Coral Consultation Framework
NOAA Fisheries Southeast Regional Office

Revised August 2022

Purpose and Scope

In order to inform the Southeast Region's consultation activities regarding the ESA-listed corals, this document consolidates and interprets information obtained through the listing process and collected through collaboration with the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center, state, federal, and university partners. This collection of information provides Section 7 assistance, and identifies early conservation/recovery concepts to be considered during consultation. The contents are intended to summarize best available information as well as facilitate integration of conservation/recovery considerations into our routine consultation practices. A large quantity of information was synthesized in the production of this document and as such, it should be considered a job aid and used as general guidance only.

Background Information for Acropora Critical Habitat

This section presents information on basic biology, life history, ecology, and habitat use as they specifically relate to Section 7 actions. There are seven Caribbean corals listed as threatened: *Acropora cervicornis* (Staghorn coral), *Acropora palmata* (Elkhorn coral), *Orbicella annularis* (Lobed star coral), *Orbicella faveolata* (Mountainous star coral), *Orbicella franksi* (Boulder star coral), *Dendrogyra cylindrus* (Pillar coral), and *Mycetophyllia ferox* (Rough cactus coral) (Table 1). This document provides information on all seven threatened corals.

Note: previously the three *Orbicella* species were considered one species known as *Montastraea annularis.* In 2012, they were formally reclassified into the three separate species and the genus was renamed *Orbicella*. *Orbicella* species may be difficult to differentiate in the field and some resource surveys will still note them as *Montastraea* or *Orbicella* complex rather than identifying each individual species. In these cases, we must use best available information on individual species' relative densities to extrapolate to a particular action area when species-specific information is not available to estimate the numbers of colonies of each individual species in the project area.

Table 1. Threatened corals in Caribbean waters and their corresponding jurisdictions.

Threatened Corals	**US Jurisdiction**			
Caribbean Waters	Florida - Atlantic[1]	Puerto Rico	U.S. Virgin Islands	Gulf of Mexico (Flower Garden)
Staghorn coral *(Acropora cervicornis)**	X	X	X	
Elkhorn coral *(Acropora palmata)**	X	X	X	X
Lobed star coral *(Orbicella annularis)*†	X	X	X	X
Mountainous star coral *(Orbicella faveolata)*†	X	X	X	X
Boulder star coral *(Orbicella franksi)*†	X	X	X	X
Pillar coral *(Dendrogyra cylindrus)*†	X	X	X	
Rough cactus coral *(Mycetophyllia ferox)*†	X	X	X	

* Listed as threatened in 2006 † Listed as threatened in 2014

ESA Documentation

Elkhorn and staghorn corals were listed as threatened under the Endangered Species Act (ESA) in May 2006 (71 FR 26852). In December 2012, NMFS proposed changing their status from threatened to endangered (77 FR 73219). On September 10, 2014, NMFS determined that elkhorn and staghorn corals should remain listed as threatened (79 FR 53851).[2] NMFS also listed lobed star, mountainous star, boulder star, pillar, and rough cactus corals as threatened on September 10, 2014 (79 FR 53851).

Species Description

Corals are marine invertebrates in the phylum Cnidaria that occur as polyps, usually forming colonies of many clonal polyps on a calcium carbonate skeleton. All seven threatened Caribbean corals are reef-building corals because they secrete massive calcium carbonate skeletons that form the physical structure of coral reefs. Reef-building coral species collectively produce coral reefs over time in high-growth conditions.

[1] The Dry Tortugas are included in the Florida range of these species.

[2] Cite this rule in listing tables, consultations, etc. as the most current FR listing rule.

Acropora cervicornis is characterized by staghorn-antler-like colonies, with cylindrical, straight, or slightly curved branches (Figure 1). Branching is irregular and secondary branches form at approximately 60 to 90 degrees relative to a primary branch. Individual colonies are up to 1.5 meters (m) across but may form large groups of colonies called thickets where it is difficult to identify individual colonies. In calm-water conditions, the colonies have an open appearance with long stems between the diverging branches. In turbulent wave surge or currents, the colonies are smaller with greater branch density. Tissue color ranges from golden yellow to medium brown; growing tips tend to be lighter or lack color.

Figure 1. Staghorn coral (*Acropora cervicornis*).

Acropora palmata forms colonies that are flattened to near round with frond-like branches (Figure 2). Branches typically radiate outward from a central trunk that is firmly attached to hardbottom. Branches are white near the growing tip, and brown to tan away from the growing area. Colonies can grow at least 2 m high and 4 m in diameter.

Figure 2. Elkhorn coral (*Acropora palmata*).

Orbicella annularis colonies grow in columns that exhibit rapid and regular upward growth (Figure 3). In contrast to the other two Orbicella species, margins on the sides of columns are typically dead. Live colony surfaces usually lack ridges or bumps.

Figure 3. Lobed star coral (*Orbicella annularis*).

Orbicella faveolata grows in heads or sheets, the surface of which may be smooth or have keels or bumps (Figure 4). Colony diameter can reach up to 10 m with a height of 4 to 5 m.

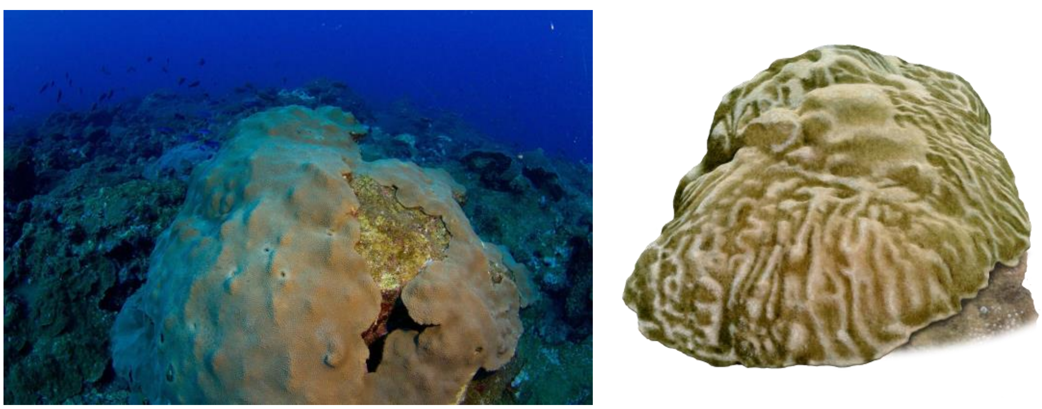

Figure 4. Mountainous star coral (*Orbicella faveolata*).

Orbicella franksi is distinguished by large, unevenly arrayed polyps that give the colony its characteristic irregular surface (Figure 5). Colony form is variable, and colony diameter can reach up to 5 m with a height of up to 2 m.

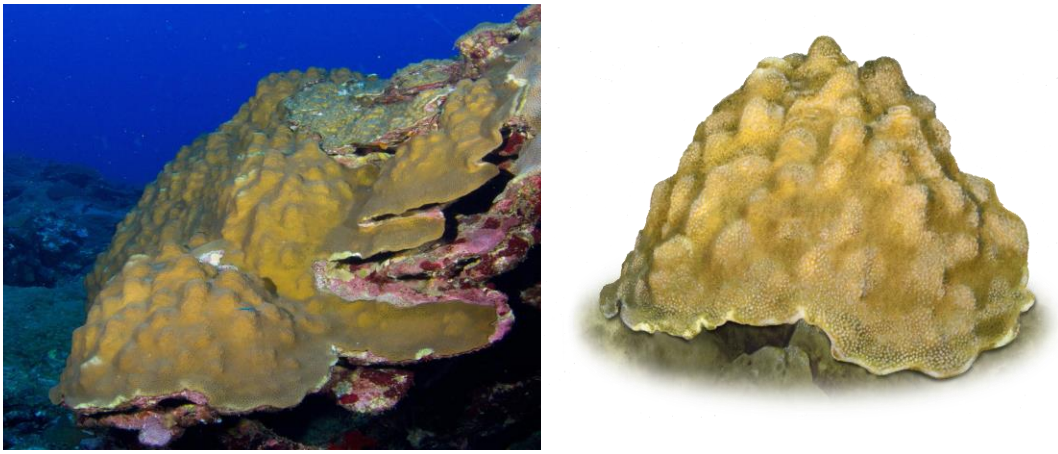

Figure 5. Boulder star coral (*Orbicella franksi*).

Dendrogyra cylindrus forms cylindrical columns on top of encrusting bases (Figure 6). Colonies are generally grey-brown in color and may reach 3 m in height. Tentacles remain extended during the day, giving columns a furry appearance.

Figure 6. Pillar coral (*Dendrogyra cylindrus*).

Mycetophyllia ferox forms a thin, encrusting plate that is weakly attached (Figure 7). Colonies are most commonly greys and browns in color with valleys and walls of contrasting colors. Maximum colony size is 50 centimeters (cm).

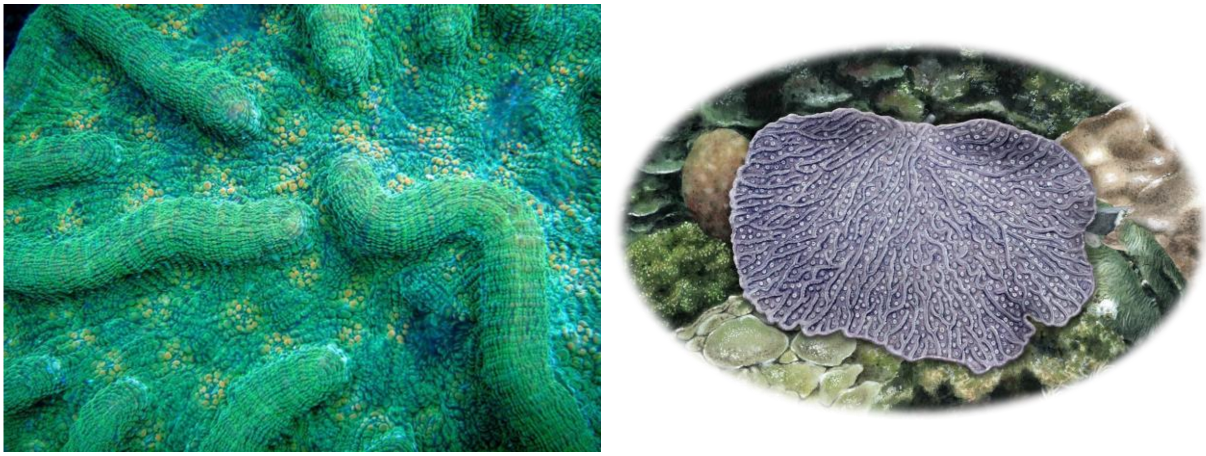

Figure 7. Rough cactus coral (*Mycetophyllia ferox*).

Range

The seven ESA-listed coral species occur on shallow coral reefs (Figure 8) throughout the wider-Caribbean, including south Florida, Puerto Rico, U.S. Virgin Islands (USVI), and the Gulf of Mexico (Table 1). All seven species also occur at Navassa Island, which is a U.S. National Wildlife Refuge, located in the Caribbean between Jamaica, Haiti, and Cuba.

Individual species have different, but mostly overlapping ranges and occupy different reef environments and depths (Figures A1-A7 and Table 2).

