NOAA FISHERIES

Endangered Species Act Critical Habitat Report

Final Information Basis and Impact Considerations of Critical Habitat Designations for Threatened Caribbean Corals

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1 Introduction

Critical habitat is defined in Section 3 of the Endangered Species Act (ESA; 16 U.S.C. 1532(3)) as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed upon a determination that such areas are essential for the conservation of the species. ''Conservation'' is defined in the ESA as the use of all methods and procedures which are necessary to bring any endangered or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary. In other words, conservation is synonymous with recovery in the context of the ESA, thus critical habitat designations identify habitat features necessary to recovery of listed species.

In addition to the determination of physical or biological features essential for the conservation of the listed species, the ESA requires several additional considerations to inform the delineation of critical habitat. Section 4(a)(3)(B) of the ESA prohibits designating as critical habitat any lands or other geographical areas owned or controlled by the Department of Defense or designated for its use that are subject to an integrated natural resources management plan (INRMP) if we determine that such a plan provides a benefit to the species. Section 4(b)(2) of the ESA requires the Secretary to take into consideration the economic, national security, and any other relevant impacts of designating any particular area as critical habitat. Additionally, the Secretary has the discretion to exclude any area from a designation if he or she determines that the benefits of exclusion outweigh the benefits of designation, based on the best available scientific and commercial data.

In the final rule listing 5 Caribbean and 15 Indo-Pacific corals as threatened under the ESA (79 FR 53852, September 10, 2014), we did not concurrently propose critical habitat but stated that we would continue to gather information and perform the required analyses of the impacts of critical habitat designation for the listed species. On November 27, 2020, we proposed critical habitat for the 5 listed Caribbean coral species (*Oribella annularis, O. faveolata, O. franski, Dendrogyra cylindrus, and Mycetopyllia ferox*). A total of 28 specific occupied areas containing physical features essential to the conservation of these coral species were proposed (85 FR 76302, November 27, 2020).

This report provides the biological, geographic, economic, national security, and other information necessary for determining which areas are designated as final critical habitat for listed Caribbean corals within U.S. waters. Section 2 provides background on the listings and proposed critical habitat, biological information for the 5 corals that occur in U.S. waters, and an explanation of revisions made to the proposed critical habitat boundaries. Sections 3-8 describe the steps of designating critical habitat for these species. Sections 9 and 10 provide the information needed to complete the analyses required by Sections 4(a)(3) and 4(b)(2) of the ESA to determine if any areas are ineligible or should be excluded from designation, respectively.

2 Background

2.1 Listing History

Twenty coral species were listed as threatened under the ESA by the National Marine Fisheries Service (NMFS) effective October 10, 2014 (79 FR 53851; October 10, 2014). Five of the species occur in the Caribbean: pillar coral (*Dendrogyra cylindrus*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), boulder star coral (*Orbicella franksi*), and rough cactus coral (*Mycetophyllia ferox*). In the same rule, we updated the status review of the 2 Caribbean species previously listed as threatened in 2006, staghorn coral (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*), and determined they still warrant listing as threatened. The final determinations were all based on the best available information on a suite of demographic, spatial, and susceptibility components that influence the species' vulnerability to extinction in the face of continuing threats over the foreseeable future. All of the species had undergone some level of population declines and are susceptible to multiple threats including but not limited to: ocean warming, disease, ocean acidification, trophic effects of reef fishing, nutrient enrichment, and sedimentation. However aspects of the species' demography and distribution buffer the effects of the threats. Therefore, we determined that they all were likely to become in danger of extinction throughout all of their ranges within the foreseeable future as a result of a combination of threats, of which the most severe are related to climate change, and we listed them as threatened.

In 2008, critical habitat was designated for threatened Caribbean acroporid corals (73 FR 72210; November 26, 2008). Therefore, this information report will support the designation of critical habitat for the 5 corals listed in 2014.

2.2 Natural History

This section summarizes life history and biological characteristics of threatened Caribbean corals to provide context for the determination of physical or biological features that are essential for the conservation of these species. In this section, we cover several topic areas including an introduction to reef-building corals, reproduction, settlement and growth, coral habitat types, and coral reef ecosystems. There is a variable amount of information available on the life history, reproductive biology, and ecology for each of the 5 corals that occur in U.S. waters. We provide specific information for each species where possible. In addition, we provide information on the biology and ecology of Caribbean corals in general, highlighting traits that these 5 corals share. The information below is largely summarized from the final listing rule so more detail can be found there (79 FR 53851; October 10, 2014), and updated with the best available scientific information to date.

Reef-building corals are marine invertebrates in the phylum Cnidaria that occur as polyps. The Cnidaria include true stony corals (class Anthozoa, order Scleractinia), the blue coral (class Anthozoa, order Helioporacea), and fire corals (class Hydrozoa, order Milleporina). These species secrete massive calcium carbonate skeletons that form the physical structure of coral reefs. Reef-building coral species collectively produce coral reefs over time when growth outpaces erosion. Corals may also occur on hard substrate that is interspersed among other benthic features in the coral reef ecosystem, but not on the "reef" proper (e.g., seagrass beds in the back reef lagoon). About 10% of the world's approximately 800 reef-building coral species occur in the Caribbean (79 FR 53851; October 10, 2014). These unique animals contain symbiotic algae within their cells, they produce clones of themselves by different means, and most of them occur as colonies of polyps, as described below.

Reef-building corals are able to grow and thrive in the characteristically nutrient-poor environments of tropical and subtropical regions due to their ability to form mutually beneficial symbioses with unicellular photosynthetic algae belonging to the dinoflagellate genus Symbiodinium called zooxanthellae that live within the host coral's tissues. Zooxanthellae provide a food source for their host by translocating fixed organic carbon and other nutrients. In return, the algae receive shelter and nutrients in the form of inorganic waste metabolites from host respiration. This exchange of energy, nutrients, and inorganic metabolites allows the symbionts to flourish and helps the coral secrete calcium carbonate that forms the skeletal structure of the coral colony, which in turn contributes to the formation of the reef. Thus, reef-building corals are also known as zooxanthellate corals. Some corals, which do not contain zooxanthellae, form skeletons much more slowly, and therefore are not considered reef-building. The 5 corals included in this report are zooxanthellate species, and thus reef-building, because they contain symbiotic algae in their cells, enabling them to grow large skeletons that contribute to the physical structure of coral reefs.

The acroporids were once the most abundant and most important species on Caribbean coral reefs in terms of accretion of reef structure, characterizing the "palmata" and "cervicornis" zones in the classical descriptions of Caribbean reefs (Goreau 1959). The 3 species (*O. annularis*, *O. faveolata*, and O. franski) in the *Orbicella* star coral species complex have also been dominant components on Caribbean coral reefs, characterizing the "buttress zone" and "annularis zone." The star coral species complex is the major reef-builder in the greater Caribbean, since the dramatic decline of *Acropora* spp., due to their large size and once-high abundance.

Most reef-building coral species are colonial, producing colonies made up of polyps that are connected through tissue and skeleton. In a colonial species, a single larva will develop into a discrete unit (the primary polyp) that then produces modular units of itself (i.e., genetically-identical copies of the primary polyp). Each polyp consists of a column with mouth and tentacles on the upper side growing on top of a calcium carbonate skeleton, which the polyps produce through the process of calcification. Colony growth is achieved mainly through the addition of more cloned polyps, and colony growth is indeterminate. The colony can continue to exist even if numerous polyps die, or if the colony is broken apart or otherwise damaged (79 FR 53851; September 10, 2014). The 5 corals are all colonial species, although polyp size, colony size, and colony morphology vary considerably by species and can also vary based on environmental variables in different habitats. Colonies can produce clones most commonly through fragmentation or budding (described in more detail below). The 5 corals are all clonal species, both as colonies of cloned polyps, and with the ability to produce clones of individual colonies. The way they produce colony-level clones varies by species (e.g., branching species are much more likely to produce clones via fragmentation than encrusting species).

Corals use a number of diverse reproductive strategies that have been researched extensively; however, many individual species' reproductive modes remain poorly described. Most coral species use both sexual and asexual propagation. Sexual reproduction in corals is primarily through gametogenesis (i.e., development of eggs and sperm within the polyps near the base). Some coral species have separate sexes (gonochoric), while others are hermaphroditic (individuals simultaneously containing both sexes), and others are a combination of both (Richmond 1997). Strategies for fertilization are either by "brooding" or "broadcast spawning" (i.e., internal or external fertilization, respectively). Asexual reproduction in coral species usually occurs by fragmentation, where colony pieces or fragments are dislodged from larger colonies to establish new colonies, or by the budding of new polyps within a colony (79 FR 53851; October 10, 2014).

Depending on the mode of fertilization, coral larvae (called planulae) undergo development either mostly within the mother colony (brooders) or outside of the mother colony, adrift in the ocean (broadcast spawners). In either mode of larval development, larvae presumably experience considerable mortality (up to 90% or more) from predation or other factors prior to settlement and metamorphosis (Goreau et al. 1981). Such mortality cannot be directly observed, but is inferred from the large amount of eggs and sperm spawned versus the much smaller number of recruits observed later. Coral larvae are relatively poor swimmers; therefore, their dispersal distances largely depend on the duration of the pelagic phase and the speed and direction of water currents transporting the larvae.

All 3 species of the *Orbicella* star coral species complex are hermaphroditic broadcast spawners, spawning over a 3 night period, 6 to 8 nights following the full moon in late August, September, or early October (Levitan et al. 2004). *Orbicella faveolata* is largely reproductively incompatible with *O. franksi* and *O. annularis*, and it spawns about 1 to 2 hours earlier. Fertilization success measured in the field was generally below 15% for all 3 species, being closely linked to the number of colonies concurrently spawning (Levitan et al. 2004). The minimum size at first reproduction for the *Orbicella* species complex is 83 cm^2 (Szmant-Froelich 1985). Successful recruitment by the *Orbicella* species has seemingly always been rare with many studies throughout the Caribbean reporting negligible to no recruitment (Bak and Engel 1979; Hughes and Tanner 2000; Rogers et al. 1984b; Smith and Aronson 2006).

Dendrogyra cylindrus is a gonochoric (separate sexes) broadcast spawning species with relatively low annual egg production for its size. The combination of gonochoric spawning with persistently low population densities is expected to yield low rates of successful fertilization and low larval supply.

Spawning has been observed several nights after the full moon of August in the Florida Keys (Neely et al. 2013; Waddell and Clarke 2008). In Curacao, *D. cylindrus* was observed to spawn over a 3-night period, 2-5 nights after the full moons in August and September (Marhaver et al. 2015). Lab-reared embryos developed into swimming planulae larvae within 16 hours after spawning, and were competent to settle relatively soon afterward (Marhaver et al. 2015). Despite short duration from spawn to settlement competency in the lab, sexual recruitment of this species is low, and reported juvenile colonies in the Caribbean are lacking (Bak and Engel 1979; Chiappone 2010; Rogers et al. 1984b). *Dendrogyra cylindrus* can propagate by fragmentation following storms or other physical disturbance (Hudson and Goodwin 1997). Recent investigations determined that there is no genetic differentiation along the Florida Reef Tract, meaning that all colonies belong to a single mixed population (Baums et al., 2016). The same study found that all sampled colonies from Curacao belonged to a unique population. Similar studies have not been conducted elsewhere in the species range.

Mycetophyllia ferox is a hermaphroditic brooding species producing larvae during the winter months (Szmant 1986). Brooded larvae are typically larger than broadcast spawned ones and are expected to have higher rates of survival once settled. However, recruitment of *M. ferox* appears to be very low, even in studies from the 1970s (Dustan 1977; Rogers and Garrison 2001).

Spatial and temporal patterns of coral recruitment are affected by substrate availability and community structure, grazing pressure, fecundity, mode and timing of reproduction, behavior of larvae, hurricane disturbance, physical oceanography, the structure of established coral assemblages, and chemical cues. Additionally, factors other than dispersal may influence recruitment, and several other factors may influence reproductive success and reproductive isolation, including external cues, genetic precision, and conspecific signaling.

Like most corals, the threatened Caribbean corals require hard, consolidated substrate, including attached, dead coral skeleton, for their larvae to settle. The settlement location on the substrate must be free of macroalgae, turf algae, or sediment for larvae to attach and begin growing a colony. Further, the substrate must provide a habitat where burial by sediment or overgrowth by competing organisms (i.e., algae) will not occur. In general, on proper stimulation, coral larvae settle and metamorphose on appropriate hard substrates. Some evidence indicates that chemical cues from crustose coralline algae (CCA), microbial films, and/or other reef organisms or acoustic cues from reef environments stimulate settlement behaviors. Calcification begins with the forming of the basal plate. Buds formed on the initial corallite develop into daughter corallites. Once larvae metamorphose onto appropriate hard substrate, metabolic energy is diverted to colony growth and maintenance. Because newly settled corals barely protrude above the substrate, juveniles need to reach a certain size to limit damage or mortality from threats such as grazing, sediment burial, and algal overgrowth. In some species, it appears that there is virtually no limit to colony size beyond structural integrity of the colony skeleton, as polyps apparently can bud indefinitely.

Polyps are the building blocks of colonies, and colony growth occurs both by increasing the number of polyps, as well as extending the supporting skeleton under each polyp. Reef-building corals combine calcium and carbonate ions derived from seawater into crystals that form their skeletons. Skeletal expansion rates vary greatly by taxa, morphology, location, habitat and other factors. For example, in general, branching species (e.g., most *Acropora* species) have much higher skeletal extension rates than massive species (e.g., massive *Orbicella* species). The energy required to produce new polyps and build calcium carbonate skeleton is provided by the symbiotic relationship corals have with photosynthetic zooxanthellae. As such, corals need light for their zooxanthellae to photosynthesize and provide the coral with food; thus they require low turbidity for energy, growth, and survival. Lower water clarity sharply reduces photosynthesis in zooxanthellae and results in reductions in adult colony calcification and survival (79 FR 53851 September 10, 2014). Some additional information on the biological requirements for reproduction, settlement, and growth is provided in the Physical or Biological Features section below.

Coral reefs are fragile ecosystems that exist in a narrow band of environmental conditions that allow the skeletons of reef-building coral species to grow quickly enough for reef accretion to outpace reef erosion. High-growth conditions for reef-building corals include clear, warm waters with abundant light, and low levels of nutrients, sediments, and freshwater. There are several categories of coral reefs (fringing reefs, barrier reefs, patch reefs, platform reefs, and atolls). Despite the differences between the reef categories, most fringing reefs, barrier reefs, atolls, and platform reefs consist of a reef slope, a reef crest, and a back-reef, which in turn are typically characterized by distinctive habitats (79 FR 53851 Septemebr 10, 2014). The characteristics of these habitat types vary greatly by reef categories, locations, latitudes, frequency of disturbance, etc., and there is also much habitat variability within each habitat type. Temporal variability in coral habitat conditions is also very high, both cyclically (e.g., from tidal, seasonal, annual, and decadal cycles) and episodically (e.g., storms, temperature anomalies, etc.). Together all these factors contribute to the habitat heterogeneity of coral reefs.

The term “mesophotic habitats” refers to coral reefs deeper than 30 m. Shallow reefs and mesophotic areas are not necessarily sharply delineated from one another, thus one may gradually blend into another. The total area of mesophotic habitats (and non-reefal) is likely greater than the total area of shallow coral reef habitats within the ranges of the listed corals (79 FR 53851 Septemebr 10, 2014).

Despite the large amount of variability in habitats occupied by corals, they have several characteristics in common that provide the fundamental support necessary for coral settlement and growth including hard substrate, low-nutrient, clear water with good light penetration.

The 5 corals vary in their recorded depth ranges and habitat types (Table 1). All 5 corals generally have overlapping ranges and occur throughout the wider-Caribbean. The major variance in their distributions occurs at the northern-most extent of their ranges in Florida or the Flower Garden Banks (FGB) in the northwest Gulf of Mexico. There are also variations in depth distribution within and between species. A particular species may occupy a different depth distribution depending on various bethic and environmental conditions. For example, *Orbicella* faveolata occurs to 90 m depth in most locations; however, it only occurs to 40 m depth in Florida. The depth distributions below are updated from the Draft Report based on new information obtained through public comment and new surveys in Florida. Previously, it was assumed *O. faveolata, O. franksi, and M. ferox* were presnt to 90 m in Florida. However, new information confirms it is extremely rare to find these corals below 40 m in Florida (Reed and Farrington). Additionally, information provided through public comment confirms the presence of the 3 *Orbicella* spp. in the waters north of the Florida Keys within the Florida Keys National Marine Santuary and at Bright, McGrail, and Geyer Banks within FBG {FKNMS and FGBNMS 2021}. As described below, critical habitat can only be designated in U.S. jurisdiction, thus we provide the species' distribution in U.S. waters (Table 1).

Table 1. DISTRIBUTIONS OF THREATENED CARIBBEAN CORAL SPECIES IN US JURISDICTIONS. DEPTH RANGES REFLECT THE TYPICAL DEPTH DISTRIBUTION OF EACH SPECIES.

Species	Reef Environment	Depth Distribution	US Geographic Distribution
Dendrogyra cylindrus	most reef environments	1 to 25 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; Puerto Rico; USVI; Navassa
Mycetophyllia ferox	most reef environments	5 to 90 m*	Southeast Florida from Broward County to the Dry Tortugas; Puerto Rico; USVI; Navassa
Orbicella annularis	most reef environments	0.5 to 20 m	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa
Orbicella faveolata	most reef environments	0.5 to 90 m*	Southeast Florida from St. Lucie Inlet in Martin County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa
Orbicella franksi	most reef environments	5 to 90 m*	Southeast Florida from Lake Worth Inlet in Palm Beach County to the Dry Tortugas; FGB; Puerto Rico; USVI; Navassa

*Depth distribution in Florida is limited to 40 m.

