UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

Florida Keys National Marine Sanctuary
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# Restoration Guidelines for Coral Reefs and Associated Habitats in FKNMS

Florida's coral reefs have degraded over many years, losing much of their stony coral cover and other community attributes that are vital to a healthy and resilient ecosystem. Multiple stressors are responsible for this decline. NOAA Office of National Marine Sanctuaries' (ONMS) Florida Keys National Marine Sanctuary (FKNMS) intends to **actively** participate in efforts to restore depleted species, lost habitat, biodiversity, and key ecosystem functions in the Florida Keys. NOAA and the State of Florida are working together to develop a streamlined permitting process to facilitate restoration activities. This vision requires NOAA and the State of Florida to support comprehensive coral reef restoration research and restoration activities. Our vision for the next decade is to see a recovering Florida Keys ecosystem that is increasingly resistant and resilient, with native biodiversity functioning naturally and supported by improved environmental conditions and ecological symbioses.

## Authorities

With respect to restoration activities, the FKNMS is the primary regulatory authority for the sanctuary, and is also responsible for issuing permits in addition to the State of Florida in state waters, to allow activities that are otherwise prohibited by sanctuary regulations to occur. Thus, decisions on locations for coral outplanting, coral seeding, species introductions, removal of pest species, and other activities associated with restoration will be made on a case-by-case basis and will be informed by the FKNMS Management Plan and ONMS/FKNMS science and management expertise. Additionally, projects approved for permitting will need to fall within those categories of activities for which permits may be issued and meet all regulatory review criteria (15 CFR § 922.166). Most restoration activities will trigger other regulatory and statutory authorities and must comply with all law and regulation (e.g., Endangered Species Act, Magnuson-Stevens Act, National Historic Preservation Act, and others). Restoration activities involving coral species listed under the Endangered Species Act that fall within the scope of the *Programmatic Biological Opinion on Threatened Caribbean Coral Research, Restoration and Relocation*, initiated on October 18, 2016, would likely be able to proceed without an additional Biological Opinion from NOAA Protected Resources Division; however, all other laws and regulations would still need to be satisfactorily addressed during the permit application process.

## Restoration Categories

Below are categories of restoration activities that are expected to be subject to sanctuary consideration in the near future. They are grouped as "green light," "yellow light,"

and “red light” to indicate their likelihood of meeting FKNMS permit review criteria and to provide permittees a sense of the level of required review and whether the issuance of a permit is likely. “Green light” activities are likely to be approved with a simple review, while “yellow light” activities may need additional information and analysis. “Red light” activities likely need significant review and may not be found eligible for permitting. All proposals will be reviewed impartially for their ability to meet permit review criteria. There may be types of restoration activities eligible for permitting that are not listed here, and there may be activities listed below (under any category) that are not able to meet the permit review criteria and therefore will not be permitted. It is possible that clarifications or changes to a permit application would address concerns and facilitate approvals. The green light, yellow light, and red light activities listed below are not inclusive of every restoration action that might be undertaken in the sanctuary, but are meant to serve as guidance for the restoration community based on the experience of resource managers with these types of activities. Restoration activities may have specific monitoring requirements that are focused on the determination of efficacy, need for mid-course corrections, and long term success.

**ONMS/FKNMS Input on Restoration Options:**

**Green light** actions are likely to be approved without significant or complex review:

- Outplanting of *in situ* nursery-reared corals into habitats typically occupied by these species, in suitable similar habitats, or in areas that have not been impacted by a significant recent outbreak of coral disease, using typical outplanting techniques and visual health assessments for *in situ* corals
- Outplanting of *ex situ* nursery-reared asexual coral fragments into the same population from which it was collected/reared and habitats typically occupied by these species, in suitable similar habitats or in areas that have not been impacted by a significant recent outbreak of coral disease, using typical outplanting techniques and adhering to visual health assessment for *ex situ* corals (see yellow light action).
- All coral and substrate triage activities: flip and cache, stabilize in place, stabilize nearby, restoration using fragments of opportunity/corals of opportunity (COOs), and transfer fragments to nursery
- Collection of small corals and fragments of opportunity for use as broodstock in nurseries, including detached corals, healthy portions of corals removed from diseased colonies, and corals that have been dislodged and deposited within sand and seagrass areas (where they do not normally occur), as well as corals rescued from coastal construction locations (e.g., dredging/filling locations, docks, pilings, bridges, seawalls, utility poles)
- Maintenance of coral outplants, including removal of fishing line, corallivores, algae, *Palythoa* and *Erythropodium*, and other epibionts from outplants and adjacent substrate
- Removal of outplants from restoration sites and nurseries that succumb to disease (to avoid spread to healthy outplants)
- Deployment and maintenance of nursery structures at appropriate water depths, which are constructed of appropriate materials and designed to ensure stability of the

structures themselves and the restoration organisms they support and to reduce the possibility of entangling marine life
- Collection of spawn from wild corals or nursery-reared corals located within FKNMS, cross fertilization of coral gametes to create new genotypes, and rearing of those corals in *ex situ* settings
- Asexual propagation of coral genotypes, including those collected from extreme environments, having exhibited natural resistance and/or resilience to stressors, or purposefully "stress-hardened," for use in restoration projects (e.g., propagating corals collected from nearshore sites that resisted cold water stress or are exposed to high sediment and nutrient loading; survivors of a mass bleaching event)
- Asexual propagation of coral genotypes originally reared from *ex situ* sexual recruits reintroduced into the population in which their parents occurred and adhering to visual health assessment protocols
- Monitoring of outplanted species and surrounding habitats
- Propagation, development and transplantation/relocation of *Diadema,* subject to appropriate veterinarian check for health considerations if reared *ex situ*
- Removal of coral predators, bioeroding sponges, invasive species (e.g. lionfish)
- Restoration projects that work across associated habitats that support coral reef health such as restoration of nearby seagrass beds using established methods