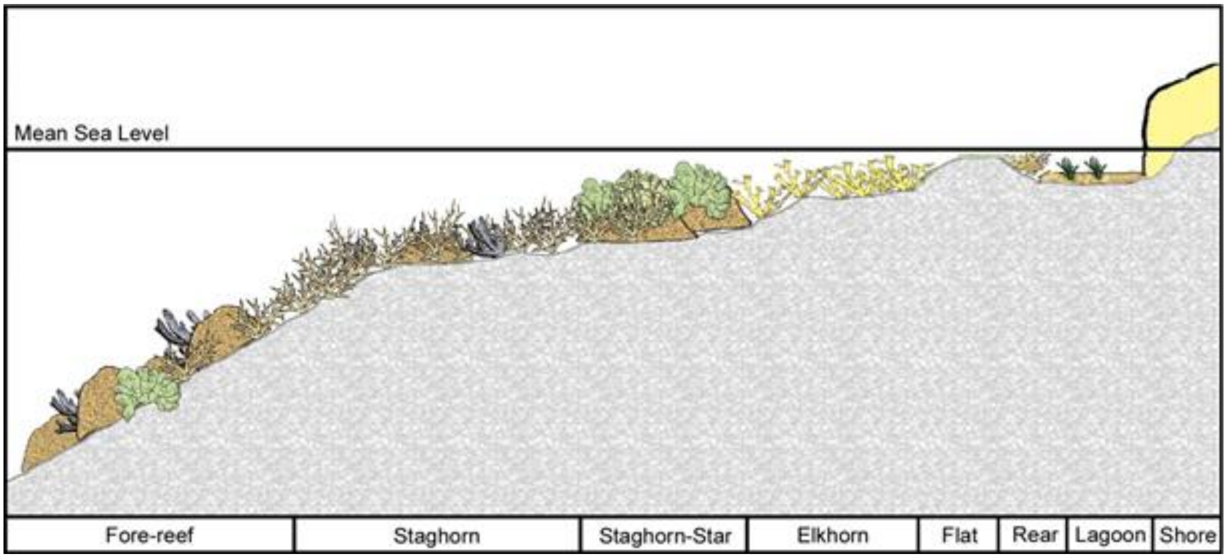

Figure 8. Reef zonation schematic example modified from several reef zonation-descriptive studies (Bak 1977; Goreau 1959).

Table 2. Species Distribution.

Species	Reef Environment	Depth Distribution	US Geographic Distribution
Staghorn coral *(Acropora cervicornis)*	spur and groove, bank reef, patch reef, and transitional reef habitats, as well as on limestone ridges, terraces, and hardbottom habitats	most common 5-25 m total range 0-30 m	Southeast Florida from the northern limit of Palm Beach County to the Dry Tortugas; Puerto Rico; USVI; Navassa Island
Elkhorn coral *(Acropora palmata)*	fore-reef, reef crest, and shallow spur-and-groove zone	most common 0.5-5 m total range 0.5-40 m	Southeast Florida from the northern limit of Broward County to the Dry Tortugas; Flower Garden Banks National Marine Sanctuary; Puerto Rico; USVI, Navassa Island
Lobed star coral *(Orbicella annularis)*	most reef environments	most common 1-10 m total range 1-82 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; Flower Garden Banks National Marine Sanctuary; Puerto Rico; USVI; Navassa Island
Mountainous star coral *(Orbicella faveolata)*	most reef environments	most common 10-20 m total range 1-30 m	Southeast Florida from St. Lucie Inlet in Martin County to the Dry Tortugas; Flower Garden Banks National Marine Sanctuary; Puerto Rico; USVI; Navassa Island
Boulder star coral *(Orbicella franksi)*	most reef environments	most common 15-30 m total range 5-50 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; Flower Garden Banks National Marine Sanctuary; Puerto Rico; USVI; Navassa Island
Pillar coral *(Dendrogyra cylindrus)*	most reef environments	most common 5-15 m total range 1-25 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; Puerto Rico; USVI; Navassa Island
Rough cactus coral *(Mycetophyllia ferox)*	most reef environments	most common 10-20 m total range 5-30 m	Southeast Florida from Broward County to the Dry Tortugas; Puerto Rico; USVI; Navassa Island

Important biological facts

How Corals Reproduce

Coral reproductive methods vary according to the species. Some species are hermaphrodites, meaning they produce both sperm and eggs at the same time. Other corals are gonochoric, meaning that they produce single-sex colonies. In these species, all of the polyps in one colony produce only sperm, and all of the polyps in another colony produce only eggs. Additionally, some species reproduce asexually via fragmentation.

Coral larvae are formed in two different ways, depending on the species of coral. The larvae are either (1) fertilized within the body of a polyp (brooders) or (2) fertilized outside of the polyp's body in the water (spawners) (Figure 9). One of the ESA-listed Caribbean corals is a brooder and six of the seven are spawners (Table 3).

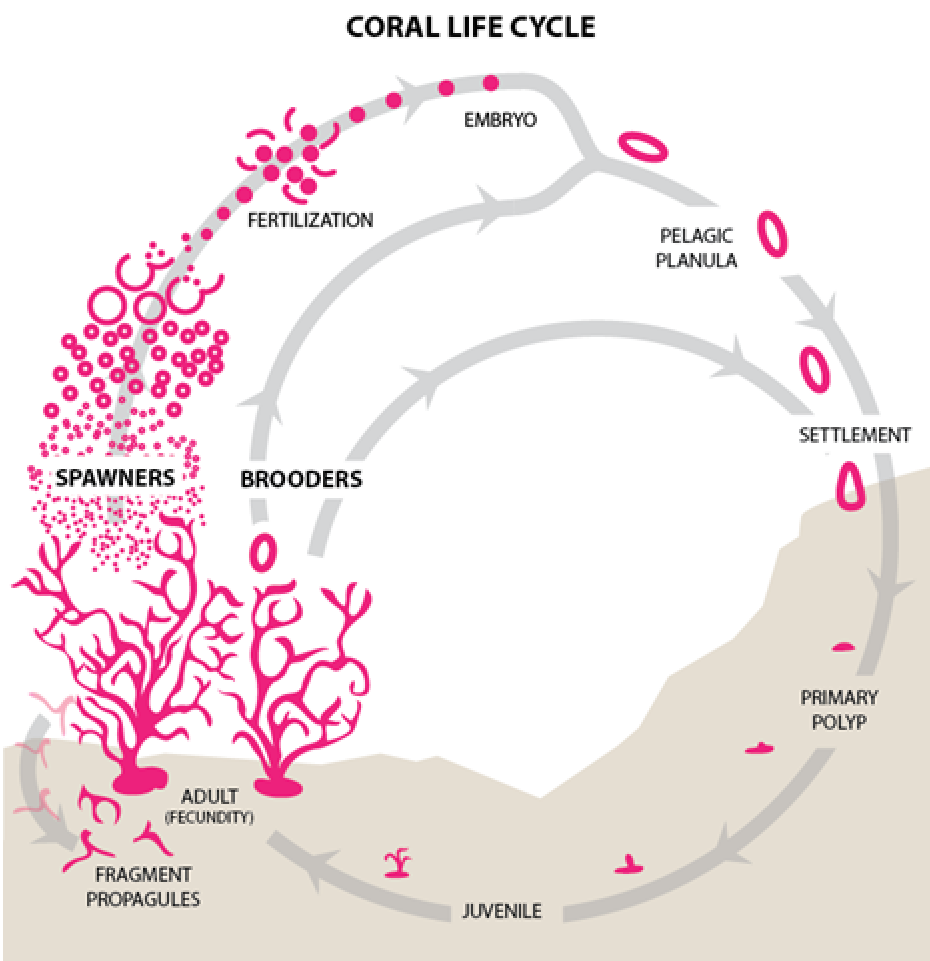

Figure 9. Coral Life Cycle.

Brooding coral fertilize an egg within the body of a coral polyp using sperm that is released through the mouth of another polyp. The sperm and egg merge and form a *planula larva*, which matures inside the body of its parent colony. When the larva is ready, it is released into the water through the mouth of its parent colony.

Brooders' reproduction window may be limited to only a few months or nearly continuous throughout the year. Brooders can produce larvae that already contain zooxanthellae and are generally larger in size, which makes them more capable of avoiding threats. However, similar to broadcast spawners, when corals are stressed, coral reproductive success is diminished.

Spawning coral reproduce by ejecting large quantities of eggs and sperm into the surrounding water, called broadcast spawning. When this happens, the eggs and sperm fertilize in the water. In some areas, mass broadcast spawning events occur on one particular night per year, and scientists can predict when this will happen.

Once in the water column, larvae are naturally attracted to the light. They swim to the surface of the ocean, where they may remain for days or even weeks. If predators do not eat the larvae during this time, they swim back to the ocean floor and attach themselves to a hard surface. An attached planula (juvenile) metamorphosizes into a coral polyp and begins to grow—dividing itself in half and making exact genetic copies of itself. As more and more polyps are added, a coral colony develops. Eventually the coral colony becomes mature, begins reproducing (adult), and the cycle of life continues (https://coral.org/coral-reefs-101/coral-reef-ecology/how-corals-reproduce/).

The high quantity of larvae produced at the same time is necessary to offset a high loss of offspring in the early development phases. The released gametes require favorable water quality to enable them to ascend to the ocean surface where fertilization takes place. Degraded water quality, e.g., waters laden with suspended sediments can ballast gametes with sediment thereby preventing or delaying the ascent of gametes to the ocean surface, and reducing egg-sperm encounter rates and overall successful spawning. Favorable water quality is also needed for several weeks after fertilization prior to swimming back down to the reef in search for suitable settlement substrate. The weeks following settlement are crucial times for the polyp to avoid threats such as overgrowth by algae or being buried by sedimentation. Long distances between spawning colonies as well as unfavorable environmental conditions for larval development and the survival of recruits can also reduce spawning success.

Broadcast spawners are faced with several more life history bottlenecks compared to brooders before they are established as recruits on a reef. Minimizing threats during known times of year when broadcast spawning occurs can help improve coral spawning success of ESA-listed corals that have evolved with this reproductive strategy.

The Acropora genus is known to reproduce asexually by fragmentation. Fragmentation occurs when an event causes the parent colony to break and the resulting fragments are, at times, able to attach on a nearby substrate and continue growing into a new colony.

Table 3. Known ESA-listed coral reproduction strategies, time of year for spawning, and duration in the water column (Moulding and Trnka 2006).

Species	Reproduction	Time of year for broadcast spawning	Duration in water column
Staghorn coral *(Acropora cervicornis)*	Broadcast spawning and fragmentation	2-15 days after July full moon; 2-15 days after August full moon	Unknown
Elkhorn coral *(Acropora palmata)*	Broadcast spawning and fragmentation	August through September; August full moon or 4-5 days after full moon	6-8 days
Lobed star coral *(Orbicella annularis)*	Hermaphroditic broadcast spawners	7 days after July full moon; August through October; 6-9 days after August full moon; 6-8 days after September full moon; 6-8 days after October full moon	Unknown
Mountainous star coral *(Orbicella faveolata)*	Hermaphroditic broadcast spawners	6-9 days after August full moon; 5-7 days after September full moon; 6-8 days after October full moon	3-5 days up to 34 days
Boulder star coral *(Orbicella franksi)*	Hermaphroditic broadcast spawners	6-10 days after August full moon; 5-8 days after September full moon; 6-8 days after October full moon	Unknown
Pillar coral *(Dendrogyra cylindrus)*	Simultaneous gonochoric spawner	2-4 days after August full moon (Neely et al. 2013)	Unknown
Rough cactus coral *(Mycetophyllia ferox)*	Hermaphroditic brooder	broods planulae between December and April, with observed planulae release in March and April. Presumably releases sperm in December/January based on histological analysis (not field observations) (Morales Tirado 2006; Szmant 1986)	Unknown

Corals have a wide range of growth rates and mature at different sizes. The known ESA-listed coral species growth rate ranges from 0.04 to 20 cm per year. Some species, such as the pillar coral, derive its name from the great heights it can achieve when growing undisturbed (Table 4).

Table 4. ESA-listed species growth, size at maturity, and maximum size.

Species	Growth rate	Size at reproduction	Max size
Staghorn coral *(Acropora cervicornis)*	10-20 cm/year	Estimated size at puberty is 17 cm	At least 2 m diameter and 1 m in height
Elkhorn coral *(Acropora palmata)*	5-10 cm/year	Estimated size at puberty 1,600 cm^2	At least 4 m diameter and 2 m in height
Lobed star coral *(Orbicella annularis)*	~0.04-1.2 cm/year; water quality and depth dependent	Minimum size for reproduction was found to be 83 cm^2	Colony diameter can reach up to 5 m with a height of up to 2 m
Mountainous star coral *(Orbicella faveolata)*	~0.04-1.2 cm/year; water quality and depth dependent	Minimum size for reproduction was found to be 83 cm^2	Colony diameter can reach up to 10 m with a height of 4–5 m
Boulder star coral *(Orbicella franksi)*	~0.04-1.2 cm/year; water quality and depth dependent	Minimum size for reproduction was found to be 83 cm^2	Colony diameter can reach up to 5 m with a height of up to 2 m
Pillar coral *(Dendrogyra cylindrus)*	0.8-2 cm/year	Presumably 36 cm, given the growth rate and an estimated 30 year maturity rate	3 m in height
Rough cactus coral *(Mycetophyllia ferox)*	Unknown, but most non-branching species grow on the order of a cm or less per year	> 100 cm^2	50 cm diameter

Primary threats to the species

Corals face numerous natural and human-caused threats that shape their status and affect their ability to recover. Many of the threats are either the same or similar in nature for all listed coral species and are expected to increase in severity in the future. Several of the most important threats contributing to the extinction risk of corals are related to global climate change. The main threats are listed below and more detailed information can be found in the final listing rule, the status review, and the latest "Status of the Species" document:

- Ocean warming
- Ocean acidification
- Diseases
- Trophic effects of reef fishing
- Nutrient enrichment
- Sedimentation and turbidity, particularly from coastal construction activities

This framework provides information about sedimentation and turbidity since these are the most common threats related to actions on which we conduct consultations.