3 Critical Habitat Identification and Designation

Critical habitat is defined by Section 3 of the ESA (and further by 50 CFR 424.02(d)) as ‘‘(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of Section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation1 of the species.’’[1] This definition provides the approach to identifying areas that may be designated as critical habitat for listed corals. We have chosen to use the definition to designate critical habitat in a step-wise approach. The following sections provide the information basis for each of the steps.

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[1] Section 3 of the ESA (16 U.S.C. 1532(3)) defines the terms “conserve,” “conserving,” and “conservation” to mean: “to use, and the use of, all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary.”

4 Geographical Areas Occupied by the Species

"Geographical areas occupied by the species at the time of listing" in the definition of critical habitat is interpreted to mean the entire range of the species at the time it was listed and not every discrete location on which individuals of the species are physically located (81 FR 7413, February 11, 2016). The best scientific data available show the current geographical area occupied by all 5 corals has remained unchanged from their historical ranges. In other words, there is no evidence of range constriction for any of the species. However, within their ranges, the species have experienced mortality events that have led to local extirpations at the reef or island level (79 FR 53851; October 10, 2014). The 5 corals' ranges vary in size throughout the wider-Caribbean based on their geographic and depth distributions. The species also vary in the habitat zones they occupy within a coral reef.

Our regulations at 50 CFR 424.12(g) state: ''Critical habitat shall not be designated within foreign countries or in other areas outside of United States jurisdiction.'' Within the U.S., all 5 corals occur in Florida, Puerto Rico, USVI, and Navassa; 3 of the species also occur at the FGB in the northwest Gulf of Mexico. Table 1 summarizes the species' distribution information.

5 Physical or Biological Features Essential for Conservation

As noted above, occupied critical habitat for listed species consists of specific areas on which are found those physical or biological features (PBFs) essential to the conservation of the species and that may require special management considerations or protection (hereafter also referred to as PBF or essential features). The ESA does not specifically define essential features; however, consistent with recent designations, the Services have published a final rule giving examples and describing the essential features as those habitat features which support the life history needs of the listed species (81 FR 7413 February 11, 2016). The essential features may include, but are not limited to, water characteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features. A feature may be a single habitat characteristic, or a more complex combination of habitat characteristics. Features may include habitat characteristics that support ephemeral or dynamic habitat conditions. Features may also be expressed in terms relating to principles of conservation biology, such as patch size, distribution distances, and connectivity (50 CFR 424.02).

In the final listing rule, we determined that the 5 corals were threatened under the ESA. This means that while the species are not in danger of extinction currently, they are likely to become so within the next several decades based on their current abundances and trends in abundance, distributions, and threats they experience now and in the future. Further, the reproductive strategies of the Caribbean *Orbicella* spp., and *Dendrogyra cylindrus* present a challenge to repopulation after mortality events they have experienced and will likely experience in the future. The goal of an ESA listing is to first prevent extinction, and then to recover the species so they no longer meet the definition of a threatened species and no longer need the protections of the ESA. One of the first steps in recovery planning we conduct after listing a species is to identify a Recovery Vision, which describes what the state of full recovery "looks like" for the species. We have identified the following Recovery Vision for the 5 corals listed in 2014: populations of the 5 threatened Caribbean corals should be present across their historical ranges, with populations large enough and genetically diverse enough to support successful reproduction and recovery from mortality events and dense enough to maintain ecosystem function.

Recovery of these species will require conservation of the coral reef ecosystem through threats abatement to ensure a high probability of survival into the future (NMFS 2015). The key conservation objective that facilitates this Recovery Vision, and can be implemented through this critical habitat designation, is supporting successful reproduction and recruitment, and survival and growth of all life stages, by abating threats to the corals' habitats. In the final listing rule, we identified the major threats contributing to the 5 corals' extinction risk: ocean warming, disease, ocean acidification, trophic effects of reef fishing, nutrient enrichment, and sedimentation. Five of the six major threats (i.e., all but disease) impact corals in part by changing the corals' habitat, making it unsuitable for them to carry out the essential functions at all life stages. We identified contaminants as a threat in the final listing rule; however, they were rated as low in terms of contribution to the global extinction risk of corals. The field of research on the effects of contaminants on corals is relatively new and growing fast. Therefore, the impact of contaminants may be significant, but we did not know how to rate them compared to the other major threats. Thus, we identify ocean warming, ocean acidification, trophic effects of reef fishing, nutrient enrichment, sedimentation, and contaminants as the threats to the 5 corals' habitat that are impeding their recovery. Protecting essential features of the corals' habitat from these threats will facilitate the Recovery Vision.

We then turned to determining the physical or biological features essential to this conservation objective of supporting successful reproduction and recruitment, and survival and growth of all life stages. Specifically, we evaluated whether particular habitat features will facilitate recovery through enhancing population growth. Although there are many physical and biological features that characterize a coral reef habitat, we focus on a composite habitat feature that supports the conservation objective through its relevance to the major threats and threats impeding recovery: Reproductive, recruitment, growth, and maturation sites. This essential feature is a complex combination of habitat characteristics that support all demographic functions of the corals. Due to corals being sessile for almost their entire life cycle, they carry-out most of their demographic functions in one location. Thus, we have identified sites with a combination of substrate and water column characteristics as the essential feature. Appropriate attachment substrate, in association with warm, aragonite-supersaturated, oligotrophic, clear marine water, is essential to reproduction and recruitment, survival, and growth of all life stages of all five species of coral. The substrate can be impacted by ocean acidification, trophic effects of reef fishing, nutrient enrichment, and sedimentation, and the associated water column can be impacted by ocean warming, ocean acidification, nutrient enrichment, and sedimentation. The quality of the associated water column can also be impacted by contaminants, but as we discuss below, we are not including a contaminant parameter in the water quality feature in this final rule. Other features of coral reef habitats are not directly affected by the major threats to the 5 corals and do not particularly limit the conservation objective for these 5 corals.

Based on the best scientific information available we identify the following physical feature essential to the conservation of the 5 corals. Our final definition for the essential feature is:

Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column. Several attributes of these sites determine the quality of the area and influence the value of the associated feature to the conservation of the species:

1. The presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae;
2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae; and
3. Marine water with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function.
4. Marine water with levels of anthropogenically-introduced chemical contaminants that do not preclude or inhibit any demographic function.

5.1 Substrate Component

All reef-building corals require exposed natural consolidated hard substrate for the settlement and recruitment of larvae or asexual fragments. Substrate provides the physical surface and space necessary for settlement of coral larvae, and a stable environment for metamorphosis of the larvae into the primary polyp, growth of juvenile and adult colonies, and re-attachment of fragments. The substrate must be available at appropriate physical and temporal scales for attachment to occur. In other words, the attachment location must be available at the physical scale of the larva or fragment, and at the temporal scale of when the larva or fragment is “seeking” recruitment. Larvae can also settle and attach to dead coral skeleton (Grober-Dunsmore et al. 2006; Jordán-Dahlgren 1992). A number of features have been shown to influence coral larval settlement. Positive cues include the presence of particular species of crustose coralline algae (Morse and Morse 1996; Ritson-Williams et al. 2010), microbial biofilms (Sneed et al. 2014; Webster et al. 2004), and cryptic habitat such as crevices and holes (Edmunds et al. 2004; Edwards et al. 2014; Nozawa 2012). Features that negatively affect settlement include presence of sediment, turf algae, sediment-bound in turf algae, and macroalgae (Birrell et al. 2005; Kuffner et al. 2006; Richmond et al. 2018; Speare et al. 2019; Vermeij et al. 2009). While sediment, turf algae, and macroalgae are all natural features of the coral reef ecosystem, it is the relative proportion of free space versus occupied space that influences recruitment; recruitment rate is positively correlated with free space (Connell et al. 1997). The recruitment substrate feature is adversely affected by four of the major threats to the 5 corals: ocean acidification, trophic effects of reef fishing, nutrient enrichment, and sedimentation.

The dominance of fleshy macroalgae as major space-occupiers on many Caribbean coral reefs impedes the recruitment of new corals. A shift in benthic community structure over recent decades from the dominance of stony corals to fleshy algae on Caribbean coral reefs is generally attributed to the greater persistence of fleshy macroalgae under reduced grazing regimes due to human overexploitation of herbivorous fishes (Edwards et al. 2014; Hughes 1994; Jackson et al. 2014) and the regional mass mortality of the herbivorous long-spined sea urchin in 1983-84 (Hughes et al. 1987). As overall coral cover has declined, the absolute area occupied by macroalgae has increased and herbivore grazing capacity is spread more thinly across a larger relative amount of space (Williams et al. 2001). A recent study found that when herbivorous fish biomass was relatively high, macroalgae declined and juvenile coral density increased {Steneck 2019}. Further, impacts to water quality (principally nutrient input) coupled with low herbivore grazing are also believed to enhance fleshy macroalgal productivity. Fleshy macroalgae are able to colonize dead coral skeleton and other available substrate, preempting space available for coral recruitment (McCook et al. 2001; Pastorok and Bilyard 1985). The increasing frequency of coral mortality events, such as the 2014-2016 global bleaching event or stony coral tissue loss disease outbrak, continue to increase the amount of dead skeleton available to be colonized by algae due to the enabling conditions.

The persistence of fleshy macroalgae under reduced grazing regimes also negatively impacts CCA growth, potentially reducing settlement cues which may reduce settlement of coral larvae (Ritson-Williams et al. 2010). Most CCA are susceptible to fouling by fleshy algae, particularly when herbivores are absent (Steneck 1986). Patterns observed in St. Croix, USVI, also indicate a strong positive correlation between CCA abundance and herbivory (Steneck and Testa 1997). Both turf and macroalgal cover increases and CCA cover decreases with reductions in herbivory, which may last for a period of time even when herbivores are reintroduced (de Ruyter van Steveninck and Bak 1986; Liddell and Ohlhorst 1986; Miller et al. 1999). The ability of fleshy macroalgae to affect growth and survival of CCA has indirect, yet important, impacts on the ability of coral larvae to successfully settle and recruit.

In addition to the direct impacts of ocean acidification on the corals from reduced aragonite saturation state (discussed below), there will also be significant impacts to recruitment habitat. Kuffner et al. (2007) and Jokiel et al. (2008) showed dramatic declines in the growth rate of CCA and other reef organisms, and an increase in the growth of fleshy algae at atmospheric CO_2 levels expected later this century. The decrease in CCA growth, coupled with rapid growth of fleshy algae, will result in less available habitat and more competition for settlement and recruitment of new coral colonies.

Several studies show that coral recruitment tends to be greater when macroalgal biomass is low (Birrell et al. 2008a; Birrell et al. 2005; Birrell et al. 2008b; Connell 1997; Edmunds et al. 2004; Hughes 1985; Kuffner et al. 2006; Rogers et al. 1984a; Vermeij et al. 2006). In addition to preempting space for coral larvae settlement, many fleshy macroalgae produce secondary metabolites with generalized toxicity that also may inhibit larval settlement, recruitment, and survival (Kuffner and Paul 2004; Kuffner et al. 2006; Paul et al. 2011). Furthermore, algal turfs can trap sediments (Kendrick 1991; Nugues and Roberts 2003; Purcell and Bellwood 2001; Purcell 2000; Steneck and Testa 1997; Wilson and Harrison 2003), which then creates the potential for algal turfs and sediments to act in combination to hinder coral settlement (Birrell et al. 2005; Nugues and Roberts 2003). Specifically, (Speare, Duran et al.) found a strong negative relationship between the abundance of algal turfs with bound sediment and the abundance of *A. palmata* and *O. favaeolata* juvenile corals. These turf algae-sediment mats also can suppress coral growth under high sediment conditions (Nugues and Roberts 2003) and may gradually kill the marginal tissues of stony corals with which they come into contact (Dustan 1977). There is evidence that benthic cyanobacterial mats are becoming more prevelant and can also inhibit coral recruitment (Ford et al. 2018).

Coral recruitment habitat is also adversely impacted by sediment cover. Sediments enter the reef environment through many processes that are natural or anthropogenic (human-derived) in origin, including coastal erosion, coastal development, resuspension of bottom sediments, terrestrial erosion and run-off, in-water construction, dredging for coastal construction projects and navigation purposes, and in-water and beach placement of dredge spoils or other sand sources. The rate of sedimentation affects reef distribution, community structure, growth rates, and coral recruitment (Dutra et al. 2006). Accumulation of sediment can smother living corals and cover dead coral skeleton and exposed hard substrate (Erftemeijer et al. 2012a; Fabricius 2005). Sediment accumulation on dead coral skeletons and exposed hard substrate reduces the amount of available substrate for coral larvae settlement and fragment reattachment (Rogers 1990). The location of larval settlement must be “free” of sediment for attachment to occur (Harrington et al. 2004; Mundy and Babcock 1998). The depth of sediments over hard substrate affects the duration that the substrate may be unavailable for settlement. The deeper the sediment, the longer it may take for natural waves and currents to remove the sediment from the settlement substrate.

Lirman et al. (2003) found sediment depth next to live coral colonies was approximately 1 cm deep and significantly lower than mean sediment depth collected haphazardly on the reef. Sediment deposition threshold criteria have recently been proposed for classifying sediment impacts to reef habitats based on threshold values in peer-reviewed studies and new modeling approaches (Nelson et al. 2016). Nelson et al. (2016) suggest that sediment depth greater than 1 cm represents a significant impact to corals, while sediment between 0.5 and 1 cm depth represents a moderate impact, with the ability to recover. Nelson et al. (2016) identify sediment depth less than 0.5 cm as minimal stress to corals and settlement habitat. Sediment texture also affects the severity of impacts to corals and recruitment substrate. Fine grain sediments have greater negative effects to live coral tissue and to recruitment substrate (Erftemeijer et al. 2012a). Accumulation of sediments is also a major cause of mortality in coral recruits (Fabricius et al. 2003). In some instances, if mortality of coral recruits does not occur under heavy sediment conditions, then settled coral planulae may undergo reverse metamorphosis and die in the water column (Te 1992). Sedimentation, therefore, impacts the health and survivorship of all life stages (i.e., adults, fragments, larvae, and recruits) of corals, in addition to adversely affecting recruitment habitat.

There are hard substrates and structures within the marine environment on which corals may settle that are not essential to their conservation. Only natural substrates provide the quality and quantity necessary for the conservation of threatened corals. Artificial substrates are generally less functional than natural substrates in terms of supporting healthy and diverse coral reef ecosystems (Edwards and Gomez 2007; USFWS 2004). Artificial substrates are typically man-made or introduced substrates that are not naturally occurring to the area. Examples include, but are not necessarily limited to, fixed and floating structures, such as aids-to-navigation (AToNs), seawalls, wharves, boat ramps, fishpond walls, pipes, wrecks, mooring balls, docks, and aquaculture cages. Our definition of recruitment substrate does not include any artificial substrate. In addition, there are some natural substrates that, because of their consistently disturbed nature, also do not provide the quality of substrate necessary for the conservation of threatened corals. While these areas may provide hard substrate for coral settlement and growth over short periods, the periodic nature of direct human disturbance renders them poor environments for coral growth and survival over time (e.g., maintained channels). Therefore, they are not essential to the conservation of the species. Specific areas that may contain these disturbed natural substrates are described in the Specific Areas Containing the Essential Features within the Geographical Area Occupied by the Species section of this final rule.

5.2 Water Quality Component

The substrate characterized above must be associated with water that also supports the demographic functions of corals that are carried-out at the site. Water quality conditions fluctuate greatly over various spatial and temporal scales in natural reef environments (Kleypas et al. 1999). However, certain optimal levels of particular parameters must exist on average to provide the conditions for coral growth, reproduction, and recruitment. Corals may tolerate and survive in conditions outside the optimal levels, depending on the local baseline conditions to which they have acclimatized and the intensity and duration of any deviations from optimal conditions. Deviations from tolerance levels of certain parameters result in direct negative effects on all life stages. Water quality that supports demographic functions of corals is adversely affected by four of the major threats: ocean warming, ocean acidification, nutrient enrichment, and sedimentation. As described in the Draft Information Report, corals thrive in warm, clear, nutrient-poor marine waters with calcium carbonate concentrations that allow for symbiont photosynthesis, coral physiological processes and skeleton formation. Water quality for corals is also adversely affected by contaminants, which impede the recovery of corals.

