that are identified and ultimately restored will have a better chance of producing new coral larvae that could re-seed upstream locations and ultimately expedite the recovery of the entire reef. This is considered the Tier 1 Strategy and was finalized at the end of Spring 2024.

Kristin Jacobs Coral Reef Ecosystem Conservation Area Aquatic Preserve Restoration Plan

Building off Florida's Coral Reef Restoration Strategy, each managed area across the reef will have a restoration plan that incorporates priorities of the coral resources in that managed area and of the people that use those resources. Focused on the northern 105 miles of Florida's Coral Reef, the Kristin Jacobs Coral Reef Ecosystem Conservation Area Aquatic Preserve (Coral ECA) Restoration Plan will identify locations in Miami-Dade, Broward, Palm Beach, and Martin Counties that overlap with Tier 1 areas and will result in the biggest benefit possible for ecosystem services such as shoreline protection, fisheries habitat and tourism. The plan also avoids areas that were identified as not suitable for restoration. This is considered a Tier 2 Plan and it is estimated to be complete by Fall 2024.

Mission: Iconic Reefs

NOAA's Mission: Iconic Reefs is a blueprint for ecosystem restoration at seven specific sites located within the Florida Keys National Marine Sanctuary. This plan, developed with input from the reef management and restoration communities, identifies detailed places, actions and costs needed to achieve a meaningful scale of restoration at the seven prioritized sites. For each site, the design identifies the species to be outplanted and the number of nursery-grown corals necessary to reach coral cover goals. NOAA is funding multiple restoration practitioners to grow and outplant enough corals to achieve the Misson's goals. This is considered a Tier 3 Plan and was completed in December 2022; restoration efforts are underway and ongoing.

Florida's Coral Reef Restoration and Recovery (FCR3) Initiative

In January 2023, Governor DeSantis established the FCR3 Initiative through Executive Order 23-06 with the goal of developing the infrastructure, technology, and skilled workforce necessary to support the long-term recovery of no less than 25% of Florida's Coral Reef by 2050. Led by the DEP Coral Protection and Restoration Program, the FWC's Fish and Wildlife Research Institute, and the State's Office of Resilience, this 10-year initiative will facilitate an unprecedented, evidence-based propagation and outplanting program to restock Florida's Coral Reef with hardy populations of native corals and other keystone species to re-establish and strengthen natural reproduction, dispersal and recruitment patterns. Along with supporting the expansion, construction, and maintenance of in-state facilities for coral propagation, the FCR3 Initiative will also directly restore five-10 sites across Florida's Coral Reef with a goal of significantly enhancing flood protection and strengthening Southeast Florida's coastal economies. A minimum of one site will be chosen per county, so at least four sites will be within the Coral ECA. This will be considered a Tier 3 Plan and is expected to be completed by Fall 2025.

Current Tire Removal Project

The current tire removal project (summarized in the Status Report; **Appendix A**) and this Plan are contained in the Coral ECA and therefore align most closely with its restoration strategies. Currently, the permit for the tire removal project is not authorized to remove any tire with stony corals present. As a result, contractors were hired by DEP ORCP to facilitate the removal and relocation of the corals. As of May 29, 2024, 1400 corals have been removed from tires (700 colonies each during FY 2022-23 and FY 2023-24).

- 1,013 corals were outplanted directly onto local natural reefs (472 colonies during FY 2022-23 and 541 during FY 2023-24).
- 206 corals were donated to researchers (133 colonies during FY 2022-23 and 73 during FY 2023-24).
- 128 corals remain in NSU's offshore nurseries to be utilized for further restoration or research programs.
- 53 corals were lost to inclement weather.

ORCP will continue to use these corals to restore the natural reefs within the Coral ECA. The corals that are removed from the tires may also contribute to the propagation pipeline, led by FWC, for the advancement of the FCR3 Initiative. As the FCR3 Initiative's infrastructure and capability expand, the corals could be used as broodstock for sexually propagating new corals to be used to restore the broader Coral ECA to achieve goals identified in restoration plans for the ECA.

Using maps and data from Tier 1, along with research from other data collection projects, the northern sites for the FCR3 Initiative may overlap and benefit the reefs identified for restoration in The ECA Restoration Strategy (Tier 2 and 3) and Osborne's Reef Restoration. Thus, the combined resources from these projects could benefit and restore a substantial section of the northernmost part of Florida's Coral Reef.

The corals removed from the tires are also currently utilized in projects funded by the DEP Coral Protection and Restoration Program that focus on restoration research, symbiont community and immunity studies, and growth and predation studies. The results of these research projects will inform resource managers on matters ranging from restoration site selection to coral disease treatment.

Coral restoration and propagation partners and resource managers at the state and federal level will continue to evaluate the interconnectivity of restoration projects and explore collaboration when appropriate. While the current tire removal project is focused on the northern reefs, the salvage corals removed from the tires will benefit the immediate reefs and eventually the entirety of Florida's Coral Reef as they provide individuals for outplant, propagation and research.

Clipper Lasco / Spar Orion Grounding Restoration Sites

In 2006, two large ships, *Clipper Lasco* and *Spar Orion*, ran aground less than 3 km north of Port Everglades causing fundamental changes to benthic community structures, fracturing complex reef framework and crushing coral into debris rubble. The two sites had not shown any indications of recovering to pre-impact conditions in the 10 years that followed and mitigation was required. As a result, large scale mitigation efforts were performed in 2015. Specific tasks included stabilizing loose rubble and improving complexity in the bow scars with the addition of limestone boulders. Both sites are monitored annually. Since 2016, stony coral density has increased 300% on the boulder sites with lower coral density on unconsolidated rubble. Both sites still have a limited gorgonian and *Xestospongia muta* recruitment. In the past two fiscal years, 306 corals were removed from tires and relocated to the *Clipper Lasco* site (172 colonies in FY22-23; 134 in FY23-24). Corals were only added to the *Clipper Lasco* site so that the coral reef recovery rates can be compared between a biologically restored site (*Clipper Lasco)* and a stabilized site (*Spar Orion*). The ten-year monitoring report will be published in 2026.

US Army Corps of Engineers – Natural Reef Enhancement and Tire Removal for Mitigation

The proposed Port Everglades Deepening and Widening Project, which would deepen and widen the outer entrance channel at Port Everglades, is predicted to result in over 60 acres of direct impacts to coral reef habitat. As part of the mitigation activities that would be conducted to offset these impacts, the USACE has proposed to remove tires from, and outplant coral colonies to, the 41-acre area on Outer Reef identified in Figure 8. Four priority grid cells identified for restoration in this Plan fall within the 41-acre area proposed for use by the USACE. These grid cells can be reassigned to other areas of Outer Reef as described in Section 4.2.1. Nothing in this plan precludes the USACE from using tire removal or reef enhancement in the 41-acre area as mitigation for future coastal construction activities which are part of the Port Everglades Deepening and Widening Project, subject to approval by the Department, through a 10-year time period. The 10-year time period may be extended upon mutual agreement of USACE and DEP, as long as USACE provides in writing the reason for delay and an updated timeline.

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