Sedimentation/Turbidity

Sediment movement and deposition is a normal process in a coral reef ecosystem; however, offshore coral reefs are not capable of developing or sustaining biological or ecological functions when covered by more than a centimeter of sediment for prolonged periods of time (Erftemeijer et al. 2012). Sedimentation on reefs can reduce coral recruitment, survival, and settlement of larvae, suppress colony growth (Bak 1978), and may increase disease prevalence (Pollock et al. 2014). Adult corals will attempt to clean themselves of sediment using a combination of ciliary action and the production and sloughing of mucus sheets. These actions use a great deal of energy and can lead to exhaustion of mucus-producing cells (Riegl 1995; Riegl and Branch 1995). At the individual (colony) level, energy diverted to clearing the colony surface of sediment can lead to growth inhibition and a reduction in other metabolic processes (Dodge and Vaisnys 1977; Rogers 1983). At the population level, increased sedimentation may inhibit sexual recruitment, changes the relative abundance of species, decrease live coral cover and reduce the abundance and diversity of corals (Gilmour 1999; Rogers 1990). The texture, grain size, origin, and composition of sediments are important. Fine (silts and clays) or non-native sediments can be more damaging to corals than coarse or native reef sediments, especially to recruits and juveniles.

The major problems arising from turbidity and sedimentation are related to the shading caused by decreases in ambient light and sediment cover on the coral's surface. Suspended sediments, especially when fine-grained, decrease the quality and quantity of light levels, resulting in a decline in photosynthetic productivity of the zooxanthellae (Richmond 1993). High turbidity and sedimentation rates may depress coral growth and survival due to attenuation of light available to symbiotic zooxanthellae, and redirection of energy expenditures for clearance of settling sediments. The potential effects of sediment input not only include direct mortality, but also involve sublethal effects such as reduced growth, lower calcification rates and reduced productivity, reduced or ceased reproduction, bleaching, increased susceptibility to diseases, physical damage to coral tissue and reef structures (e.g., abrasion), and reduced regeneration from tissue damage.

Dredging is one of the major contributors to sedimentation and turbidity impacts to coral. Dredging results in the mobilization, suspension, transport by currents, and deposition of sediments, which can lead to tissue damage and burial causing coral stress and mortality. Further, potential leakage during transport of the sediment and eventual disposal (e.g., at an offshore location or along a beach for nourishment) also results in water clarity decreases. Dredging activities potentially affect not only the site itself, but also surrounding areas, through turbidity plumes, sedimentation, and resuspension (Wolanski and Gibbs 1992). The effects from dredging related sediment can be immediate or may develop over a longer period. Sedimentation effects may be temporary or permanent.

Section 7 Considerations for the listed species

For projects occurring within the range of listed corals (Table 2), the action agency should conduct a resource survey. NMFS recommends following the *ESA-Listed Coral Colony and Acropora Critical Habitat Survey Protocol* (updated June 20019) can be adapted for use to determine whether any listed corals are present in the action area. If they are, the action agency should clearly indicate where listed corals are located in relation to proposed project activities and what, if any, conservation measures are planned to avoid or minimize effects to listed corals. For projects where coral take is expected and impacts may be expected to occur over a larger area (e.g., dredging), then the survey should result in a density of coral species that can be extrapolated over the action area (direct and indirect impacts area).

No Effect Determination

When making a “no effect” determination, it is not necessary to mention the species in the consultation. Identification of locations and common activities that are “no effect” to the listed species (Table 5):

- Rationale for a “no effect” determination (i.e. species not present or will be completely avoided)
  - North of St Lucie inlet, species not present
  - Outside of the FL Keys and the Dry Tortugas, the only listed corals in the Gulf of Mexico are located in the Flower Garden Banks National Marine Sanctuary
  - Within the range of the species, site-specific resource survey indicates species not present

- Activities that have no effect on corals
  - Noise

    - Vessel traffic

Not Likely to Adversely Affect Determination

Identification of common activities that are "not likely to adversely affect" the listed species (Table 5):

- Identify each route of effect associated with the activity type
    - Docks and marinas unless corals are in direct footprint
    - Seawalls unless corals are growing on an existing wall to be removed
    - Artificial reefs: Guidance being developed for the effects determinations and standard language used for artificial reef analyses
    - Coral nursery structures constructed in accordance with the Project Design Criteria listed under the programmatic consultation, *U.S. Army Corps of Engineers (USACE) Regional General Permit SAJ-112 for Coral Propagation/Nursery Structures off the Coasts of Florida, Puerto Rico, and U.S. Virgin Islands* (SER-2014-15282)
    - Aids to Navigation (ATONs) if following the PDCs of the programmatic biological opinion for Maintenance of Existing Fixed and Floating Aids to Navigation (ATON) within Sectors Miami and Key West, Florida, and Sector San Juan, Puerto Rico (SER-2011-3196)
    - Dredging where the activities are far enough away from the corals, and follow conditions to ensure sediment/turbidity impacts are discountable and/or insignificant. San Juan Harbor is an example (SER-2017-18763)
    - Core borings if using divers/surveys to ensure coral isn't within the boring footprint
    - Coral research and monitoring activities that do not directly sample or manipulate listed corals

Factors to consider when making an insignificant or discountable determination:

- Distance from the coral minimizes impacts
- Turbidity curtains used to minimize impacts
- Monitoring to include turbidity less than 7 NTU (Nephelometric Turbidity Units) and/or sediment depth measurements along the reef to ensure no sediment impacts (time, duration, location, and spatial extent of monitoring to be determined based on project specifics) (Fourney and Figueiredo 2017)
- To minimize sediment impacts on coral, information regarding sediment type and hydrodynamics of the area should be collected to assist in understanding sediment fate and transport

Likely to Affect Determination

Identification of activities that are "likely to adversely affect" the listed species (Table 5):

- Identify each route of effect associated with the activity type and note whether the route of effect is expected to be insignificant, discountable, or likely to adversely affect the listed species
  - Sediment Manipulation
    - Dredging
      - physical removal, sedimentation/turbidity (from dredging, transport, dewatering, and disposal operations)
    - Fill/Beach Nourishment
      - burial, sedimentation/turbidity
    - Sand bypass
      - physical removal, sedimentation/turbidity, burial at the output site
  - Cables, gas lines, pipelines, etc. crossing the bottom or drilled below the surface
    - physical impacts from direct contact of lines (including during installation and any subsequent cable movement), possible contamination from frac out or leaks
  - Removal/Repair of seawalls and riprap, particularly large continuous structures
    - physical removal of corals, turbidity/sedimentation
  - Construction and demolition of pile-supported structures (e.g., docks, boatlifts)
    - shading, damage (bumps/scrapes) from vessels
  - ATON installation and removal
    - direct removal from pile and/or cable drag, sedimentation
  - Discharge leading to water quality impacts
    - increased macroalgal growth, sedimentation
  - Anchoring
    - direct removal from anchors and cable drag (swing circles)
  - Artificial Reefs: Guidance being developed for effects determinations and standard language used for artificial reef analyses
    - direct removal, sedimentation during placement, damage from shifting materials if placed too close to natural colonies
  - Outfalls/Discharge/Stormwater Runoff
    - water quality changes including increased nutrients and changes in ambient water temperatures which can lead to coral bleaching, increased macroalgal growth, and increased sedimentation

Conservation and recovery considerations

Biologists should consider the following conservation or recovery actions when engaging with action agencies and applicants throughout the entire the consultation process. In many cases, the process of avoidance, minimization, and mitigation can be incorporated into the proposed action. If not, and take or adverse effects to the species are anticipated, these consideration actions can be added as Terms and Conditions and Conservation Recommendations to reduce the impacts.

- Avoidance
    - Avoiding impacts completely by not taking a certain action, or parts of an action, or redesigning the action to avoid adverse impacts to reefs
- Minimization:
    - All corals should be relocated outside the action area. The effects of the transplantation and unavoidable mortality should be considered in the effects analysis.
    - Environmental windows to avoid dredge/beach nourishment during coral spawning
    - Monitoring to maintain turbidity of less than 7 NTU areas of coral and reef habitat
    - Buffers designed using the sediment types, dredge types, and hydrodynamics of the project area. Sediment transport modeling may be helpful
    - Sediment depth measurements in lieu of sediment traps which do not work
    - Limiting use of overflow during dredging near corals. Overflow is used when loading scows to allow water to discharge leading to fuller scow barges. This practice also leads to extensive increases in turbidity and can cause sedimentation impacts.
    - Moving or stopping the dredge if turbidity is equal to or greater than 7 NTU or sediment depth measurements equal 0.5 cm or more until levels recede to an acceptable level
    - Re-routing or relocating the placement of structures (e.g., pipeline, ATON) on the bottom to avoid corals or designated critical habitat essential feature
- Mitigation
    - If impacts to listed corals are expected, mitigation should be sought.
        - Because the Acropora recovery plan has an action of no net loss from planned projects, mitigation in the form of propagation and outplanting corals from a coral nursery should be sought to offset losses of Acropora species. A Resource Equivalency Analysis (REA) can be used to determine the amount of mitigation required. Contact Alison Moulding regarding REA (Appendix B).
        - Because other ESA-listed coral species are not as widely or easily propagated in nurseries, preferred mitigation includes transplantation of corals of opportunity (corals rescued from an impact site or fragments that have been dislodged for some reason or another) or outplanting

existing colonies from a coral nursery if available. A REA may also be used to determine the amount and type of mitigation required.

- Programmatic Biological Opinion on Research, Restoration, and Relocation of Threatened Corals (a.k.a., "3 Rs PBO"; currently under development):
    - o 3Rs covers coral relocation for projects that would otherwise be NLAA for all other species and critical habitats. In other words, the only trigger for a biological opinion would be the need to relocate the coral. An example is the Fisher Island Boat Basin letter of concurrence (SER-2017-19009, June 8, 2018) - construction in a boat basin whose seawall has listed corals - the corals in the direct construction zone were relocated prior to construction using 3Rs
    - o 3Rs covers coral propagation and outplanting for recovery purposes. If project would have incidental take of listed corals and we require mitigation in the form of coral propagation and outplanting, that would need to be considered in the biological opinion for that project. Typically, these types of projects would be formal for reasons other than the relocation of the coral, if we would be requiring mitigation. Example is PE Sand Bypass (SER-2014-15674)
- Corals, coral reef, and hardbottom are designated Essential Fish Habitat (EFH) by Caribbean and South Atlantic Fishery Management Councils under the EFH provisions of the Magnuson-Stevens Fishery Conservation and Management Act. Coordinate early and often with peers within the Habitat Conservation Division (HCD) for projects that require both Section 7 ESA and EFH consultations. In particular, habitat characterization surveys, monitoring plans, and compensatory mitigation planning should reflect input by both PRD and HCD for projects. Best practices include coordinating draft Reasonable and Prudent Measures, Terms and Conditions, and EFH Conservation Recommendations to ensure thoroughness and consistency prior to review by General Counsel, especially for controversial or high profile projects. HCD points of contact may be found: https://www.fisheries.noaa.gov/content/contact-habitat-conservation-division-southeast

Determining buffer distances between construction activities and corals

There is no one-size-fits-all buffer distance between a construction activity and corals. The buffer distance applied should ensure the nearest edge of resource is outside the influence of all direct and indirect impacts (e.g., sedimentation and turbidity generated from dredging). Factors to consider in determining a buffer distance include:

- Type of activity and construction methodology being employed
- Duration, frequency, and concentration of the activity
- Time of day of the activity (e.g., nighttime dredging may make it difficult to see and maintain appropriate buffer distances)
- Known hydrographic conditions (e.g., tidal phase, current speeds and direction

- Characterization of the suspended benthic materials causing turbidity and sedimentation including geophysical composition (e.g., type and concentration of sediment grain sizes [fine material is more problematic than natural reef sediment grain sizes]) and chemical composition (e.g., type and concentration of chemical constituents)
- Type of equipment to be used for the work and ancillary activities (e.g., dredge type, anchoring or spudding of dredge support vessels)
- Sediment transport modeling may be useful in predicting appropriate buffer distances
- Can best management practices be implemented? (e.g., can turbidity curtains be used to limit sediment dispersal and protect water quality?)