5.2.1 Sea Water Temperature

Sea water temperature is a particularly important limiting factor of coral habitat. Corals occur in a fairly-wide temperature range across geographic locations (15.7°C–35.5°C weekly average and 21.7–29.6°C annual average; Guan et al. 2015), but only thrive in areas with mean temperatures in a fairly-narrow optimal range (typically 25°C– 29°C) (Brainard et al. 2011; Kleypas et al. 1999; Stoddart 1969). Short-term exposures (days) to temperature increases of a few degrees (i.e., 3°C–4°C increase above climatological mean maximum summer temperature) or long-term exposures (several weeks) to minor temperature increases (i.e., 1°C–2°C above mean maximum summer temperature) can cause significant thermal stress and mortality to most coral species (Berkelmans and Willis 1999; Jokiel and Coles 1990)(Donner, Skirving et al. , Donner). Such temperature thresholds are variable in both time (e.g., season) and geographic location (i.e., latitude and longitude) and may be nonlinear. For example, in the Arabian Gulf, where corals have adapted to one of the lowest ambient winter temperatures recorded in reef areas, coral mortality occurred when on 4 consecutive days the water temperature dropped to 11.5°C and stayed at 13°C for 30 days, but corals were not damaged at sites where temperature was

12.5°C for 2 days and mean temperatures were 14°C for 5 days (Coles and Fadlallah 1991). In such locations and other high latitude reefs, such as the Northwestern Hawaiian Islands (Hoeke et al. 2006), corals have adapted to tolerate significant seasonal cycles of temperature fluctuations of 10°C in magnitude and greater. However, despite adaptation to extremely high summer (and low winter) temperatures, corals in such areas bleach (expel their symbiotic algae) when their normal maximum and minimum temperature tolerances are exceeded. For example, bleaching occurred in the Arabian Gulf in 1996, 1998, and 2002 when temperatures remained warmer than 35°C–36°C for greater than 3 weeks (Riegl 2002), and in 2010, corals bleached and died in both the Red Sea and Arabian Gulf. Over shorter time periods (hours to days), corals have commonly survived water temperatures exceeding the mean maximum temperatures for their area and exposure. For instance, corals in relatively enclosed shallow waters in American Samoa have been shown to survive temperature increases to 35°C, well above the maximum monthly mean (Craig et al. 2001).

In addition to coral bleaching, elevated seawater temperatures impair coral fertilization and settlement (Negri and Heyward 2000; Nozawa and Harrison 2007) and cause increases in coral disease (Jones et al. 2004; Miller et al 2009b). Effects of elevated seawater temperatures are well-studied for reef-building corals, and many approaches have been used to estimate temperature thresholds for coral bleaching and mortality (see reviews by (Baker et al. 2008; Berkelmans 2002; Brown 1997a; Coles and Brown 2003; Coles and Riegl; Jokiel 2004; Jones 2008)). The tolerance of corals to temperature is species-specific (Barker 2018; Bruno et al. 2007; Eakin et al. 2010; Heron et al. 2010; Ruzicka et al. 2013; Smith and Buddemeier 1992; van Woesik et al. 2011; Vega-Rodriguez et al. 2015) and depends on suites of other variables that include acclimation temperature, aragonite saturation state, dissolved inorganic nitrogen (Barker 2018; Cunning and Baker 2013; Fabricius 2005; Wooldridge 2013); suspended sediments and turbidity (Anthony et al. ; Devlin-Durante et al.); trace metals such as copper (Kwok et al. 2016; Negri and Hoogenboom 2011a; Woods et al. 2016), ultraviolet radiation (Anthony et al. 2007), salinity, nitrates, and phosphates (Negri and Hoogenboom 2011a), among other physical, physiological, and chemical stressors (Barker 2018).

Ocean warming is one of the most significant threats to the 5 corals. Mean seawater temperatures in reef-building coral habitat in both the Caribbean and Indo-Pacific have increased during the past few decades, and are predicted to continue to rise between now and 2100 (IPCC 2013). The primary observable coral response to ocean warming is bleaching of adult coral colonies, wherein corals expel their symbiotic zooxanthellae in response to stress (Brown 1997b). For many corals, an episodic increase of only 1°C–2°C above the normal local seasonal maximum ocean temperature can induce bleaching (Hoegh-Guldberg et al. 2007). Corals can withstand mild to moderate bleaching; however, severe, repeated, or prolonged bleaching can lead to colony death (Brown 1997b). Increased sea surface temperatures are occurring more frequently and leading to multiple mass bleaching events (Hughes et al. 2017), which are reoccurring too rapidly for coral populations to rebound in between (Hughes et al. 2018). In addition to coral bleaching, other effects of ocean warming detrimentally affect virtually every life-history stage in reef-building corals. Impaired fertilization and developmental abnormalities (e.g., Negri and Heyward 2000), mortality and impaired settlement success (e.g., Randall and Szmant 2009) have all been documented. Increased seawater temperature also may act synergistically with coral diseases to reduce coral health and survivorship (Bruno et al. 2007). Coral disease outbreaks often have either accompanied or immediately followed bleaching events (Brandt and McManus 2009; Jones et al. 2004; Lafferty et al. 2004; Miller et al. 2009a; Muller et al. 2008). Outbreaks also follow seasonal patterns of high seawater temperatures (Sato et al. 2009; Willis et al. 2004).

5.2.2 Aragonite Staturation State

Carbonate ions (CO_3^{2-}) are used by many marine organisms, including corals, to build calcium carbonate skeletons. For corals, the mineral form of calcium carbonate in their skeletons is called "aragonite". The more calcium and carbonate ions there are dissolved in sea water, the easier it is for corals to build their aragonite skeletons. The metric used to express the relative availability of calcium and carbonate ions is the aragonite saturation state (Ωarg), which varies with temperature, salinity, and pressure. At saturation states between 1 and 20, marine organisms can create calcium carbonate shells or skeletons using a physiological calcifying mechanism and the expenditure of energy. The aragonite saturation state varies greatly within and across coral reefs and through daily cycles. Much of this variability is driven by photosynthesis, respiration, and calcification by marine organisms.

Coral reefs form in an annually-averaged saturation state of 4.0 or greater for optimal calcification, and an annually-averaged saturation state below 3.3 will result in reduced calcification at rates insufficient to maintain net positive reef accretion, resulting in loss of reef structure (Guinotte et al. 2003; Hoegh-Guldberg et al. 2007). Guinotte et al. (2003) classified the range of aragonite saturation states between 3.5-4.0 as "adequate" and < 3 as "extremely marginal." Thus, aragonite saturation state between 3 and 4 is likely necessary for coral calcification. But, generally, seawater Ωarg should be 3.5 or greater to enable maximum calcification of reef-building corals, and average Ωarg in most coral reef areas is currently in that range (Guinotte et al. 2003). Further, Kleypas et al. (1999) concluded that a general threshold for Ωarg occurs near 3.4, because only a few reefs occur where saturation is less than this. Guan et al. (2015) found that the minimum aragonite saturation observed where coral reefs currently occur is 2.82; however, it is not known if this location hosted live accreting corals.

Ocean acidification is a term referring to changes in ocean carbonate chemistry, including a drop in the pH of ocean waters, that is occurring in response to the rise in the quantity of atmospheric CO_2 and the partial pressure of CO_2 (pCO_2) absorbed in oceanic waters (Caldeira and Wickett 2003). As pCO_2 rises, oceanic pH declines through the formation of carbonic acid and subsequent reaction with water resulting in an increase of free hydrogen ions. The free hydrogen ions react with carbonate ions to produce bicarbonate, reducing the amount of carbonate ions available, and thus reducing the aragonite saturation state. A variety of laboratory studies conducted on corals and coral reef organisms (Langdon and Atkinson 2005) consistently show declines in the rate of coral calcification and growth with rising pCO_2, declining pH, and declining carbonate saturation state.

Laboratory experiments have also shown that skeletal deposition and initiation of calcification in newly settled corals is reduced by declining aragonite saturation state (Albright et al. 2008; Cohen et al. 2009). Field studies from a variety of coral locations in the Caribbean, Indo-Pacific, and Red Sea have shown a decline in linear extension rates (Bak et al. 2009; De'ath et al. 2009; Schneider and Erez 2006; Tanzil et al. 2009). In addition to effects on growth and calcification, recent laboratory experiments have shown that increased CO_2 also substantially impairs fertilization and settlement success in *Acropora palmata* (Albright et al. 2010). Reduced calcification and slower growth will mean slower recovery from breakage, whether natural (hurricanes and storms) or human (breakage from vessel groundings, anchors, fishing gear, etc.), or mortality from a variety of disturbances. Slower growth also implies even higher rates of mortality for newly settled corals due to the longer time it will take to reach a colony size that is no longer vulnerable to overgrowth competition, sediment smothering, and incidental predation. Reduced calcification and slower growth means more time to reach reproductive size and reduces sexual and asexual reproductive potential. Increased p CO_2 coupled with increased sea surface temperature can lead to even lower rates of calcification, as found in the meta-analysis by Kornder et al. (2018).

5.2.3 Nutrients

Nitrogen and phosphorous are two of the main nutrients that affect the suitability of the water column in coral reef habitats (Fabricius et al. 2005; Fabricius 2005). These two nutrients occur as different compounds in coral reef habitats and are necessary in low levels for normal reef function. Dissolved inorganic nitrogen and dissolved inorganic phosphorus in the forms of nitrate ($NO3^-$) and phosphate ($PO43^-$) are particularly important for photosynthesis, with dissolved organic nitrogen also providing an important source of nitrogen, and are the dominant forms of nitrogen and phosphorous in coral reef waters. Corals tolerate a range of nutrient concentrations (i.e., 0.0 to 4.51 micromole per liter [µM] $NO3^-$ and 0.0 to 0.63 µM $PO43^-$)(Guan et al. 2015), but only thrive in areas within the relatively low optimal ranges of < 0.6 µM $NO3^-$ and < 0.2 µM $PO43^-$ (Kleypas et al. 1999).

Excessive nutrient levels affect corals through two main mechanisms: direct impacts on coral physiology and indirect effects through nutrient-stimulation of other community components (e.g., macroalgae seaweeds, turfs/filamentous algae, cyanobacteria, and filter feeders) that compete with corals for space on the reef (79 FR 53851 October 10, 2014). The latter also affects the quality of recruitment substrate discussed previously. The physiological response a coral exhibits to an increase in nutrients mainly depends on intensity and duration. A short duration of a high increase in a nutrient may result in a severe adverse response, just as a chronic, lower concentration might. Increased nutrients can result in adverse responses in all life stages and affect most physiological processes, resulting in reduced number and size of gametes (Ward and Harrison 2000), reduced fertilization (Harrison and Ward 2001), reduced growth and mortality (Ferrier-Pages et al. 2000; Koop et al. 2001), increased disease progression (Vega Thurber et al. 2013; Voss and Richardson 2006), tissue loss (Bruno et al. 2003), and bleaching (Kuntz et al. 2005; Wiedenmann et al. 2012).

5.2.4 Water Clarity

Water clarity or transparency is a key factor for marine ecosystems and it is the best explanatory variable for a range of bioindicators of reef health (Fabricius et al., 2012). Water clarity affects the light availability for photosynthetic organisms and food availability for filter feeders. Corals depend upon their symbiotic algae for nutrition and thus depend on light availability for algal photosynthesis.

Reduced water clarity is determined by the presence of particles of sediment, organic matter, and/or plankton in the water, and so is often associated with elevated sedimentation and/or nutrients. Water clarity can be measured in multiple ways, including percent of solar irradiance at depth, Secchi depth (the depth in the water column at which a black and white disk is no longer visible), Nephelometric Turbidity Unit (NTU – measure of light scatter based on particles in the water column). Corals tolerate a wide range of water clarity, but thrive in extremely clear areas where Secchi depth is ≥ 15 m or light scatter is < 1 NTU (De'ath and Fabricius 2010). Further, water clarity conditions unsuitable for reef growth have been described as < 10 m Secchi Depth or > 20 NTU (De'ath and Fabricius 2010). Typical levels of total suspended solids in reef environments are less than 10 mg/L (Rogers 1990). The minimum light level for reef development is about 6-8 percent of surface irradiance (Fabricius et al. 2014).

For a particular coral, water clarity levels tolerated likely depend on several factors, including species, life history stage, spatial variability, and temporal variability. For example, colonies of a species occurring on fringing reefs around high volcanic islands with extensive groundwater inputs are likely to be better acclimatized or adapted to higher turbidity than colonies of the same species occurring on offshore barrier reefs or around atolls with very little or no groundwater inputs. In some cases, corals occupy naturally turbid habitats (Anthony and Larcombe 2000; McClanahan and Obura 1997; Te 2001) where they may benefit from the reduced amount of UV radiation to which they are exposed (Zepp et al. 2008).

Reductions in water clarity affect light availability for corals. As turbidity and nutrients increase, thus decreasing water clarity, reef community composition shifts from coral dominated to macroalgae to ultimately heterotrophic animals (Fabricius et al. 2012). Light penetration is diminished by suspended abiotic and biotic particulate matter (esp. clay and silt-sized particles) and some dissolved substances (Fabricius et al. 2014). The availability of light decreases directly as a function of particle concentration and water depth, but also depends on the nature of the suspended particles. Fine clays and organic particles are easily suspended from the sea floor, reducing light for prolonged periods while undergoing cycles of deposition and resuspension. Suspended fine particles also carry nutrients and other contaminants (Fabricius et al. 2013). Increased nutrient runoff into semi-enclosed seas accelerates phytoplankton production to the point that it also increases turbidity and reduces light penetration, and can also settle on colony surfaces (Fabricius 2005). In areas of nutrient enrichment, light for benthic organisms can be additionally severely reduced by dense stands of large fleshy macroalgae shading adjacent corals (Fabricius 2005).

A coral's response to a reduction in water clarity is dependent on intensity and duration. For example, corals exhibited partial mortality when exposed to 476 mg/L total suspended solids (TSS) for 96 hours, but had total mortality when exposed to 1000 mg/L TSS for 65 hours (Thompson and Bright 1980).

Depending on the duration of exposure, most coral species exhibited sublethal effects when exposed to turbidity levels between 7 and 40 NTU (Erftemeijer et al. 2012b). The most tolerant coral species exhibited decreased growth rates when exposed to 165 mg/L TSS for 10 days (Rice and Hunter 1992).

Turbidity reduces water clarity and so reduces the maximum depth at which corals can live, making deeper habitat unsuitable (Fabricius 2005). Existing data suggest that coral reproduction and settlement are more highly sensitive to changes in water clarity than adult survival and these functions are dependent on clear water. Suspended particulate matter reduces fertilization and sperm function (Ricardo et al. 2015) and strongly inhibits larvae survival, settlement, recruitment, and juvenile survival (Fabricius 2005).

5.2.5 Water Quality Summary

As described above, coral reefs form on solid substrate but only within the narrow range of water column conditions that allows the deposition rates of corals to exceed the rates of physical, chemical, and biological erosion (Brainard et al. 2005). These well-established optimal conditions have allowed for the formation of the massive coral reef structures that occur in the global tropical oceans. However, as with all ecosystems, these conditions are dynamic and vary over space and time. Therefore, we also identify environmental conditions in which coral reefs currently exist globally, thus indicating the conditions that may be tolerated by corals and allow for survival. These annually and spatially averaged-tolerance ranges provide the limits of the environmental conditions in which coral reefs exist globally (Guan et al. 2015). These conditions are not specific to individual coral species. Individual species may or may not be able to withstand conditions within or that exceed the global tolerance limits for coral reefs, depending on local average conditions to which they are acclimatized, and intensity and duration of exposure to suboptimal conditions. Table 2 summarizes the information presented above on example metrics of optimal and tolerance conditions for each water quality parameter (noting that other forms of measure may be applicable for nutrients and water clarity):

Table 2. EXAMPLES OF WATER CONDITIONS THAT SUPPORT CORAL REEFS.

Parameter	Optimal Range	Tolerance Range
Temperature	25°C to 29°C (annual average)	21.7°C to 29.6°C (annual average)
Aragonite saturation	>4 (annual average)	> 2.82 (annual average)
Nutrients **Nitrate** **Phosphate**	 < 0.6 µM < 0.2 µM ⁻ (monthly averages)	 0 to 4.51 µM 0 to 0.63 µM (annual averages)
Clarity	Secchi depth of ≥ 15 m or < 1 NTU (annual average)	>6-8 percent of surface irradiance (annual average)

The information on these four water quality parameters is relatively well-known and based on a long history of study with respect to the ranges that support coral reef formation. The same is not true with respect to contaminants, as this is a field of rapidly growing science. The best available science (summarized below) indicates that contaminants harm corals, decrease the value of their habitat, and may impede recovery. Thus, we are considering including contaminants, or more specifically lack of harmful levels of contaminants, as an attribute of the water quality portion of the essential feature, though have not made a determination at this final rule stage.

5.2.6 Contaminants

"Contaminants" is a collective term to describe a suite of physical, chemical, biological, or radiological substances in water or sediments that may adversely affect corals. The study of the effects of contaminants on corals is a relatively new field and information on sources and ecotoxicology is incomplete. The major groups of contaminants that have been studied for effects to corals include heavy metals (also called trace metals), pesticides, and hydrocarbons. Other organic pollutants, such as chemicals in personal care products, have also been studied. Contaminants may be delivered to coral reefs via point or non-point sources. Specifically, contaminants enter the marine environment through wastewater discharge, shipping, industrial activities, and agricultural and urban runoff. These pollutants cause negative effects to coral reproduction, development, growth, photosynthesis, and survival.

Heavy metals (e.g., copper, cadmium, manganese, nickel, cobalt, lead, zinc, and iron) can be toxic at concentrations above naturally-occurring levels. Heavy metals are persistent in the environment and can bioaccumulate. Metals are adsorbed to sediment particles, which can result in their long distance transport away from sources of pollution. Corals incorporate metals in their skeleton and accumulate them in their soft tissue (Al-Rousan et al. 2012; Barakat et al. 2015). Although heavy metals can occur in the marine environment from natural processes, in nearshore waters they are mostly a result of anthropogenic sources (e.g., wastewater, antifouling and anticorrosive paints from marine vessels and structures, land filling and dredging for coastal expansion, maritime activities, inorganic and organic pollutants, crude oil pollution, shipping processes, industrial discharge, agricultural activities) and are found near cities, ports, and industrial developments.