**Yellow light** actions will likely require additional information and analysis to address timing, techniques or other criteria:

- Outplanting of coral species that are susceptible to stony coral tissue loss disease within endemic, epidemic, and invasion zones
- Outplanting corals that were produced as a result of *ex situ* sexual reproduction from broodstock or gametes collected from Florida Keys corals
- Outplanting with larvae of native taxa sourced (in whole or in part) from elsewhere in the wider-Caribbean in order to increase genetic diversity, subject to biosecurity considerations
- Deployment of artificial or non-natural substrates, structures, or materials during the outplanting process (e.g., outplanting corals that have been grown on plastic cards, using excessive numbers of plastic cable ties or similar materials to secure coral fragments, deploying reef modules, porcelain or other hard substrates or "gray green infrastructure" as base structure for outplants, scattering larval attachment substrates along the reef)
- Testing of novel structures (bamboo, hemp rope and natural limestone) to propagate and hold corals in nurseries and the outplanting of these structures directly onto the reef on a pilot scale to further advance outplant success and scale up restoration
- Outplanting of laboratory-reared corals that have been selected to exhibit enhanced stress tolerance and/or assisted evolution (e.g., exposure and acclimation to conditions of high stress, selective breeding of certain genotypes, or modification of the community composition of coral associated microbes and algal endosymbionts)
- Outplanting of both *ex situ* and *in situ* nursery-reared corals into habitats formerly occupied by these species in areas that have been impacted by a significant recent outbreak of coral disease, with caveats related to outplanting techniques

- Removal of corals and other organisms from Sanctuary Preservation Areas (SPA) and Research Only Areas for use in nurseries, following a catastrophic event such as coral disease outbreaks or similar events that has caused the loss of those species in existing nurseries
- Collection of *Diadema* for broodstock

**Red light** actions are considered so novel, potentially risky, or beyond the scope of normal restoration activities that a significant review is necessary.
Red light actions *may* not be eligible for permitting:

- Collection of whole, intact, attached, unimpaired ESA-listed corals and fragments or cores from unblemished colonies of these species for use in coral nursery programs, unless these colonies are rescued from docks, pilings, seawalls, utility poles, and similar coastal construction locations (as noted in the green light section)
- Outplanting of organisms and propagation of organisms within *in situ* nurseries that are not native to the wider Caribbean
- Conducting projects that involve restoration-like activities, but whose primary goal is not scientifically-based species or habitat restoration designed with a reasonable chance of success (e.g., outplanting corals to artificial reef modules to create a snorkel trail, outplanting corals to underwater sculptures)
- Undertaking large-scale or reef-wide interventions that have not been sufficiently tested at the pilot level to document success of those techniques (e.g., UV screens over reefs, outplanting corals using underwater robots)
- Restoration activities performed or required as compensatory mitigation (if G/Y activities are used for compensatory mitigation) may need more rigorous monitoring to ensure mitigation criteria are met. Amount of compensatory restoration is linked to injury/impact

**Additional ONMS/FKNMS Restoration Criteria:**
Location:

- Prioritize outplanting into SPAs and other high value areas, with species placed into appropriate habitats at appropriate densities based on their life history and previous distribution
- Prioritize outplanting into appropriate habitats typically occupied by these species, in suitable similar habitats or in areas that have not been impacted by a significant recent outbreak of coral disease, with emphasis on restoring species richness and avoidance of monospecific outplants with low genetic diversity
- Prioritize establishment of demonstration sites with multispecies and multi phyla introductions
- Outplant with adequate spacing and distribution to minimize the likelihood of losses to diseases and corallivores

Species Type

- Greater emphasis and experimentation on species, including those that are ESA-listed or state listed, that have experienced substantial declines, those with the highest potential of long term survival, and species that will improve habitat quality, build reef framework and enhance ecosystem function

Fragment size

- Considerations of size of outplants to maximize survival, based on existing best practices and future research (examination of broader SCREAM and other data sets for recruitment/size class data may provide guidance about success)

Potential survivability

- Outplants should mimic their native distribution with avoidance of outplanting into habitats where survival will be low due to storm damage (e.g., planting fragile corals in outer fore reef habitats on the top of spurs), temperature stress, abnormal sedimentation and nutrient loading, excessive light (e.g., planting corals grown in deeper, light limited areas onto reef tops), or other factors that would limit survival (e.g., nearby construction that could damage outplants)
- Substrate quality for outplanting: avoiding placing outplants onto substrates with high cover of macroalgae, *Palythoa*, and clinoid sponges, areas subject to excessive sand movement and potential burial, etc.
- Projects that address other factors (e.g., reducing harmful algal cover) that could be advantageous to restoration success

Outplanting approach

- Minimize use of non-natural structures including cement modules, plastic cable ties, excessive epoxy, large and excessive numbers of tags, etc., and minimize drilling holes into the reef framework to attach corals or secure structures
- Avoid outplanting onto unstable, bioeroded coral skeletons and other locations that are likely to be broken/removed as outplants increase in size. Substrate stabilization may facilitate the use of coral skeletons or previously unstable substrates, but the degree of bioerosion and encrustation must be considered
- Avoid outplanting within 10 meters of mooring buoy pins
- Avoid existing long-term habitat and species monitoring programs during all outplanting activities, and avoid outplanting within permanent monitoring stations (e.g., CREMP sites)

Achievability (e.g., scale of effort)

Time sensitivity of response