In general, the more uncertainty surrounding the information available on the items above, could justify requiring a larger buffer distance.

Section 4d Considerations for the Listed Species

An exemption for the take of *Orbicella annularis* (Lobed star coral), *Orbicella faveolata* (Mountainous star coral), *Orbicella franksi* (Boulder star coral), *Dendrogyra cylindrus* (Pillar coral), and *Mycetophyllia ferox* (Rough cactus coral) in connection with formal consultations is not needed because take of these species is not prohibited; NMFS has not promulgated a Section 4(d) rule for these species. However, one Federal circuit has held that non-prohibited incidental take must be included in the ITS.[3] Providing an exemption from Section 9 liability is not the only purpose of specifying take in an incidental take statement. Specifying incidental take ensures we have a metric against which we can measure whether or not reinitiation of consultation is required. It also ensures that we identify reasonable and prudent measures that we believe are necessary or appropriate to minimize the impact of such incidental take.

[3] *Center for Biological Diversity v. Salazar*, 695 F.3d 893 (9th Cir. 2012). Though the *Salazar* case is not a binding precedent for this action, which occurs outside of the Ninth Circuit, we find the reasoning persuasive and are following the case out of an abundance of caution and in anticipation that the ruling will be more broadly followed in future cases.

Table 5. Activity, Effect Determination, Route of Effect, Life Stage, and Considerations for listed coral species.

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
Dredging	LAA	Direct removal via dredge, blasting, relocation, anchor and cable drag	All life stages	
	LAA	Sedimentation during dredging or disposal transport	Adult, Juvenile	
	LAA	Turbidity during dredging or disposal transport	All life stages	
	NLAA	Sedimentation during dredging or disposal transport	Adult, Juvenile	Distance from corals, use of turbidity controls, turbidity and sedimentation monitoring to ensure turbidity does not exceed 7 NTU and sedimentation does not exceed 0.5 cm. Use of environmental windows.
	NLAA	Turbidity during dredging or disposal transport	All life stages	Distance from corals, use of turbidity controls and turbidity monitoring to ensure turbidity does not exceed 7 NTU. Use of environmental windows.
Fill/Beach Nourishment	LAA	Direct burial	Adult, Juvenile	
	LAA	Sedimentation	Adult, Juvenile	
	LAA	Turbidity	All life stages	
	LAA	Coral relocation	Adult, Juvenile	
	NLAA	Sedimentation	Adult, Juvenile	Distance from corals, use of turbidity controls, turbidity monitoring not to exceed 7 NTU, sedimentation monitoring not to exceed 0.5 cm. Use of environmental windows.
	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls, turbidity monitoring not to exceed 7 NTU. Use of environmental windows.

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
Sand bypass	LAA	Direct removal via dredge, relocation, burial at placement site	All life stages	
	LAA	Turbidity from dredging and placement	All life stages	
	LAA	Sedimentation from dredging and placement	Adult, juvenile	
	NLAA	Turbidity from dredging and placement	All life stages	Distance from corals, use of turbidity controls, turbidity monitoring not to exceed 7 NTU. Use of environmental windows.
	NLAA	Sedimentation from dredging and placement	Adult, juvenile	Distance from corals, use of turbidity controls, turbidity monitoring not to exceed 7 NTU, sedimentation monitoring not to exceed 0.5 cm. Use of environmental windows.
Cables, Gas lines, Pipelines	LAA	Direct removal via placement or movement	All life stages	
	LAA	Release of contaminants from frac outs, etc.	All life stages	
	LAA	Sedimentation from placement or leakage of pipeline	Adult, Juvenile	
	NLAA	Release of contaminants	All life stages	Distance from corals

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
	NLAA	Sedimentation from placement or leakage of pipeline	Adult, Juvenile	Distance from corals, use of turbidity controls, turbidity monitoring not to exceed 7 NTU, sedimentation monitoring not to exceed 0.5 cm. Use of environmental windows.

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
	NLAA	Sedimentation from placement or leakage of pipeline	Adult, Juvenile	Distance from corals, use of turbidity controls, turbidity monitoring not to exceed 7 NTU, sedimentation monitoring not to exceed 0.5 cm. Use of environmental windows.
Removal of seawalls / riprap	LAA	Direct removal of corals growing on existing wall/rip rap	Adult, Juvenile	
	LAA	Sedimentation during removal / construction	Adult, Juvenile	
	LAA	Turbidity	All life stages	
	NLAA	Sedimentation during removal / construction	Adult, Juvenile	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls
New seawall / riprap	LAA	Direct removal	Adult, Juvenile	
	LAA	Sedimentation	Adult, Juvenile	
	LAA	Turbidity	All life stages	
	NLAA	Sedimentation	Adult, Juvenile	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls
ATONs	LAA	Direct removal	All life stages	
	LAA	Turbidity	All life stages	
	LAA	Sedimentation	Adult, Juvenile	

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
	NLAA	Following PDC's of programmatic	All life stages	SER-2011-3196
	NLAA	Sedimentation	Adult, Juvenile	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
ATONs	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls
Outfalls	LAA	Sedimentation	Adult, Juvenile	
Outfalls Anchoring	LAA	Turbidity	All life stages	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
	LAA	Release of nutrients or contaminants	All life stages	
	NLAA	Sedimentation	Adult, Juvenile	
	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls
	NLAA	Release of nutrients or contaminants	All life stages	Distance from corals, use of retrofitting or other controls to prevent nutrient and contaminants
	LAA	Direct removal via anchor and cable drag (swing circles)	Adult, Juvenile	
Docks / Marinas	LAA	Direct removal	Adult, Juvenile	

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
Docks / Marinas Core borings	LAA	Sedimentation	Adult, Juvenile	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
	LAA	Turbidity	All life stages	
	NLAA	Sedimentation	Adult, Juvenile	
	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls
	NLAA	Turbidity	All life stages	Distance from corals, use of turbidity controls
Core borings Activity	NLAA	Direct physical impacts	Adult, Juvenile	Use of divers to ensure no corals within drilling footprint
	NLAA	Sedimentation	Adult, Juvenile	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
	NLAA	Direct physical impacts	Adult, Juvenile	Must follow artificial reef guidelines
Artificial Reef	LAA	Sedimentation	Adult, Juvenile	
Artificial Reef 3R's: Coral Research, Restoration, and Relocation (which can include Coral Nurseries)	LAA	Turbidity	All life stages	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals
	NLAA	Sedimentation	Adult, Juvenile	Distance from corals, use of turbidity controls to prevent sediments from traveling and depositing on the corals Distance from corals, use of turbidity controls
	NLAA	Turbidity	All life stages	
	NLAA	Covered under programmatic	All life stages	
		Provide a rationale (i.e. species not present or will be completely avoided):		

Activity	Potential Effect Determination	Potential Route of Effects to Species	Life Stage (larval, juvenile, adult)	Considerations Which Could Lead to NLAA
Location	No Effect	- North of St Lucie inlet, species not present.	All life stages	
Location	No Effect	- Outside of the Keys, the only listed corals in the Gulf of Mexico are located in the Flower Gardens NMS	All life stages	
	No Effect	- Within the range of the species, site-specific resource survey indicates species not present.	All life stages	

Note: An increase in noise and vessel traffic may occur within the listed activities. However, these have no effect on the coral species thus are not included.

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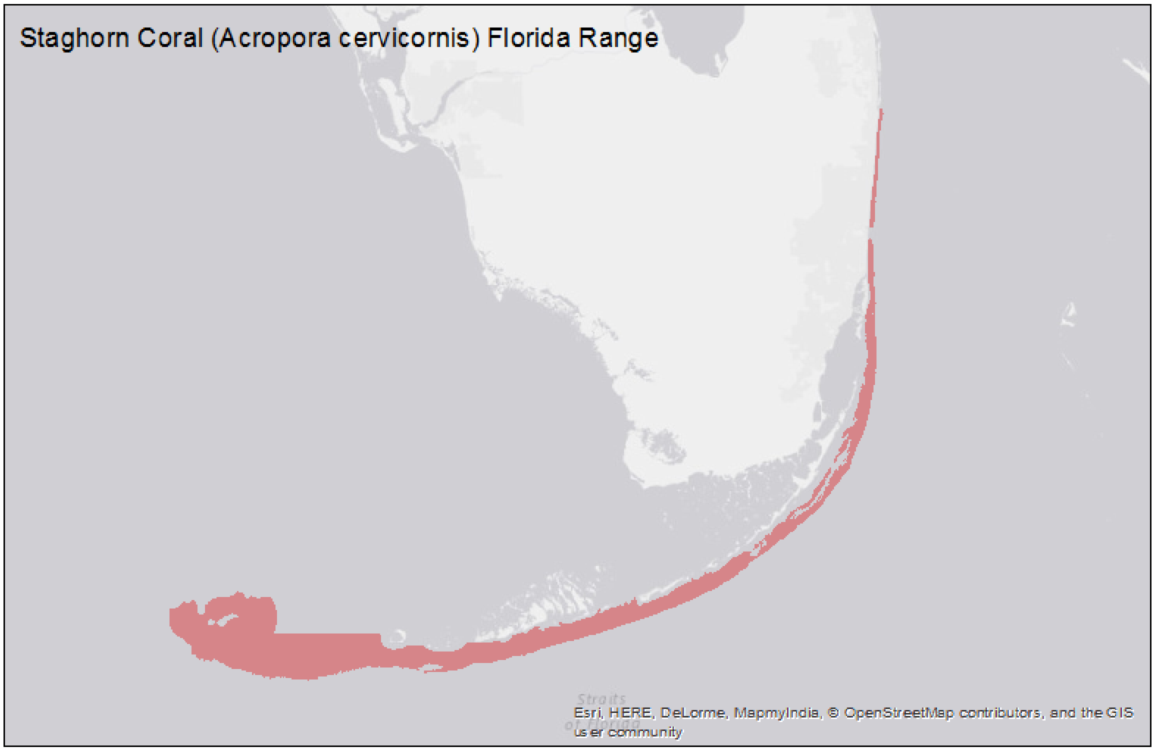
Appendix A1. General Distribution Maps of Listed Corals.