The effects of copper on corals include physiological impairment, impaired photosynthesis, bleaching, reduced growth, and DNA damage (Bielmyer et al. 2010; Schwarz et al. 2013). Adverse effects to fertilization, larval development, larval swimming behavior, metamorphosis, and larval survival have also been documented (Kwok and Ang 2013; Negri and Hoogenboom 2011b; Puisay et al. 2015; Reichelt-Brushett and Hudspith 2016; Rumbold and Snedaker 1997). Toxicity of copper was found to be higher when temperatures are elevated (Negri and Hoogenboom 2011b). Nickel and cobalt can also have negative effects on corals, such as reduced growth and photosynthetic rates (Biscere et al. 2015), and reduced fertilization success (Reichelt-Brushett and Hudspith 2016). Chronic exposure of corals to higher levels of iron may significantly reduce growth rates (Ferrier-Pages et al. (2001). Further, iron chloride has been found to cause oxidative DNA damage to coral larvae (Vijayavel et al. 2012).

Polycyclic aromatic hydrocarbons (PAHs) are found in fossil fuels such as oil and coal and can be produced by the incomplete combustion of organic matter. PAHs disperse through non-point sources such as road run-off, sewage, and deposition of particulate air pollution. PAHs can also disperse from point sources such as oil spills and industrial sites. Studies have found effects of oil pollution on corals include growth impairments, mucus production, and decreased reproduction, especially at increased temperature (Kegler et al. 2015). Hydrocarbons have also been found to affect early life stages of corals. Oil-contaminated seawater reduced settlement of *O. faveolata* and of *Agaricia humilis* and was more severe than any direct or latent effects on survival (Hartmann et al. 2015). Natural gas (water accommodated fraction) exposure resulted in abortion of larvae during early embryogenesis and early release of larvae during late embryogenesis, with higher concentrations of natural gas yielding higher adverse effects (Villanueva et al. 2011). Exposure to oil, dispersant, and a combination of oil and dispersant, significantly decreased settlement and survival of *Porites astreoides* and *Orbicella faveolata* larvae (Goodbody-Gringley et al. 2013).

Anthracene (a PAH that is used in dyes, wood preservatives, insecticides, and coating materials) exposure to apparently healthy fragments and diseased fragments (Caribbean yellow band disease) of *O. faveolata* reduced activity of enzymes important for protection against environmental stressors in the diseased colonies (Montilla et al. 2016). The results indicated that diseased tissues might be more vulnerable to exposure to PAHs such as anthracene compared to healthy corals. PAH concentrations similar to those after an oil spill inhibited metamorphosis of *Acropora tenuis* larvae and sensitivity increased when co-exposed to "shallow reef" UV light levels (Negri et al. 2016).

Pesticides include herbicides, insecticides, and antifoulants used on vessels and other marine structures. Pesticides can affect non-target marine organisms like corals and their zooxanthellae. Diuron, an herbicide, decreased photosynthesis in zooxanthellae that had been isolated from the coral host and grown in culture (Shaw et al. 2012). Irgarol, an additive in copper-based antifouling paints, significantly reduced settlement in *Porites hawaiiensis* (Knutson et al. 2012). *Porites astreoides* larvae exposed to two major mosquito pesticide ingredients, naled and permethrin, for 18-24 hours showed differential responses. Concentrations of 2.96 µg/L or greater of naled significantly reduced larval survivorship, while exposure of up to 6.0 µg/L of permethrin did not result in reduced larval survivorship. Larval settlement, post-settlement survival, and zooxanthellae density were not impacted by any treatment (Ross et al. 2015).

Benzophenone-2 (BP-2) is a chemical additive to personal care products (e.g., shampoo, body lotions, soap, and detergents), product coatings (oil-based paints, polyurethanes), acrylic adhesives, and plastics that protects against damage from ultraviolet light. It is released into the ocean through municipal and boat/ship wastewater discharges, landfill leachates, residential septic fields, and unmanaged cesspits (Downs et al. 2014). BP-2 is a known endocrine disruptor and a DNA mutagen, and its effects are worse in the light. It caused deformation of *Stylophora pistillata* larvae, changing them from a motile planktonic state to a deformed sessile condition at low concentrations (Downs et al. 2014). It also caused increasing larval bleaching with increasing concentration (Downs et al. 2014). Benzophenone-3 (BP-3; oxybenzone) is an ingredient in sunscreen and personal care products (e.g., hair cleaning and styling products, cosmetics, insect repellent, soaps) that protects against damage from ultraviolet light. It enters the marine environment through swimmers and municipal, residential, and boat/ship wastewater discharges and can cause DNA mutations. Oxybenzone is a skeletal endocrine disruptor, and it caused larvae of *S. pistillata* to encase themselves in their own skeleton (Downs et al. 2016). Exposure to oxybenzone transformed *S. pistillata* larvae from a motile state to a deformed, sessile condition (Downs et al. 2016). Larvae exhibited an increasing rate of coral bleaching in response to increasing concentrations of oxybenzone (Downs et al. 2016). Inorganic filters have also been found to cause bleaching in particular forms, specifically uncoated zinc oxide nanoparticles {Corinaldesi 2018}.

Polychlorinated biphenyls (PCBs) are environmentally stable, persistent organic pollutants that have been used as heat exchange fluids in electrical transformers and capacitors and as additives in paint, carbonless copy paper, and plastics. They can be transported globally through the atmosphere, water, and food chains. A study of the effects of the PCB, Aroclor 1254, on the scleractinian coral *S. pistillata* found no effects on coral survival, photosynthesis, or growth; however, the exposure concentration and duration may alter the expression of certain genes involved in various important cellular functions (Chen et al. 2012).

Surfactants are used as detergents and soaps, wetting agents, emulsifiers, foaming agents, and dispersants. Linear alkylbenzene sulfonate (LAS) is one of the most common surfactants in use. Biodegradation of surfactants can occur within a few hours up to several days, but significant proportions of surfactants attach to suspended solids and remain in the environment. This absorption of surfactants onto suspended solids depends on environmental factors such as temperature, salinity, or pH. Exposure of *Pocillopora verrucosa* to LAS resulted in tissue loss on fragments (Kegler et al. 2015). The combined effects of LAS exposure with increased temperature (+3°C to 31°C) resulted in greater tissue loss than LAS exposure alone (Kegler et al. 2015).

6 Specific Areas Within the Geographical Areas Occupied by the Species

The definition of critical habitat further instructs us to identify specific areas on which are found the physical or biological features essential to the species' conservation that may require special management considerations or protection. Our regulations state that critical habitat will be shown on a map, with more-detailed information discussed in the preamble of the rulemaking documents in the Federal Register, and will reference each area by the State, county, or other local governmental unit in which it is located (50 CFR 424.12(c)). Our regulations also state that when several habitats, each satisfying requirements for designation as critical habitat, are located in proximity to one another, an inclusive area may be designated as critical habitat (50 CFR 424.12(d)).

Within the geographical areas occupied by each of the 5 corals in U.S. waters, at the time of listing, there are five or six broad areas in which the essential feature occurs. To identify the specific areas under consideration for critical habitat, for each of the 5 corals, the boundaries of the specific areas are determined by each coral's commonly occupied minimum and maximum depth ranges within each coral's specific geographic distribution. For the 5 corals, this results in 28 specific areas being designated as critical habitat. There are five or six specific areas per species depending on whether it occurs in FGB; one each in Florida, Puerto Rico, St. Thomas and St. John, USVI, and St. Croix, USVI, FGB, and Navassa Island. Within each of these areas, the individual species' specific areas are largely- overlapping. For example, in Puerto Rico, there are 5 largely-overlapping specific areas, one for each species, that surround each of the islands. The difference between each of the areas is the particular depth contours that create the boundaries. For example, *Dendrogyra cylindrus*' specific area in Puerto Rico extends from the 1-m contour to the 25-m contour, which mostly overlaps the *Orbicella annularis* specific area that extends from the 0.5-m contour to the 20-m contour. Overlaying all of the specific areas for each species results in the maximum geographic extent of these new critical habitat designations, which cover 1.6 to 295 ft (0.5-90 m) water depth around all the islands of Puerto Rico, USVI, and Navassa; 53 ft to 295 ft (16-90 m) in FGB; and 1.6 to 131 ft (0.5-40 m) from St. Lucie Inlet, Martin County to Dry Tortugas, Florida. The minimum depth in FGB was updated from 17 m to 16 m based on public comment. The maximum depth was updated from 90 m to 40 m in Florida based on public comment and new information (Reed and Farrington).

To map these specific areas we reviewed available species occurrence, bathymetric, substrate, and water quality data. We used the highest resolution bathymetric data available from multiple sources depending on the geographic location. In Florida and the FGB, we used contours created from National Ocean Service Hydrographic Survey Data and NOAA ENCDirect bathymetric point data (NPS) and contours created from NOAA's Coastal Relief Model. We also used bathymetry collected with multi-bean sonar in the FGB (USGS 2002). In Puerto Rico, contours were derived from the National Geophysical Data Center's (NGDC) 2005 U.S. Coastal Relief Model. In USVI, we used contours derived from NOAA's 2004-2015 Bathymetric Compilation. In Navassa, contours were derived from NOAA's NGDC 2006 bathymetric data. These bathymetric data (i.e., depth contours) are used, with other geographic or management boundaries, to draw the boundaries of each specific area on the maps in the final critical habitat designation.

Within the areas bounded by depth and species occurrence, we evaluated available data on the essential feature. For substrate, we used information from the NCCOS Benthic Habitat Mapping program, which provides data and maps at http://products.coastalscience.noaa.gov/collections/benthic/default.aspx, summarized in the Coral Reef Data Explorer at http://maps.coastalscience.noaa.gov/coralreef/#, and the Unified Florida Reef Tract Map found at http://geodata.myfwc.com/datasets/6090f952e3ee4945b53979f18d5ac3a5_9. Using GIS software, we extracted all habitat classifications that could be considered potential recruitment habitat, including hardbottom and coral reef. The benthic habitat information assisted in identifying any major gaps in the distribution of the substrate essential feature. The data show that hard substrate is unevenly distributed throughout the ranges of the species. However, there are large areas where benthic habitat characterization data are still lacking, particularly deeper than 99 ft (30 m). Therefore, we made assumptions that the substrate feature does exist in those areas, though in unknown quantities, because the species occur there. The available data also represent a snapshot in time, while the exact location of the habitat feature may change over time (e.g., natural sediment movement covering or exposing hard substrate).

There are areas within the geographical and depth ranges of the species that contain natural hard substrates that, due to their consistently disturbed nature, do not provide the quality of substrate essential for the conservation of threatened corals. These disturbances may be naturally occurring or caused by human activities, as described below. While these areas may provide hard substrate for coral settlement and growth over short periods, the periodic nature of direct human disturbance renders them poor habitat for coral growth and survival over time. These “managed areas,” for the purposes of this final rule, are specific areas where the substrate has been persistently disturbed by planned management authorized by local, state, or Federal governmental entities at the time of critical habitat designation, and expectations are that the areas will continue to be periodically disturbed by such management. Examples include, but are not necessarily limited to, dredged navigation channels, vessel berths, and active anchorages. These managed areas are not under consideration for critical habitat designation. GIS data of the locations of some managed areas were available and extracted from the maps of the specific areas being considered for critical habitat designation. These data were not available for every managed area; however, regardless of whether the managed area is extracted from the maps depicting the specific areas being designated as critical habitat, no “managed areas” are part of the specific areas that contain the essential feature.

The nearshore surf zones of Martin, Palm Beach, Broward, and Miami-Dade Counties are also consistently disturbed by naturally-high sediment movement, suspension, and deposition levels. Hard substrate areas found within these nearshore surf zones are ephemeral in nature and are frequently covered by sand, and the threatened coral species have never been observed there. Thus, this area (water in depths from 0 ft to 6.5 ft offshore St. Lucie Inlet to Government Cut) does not contain the essential feature and is not considered part of the specific areas under consideration for critical habitat. The shallow depth limit (i.e., inshore boundary) was identified based on the lack of these or any reef building corals occurring in this zone, indicating conditions are not suitable for their settlement and recruitment into the population.

Due to the ephemeral nature of conditions within the water column and the various scales at which water quality data are collected, this aspect of the essential feature is difficult to map at fine spatial or temporal scales. However, annually-averaged plots of temperature, aragonite saturation, nitrate, phosphate, and light, at relatively large spatial scale (e.g., 1° X 1° grid) are available from Guan et al. (2015), using 2009 data for some parameters, and updated with newer data from the World Ocean Atlas (2013) for temperature and nutrients. Those maps indicate that conditions that support coral reef growth, and thus coral demographic functions, occur throughout the specific areas under consideration.

Based on the available data, we identified 28 mostly-overlapping specific areas that contain the essential feature. The units can generally be grouped as the: (1) Florida units, (2) Puerto Rico units, (3) St. Thomas/St. John units (STT/STJ), (4) St. Croix units, (5) Navassa units, and (6) FGB units (Table 3). Within each group of units, each species has its own unique unit that is specific to its geographic and depth distributions. Therefore, within a group there are five mostly-overlapping units – one for each species. The exception is that there are only three completely-overlapping units in the FGB group, because only the three species of *Orbicella* occur there. The essential feature is unevenly distributed throughout these 28 specific areas. Within these areas there exists a mosaic of habitats at relatively small spatial scales, some of which naturally contain the essential features (e.g., coral reefs) and some of which do not (e.g., seagrass beds). Further, within these large areas, specific "managed areas" and naturally disturbed areas described above also exist. Due to the spatial scale at which the essential feature exists interspersed with these other habitats and disturbed areas, and the resolution of we are not able to more discretely delineate the specific areas under consideration for critical habitat designation.

Table 3. UNITS OF CRITICAL HABITAT FOR EACH OF THE 5 THREATENED CARIBBEAN CORALS.

Species	Critical Habitat Unit Name	State	Geographic Extent	Water Depth Range
Orbicella annularis	OANN-1	Florida	Lake Worth Inlet, Palm Beach County to Government Cut, Miami-Dade County	2-20 m (6.5-65.6 ft)
		Florida	Government Cut, Miami-Dade County to Dry Tortugas	0.5-20m (1.6-65.6 ft)
	OANN-2	Puerto Rico	All islands	0.5-20m (1.6-65.6 ft)
	OANN-3	USVI	All islands of St. Thomas and St. John	0.5-20m (1.6-65.6 ft)
	OANN-4	USVI	All islands of St. Croix	0.5-20m (1.6-65.6 ft)
	OANN-5	Navassa	Navassa Island	0.5-20m (1.6-65.6 ft)
	OANN-6	FGB	East and West Flower Garden Banks, Bright, McGrail, and Geyer Banks	16-90 m (53-295 ft)

Species	Critical Habitat Unit Name	State	Geographic Extent	Water Depth Range
Orbicella faveolata	OFAV-1	Florida	St. Lucie Inlet, Martin County to Government Cut, Miami-Dade County	2-40 m (6.5-131 ft)
			Government Cut, Miami-Dade County to Dry Tortugas	0.5-40 m (1.6-131 ft)
	OFAV-2	Puerto Rico	All islands of Puerto Rico	0.5-90 m (1.6-295 ft)
	OANN-3	USVI	All islands of St. Thomas and St. John	0.5-90 m (1.6-295 ft)
	OFAV-4	USVI	All islands of St. Croix	0.5-90 m (1.6-295 ft)
	OFAV-5	Navassa	Navassa Island	0.5-90 m (1.6-295 ft)
	OFAV-6	FGB	East and West Flower Garden Banks, Bright, McGrail, and Geyer Banks	16-90 m (53-295 ft)
Orbicella franksi	OFRA-1	Florida	St. Lucie Inlet, Martin County to Government Cut, Miami-Dade County	2-40 m (6.5-131 ft)
		Florida	Government Cut, Miami-Dade County to Dry Tortugas	0.5-40 m (1.6-131 ft)
	OFRA-2	Puerto Rico	All islands of Puerto Rico	0.5-90 m (1.6-295 ft)
	OFRA-3	USVI	All islands of St. Thomas and St. John	0.5-90 m (1.6-295 ft)
	OFRA-4	USVI	All islands of St. Croix	0.5-90 m (1.6-295 ft)
	OFRA-5	Navassa	Navassa Island	0.5-90 m (1.6-295 ft)
	OFRA-6	FGB	East and West Flower Garden Banks, Bright, McGrail, and Geyer Banks	16-90 m (53-295 ft)
Dendrogyra cylindrus	DCYL-1	Florida	Lake Worth Inlet, Palm Beach County to Government Cut, Miami-Dade County	2-25 m (6.5-82 ft)
		Florida	Government Cut, Miami-Dade County to Dry Tortugas	1-25 m (3.3-82 ft)
	DCYL-2	Puerto Rico	All islands	1-25 m (3.3-82 ft)
	DCYL-3	USVI	All islands of St. Thomas and St. John	1-25 m (3.3-82 ft))
	DCYL-4	USVI	All islands of St. Croix	1-25 m (3.3-82 ft)
	DCYL-5	Navassa	Navassa Island	1-25 m (3.3-82 ft))
Mycetophyllia ferox	MFER-1	Florida	Broward County to Dry Tortugas	5-40 m (16.4-131 ft)
	MFER-2	Puerto Rico	All islands of Puerto Rico	5-90 m (16.4-295 ft)
	MFER-3	USVI	All islands of St. Thomas and St. John	5-90 m (16.4-295 ft)
	MFER-4	USVI	All islands of St. Croix	5-90 m (16.4-295 ft)
	MFER-5	Navassa	Navassa Island	5-90 m (16.4-295 ft)

7 Unoccupied Areas

ESA Section 3(5)(A)(ii) defines critical habitat to include specific areas outside the geographical area occupied by the species at the time of listing if the areas are determined by the Secretary to be essential for the conservation of the species. Our regulations at 50 CFR 424.12(b)(2) further explain that unoccupied areas shall only be designated after determining that occupied areas are inadequate to ensure the conservation of the species, and the unoccupied areas is reasonably certain to contribute to the conservation of the species and contains one or more essential feature. Our regulations at 50 CFR 424.12(g) also state: “The Secretary will not designate critical habitat within foreign countries or in other areas outside of the jurisdiction of the United States.”

The threats to these 5 corals are generally the same threats affecting coral reefs throughout the world (climate change, fishing, and land-based sources of pollution) and are fully described in the final listing rule (79 FR 53852, September 10, 2014). Specifically, ocean warming, disease, and ocean acidification are the 3 most important threats that will impact the potential for recovery of all the listed coral species. Because the primary threats are global in nature, adapting to changing conditions will be critical to the species’ conservation and recovery. We issued guidance in 2016 on the treatment of climate change uncertainty in ESA decisions, which addresses critical habitat specifically {Tortoricci 2016}. The guidance states that “when designating critical habitat, NMFS will consider proactive designation of unoccupied habitat as critical habitat when there is adequate data to support a reasonable inference that the habitat is essential for the conservation of the species because of the function(s) it is likely to serve as climate changes.” We specifically address this consideration for threatened Caribbean corals in this section.

All 5 corals occur in the Caribbean, an area predicted to have rapid and severe impacts from climate change (van Hooidonk et al. 2014). Shifting into previously unoccupied habitats that become more suitable as other parts of their range become less suitable may be a strategy these corals employ in the future to adapt to changing conditions. However, due to the nature of the Caribbean basin, there is little opportunity for range expansion. The only area of potential expansion is north up the Florida coast. Several of the 5 corals have different current northern-most extents, with *Orbicella faveolata*’s limit at St. Lucie Inlet, Martin County, Florida being the farthest north and at the limit of coral reef formation in Florida. A northern range expansion along Florida’s coast beyond this limit is unlikely due to lack of evidence of historical reef growth under warmer climates and inhibition by present-day hydrographic conditions (Walker and Gilliam 2013). The other six corals could theoretically expand into the area between their current northern extents to the limit of reef formation. However, temperature is not likely the factor limiting occupation of those areas, given the presence of other reef-building corals. Thus, there are likely other non-climate-related factors limiting the northern extent of the corals’ ranges. Therefore, we are not considering any unoccupied areas for designation of critical habitat for the 5 corals.

8 Special Management Considerations

Specific areas within the geographical area occupied by a species may be designated as critical habitat only if they contain essential features that “may require special management considerations or protection” (16 U.S.C. 1532(5)(A)(i)(II). Special management considerations or protection are any “methods or procedures useful in protecting physical or biological features for the conservation of listed species” (50 CFR 424.02). Only those essential features that may need special management considerations or protection are considered further. We may conduct this analysis of the potential need for special management considerations or protection at the scale of all specific areas, but we may also do so within each specific area. We conducted our analysis at the scale of all specific areas due to the global nature of the threats related to climate change and their effects on the essential feature.

The essential feature is particularly susceptible to impacts from human activity because of the relatively shallow water depth range (less than 295 ft (90 m)) the corals inhabit and proximity of this habitat to coastal areas. Proximity to coastal areas subjects this feature to impacts from multiple activities, including, but not limited to, coastal and in-water construction, dredging and disposal activities, beach nourishment, stormwater run- off, wastewater and sewage outflow discharges, point and non-point source pollutant discharges, and fishery management. Further, the global oceans are being impacted by climate change from greenhouse gas emissions, particularly the tropical oceans in which the Caribbean corals occur (van Hooidonk et al. 2014). The impacts from these activities, combined with those from natural factors (e.g., major storm events), significantly affect habitat for all life stages for these threatened corals. We conclude that the essential feature is currently and will likely continue to be negatively impacted by some or all of these factors.

Greenhouse gas emissions (e.g., fossil fuel combustion) lead to global climate change and ocean acidification. These activities adversely affect the essential feature by increasing sea surface temperature and decreasing the aragonite saturation state. Coastal and in-water construction, channel dredging, and beach nourishment activities can directly remove the essential feature by dredging it or by depositing sediments on it, making it unavailable for settlement and recruitment of coral larvae or fragments. These same activities can impact the essential feature by creating turbidity during operations. Stormwater run-off, wastewater and sewage outflow discharges, and point and non-point source pollutant discharges can adversely impact the essential feature by allowing nutrients and sediments from point and non-point sources, including sewage, stormwater and agricultural runoff, river discharge, and groundwater, to alter the natural levels of nutrients and sediments in the water column. The same activities can also adversely affect the essential feature by increasing the growth rates of macroalgae, preempting available coral recruitment habitat. Further, these same activities can be thesource of introducing contaminants into the water column. Fishery management can adversely affect the essential feature by reducing the number of herbivorous fishes available to control the growth of macroalgae on the substrate.

Based on the above, we determined that the essential feature may require special management considerations or protection generally throughout the species’ ranges, because threats to this feature exist within these areas.

9 Application of ESA Section 4(a)(3)(B)(i)

Section 4(a)(3)(B) of the ESA prohibits designating as critical habitat any lands or other geographical areas owned or controlled by the Department of Defense (DOD), or designated for its use, that are subject to an Integrated Natural Resources Management Plan (INRMP) prepared under section 101 of the Sikes Act (16 U.S.C. 670a), if the Secretary determines in writing that such plan provides a benefit to the species for which critical habitat is being designated. Our regulations at 50 CFR 424.12(h) provide that in determining whether an applicable benefit is provided, we will consider:

1. The extent of the area and features present;
2. The type and frequency of use of the area by the species;
3. The relevant elements of the INRMP in terms of management objectives, activities covered, and best management practices, and the certainty that the relevant elements will be implemented; and
4. The degree to which the relevant elements of the INRMP will protect the habitat from the types of effects that would be addressed through a destruction-or-adverse-modification analysis.

Naval Air Station Key West (NASKW) is the only installation controlled by the DOD, specifically the Department of the Navy (Navy), which coincides with any of the areas under consideration for critical habitat. On September 21, 2015, the Navy requested in writing that the areas covered by the 2014 INRMP for NASKW not be designated as critical habitat, pursuant to ESA section 4(a)(3)(B)(i), and provided the INRMP for our review.

The NASKW INRMP covers the lands and waters – generally out to 50 yards (45.7 m) – adjacent to NASKW, including several designated restricted areas (see INRMP figures C-1 through C-14). The total area of the waters covered by the INRMP and overlaping with areas considered for the final critical habitat is approximately 800 acres. Within this area, four of the threatened corals (*D. cylindrus*, *O. annularis*, *O. faveolata*, and *O. franksi*) and the essential feature are present in densities and proportions similar to those throughout the rest of the nearshore habitat in the Florida Keys. The species use this area in the same way that they do all areas designated as critical habitat – to carry out all life functions. As detailed in Chapter 4 and Appendix C of the INRMP, the plan provides benefits to the threatened corals and existing *Acropora* critical habitat through the following NASKW broad programs and activities: (1) erosion control – which will prevent sediments from entering into the water; (2) Boca Chica Clean Marina Designation – which eliminates or significantly reduces the release of nutrients and contaminants; (3) stormwater quality improvements – which prevents or reduces the amount of pollution in water to a level compatible with ; and (4) wastewater treatment – which reduces the release of nutrients and contaminants consistent with Florida Surface Water Quality Standards. Within these categories there are 15 specific management activities and projects that provide benefit to the corals and their habitat (see Table 4-2 of the INRMP). These types of best management practices have been ongoing at NAS Key West since 1983; thus they are likely to continue into the future. Further, the plan specifically provides assurances that all NASKW staff have the authority and funding (subject to appropriations) to implement the plan. The plan also provides assurances that the conservation efforts will be effective through annual reviews conducted by state and federal natural resource agencies.

These activities provide a benefit to the species and the identified essential feature in the final critical habitat designations by reducing sediment and nutrient discharges into nearshore waters, which addresses some of the particular conservation and protection needs that critical habitat would afford. These activities are similar to those that we describe below as project modifications for avoiding or reducing adverse effects to the critical habitat. Therefore, were we to consult on the activities in the INRMP that may affect the designated critical habitat, we would likely not require any project modifications based on the best management practices in the INRMP. Further, the INRMP includes provisions for monitoring and evaluating conservation effectiveness, which will ensure continued benefits to the species. Annual reviews of the INRMP for years 2011-2015 found that the INRMP executions "satisfied" or "more than satisfied" conservation objectives, including actions that minimize or eliminate land-based sources of pollution. We believe the NASKW INRMP provides the types of benefits to the threatened corals described in our regulations (50 CFR 424.12(h)).

Four (*D. cylindrus*, *O. annularis*, *O. faveolata*, and *O. franksi*) of the 5 corals' specific areas overlap with NASKW based on the depth in which the species occur and the distance from shore covered by NASKW's INRMP. Therefore, we determined that the INRMP provides a benefit to those threatened corals as described above, and we are not designating critical habitat within the boundaries covered by the INRMP pursuant to Section 4(a)(3)(B)(i) of the ESA.

10 Application of ESA Section 4(b)(2)

The foregoing discussion described the specific areas within U.S. jurisdiction that fall within the ESA Section 3(5) definition of critical habitat in that they contain the physical or biological features essential to the 5 corals' conservation that may require special management considerations or protection. Section 4(b)(2) of the ESA requires that we consider the economic impact, impact on national security, and any other relevant impact, of designating any particular area as critical habitat. Additionally, the Secretary has the discretion to consider excluding any area from critical habitat if she determines the benefits of exclusion (that is, avoiding some or all of the impacts that would result from designation) outweigh the benefits of designation based upon the best scientific and commercial data available. The Secretary may not exclude an area from designation if exclusion will result in the extinction of the species. Because the authority to exclude is discretionary, exclusion is not required for any particular area under any circumstances.

The ESA provides the USFWS and NMFS (the Services) with broad discretion in how to consider impacts. (See, H.R. Rep. No. 95-1625, at 17, reprinted in 1978 U.S.C.C.A.N. 9453, 9467 (1978). "Economics and any other relevant impact shall be considered by the Secretary in setting the limits of critical habitat for such a species. The Secretary is not required to give economics or any other 'relevant impact' predominant consideration in his specification of critical habitat...The consideration and weight given to any particular impact is completely within the Secretary's discretion."). Courts have noted the ESA does not contain requirements for any particular methods or approaches (See, e.g., Bldg. Indus. Ass'n of the Bay Area et al. v. U.S. Dept. of Commerce et al., No. 13-15132, 9th Cir., July 7, 2015 [upholding district court's ruling that the ESA does not require the agency to follow a specific methodology when designating critical habitat under Section 4(b)(2]). For this final critical habitat designation, we followed the same basic approach to describing and evaluating impacts as we have for recent critical habitat rulemakings in the NMFS Southeast Region.

The following sub-sections describe the economic, national security, and other relevant impacts that we projected would result from including the 28 specific areas described above in the designated critical habitat designation. We considered these impacts in deciding whether to exercise our discretion to propose excluding particular areas from the designation. Both positive and negative impacts (these terms are used interchangeably with benefits and costs, respectively) were identified and were considered. Impacts were evaluated in quantitative terms where feasible, but qualitative appraisals were used where more appropriate to particular impacts or available information.

The primary impacts of a critical habitat designation result from the ESA Section 7(a)(2) requirement that federal agencies ensure their actions are not likely to result in the destruction or adverse modification of critical habitat, and that they consult with NMFS in fulfilling this requirement. Determining these impacts is complicated by the fact that Section 7(a)(2) also requires that federal agencies ensure their actions are not likely to jeopardize listed species' continued existence. One incremental impact of designation is the extent to which federal agencies modify their proposed actions to ensure they are not likely to destroy or adversely modify the critical habitat beyond any modifications they would make because of listing and the requirement to avoid jeopardizing listed species. When the same modification would be required due to impacts to both the species and critical habitat, the impact of the designation is co-extensive with results from the ESA listing of the species (i.e., attributable to both the listing of the species and the designation of critical habitat). To the extent possible, our analysis identified impacts that were incremental due to the final designation of critical habitat - meaning those impacts over and above impacts attributable to the species' listing or any other existing regulatory protections. Relevant, existing regulatory protections (including the species' listing) are referred to as the "baseline" and are also discussed in the following sections.

The following impact analyses describe projected future federal activities that would trigger Section 7 consultation requirements because they may affect the essential feature, and consequently may result in economic, national security, or other relevant impacts. Additionally, these analyses describe broad categories of project modifications that may reduce impacts to the essential feature, and state whether the modifications are likely to be solely a result of the critical habitat designation or co-extensive with another baseline regulation, including the ESA listing of the species.

10.1 Economic Impacts

Economic impacts of the critical habitat designation result through implementation of Section 7 of the ESA in consultations with federal agencies to ensure their proposed actions are not likely to destroy or adversely modify critical habitat. These economic impacts may include both administrative and project modification costs; economic impacts that may be associated with the conservation benefits of the designation are described later. We conducted analysis of the economic impacts of the final rule to appropriate economic or geopolitical areas (e.g., Florida county, Puerto Rico-Metro, USVI island) to assist in projecting the extent to which discrete areas may be impacted.

SUMMARY OF KEY FINDINGS

- **Total incremental costs**[2]: Total present value of impacts from critical habitat designation for the 5 corals are estimated to range from $76,000 to $690,000 over the next ten years ($11,000 to $98,000 annualized). While a degree of uncertainty underlies this analysis, the results provide an indication of the potential activities that may be affected, the relative costs of critical habitat designation across particular areas of critical habitat, and a reasonable estimate of future costs.
- **Existing baseline protections**: Baseline protections exist in large areas in this designation; however, there is uncertainty as to the degree of protection that these protections will provide. In particular:
  - The 5 corals may be present in all areas, and are already expected to receive significant protections related to the listing of the species under the ESA; however the degree to which coral presence would be known within a future action area by implementing agencies in the absence of the critical habitat designation is uncertain;
  - The 2008 *Acropora* critical habitat designation overlaps significantly with the specific areas under consideration, which includes the areas where the vast majority of projects and activities potentially affected occur. These critical habitat areas share the substrate essential features, though the critical habitat designation for the 5 corals explicitly includes a water quality feature for coral survival, growth, reproduction, and recruitment, while *Acropora* critical habitat does not. Most activities that may affect the substrate essential feature would also affect the water quality feature through impacts to the nutrients and water clarity parameters.

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[2] Cost estimates are expressed in 2021 dollars. Present values are calculated over ten years (2022 – 2031) assuming a 7% discount

- **Key assumptions**: This analysis assumes that the types, frequencies, and locations of activities that have required Section 7 consultation over the past ten years is reflective of the types, frequency, and location of activities that will require Section 7 consultation in the future. Because we have data on past consultations for impacts to the acroporid corals (10 years) as well as their critical habitat (8 years), we believe it is a reasonable assumption that the distribution of past consultations as informal, formal, and programmatic likely reflects the distribution of future consultations. To the extent that we handle consultations differently over the next ten years (e.g., more dealt with on a programmatic basis, or critical habitat results in a shift to more formal consultations), our analysis could over or underestimate the incremental administrative burden of critical habitat for the 5 corals. To address uncertainty associated with the likelihood that incremental project modifications would be required for Section 7 consultations, we developed a range of potential impacts, based on the following assumptions:
    - **Low end of cost range** ($76,000 total; $11,000 annualized) – Incremental costs would be limited to the additional administrative efforts associated with adding consideration of this new critical habitat to future Section 7 consultations in areas that do not overlap with *Acropora* critical habitat. In other words, those consultations that would have considered impacts to *Acropora* critical habitat in the absence of this designation would have approximately the same administrative effort as those that would consider impacts to this critical habitat. Since this critical habitat overlaps with *Acropora* critical habitat, there would be no new administrative effort in those locations where the two designations overlap. Existing baseline protections are assumed to be adequate to avoid adverse modification of critical habitat for the 5 corals by federal activities, with the exception of activities that would increase water temperature or contaminants since these water quality features weren't included in the *Acropora* critical habitat designation.
    - **High end of cost range** ($690,000 total; $98,000 annualized) – Incremental costs would include additional administrative effort associated with adding consideration of the final critical habitat to future Section 7 consultations described above. Incremental costs would also include incremental project modifications for activities occurring in critical habitat areas that fall outside of existing *Acropora* critical habitat or activities that may require project modifications for the water quality feature that would be different from modifications required to protect the *Acropora* substrate feature. To the extent additional project modifications are undertaken in areas that overlap the *Acropora* critical habitat, this estimate could understate impacts.
- Distribution of costs:
    - By activity: Impacts to coastal and in-water construction activities (permitted by the USACE) are greatest, followed by beach nourishment/shoreline protection (USACE) and channel dredging (USACE). Each of the remaining activities that may require consultation represents less than 2% of total cost impacts (regardless of the low-end or high-end- scenario) due to limited levels of activity.
    - By unit: Puerto Rico and Florida units account for approximately 51% and 40%, respectively, of total high-end incremental impacts, while STT/STJ and St. Croix units account for 6% and 3%, respectively.