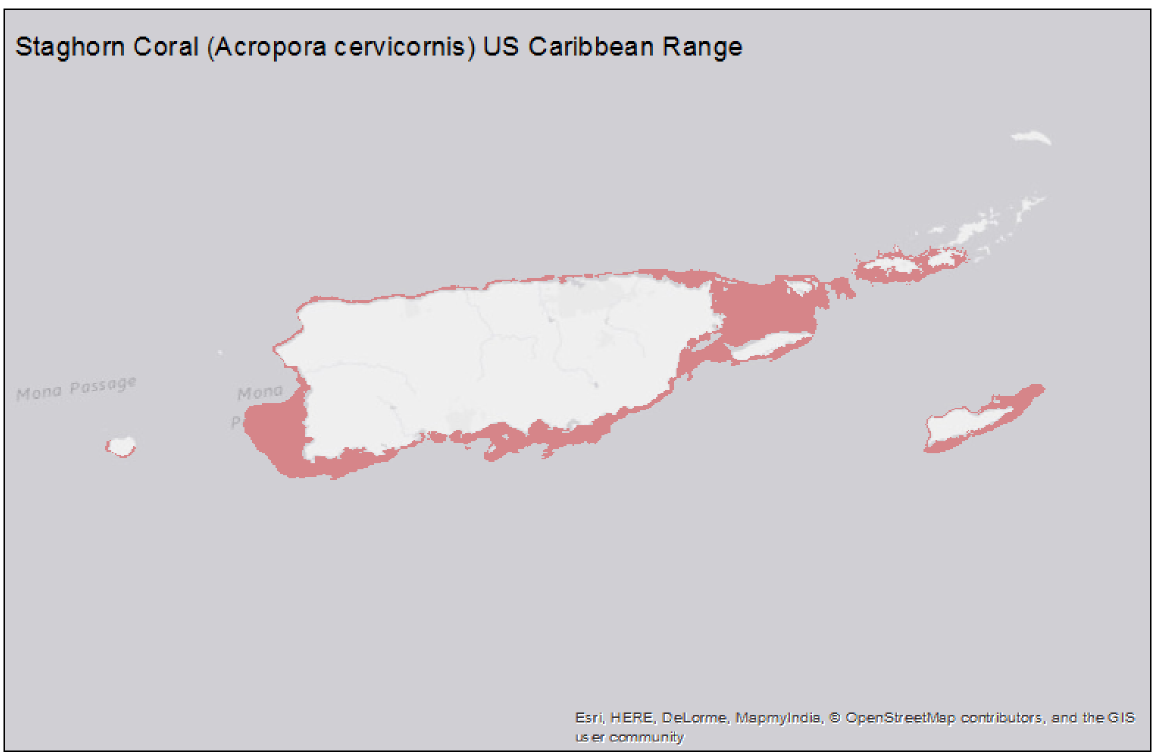
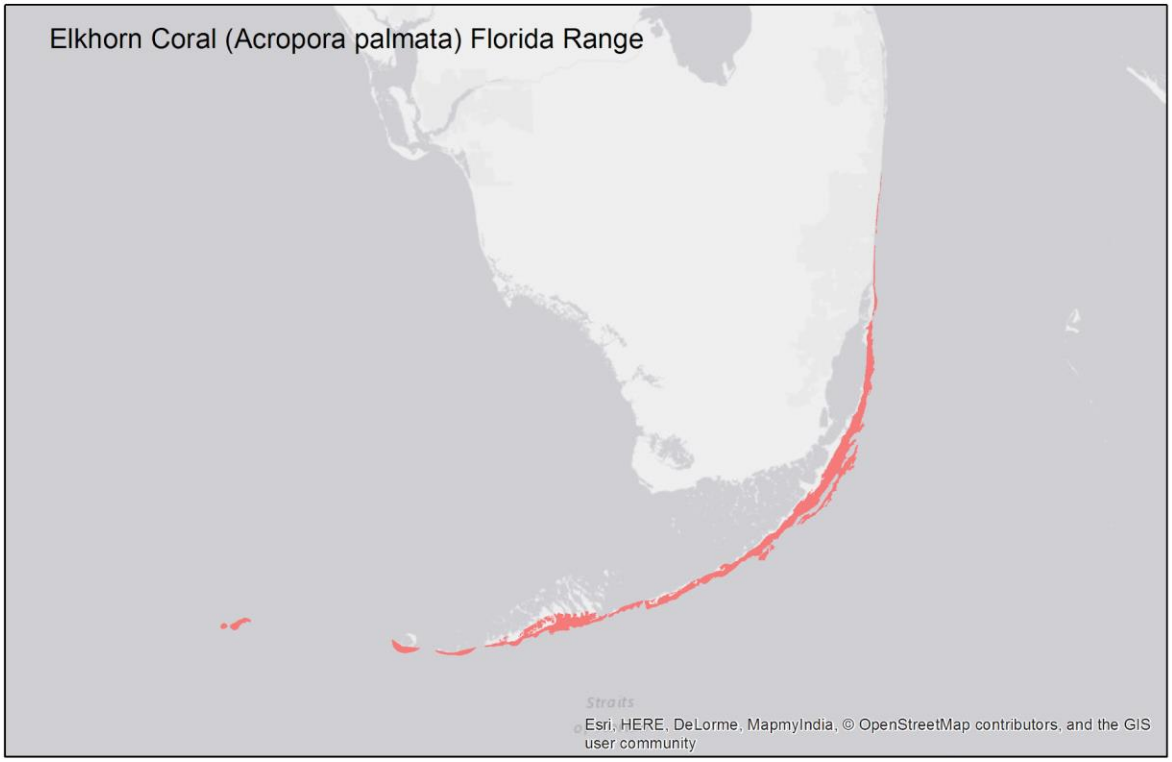


Figure A1. Geographical Distribution of Staghorn coral (*Acropora cervicornis*).



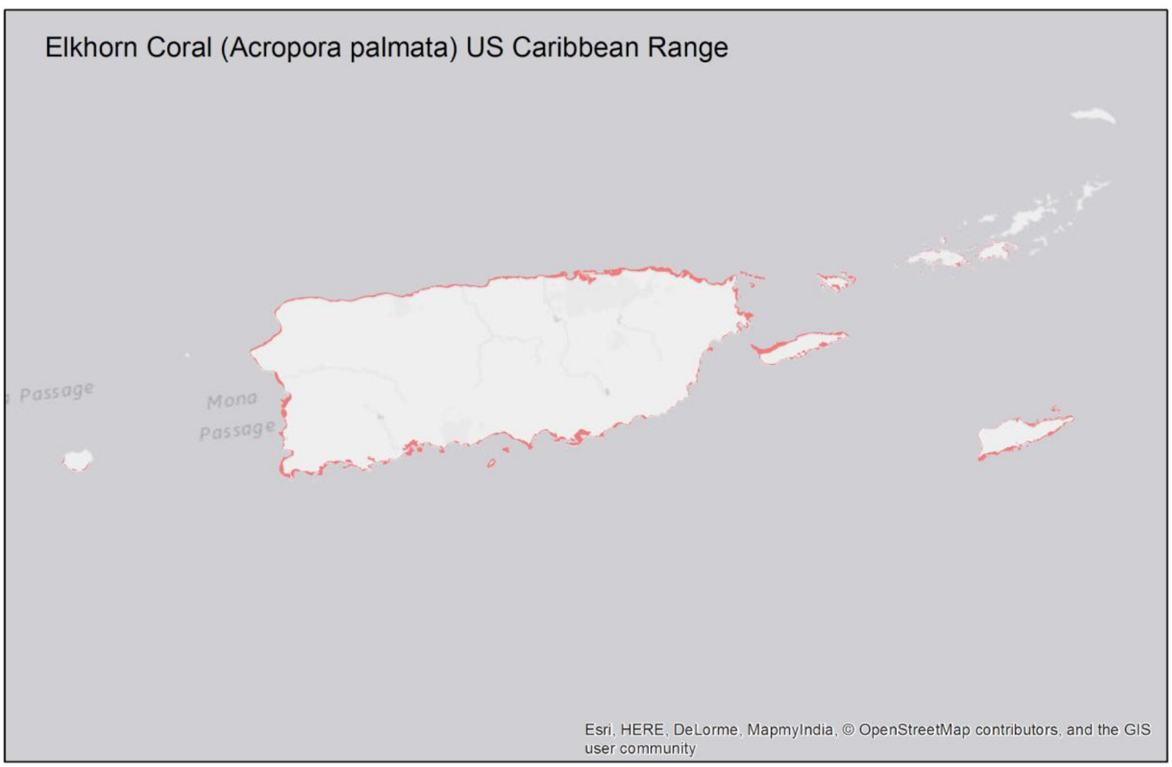
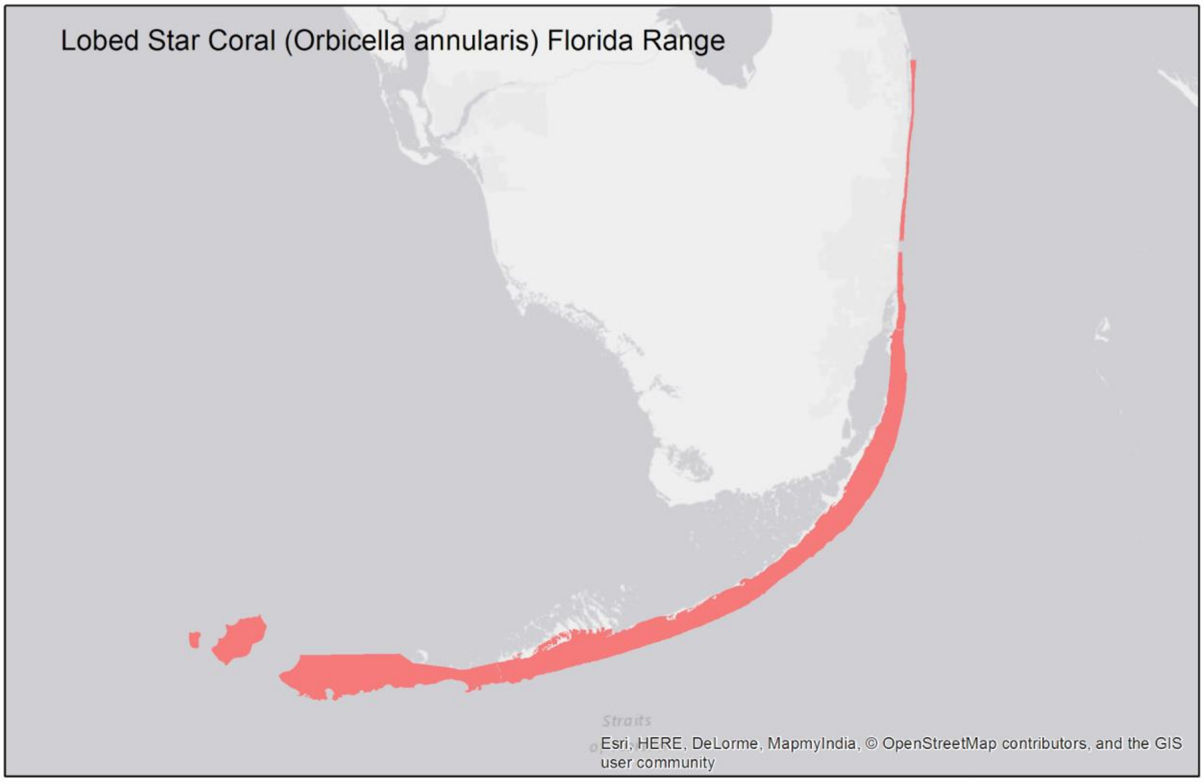
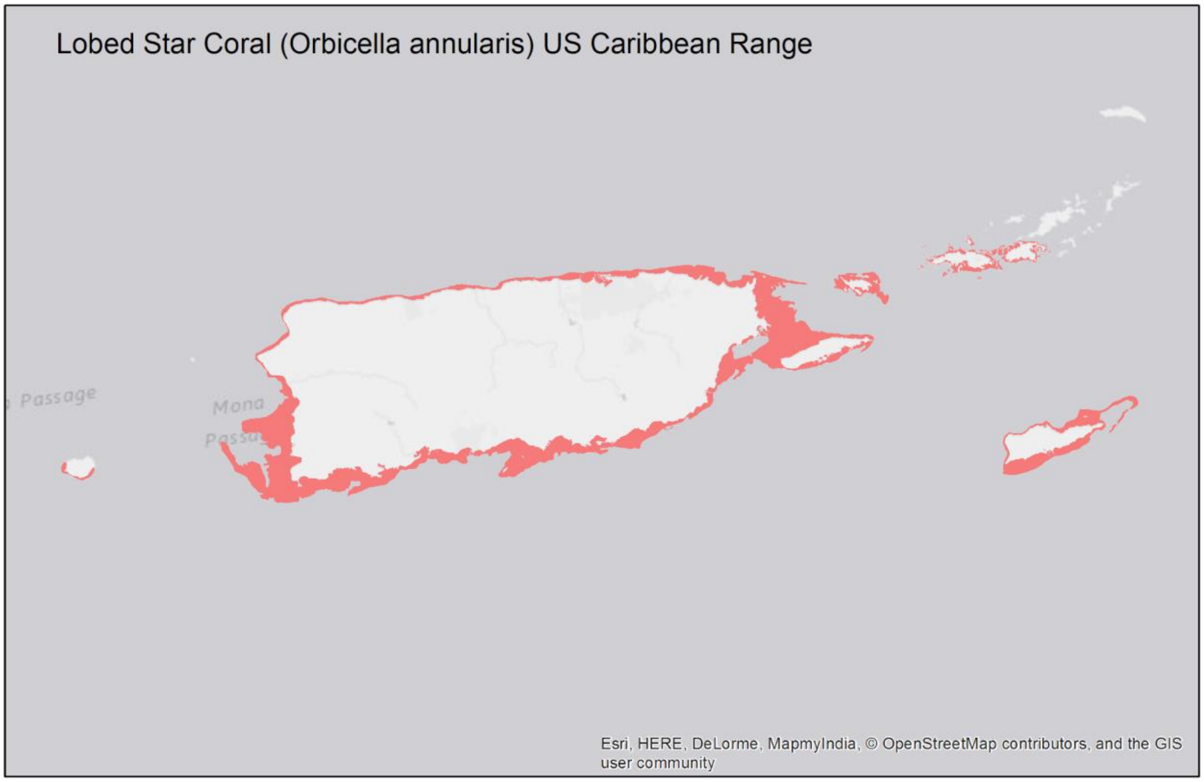


Figure A 2. Geographical Distribution of Elkhorn coral (*Acropora palmata*).