10.1.1 Introduction

The purpose of the economic analysis is to identify and consider the potential economic impacts associated with the designation of critical habitat areas for 5 corals. These economic impacts provide information on some of the potential "benefits of exclusion." In addition, this information addresses the requirements of Executive Orders 12866 (as affirmed and supplemented by Executive Order 13563), which directs federal agencies to assess the costs and benefits of regulatory actions.

To estimate the economic impacts of critical habitat designation, this analysis compares the state of the world with and without the designation of critical habitat for the 5 corals. The "without critical habitat" scenario represents the baseline for the analysis, considering protections already afforded the final critical habitat as a result of the listing of the 5 corals as threatened species, or as a result of other federal, state, and local regulations or protections, notably the previous designation of critical habitat for the 2 Caribbean acroporids. The "with critical habitat" scenario describes the incremental impacts associated specifically with this final designation of critical habitat.

To characterize the economic impacts of critical habitat designation for the 5 corals, this analysis undertakes the following general steps as detailed in the following sections:

1. Characterize the areas being designated, in terms of economic activities and existing management, as well as the presence of overlapping protections such as existing critical habitat designations or conservation areas.
2. Identify the types of projects or activities that may affect critical habitat and that may be subject to Section 7 consultation pursuant to the ESA, and forecast the expected occurrences of these activities within the boundaries of the final critical habitat. We used historical data on Section 7 consultations and interviews with federal action agencies to make these forecasts.
3. Describe the suite of potential project modifications for these activities that may be recommended through Section 7 consultation to ensure they are not likely to destroy or adversely modify critical habitat.
4. Estimate a range of economic impacts of modifying these economic activities for each particular area of designated critical habitat.
5. Provide information on the distribution of economic impacts across the particular areas being designated.
6. Evaluate the potential economic benefits stemming from the incremental project modifications.

10.1.2 Framework of the economic analysis

The U.S. Office of Management and Budget (OMB) instructs federal agencies to provide an assessment of both the social costs and benefits of proposed regulatory actions. OMB's guidelines for conducting economic analyses of regulations direct federal agencies to measure the impacts of a regulatory action against a baseline, which it defines as the "best assessment of the way the world would look absent the proposed action" (U.S. Office of Management and Budget 2003). In other words, the baseline includes the existing regulatory and socio-economic burden imposed on landowners, managers, or other resource users potentially affected by the designation of critical habitat. Impacts that are incremental to that baseline (i.e., occurring over and above existing constraints) are attributable to the regulation. NMFS's and the U.S. Fish and Wildlife Service's regulations addressing the content and timing of critical habitat economic analyses require that the economic analyses of critical habitat rules be focused exclusively on the incremental effects of the designation (50 CFR 424.19).

Accordingly, this economic analysis employs “without critical habitat” and “with critical habitat” scenarios:

1. The “**without critical habitat**” scenario represents the baseline for the analysis, considering protections already afforded the critical habitat for the 5 corals. The baseline for this analysis is the state of regulation absent designation of new critical habitat.
2. The “**with critical habitat**” scenario describes and where possible monetizes the incremental impacts due specifically to designation of critical habitat for the 5 corals. Incremental project modifications and associated impacts are those that are expected to occur solely as a result of critical habitat designation.

10.1.2.1 Identifying Baseline Protections

The baseline for this analysis is the existing state of regulation prior to the designation of critical habitat, including the listing of the 5 corals under the ESA, and other federal, state, and local laws and guidelines. The baseline also reflects a wide range of additional factors beyond compliance with existing regulations that provide protection to the habitat being designated as critical habitat. As recommended by OMB, the baseline incorporates, as appropriate, trends in market conditions, implementation of other regulations and policies by NMFS and other government entities, and trends in other factors that have the potential to affect economic costs and benefits, such as the rate of regional economic growth in potentially affected industries.

Baseline impacts and protections include implementation of sections 7, 9, and 10 of the ESA to the extent that they are expected to occur absent designation of critical habitat for the 5 corals. This analysis does not quantify the baseline costs associated with these protections, as the critical habitat designation will not affect these costs.

- Section 7 of the ESA requires federal agencies to consult with NMFS to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify critical habitat that has already been designated for listed species. Baseline consultations under the jeopardy and adverse modification standards result in administrative costs, as well as costs of implementing any project modifications resulting from consideration of these standards.
- Section 9 defines the actions that are prohibited by the ESA. In particular, it prohibits “take” of endangered wildlife, where “take” means to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (16 USC § 1532). Economic impacts associated with Section 9 that are relevant to this analysis manifest themselves in application of Sections 7 and 10 for listed species. There are no Section 9 prohibitions for critical habitat.
- Under Section 10(a)(1)(B) of the ESA, a non-federal entity (e.g., a landowner or local government) may develop a Habitat Conservation Plan (HCP) for a listed animal species in order to meet the conditions for issuance of an incidental take permit in connection with a land or water use activity or project (U.S. Fish and Wildlife Service 2002). The requirements posed by the HCP may have economic impacts associated with the goal of ensuring that effects of incidental take are adequately avoided or minimized. Development and implementation of HCPs

is considered a baseline protection for the species and habitat unless the HCP is determined to be precipitated by the designation of critical habitat, or the designation influences stipulated conservation efforts under HCPs. Because there are no such permits or plans relevant to this particular analysis, this category of potential baseline protections and costs are not discussed further in this report.

The protection of listed species and critical habitat is not limited to the ESA. Other federal agencies, as well as state and local governments, may also protect the natural resources under their jurisdiction. If compliance with the Clean Water Act (CWA), state environmental quality laws, or best management practices, for example, protects critical habitat for the 5 corals, such protective efforts are considered to be baseline protections. Of note, however, such efforts may not be considered baseline in the case that they would not have been triggered absent the designation of critical habitat. In such cases, they are considered incremental impacts.

10.1.2.2 Identifying Incremental Impacts

Incremental impacts of critical habitat rules result from changes in the management of projects and activities, above and beyond those changes resulting from existing required or voluntary conservation efforts undertaken due to other federal, state, and local regulations or guidelines.

When critical habitat is designated, Section 7 requires federal agencies to ensure that their actions are not likely to destroy or adversely modify critical habitat, in addition to ensuring that the actions are not likely to jeopardize the continued existence of the species. The added administrative costs of considering critical habitat in Section 7 consultation and the additional impacts of implementing conservation efforts (i.e., reasonable and prudent alternatives in the case of an adverse modification finding) resulting from the protection of critical habitat are the direct compliance costs of designating critical habitat.

In identifying incremental impacts, it is important to consider both economic efficiency and distributional effects resulting from critical habitat designation for the 5 corals. Economic efficiency effects generally reflect “opportunity costs” associated with the commitment of resources required to accomplish species and habitat conservation. At the guidance of OMB and in compliance with Executive Order 12866 “Regulatory Planning and Review,” federal agencies measure changes in economic efficiency in order to understand how society, as a whole, will be affected by a regulatory action. In the context of critical habitat designation, these efficiency effects represent the opportunity costs of resources used or benefits foregone by society as a result of the rule. Economists generally characterize opportunity costs in terms of changes in producer and consumer surpluses in affected markets (Gramlich 1990).

We also consider the distribution of impacts associated with the designation, including an assessment of any local or regional impacts of habitat conservation and the potential effects of conservation efforts on small entities. This information on distributional impacts may be used by decision-makers to assess whether the effects of the designation may unduly burden a particular group or economic sector. For example, while project modifications may have a small impact relative to the national economy, individuals employed in a particular sector of the regional economy may experience relatively greater impacts.

In some instances, compliance costs may provide a reasonable approximation for the efficiency effects associated with a regulatory action. For example, a federal permitting agency may enter into a consultation with NMFS to ensure that a particular project will not adversely modify critical habitat. The effort required for consultation is an economic opportunity cost because the agency and/or project proponent's time and effort would have been spent in an alternative activity had the particular area not been included in the designation. When compliance activity is not expected to significantly affect markets—that is, not result in a shift in the quantity of a good or service provided at a given price, or in the quantity of a good or service demanded given a change in price—the measurement of compliance costs can provide a reasonable estimate of the change in economic efficiency.

Where habitat protection measures are expected to significantly impact a market, it may be necessary to estimate changes in producer and consumer surpluses. For example, if a given commercial fishery is precluded from fishing across a large area, the price and quantity of fish on the market may be affected. In this case, changes in economic efficiency (i.e., social welfare) can be measured by considering changes in producer and consumer surplus in the market. As noted above, in some cases, compliance costs can provide a reasonable estimate of changes in economic efficiency. However, if the costs of project modifications are expected to significantly impact markets, the analysis will consider potential changes in consumer and/or producer surplus in affected markets. In the case of the final critical habitat for the 5 corals, incremental project modifications are not anticipated to significantly affect activity levels or markets; therefore, this report focuses solely on compliance costs.

Measurements of changes in economic efficiency focus on the net impact of project modifications, without consideration of how certain economic sectors or groups of people are affected. Thus, a discussion of efficiency effects alone may miss important distributional considerations. OMB encourages federal agencies to consider distributional effects separately from efficiency effects (U.S. Office of Management and Budget 2003). This analysis considers the entities expected to bear the costs associated with the designation, including a separate analysis of potential impacts to small entities (see Appendix B).

Regional economic impact analysis can provide an assessment of the potential localized effects of conservation efforts. Specifically, regional economic impact analysis produces a quantitative estimate of the potential magnitude of the initial change in the regional economy resulting from a regulatory action. Regional economic impacts are commonly measured using regional input/output models. These models rely on multipliers that represent the relationship between a change in one sector of the economy (e.g., expenditures by recreators) and the effect of that change on economic output, income, or employment in other local industries (e.g., suppliers of goods and services to recreators). These economic data provide a quantitative estimate of the magnitude of employment and revenue shifts in the local economy. Given the limited nature of incremental impacts likely to result from this designation, measurable regional impacts are not anticipated.

10.1.2.3 Direct Impacts

The 2 categories of direct, incremental impacts of critical habitat designation are:

1. The administrative costs of conducting Section 7 consultation; and
2. Implementation of any project modifications recommended through Section 7 consultation to avoid potential destruction or adverse modification of critical habitat.

Section 7(a)(2) of the ESA requires federal agencies to consult with NMFS whenever activities that they undertake, authorize, or fund may affect a listed species or designated critical habitat. In some cases, consultations will involve NMFS and another federal agency only, such as the U.S. Army Corps of Engineers (USACE). Often, consultations will also include a third party involved in projects, such as the applicant for a CWA Section 404 permit.

During a consultation, NMFS, the federal action agency, and the entity applying for federal funding or permitting (if applicable) communicate in an effort to minimize potential adverse effects to the species and/or designated critical habitat. Communication between these parties may occur via written letters, phone calls, in-person meetings, or any combination of these. The duration and complexity of these interactions depends on a number of variables, including the type of consultation, the activity of concern, and the potential effects to the species and designated critical habitat associated with the proposed activity, the federal agency, and whether there is a private applicant involved. Section 7 consultations with NMFS may be either informal or formal, based on the determination of adverse effects to the species or critical habitat.

Informal consultations consist of discussions between NMFS, the action agency, and applicant (if applicable) concerning an action that may affect a listed species or its designated critical habitat, and are designed to identify and resolve potential adverse effects at an early stage in the planning process. Informal consultations are concluded by determining that the action is not likely to adversely affect listed species or designated critical habitat.

By contrast, a ***formal consultation*** is required if the action agency or NMFS determines that a proposed federal action may adversely affect listed species or designated critical habitat. The formal consultation process results in NMFS's determination in its Biological Opinion (BO) of whether the action is likely to jeopardize a listed species and/or destroy or adversely modify designated critical habitat, and project modification recommendations to avoid or minimize the impacts of those adverse effects. In addition, NMFS may conduct formal programmatic consultations, which address an agency's multiple actions on a program, regional, or other basis.

Programmatic consultations can be used to evaluate the expected effects of groups of related agency actions expected to be implemented in the future, where specifics of individual projects such as project location are not definitively known. Programmatic consultations allow for streamlined project-specific consultations because much of the effects analysis is completed up front in the Programmatic Opinion. Regardless of the type of consultation or proposed project, Section 7 consultations can require administrative effort on the part of all participants.

As described above, parties involved in Section 7 consultations include NMFS, a federal action agency, and, in some cases, a third-party applicant. While consultations are required for activities that involve a federal nexus and may affect a listed species regardless of whether critical habitat is designated, the additional consideration of critical habitat may increase the effort for consultations if the project or activity in question may affect critical habitat. Administrative efforts for future consultations may therefore include baseline and incremental impacts.

In general, 3 different scenarios associated with the designation of critical habitat may result in incremental administrative consultation costs:

1. **Additional effort to address adverse effects to new critical habitat in a consultation**: Future consultations taking place after critical habitat designation may require additional effort to address critical habitat issues above and beyond addressing effects to listed species or existing designated critical habitat. In this case, only the additional administrative effort required solely to consider effects to the 5 corals critical habitat is considered an incremental impact of the designation.

2. **Re-initiation of consultation to address adverse effects to critical habitat**: Consultations that have already been completed on an ongoing project or activity may require re-initiation to address a new critical habitat designation. In this case, costs of re-initiating the consultation, including all associated administrative and conservation effort costs, are considered incremental impacts of the designation.
3. **New consultation resulting entirely from critical habitat designation**: Critical habitat designation may trigger future consultations that may not occur absent the designation (e.g., for an activity for which adverse modification may be an issue, while jeopardy is not). Such consultations, for example, may be triggered in critical habitat areas in which the species are not present, or in areas outside of critical habitat for other listed species. All associated administrative and conservation effort costs of these consultations are considered incremental impacts of the designation.

In addition to administrative costs, Section 7 consultations in designated critical habitat areas may also include additional project modifications recommended specifically to address potential destruction or adverse modification of the new critical habitat. This analysis refers to "project modifications" as a generic term for recommendations NMFS may make to modify projects or activities for the benefit of any listed species or their designated critical habitat, or that action agencies or other entities may otherwise undertake to avoid adverse effects of their actions on listed species or their designated critical habitat. The ESA Section 7 Consultation Handbook {USFWS and NMFS, 1998}includes more targeted descriptions for other terminology as follows:

- **Conservation measures** are actions to benefit or promote the recovery of listed species that are included by the federal agency as an integral part of the proposed action. These actions will be taken by the federal agency or applicant, and serve to minimize or compensate for project effects on the species under review. These may include actions taken prior to the initiation of the consultation, or actions which the federal agency or applicant have committed to complete in a biological assessment or similar document.
- **Conservation recommendations** are the Services' non-binding suggestions resulting from formal or informal consultation that: (1) identify discretionary measures that a federal agency can take to minimize or avoid the adverse effects of a proposed action on listed or proposed species, or designated or proposed critical habitat; (2) identify studies, monitoring, or research to develop new information on listed or proposed species, or designated or proposed critical habitat; and (3) include suggestions on how an action agency can assist species conservation as part of their action and in furtherance of their authorities under Section 7(a)(1) of the ESA.
- **Reasonable and prudent measures** are actions the Secretary believes necessary or appropriate to minimize the impacts, i.e., amount or extent, of incidental take. These measures are not imposed for effects to critical habitat; however, they may also reduce the impact of adverse effects to the critical habitat.
- **Reasonable and prudent alternatives** are recommended alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that the Secretary believes would avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of designated critical habitat (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998).

For future consultations considering jeopardy and adverse modification, the economic impacts of project modifications undertaken to avoid adverse modification of the designated critical habitat, above and beyond those that would have been undertaken to avoid jeopardy or adverse modification of existing critical habitat for other listed species, are considered incremental impacts of the critical habitat designation.

In some cases, project modifications that are undertaken in order to avoid jeopardy may also avoid adverse modification of critical habitat. That is, while jeopardy and adverse modification are not the same standard, project modifications undertaken to avoid jeopardy may also result in the project avoiding adverse modification of critical habitat. This finding is often true for aquatic and marine species for which the condition of the habitat is inextricably linked to the health of the species. In other words, while avoidance of adverse modification of critical habitat requires protection of essential features, avoiding jeopardy to the species may require protection of these features even absent critical habitat. Listing protections are relevant to the baseline management of activities wherever the listed species are present.

In some cases, the critical habitat impacts may be more readily apparent than the species level effects. For example, turbidity in the water column at a project site may be a concern for the species as well as the critical habitat. NMFS may recommend modifications to such projects to avoid both of these effects. However, measuring the impacts of turbidity on the species may be more difficult than on the habitat itself and, as such, NMFS may be more likely to examine and tie an activity to potential impacts to critical habitat within the Section 7 consultation than to the species. Although the link to adverse modification may be more readily drawn, the outcome of the Section 7 consultation is not expected to be different with or without critical habitat designation. Nonetheless, where adverse modification provides a simpler means to recommend project modifications, but the outcome of consultation is not expected to change as a result of critical habitat designation, we do not assume impacts of the project modifications are incremental to the designation.

10.1.2.4 Indirect Impacts

The designation of critical habitat may, under certain circumstances, affect actions that do not have a federal nexus and thus are not subject to the provisions of Section 7 under the ESA. Indirect impacts are those sometimes unintended changes in economic behavior that may occur outside of the influence of the ESA, through other federal, state, or local actions, and that are caused by the designation of critical habitat. This section identifies common types of indirect impacts that may be associated with the designation of critical habitat. Importantly, these types of impacts are not always considered incremental. In the case that these types of conservation efforts and economic effects are expected to occur regardless of critical habitat designation, they are appropriately considered baseline impacts in this analysis.

OTHER STATE AND LOCAL LAWS

Under certain circumstances, critical habitat designation may provide new information to a community about the sensitive ecological nature of a geographic region, potentially triggering additional economic impacts under other state or local laws. In cases where these impacts would not have been triggered absent critical habitat designation, they are considered indirect, incremental impacts of the designation.

ADDITIONAL INDIRECT IMPACTS

In addition to the indirect effects of compliance with other laws or triggered by the designation, project proponents, land managers and landowners may face additional indirect impacts, including the following:

- **Time Delays** - Both public and private entities may experience incremental time delays for projects and other activities due to requirements associated with the need to reinitiate the Section 7 consultation process and/or compliance with other laws triggered by the designation. To the extent that delays result from the designation, they are considered indirect, incremental impacts of the designation.
- **Regulatory Uncertainty or Stigma** - NMFS conducts each Section 7 consultation on a case-by-case basis and issues a biological opinion on formal consultations based on species-specific and site-specific information. As a result, government agencies and affiliated private parties who consult with NMFS under Section 7 may face uncertainty concerning whether project modifications will be recommended by NMFS and the nature of these modifications. This uncertainty may diminish as consultations are completed and additional information becomes available on the effects of critical habitat on specific activities. Where information suggests that this type of regulatory uncertainty stemming from the designation may affect a project or economic behavior, associated impacts are considered indirect, incremental impacts of the designation.

10.1.2.5 Benefits

Under Executive Order 12866, OMB directs federal agencies to provide an assessment of both the social costs and benefits of regulatory actions. OMB's Circular A-4 distinguishes 2 types of economic benefits: direct benefits and ancillary benefits. Ancillary benefits are defined as favorable impacts of a rulemaking that are typically unrelated, or secondary, to the statutory purpose of the rulemaking (U.S. Office of Management and Budget 2003).

In the context of the ESA, the primary purpose of a critical habitat designation (i.e., the direct benefit) is the potential to enhance conservation of the species. The published economics literature has also documented that social welfare benefits can result from the conservation and recovery of endangered and threatened species. In its guidance for implementing Executive Order 12866, OMB acknowledges that it may not be feasible to monetize, or even quantify, the benefits of environmental regulations due to either an absence of defensible, relevant studies or a lack of resources on the implementing agency's part to conduct new research (U.S. Office of Management and Budget 2003).

Critical habitat aids in the conservation of listed species specifically by protecting the essential biological and physical features of critical habitat on which the species' conservation depends. To this end, critical habitat designation can result in maintenance of particular environmental conditions that may generate social benefits aside from the conservation of the species. That is, management actions undertaken to conserve a species or habitat may have coincident, positive social welfare implications, such as increased recreational opportunities in a region. While they are not the primary purpose of critical habitat, these ancillary benefits may result in gains in employment, output, or income that may offset the direct, negative impacts to a region's economy resulting from actions to conserve a species or its habitat. Section 10.3.1 and Table 26 address the potential benefits of this critical habitat designation.

10.1.2.6 Presentation of Results

Impacts are described in present value and annualized terms applying discount rates of 7% throughout the body of the report. Additionally, Appendix A provides the present and annualized value of impacts in each unit applying a 3% discount rate for comparison with values calculated at 7%. Present value and annualized impacts are calculated according to the methods described in the text box below. Economic impacts of the designation are considered within each of the 6 broad geographic areas of overlapping units being considered for designation and by category of activity.

Ideally, the time frame of this analysis would be based on the expected time period over which the critical habitat regulation is expected to be in place. Specifically, the analysis would forecast impacts of implementing this designation through species recovery (i.e., when critical habitat is no longer required). Recent guidance from OMB indicates that “if a regulation has no predetermined sunset provision, the agency will need to choose the endpoint of its analysis on the basis of a judgment about the foreseeable future” (U.S. Office of Management and Budget 2011). The “foreseeable future” for this analysis includes, but is not limited to, activities that are currently authorized, permitted, or funded, or for which proposed plans are currently available to the public. Accordingly, this analysis forecasts impacts over a ten-year time horizon. OMB supports this time frame stating that “for most agencies, a standard time period of analysis is 10 to 20 years, and rarely exceeds 50 years” (U.S. Office of Management and Budget 2011). Therefore, this analysis considers economic impacts to activities over a 10-year period from 2022 through 2031.

This analysis compares economic impacts incurred in different time periods in present value terms. The present value represents the value of a payment or stream of payments in common dollar terms. That is, it is the sum of a series of past or future cash flows expressed in today's dollars. Translation of economic impacts of past or future costs to present value terms requires the following: a) past or projected future costs of critical habitat designation; and b) the specific years in which these impacts have been or are expected to be incurred. With these data, the present value of the past or future stream of impacts (PVc) from year t to T is measured in 2021 dollars according to the following standard formula:[a]

$$PV_c = \sum_{t}^{T} \frac{C_t}{(1+r)^{t-2021}}$$

Ct = cost of incremental impacts in year t

r = discount rate[b]

This analysis also expresses impacts for each activity as annualized values. Annualized values are calculated to provide comparison of impacts across activities with varying forecast periods (T). For this analysis, activities employ a forecast period of ten years, 2022-2031. Annualized future impacts (APVs) are calculated using the following standard formula:

$$APV_c = PV_c \left[\frac{r}{1-(1+r)^{-(N)}} \right]$$

N = number of years in the forecast period (in this analysis, 10 years)

[a] To derive the present value of future impacts to development activities, t is 2022 and T is 2031.

[b] To discount and annualize costs, guidance provided by the OMB specifies the use of a real rate of 7%. In addition, OMB recommends sensitivity analysis using other discount rates such as 3%, which some economists believe better reflects the social rate of time preference. (U.S. Office of Management and Budget, Circular A-4, September 17, 2003, and U.S. Office of Management and Budget, "Draft 2003 Report to Congress on the Costs and Benefits of federal Regulations; Notice," 68 Federal Register 5492, February 3, 2003.)

10.1.3 Activities that may be affected

To identify the types and geographic distribution of activities that may trigger Section 7 consultation for the 5 corals critical habitat, we first reviewed the Southeast Region's Section 7 consultation history from 2010 to 2020 for activities consulted on in the areas being designated as critical habitat for the 5 corals. Of these, the consultation history includes 4 programmatic, 41 formal, and 341 informal consultations that fall within the boundaries of and may affect the final critical habitat for the 5 corals. In particular, we reviewed the historical formal consultations that may affect the final critical habitat area for the 5 corals in detail to assist in understanding the impacts the activities may have on the final critical habitat, and potential project modifications. In addition to reviewing the consultation history, we conducted targeted outreach to key stakeholders, including the USACE, and state and local permitting agencies to build the list of activities potentially subject to consultation. Outreach included interviews with the Florida Department of Environmental Protection (FLDEP), Puerto Rico Department of Natural and Environmental Resources (DNER) and USVI Department of Planning and Natural Resources (DPNR), as well as county planning agencies.

Based on this information, the types of activities that have the potential to affect the essential features for the 5 corals and involve a federal nexus include the following (in order of the most frequently occurring in final critical habitat):

- Coastal and In-water Construction (e.g. docks, seawalls, piers, marinas, port expansions, anchorages, pipelines/cables, bridge repairs, aids to navigation, etc.)
- Channel Dredging (maintenance dredging of existing or new channels and offshore disposal of dredged material)
- Beach Nourishment/Shoreline Protection (placement of sand onto eroding beaches from onshore or offshore borrow sites)
- Water Quality Management (revision of national and state water quality standards, issuance of National Pollutant Discharge Elimination System (NPDES) permits and Total Maximum daily load (TMDL) standards, registrations of pesticides)
- Protected Area Management (development of management plans for national parks, marine sanctuaries, wildlife refuges, etc.)
- Fishery Management (development of fishery management plans)
- Aquaculture (development of aquaculture facilities)
- Military Activities (all activities undertaken by the Department of Defense, such as training exercises)
- Oil & Gas and Renewable Energy Development (development of oil, gas, or renewable energy, such as tidal power, in the marine environment)

Table 4 summarizes historical Section 7 consultation data for each of these activity categories from 2010 to 2020. The vast majority (approximately 88%) of historical consultations occurring within the designated critical habitat were informal. The limited subset of formal and programmatic consultations (45 actions) was primarily associated with construction activities, beach nourishment/shoreline stabilization, and fishery management activities. Activities for which formal and programmatic consultations were conducted were all located in areas less than 30 meters deep (i.e., within *Acropora* critical habitat), except for fishery management plans which were relevant to all depths. Activities were distributed across most of the designated critical habitat units.

The remainder of this section provides an overview of each of the activities potentially affected by the designated critical habitat, including a description of how they are currently managed under the baseline regulatory environment, and how they may affect the essential features of designated critical habitat for the 5 corals. Baseline protections exist in large areas being designated; however, there is uncertainty as to the degree of protection that these baseline provisions may provide relevant to future projects. In particular, there are 2 broad baseline protections that apply across all activity types that may reduce the potential effects of future activities on the designated critical habitat: (1) The listing status of the 5 corals; and (2) The 2008 *Acropora* critical habitat that overlaps designated critical habitat for the 5 corals.

Table 4. NMFS SOUTHEAST REGION CONSULTATIONS FOR ACTIVITIES THAT MAY AFFECT THE 5 CORALS CRITICAL HABITAT AREAS, BY ACTIVITY TYPE AND ACTION AGENCY (2010 – 2020)

ACTIVITY TYPE	ACTION AGENCY	TOTAL NUMBER OF CONSULTATIONS
Coastal & In-water Construction	USACE	284
Channel Dredging	USACE	14
Beach Nourishment/ Shoreline Protection	USACE	28
Water Quality Management	EPA,USACE	14
Protected Area Management	NOAA, DOI	2
Fishery Management	NMFS	25
Aquaculture	NMFS	5
Military Activities	DOD	7
Oil & Gas and Renewable Energy Development	BOEM, USCG	3
Total		**382**
Source: NMFS. Public Consultation Tracking System and Environmental Consultation Organizer.		

First, as stated above, the listing of the 5 corals under the ESA requires that activities with a federal nexus not be likely to jeopardize the species. In the case of the 5 corals, project modifications that are undertaken in order to avoid or minimize adverse effects and avoid jeopardy most likely also avoid adverse effects to critical habitat. We would likely recommend the same types of project modifications to avoid or minimize adverse modification of the critical habitat as those we would recommend to avoid or minimize adverse impacts to the listed corals due to the linkages between the condition of the habitat and the health of the species. In other words, because the same stressor may adversely affect the coral and the essential features, the same project modification would reduce the impacts to both. Thus, if a project requires consultation to avoid potential adverse effects to both the 5 corals and the designated critical habitat, and the same project modification would address both types of adverse effects, the costs of project modification are co-extensive, i.e., critical habitat would not add project modification costs. However, that assumption only holds in project areas where one or more of the coral species are present and may be affected. While the areas where the 5 corals are present are uncertain, anywhere the threatened coral species are present, project modifications are considered baseline protections which would occur regardless of critical habitat designation. Listing protections are relevant to the baseline management of activities wherever the coral species are present.

Second, the 2008 *Acropora* critical habitat overlaps significantly with the critical habitat for the 5 corals (see Figure 1 and Figure 2). The vast majority of historical activities requiring Section 7 consultation occurred within this overlapping area. In fact, all of the historical formal Section 7 consultations and 90% of historical USACE projects that may affect the final critical habitat occurred within *Acropora* critical habitat areas. Activities occurring in *Acropora* critical habitat are most likely already managed such that adverse modification of critical habitat for the 5 corals is avoided. For example, in these areas, we are already considering impacts related to the *Acropora* critical habitat essential feature of "substrate of suitable quality and availability" defined as "consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover" (73 FR 72210; November 26, 2008). Substrate free from macroalgae cover and sediment cover would encompass water with suitably low levels of nutrients and sediments. Therefore, federal activities that impact water quality by increasing nutrients or sediments may affect the essential substrate feature of *Acropora* critical habitat, and would already be expected to result in project modifications protective of the 5 corals critical habitat under the baseline (as described in the *Acropora* Critical Habitat 4(b)(2) Report).

As such, project modifications that already would have been recommended to avoid adverse modification of *Acropora* critical habitat are expected to result in future projects avoiding adverse modification of critical habitat for the 5 corals under the baseline for many future actions requiring consultation. However, the baseline protections afforded by existing *Acropora* critical habitat are not complete for the 5 corals critical habitat. The water quality component of the essential feature contains temperature and aragonite saturation state as parameters. As discussed above, no federal activities are expected to require consultation due to impacts to the aragonite feature. No baseline protections relevant to the temperature parameter exist with the *Acropora* critical habitat. Thus, incremental project modifications are anticipated for activities that may increase water temperature, should any such activities occur within the 5 corals critical habitat.

In summary, projects occurring within *Acropora* critical habitat but which don't affect water temperature, or in areas where the 5 corals are present (understanding that these areas are uncertain), are expected to implement project modifications that would avoid adverse modification of critical habitat for the 5 corals even absent new critical habitat designation. We therefore anticipate that, in general, in these areas, the final critical habitat will not change the outcome of Section 7 consultations, and additional project modifications will not be necessary. However, given the uncertainty as to where the species might be present the analysis of incremental impacts presented in Section 10.1.6 considers a range of outcomes.

PROTECTIONS PROVIDED BY KEY BASELINE REGULATIONS

Two key baseline protections (i.e., the listing status of the 5 corals and overlapping *Acropora* critical habitat) reduce the potential effects of future activities on critical habitat. In general, for in-water activities occurring in *Acropora* critical habitat or where the 5 corals are present, the following types of project modifications are expected to be implemented, regardless of the designation of critical habitat for the 5 corals:[1]

- Installation of on-land and/or in-water turbidity and sediment barriers
- Use of appropriate anchoring systems
- Conditions monitoring, including monitoring turbidity and sedimentation levels and stopping all work if levels exceed pre-established parameters
- Implementation of dock construction guidelines which prevent shading impacts

Additional information on project modifications is provided in Section 10.1.5.

[1]Based on a review of section 7 biological opinions, and information provided by USACE (USACE personnel J. Cedeño-Maldonado 2015a; USACE personnel G. Ehlinger 2021).

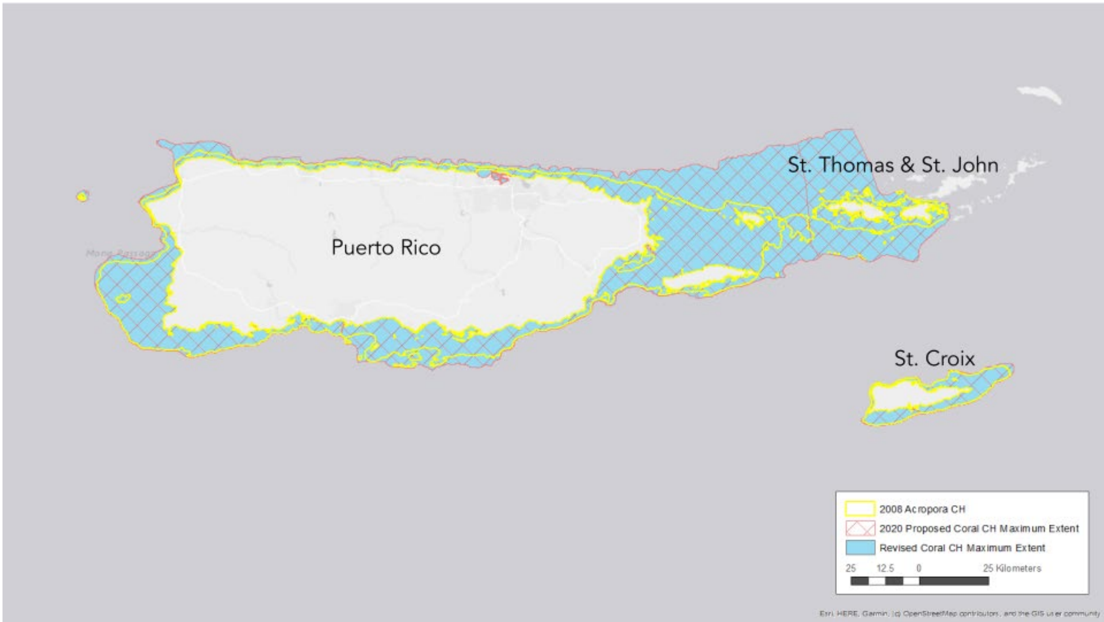

Figure 1. Comparison of maximum extent of Final 5 Coral Critical Habitat with Proposed 5 Coral Critical Habitatt and Acropora Critical Habitat areas in the US Caribbean.