Note: The two colonies located in Flower Garden Banks National Marine Sanctuary are not depicted in figure.


Lobed Star Coral (Orbicella annularis) Florida Range
Straits
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community


Lobed Star Coral (Orbicella annularis) US Caribbean Range
Passage
Mona
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

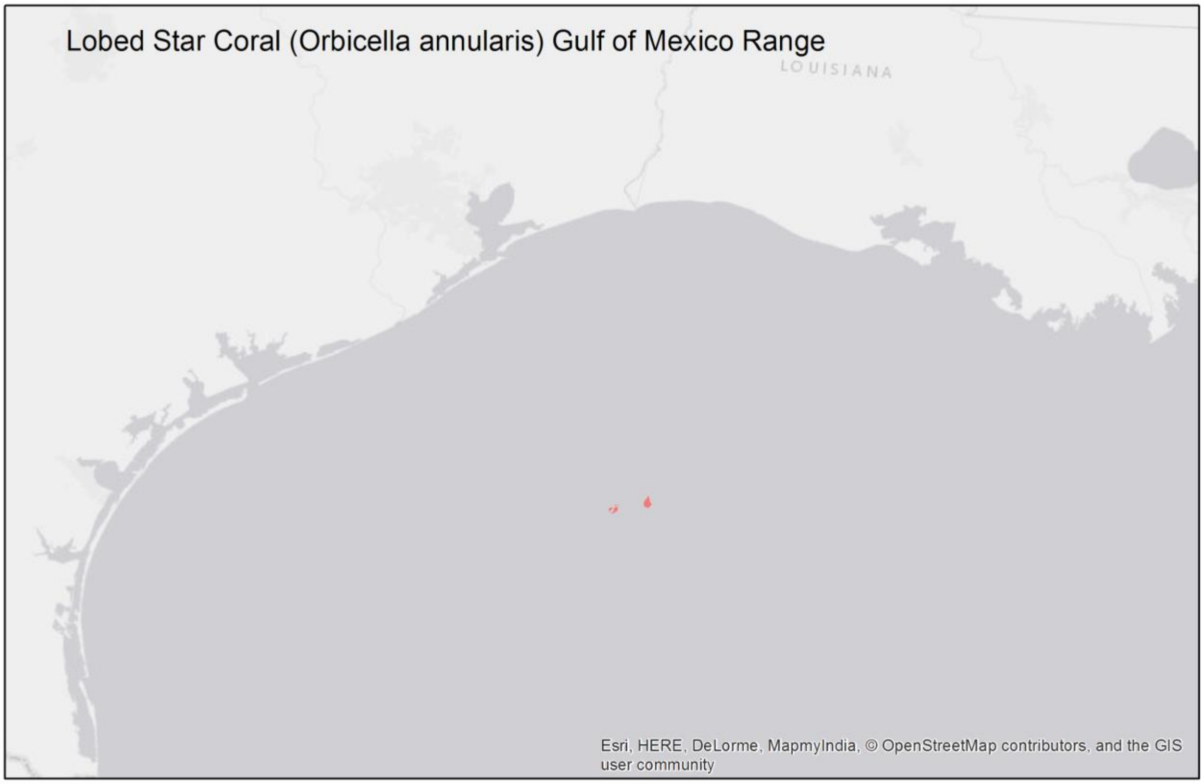
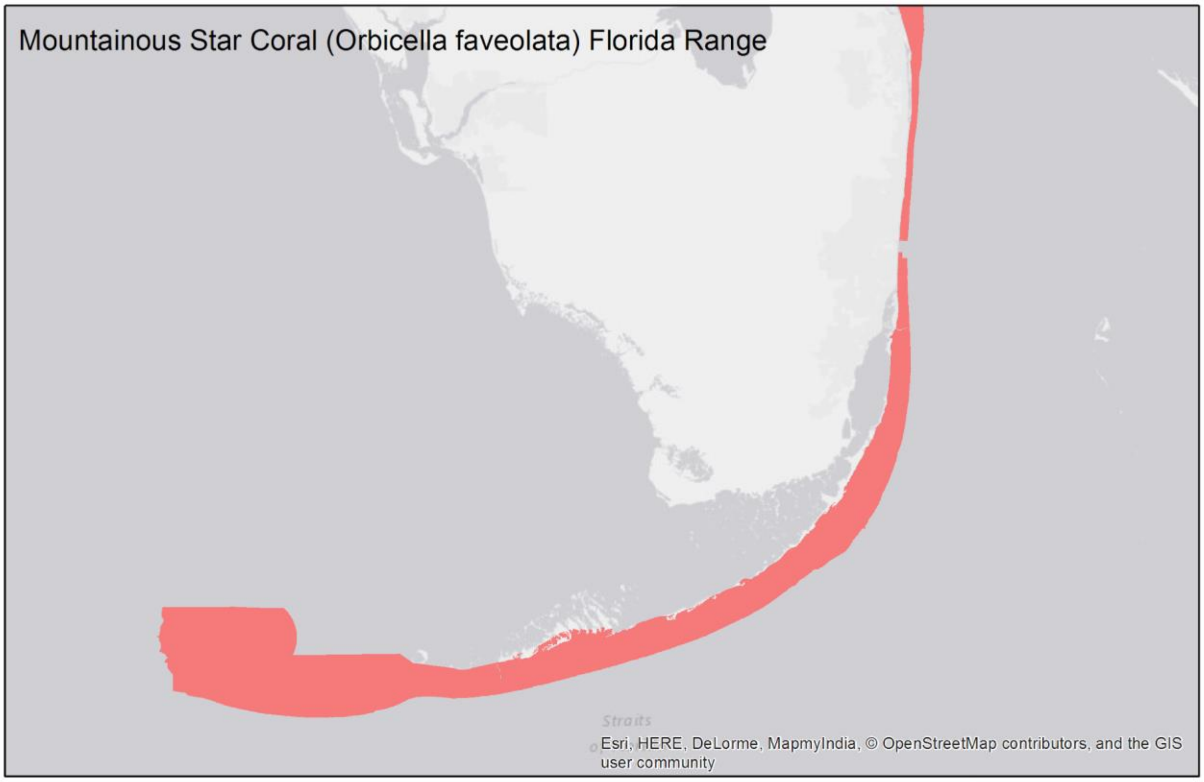
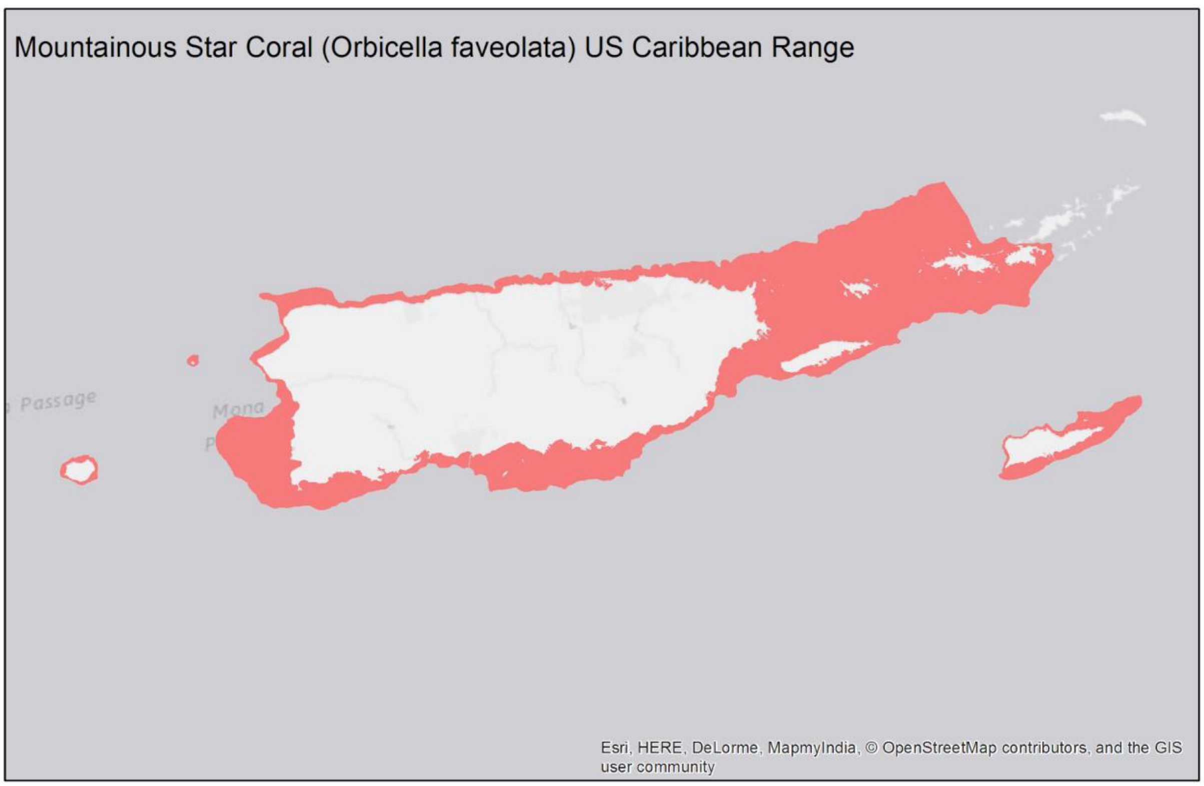


Figure A3. Geographical Distribution of Lobed star coral (*Orbicella annularis*).


Mountainous Star Coral (Orbicella faveolata) Florida Range
Straits
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community


Mountainous Star Coral (Orbicella faveolata) US Caribbean Range
Passage
Mona
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

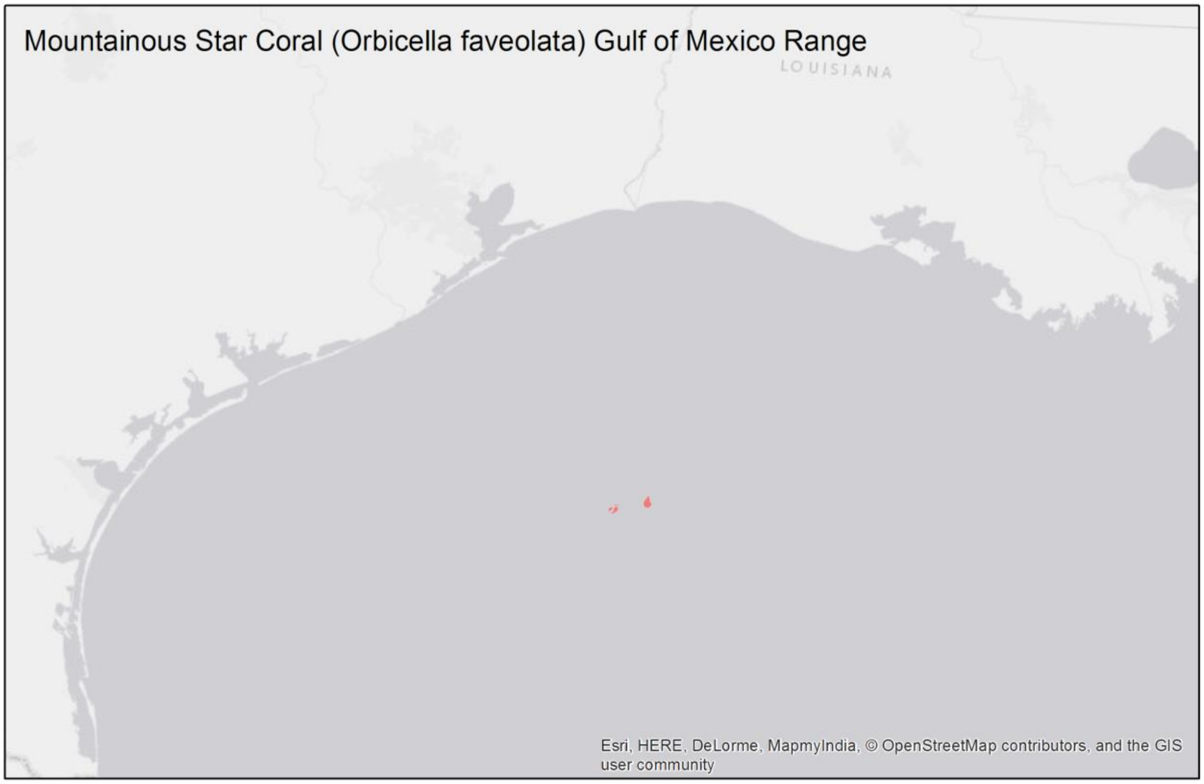
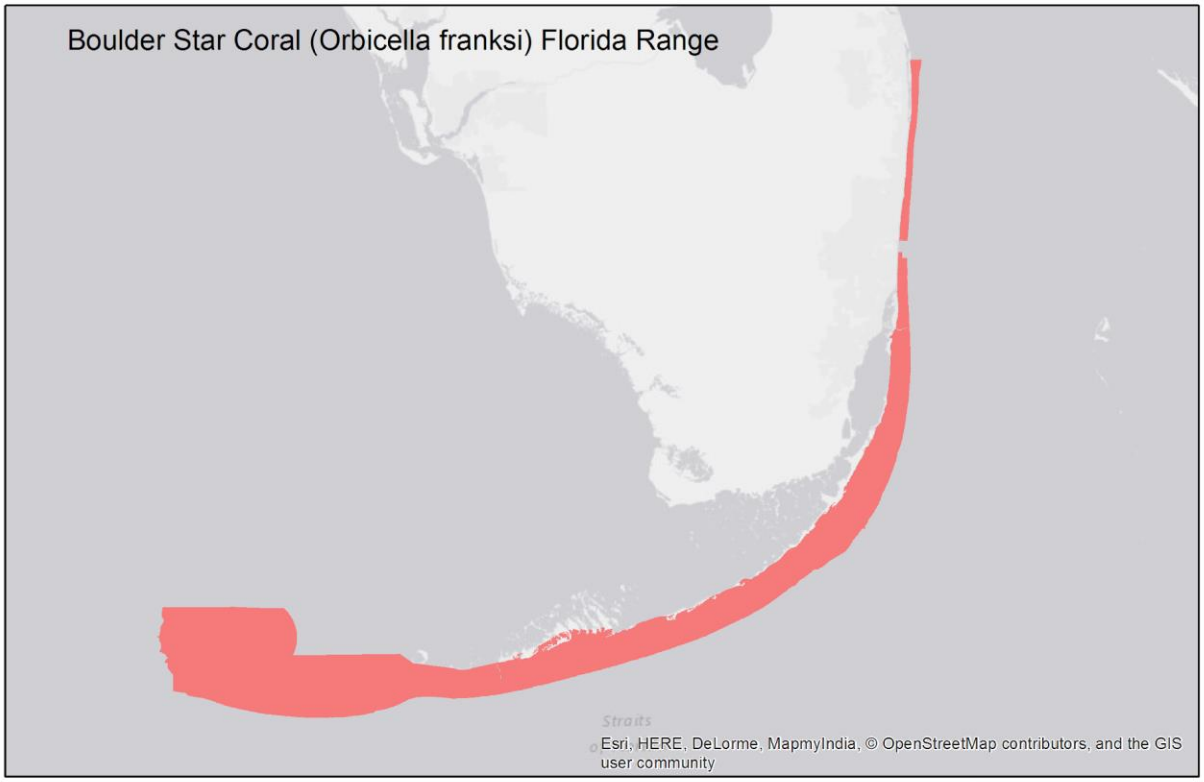
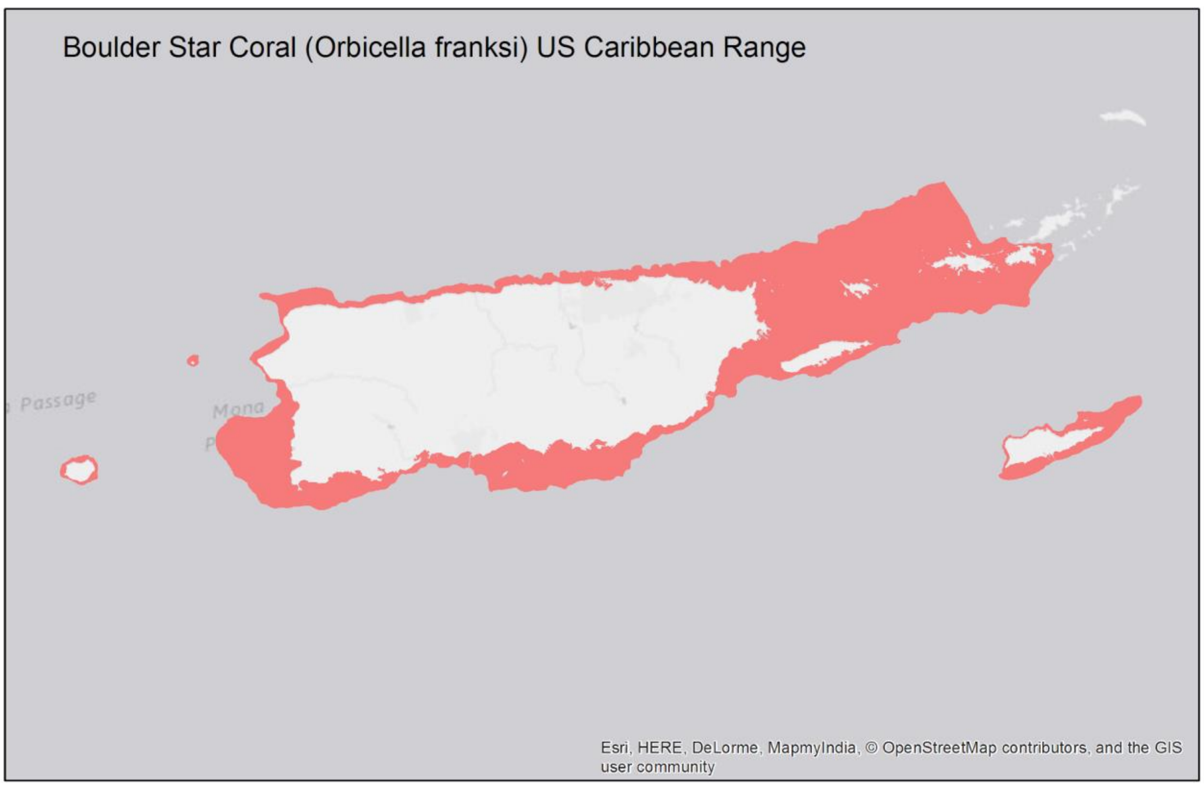


Figure A4. Geographical Distribution of Mountainous star coral (*Orbicella faveolata*).


Boulder Star Coral (Orbicella franksi) Florida Range
Straits
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community


Boulder Star Coral (Orbicella franksi) US Caribbean Range
Passage
Mona
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

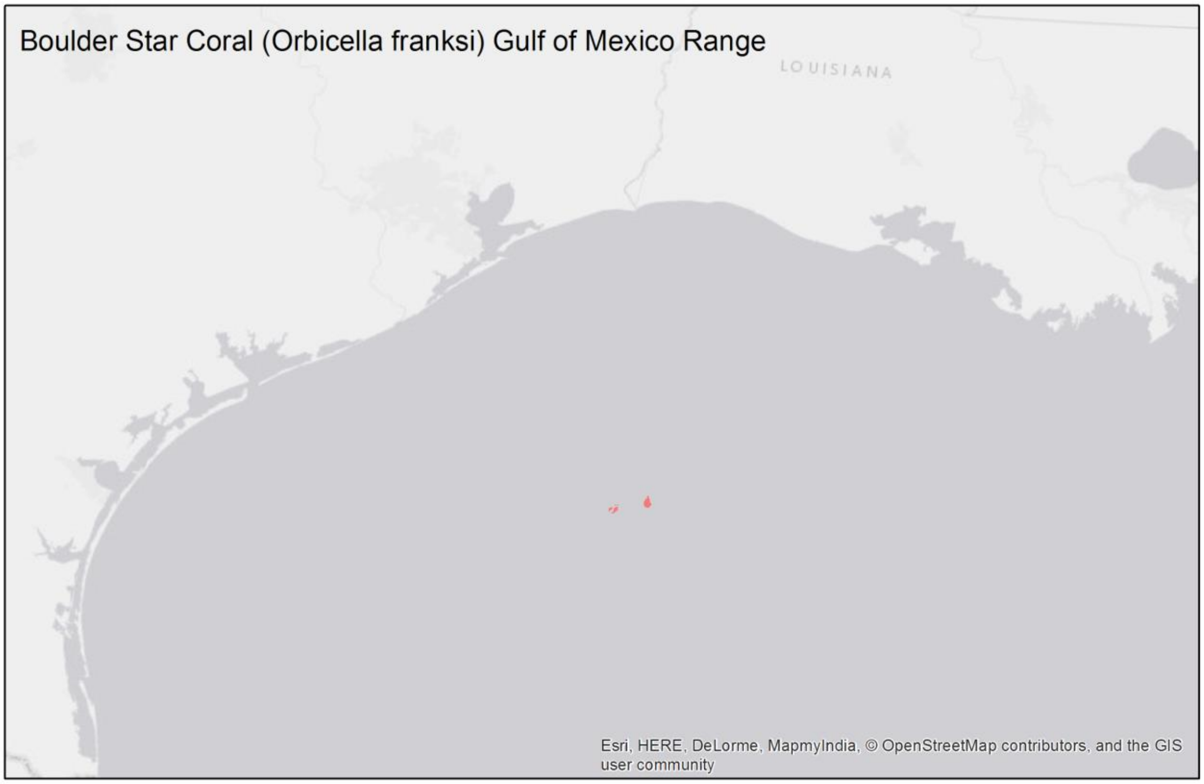


Figure A5. Geographical Distribution of Boulder star coral (*Orbicella franksi*).

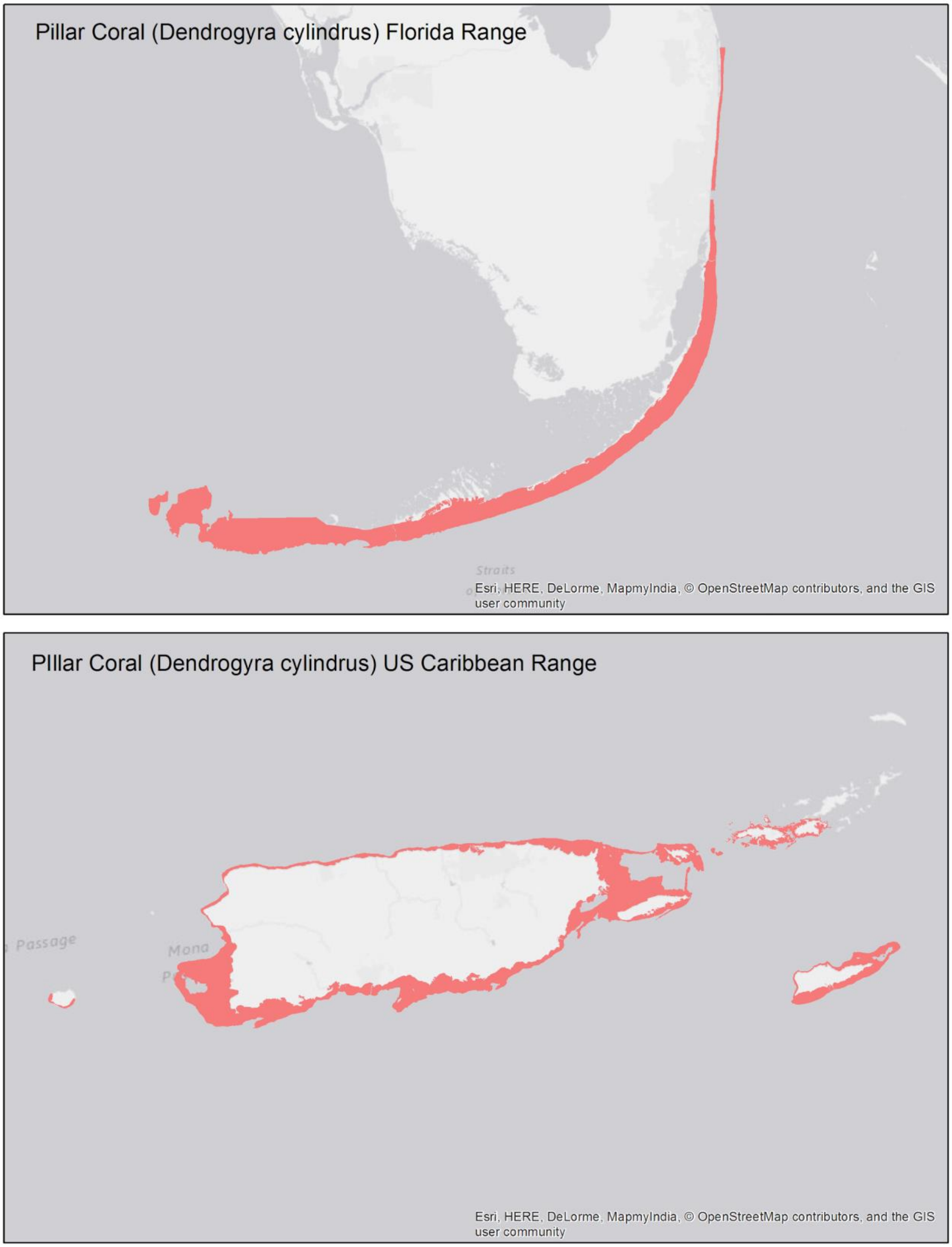
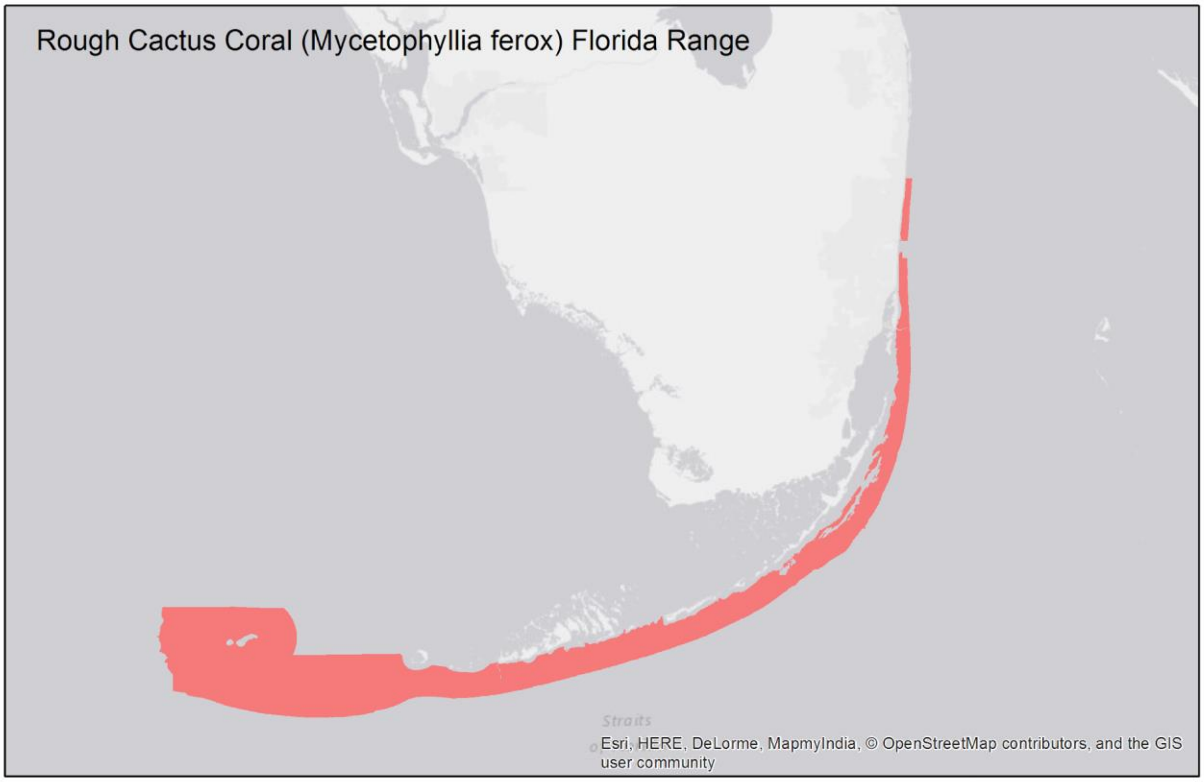


Figure A6. Geographical Distribution of Pillar coral (*Dendrogyra cylindrus*).



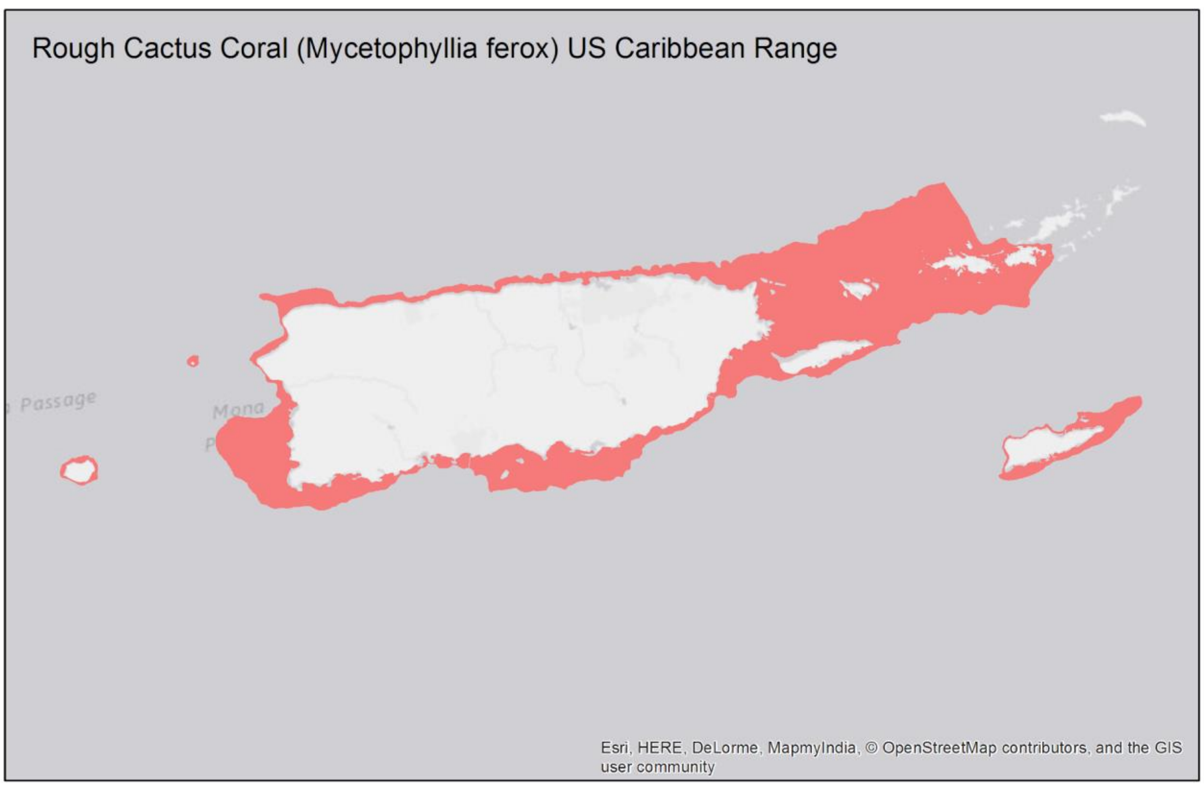


Figure A7. Geographical Distribution of Rough cactus coral (*Mycetophyllia ferox*).

Appendix 2. Resource Equivalency Analysis (REA) inputs for Species Impacts

A Resource Equivalency Analysis (REA) can be used to calculate the amount of compensatory mitigation to offset losses of ESA-listed corals. The Restoration Center has developed an REA spreadsheet that is periodically updated with improvements. Data are entered in the "Injury_Inputs" and "Credit_Inputs" tabs to calculate the losses through injury and gains through outplanting nursery-propagated corals for compensatory mitigation.

The spreadsheet groups species by life history characteristics to calculate losses and compensation. Table A shows the life history classification, species group id, and service weighting factor already in the spreadsheet for ESA-listed corals. Note that the spreadsheet lumps all *Mycetophyllia* species together, so the inputs would be the same for *Mycetophyllia ferox* as they are for *Mycetophyllia* spp.

Table A. ESA-listed coral species life history classification, species group id, and service weighting factor entered on the REA spreadsheet.

Species	Life History	Group	Service Weighting Factor
Orbicella annularis	Spawner	A	0.888
Orbicella faveolata	Spawner	A	0.816
Orbicella franski	Spawner	A	0.816
Mycetophyllia ferox	Brooder	B	0.541
Acropora cervicornis	Acropora	C	0.719
Acropora palmata	Acropora	C	0.816
Dendrogyra cylindrus	Branching	D	0.806

To calculate the debits for loss of ESA-listed corals, enter values into the REA spreadsheet in the yellow cells on the "Injury_Inputs" tab. Some are pre-filled but can be changed if needed.

- **Impact Area**: If data on species are entered into the spreadsheet using total number of corals, the impact area should be entered as 1. If data on species are entered using density, the total area of impact should be entered in square meters.
- **Impact Year**: Year in which the project will start.
- **Discount rate**: 3% is the standard rate.
- **Standard coral size**: 45 is prefilled. The value for this cell does not matter since it is the same on the debit and credit sides of the calculations.
- **% Service Loss at Injury**: Generally, 100% unless there is some expected function even with the injury (e.g., partial colony survival would result in some function).
- **Loss into Perpetuity**: Generally, false unless the corals are not expected to recover (e.g., permanent loss of habitat).
- **Annual Growth Rate**: This value will be based on the species affected; see Table B.

- **Recovery Delay**: Generally 1 year unless the project will be ongoing for more than a year.
- **% Addressed by ER**: 0% since emergency restoration does not occur for planned projects.
- **Average Recruitment Delay**: This value will be based on the species affected; see Table B.
- **% Relative Value at Recovery**: This value indicates the expected functional services relative to baseline at the injury site at the end of the recovery period. Generally, 80-100% if corals are transplanted back to the injury site after the project ends.

Table B. Injury inputs for ESA-listed corals.

Species Groups	Annual Growth Rate (cm)	Average Recruitment Delay (Years)
Spawners	0.56	6
Brooders	0.488	4
Acropora	10	10
Branching	1.8	4

Finally, abundance or density of species by size class should be entered on the spreadsheet specific to the project. The spreadsheet has size classes in 10 cm increments, but these may be adjusted to different increments by changing the average size for each size class interval in the spreadsheet (e.g., for 1-20 cm, the average size class would be 10 cm). There are service weighting factors on the spreadsheet specific to each species that should not be changed (see Table A). After all this information is entered, the spreadsheet will calculate the coral losses and convert them into debits in the column labeled "Outstanding DWCCYL."

To calculate the credits produced from outplanting corals from a nursery, enter values into the REA spreadsheet in the yellow cells on the "Credit_Inputs" tab. Some are pre-filled but can be changed if needed.

- **Service weighting factor:** Values are specific to each species (Table A) and should not be changed.
- **Target Outplant size:** This number should be the typical size of outplants in the region, which can be ascertained by talking to local coral nursery operators. Typical outplant size is usually between 15 and 20 cm in diameter for *Acropora* and is smaller for other species.