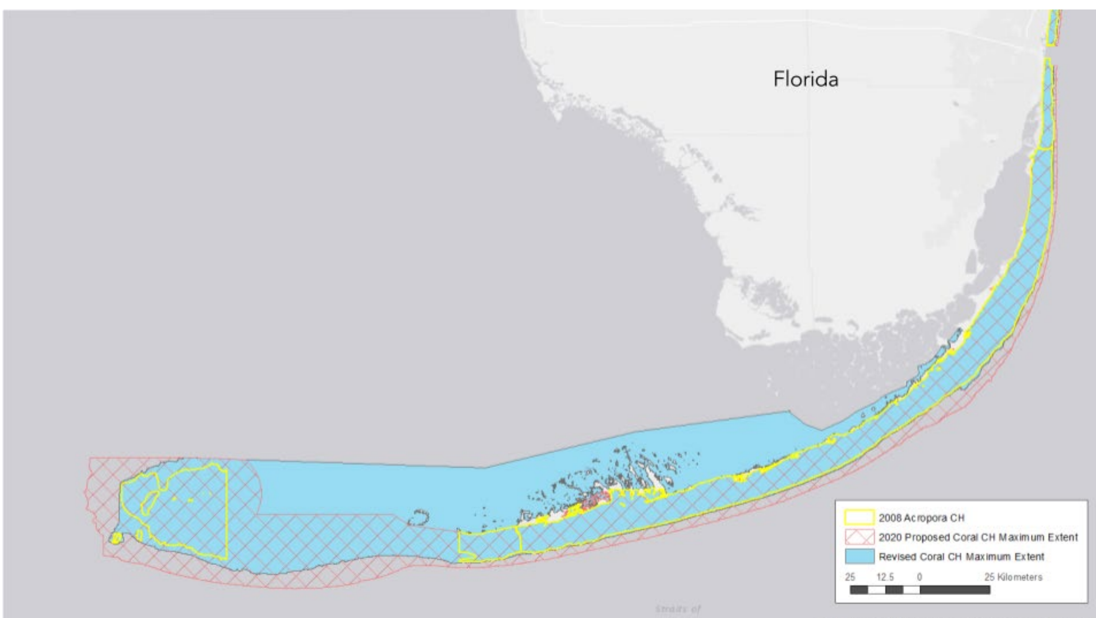

Figure 2. Comparison of the maximum extent of Final 5 Coral Critical Habitat with Proposed 5 Coral Critical Habitat and Acropora Critical Habitat areas in Florida

10.1.3.1 Coastal and In-Water Construction – USACE

Coastal and in-water construction activities are the most frequently occurring potential threat to the 5 corals critical habitat. Between 2010 and 2020, NMFS completed 1 programmatic, 25 formal and 258 informal consultations related to construction activities. These consultations were broadly distributed across the final critical habitat, with 154 in Florida, 74 in Puerto Rico, and 56 in USVI. The 25 formal consultations were all related to activities in depths less than 30 meters where existing *Acropora* critical habitat is located. Coastal and in-water construction consultations represented just under 80% of all consultations from 2010 to 2020 that may affect the final critical habitat.

Construction activities may affect the essential feature of the 5 corals critical habitat in several different ways. Construction activities have the potential to:

- Directly damage or remove hardbottom substrate;
- Create shaded areas over coral habitat, reducing the light necessary for coral growth;
- Generate turbidity and reduce water quality; or,
- Cause sedimentation of coral habitat.

The construction category encompasses a number of activities, each with varying levels of applicability to the types of adverse effects identified above. Table 5 outlines the various types of construction activities observed in the Section 7 consultation history, and lists the number of historical formal and informal consultations identified for each subcategory. While consultations comprised a large number of construction subcategories, 2 categories, "Coastal Construction/Marina/Dredge" and "Dock/Boat Ramp," encompassed more than 70% of the coastal and in-water construction consultations from 2010 to 2020 that may affect the final critical habitat.

Unlike many other construction projects, pipelines and cables may be located in depths greater than 30 meters, and thus occur outside of *Acropora* critical habitat. This is particularly common in the Caribbean, where many cables and pipelines run between islands. In these areas, projects occurring in deeper waters have not been subject to *Acropora* critical habitat consultations and associated protections under the baseline, and may accordingly be subject to incremental changes in management due to the critical habitat designation for the 5 corals. Construction activities that have resulted in consultation in areas deeper than 30 meters include construction of mooring buoys, in addition to pipelines and cables.

Construction activities in U.S. waters are regulated by the USACE. USACE regulated construction in administering permits through the CWA and the Rivers and Harbors Act. Section 404 of the CWA authorizes USACE to regulate and permit the discharge of dredged or fill material into waters of the United States (33 USC § 1344). Sections 9 and 10 of the Rivers and Harbors Act authorize USACE to regulate and permit activities and structures in or affecting navigable waters of the United States (33 USC §§ 401 et seq. 1938).

Table 5. CONSTRUCTION CONSULTATIONS IN FINAL CRITICAL HABITAT AREAS FOR THE 5 CORALS BY SUBCATEGORY (2010 – 2020)

CONSTRUCTION SUBCATEGORY	TOTAL NUMBER OF CONSULTATIONS
Dock/Boat Ramp	138
Coastal Construction/Marina/Dredge/Shoreline Stabilization	70
Pipeline/Cable	15
Marina	13
Artificial Reef	12
Port	10
Anchorage	10
Seawall	5
Bridge	4
Breakwater	3
General Permit - Minor in-water structures	3
General Permit - Coastal Construction	1
TOTAL	**284**
Construction subcategories provided by NMFS. Similar categories such as "Dock" and "Boat Ramp" were consolidated into a single subcategory. Source: NMFS Public Consultation Tracking System and Environmental Consultation Organizer	

USACE's Civil Works division also partners with local port authorities on port expansion projects, which may include dredging new or expanded areas. These projects involve a complex approval process including congressional approval and inclusion in the biennial Water Resources Development Act, legislation that authorizes funding for new civil works projects.

As a condition of permitting, USACE often requires applicants to minimize impacts to corals and coral reef habitat (USACE personnel J. Cedeño-Maldonado 2015a and USACE Jacksonville District Civil Works personnel G. Ehlinger 2021). As a result, some baseline protection for listed coral species and coral reef habitats occurs that may protect the critical habitat feature, even absent the final critical habitat designation for the 5 corals. As part of its duties under the CWA, USACE has frequently required project modifications protective of coral habitat (USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers 2015b; USACE personnel J. Cedeño-Maldonado 2015a; USACE Jacksonville District Civil Works personnel G. Ehlinger). Such protections have included:

- Limiting work and anchoring to areas devoid of coral colonization and hardbottom;
- Installation of on-land and/or in-water turbidity and sediment barriers;
- Use of appropriate anchoring systems;
- Monitoring turbidity and sedimentation levels and stopping all work if levels exceed pre-established parameters; and,
- Implementation of dock construction guidelines which prevent shading impacts over coral resources.

While these coral protection measures have been observed in several past projects, there remains considerable uncertainty regarding the overall frequency and consistency with which these measures have been included in permit applications.

10.1.3.2 Channel Dredging – USACE

Channel dredging encompasses 2 primary activities: dredging new channels or maintenance dredging of existing channels and disposal of dredged materials.[3] USACE is charged with these activities in federally-maintained waterways and federal waters. While existing channels do not contain the essential feature and are therefore not included in critical habitat designation, maintenance dredging has the potential to affect the essential feature in adjacent coral critical habitat through sedimentation of surrounding areas. Dredging new or expanding existing channels has the potential to directly remove the essential feature, or affect the essential feature through sedimentation.

There are 12 harbors with navigation channels that are maintained by the USACE within the final critical habitat that are periodically dredged or expanded (USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers 2015a). Table 6 presents the number of maintenance dredging projects for these harbors from 2002 to 2020. Additionally, USACE sometimes partners with state or local authorities to support maintenance dredging of non-federally-maintained areas. Altogether, channel dredging activities resulted in 32 consultations between 2010 and 2020, including 4 in Florida, 20 in Puerto Rico, and 8 in the USVI. These include maintenance dredging (by USACE and other parties) and siting of ocean dredged materials disposal sites (with EPA concurrence).

Table 6. SUMMARY OF DREDGING ACTIVITIES IN FEDERALLY MAINTAINED HARBORS

FEDERALLY MAINTAINED HARBOR	NUMBER OF DREDGING PROJECTS	MOST RECENT PROJECT
FLORIDA		
Palm Beach Harbor (Lake Worth Inlet)	20	2020
Port Everglades	2	2013
Miami Harbor	2	2013
Key West Harbor	3	2011
PUERTO RICO		
San Juan Harbor	3	2017
Arecibo Harbor, Fajardo Harbor, Guaynes Harbor, Ponce Harbor, and Mayaguez Harbor	3	2020
U.S. VIRGIN ISLANDS		
St Thomas Harbor and Christiansted Harbor	None expected (harbors have not been actively maintained in the past 25 years).	
Source: (USACE Jacksonville District Civil Works Division personnel G. Ehlinger 2021) Also, review of consultation history. Notes: Dredging frequency estimated based on the dredging event history from 2002 to 2020.		

As with other USACE-permitted activities, the CWA provides some baseline protection to corals and coral habitat with respect to the management of channel dredging projects, and some of these coral

[3] Note, activities involving new dredging and port expansion projects are included in the Coastal and In-water Construction category.

protection measures may also prevent adverse effects to the final critical habitat feature. For example, USACE aims to avoid and minimize the impacts of channel dredging on coral species and habitat through strategies such as sedimentation and turbidity controls (USACE personnel J. Cedeño-Maldonado 2015a).

Of note, USACE also issues permits for off-shore dumping of dredged material under the Marine Protection, Research and Sanctuaries Act, also known as the Ocean Dumping Act, using EPA's environmental criteria and subject to EPA's concurrence (United States Environmental Protection Agency 2015b). Based on available information, all of the Ocean Dredged Material Disposal Sites near the final critical habitat areas occur in areas deeper than 90 meters (United States Environmental Protection Agency 2015a); thus, this activity is not expected to be affected by the designation of critical habitat.

10.1.3.3 Beach Nourishment/Shoreline Protection – USACE

Under Section 404 of the CWA, the USACE is responsible for permitting beach nourishment and shoreline protection projects that involve potential impacts to the final critical habitat (33 USC § 1344). Both beach nourishment and shoreline protection projects can involve the placement of sand onto eroding beaches. The replacement sand is either dredged from offshore deposits (i.e., a sand borrow area) or retrieved from another source on land. In either case, beach nourishment and shoreline protection activities may affect the 5 corals critical habitat (USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers 2015b). Beach nourishment and shoreline protection may result in direct burial of recruitment substrate by placement of sand. Additionally, sand that becomes suspended in the water column has the potential to settle on hardbottom substrate, reducing the habitat's suitability for coral colonization by binding with turf algae {Clausing 2014}(Speare, Duran et al.). Both the dredging and placement of sand are likely to create turbidity, which affects water clarity and thus can impact the essential feature of designated critical habitat.

Between 2010 and 2020, USACE initiated 1 formal consultation and 27 informal consultations related to beach nourishment/shoreline protection projects in the final critical habitat, including 22 consultations in Florida, 4 in Puerto Rico, and 2 in the USVI.

As with other USACE-permitted activities, the CWA provides some baseline protection against the potential impacts of beach nourishment and shoreline protection projects. USACE aims to avoid coral habitat when selecting offshore sand deposits, and may require turbidity controls to minimize negative impacts to water clarity and substrate (USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers 2015b). The state of Florida also has regulations in place to protect water clarity, and generally requires these types of projects to apply turbidity and sedimentation controls, and to stop work if a project exceeds agreed upon limits. FLDEP has indicated that these types of baseline protections are not likely to change as a result of the final critical habitat (FLDEP personnel K. Weaver and M. Seeling 2015). Table 7 provides estimates of the number of beach nourishment projects completed at various locations within the Florida critical habitat units between 2000 and 2020. There is not a similar level of coordinated beach nourishment activities in Puerto Rico and the USVI, due to the differences in the geomorphology between Florida's continental coast and the Caribbean islands.

Table 7. SUMMARY OF BEACH NOURISHMENT PROJECTS ON THE EAST COAST OF FLORIDA (2000-2020)

COUNTY	BEACH	NUMBER OF PROJECTS	YEAR OF MOST RECENT PROJECT	OUTSIDE *ACROPORA* CRITICAL HABITAT?
Martin	Jupiter Island	4	2020	✓
Martin	Blowing Rocks Beach	3	2020	✓
Palm Beach	Coral Cove Park	5	2020	✓
Palm Beach	Jupiter-Carlin Park Beach	12	2020	✓
Palm Beach	Juno Beach	2	2010	✓
Palm Beach	Singer Island	12	2017	✓
Palm Beach	Midtown	8	2020	✓
Palm Beach	Phipps	5	2020	✓
Palm Beach	Ocean Ridge	3	2020	
Palm Beach	Delray Beach	5	2020	
Palm Beach	North Boca Raton	2	2014	
Palm Beach	Central Boca Raton	3	2017	
Palm Beach	South Boca Raton	4	2017	
Broward	Hillsboro Beach	6	2020	
Broward	Pompano Beach	5	2016	
Broward	Dr. Von D. Mizell-Eula Johnson Beach State Park	7	2019	
Miami-Dade	Golden Beach	9	2019	
Miami-Dade	Bal Harbour	9	2017	
Miami-Dade	Surfside	2	2020	
Miami-Dade	Miami Beach	18	2018	
Miami-Dade	Key Biscayne	4	2017	
Monroe	Sea Oats Beach	0	N/A	
Monroe	Long Key State Park	0	N/A	
Monroe	Curry Hammock State Park	3	2016	
Monroe	West Coco Plum Beach	2	2013	
Monroe	Key Colony Beach	0	N/A	
Monroe	West Key Colony Beach	0	N/A	
Monroe	Sombrero Beach	1	2014	
Monroe	Little Duck Key	0	N/A	
Monroe	Bahia Honda State Park	0	N/A	
Monroe	Boca Chica Key	0	N/A	
Monroe	Smathers Beach	5	2019	
Monroe	Rest Beach	3	2012	
Monroe	Simonton Beach	1	2019	
Monroe	Fort Zachary Taylor Historic State Park	2	2016	

Source: Florida Department of Environmental Protection 2020.

In addition to these beach nourishment projects, Table 8 lists the number of federal shoreline protection projects requiring dredging of offshore sand deposits completed between 2002 and 2020. These projects also have the potential to reduce water quality, and to suspend sand in the water column which could settle on hardbottom substrate, reducing the habitat's suitability for coral colonization.

Table 8. SUMMARY OF DREDGING FOR FEDERAL SHORELINE PROTECTION PROJECTS ON THE EAST COAST OF FLORIDA (2002-2020)

SHORELINE PROTECTION PROJECT	NUMBER OF DREDGING PROJECTS	MOST RECENT
Martin County	3	2017
Palm Beach County	6	2020
Broward County	1	2005
Dade County	3	2014

Source: (USACE Jacksonville District Civil Works Division personnel G. Ehlinger 2021)
Notes:

1. Dredging frequency estimated based on the dredging event history from 2002 to 2020.
2. Monroe County was not included in this table because there have been no federal shoreline protection projects in the county in the past 25 years.

10.1.3.4 Water Quality Management – EPA

This activity encompasses efforts by the EPA, states, and territories to establish appropriate water quality standards, as well as ocean discharges and onshore activities that have the potential to affect water quality. This activity also includes the registration of pesticides by the EPA. Changes in onshore land use practices can adversely affect the water column or suitable substrate aspects of critical habitat in 6 primary ways:

- Increased water temperature;
- Increased dissolved inorganic nutrients;
- Increased particulate organic matter;
- Reduction in light from turbidity;
- Increased sedimentation;
- Increase contaminants.

The status of water quality standards development in each relevant area is summarized below:

- Florida's current thermal surface water criteria for coastal and open waters are 92° F (33.3°C) and 97° F (36.1°C), respectively, turbidity limit of < 29 NTU, and site-specific criteria for chlorophyll a vary from 0.2 to 1.09 µg L-1 for open ocean coastal waters (Florida Department of State 2021). Florida is currently conducting its triennial review of its statewide water quality standards (Florida Department of Environmental Protection 2021). As part of this triennial review, FLDEP is proposing several revisions to water quality standards including a narrative turbidity criterion to protect corals and updated cadmium criteria.

- In Puerto Rico, the most recent completed formal consultation for water quality standards was in 2003, related to promulgation of standards across the territory (United States Environmental

Protection Agency 2014). According to EPA, thermal discharge and turbidity standards currently are 86° F and 10 NTUs, respectively (United States Environmental Protection Agency 2019). Several recent consultations between EPA and NMFS have considered impacts to corals and *Acropora* critical habitat.

- In the USVI, current water quality standards took effect in 2019 and include a temperature criterion that areas where coral reef ecosystems are located are not to exceed 25-29° C, nor be greater than 1.0° C above natural conditions as a result of waste discharge (U.S. Virgin Islands Department of Planning and Natural Resources 2019). This maximum temperature standard replaced the prior maximum allowable water temperature standard of 32° C (U.S. Virgin Islands Department of Planning and Natural Resources 2016). The maximum permissible turbidity reading is 1 NTU in areas where coral reefs are present and 3 NTU elsewhere, and phosphorus levels are not to exceed 50 ug/l in marine and coastal waters (U.S. Virgin Islands Department of Planning and Natural Resources 2019).

As part of the process of reviewing state or tribe-adopted water quality standards for CWA section 303(c) approval, EPA considers levels that would be needed to be protective of corals and their habitat, especially since the listing and designation of *Acropora* critical habitat (EPA Region 2 and 4 personnel I. Wojtenko C. Harper and L. Petter 2015; FLDEP personnel K. Weaver and M. Seeling 2015). Accordingly, the effect of developing water quality standards on coral habitat is a consideration even absent critical habitat designation for the 5 corals. Recommendations that result from Section 7 consultation on water quality standards related to multiple species, including the 5 corals, have the potential to result in more stringent water quality standards in the future. However, this would likely occur regardless of critical habitat designation for the 5 corals.

The NPDES program provides a method of achieving water quality standards by regulating point sources of pollution into U.S. waters. States and territories can be granted primacy by EPA to manage NPDES permits, though EPA retains the right to reject state programs and administer permits according to its own standards.

Currently, Florida and the USVI manage their own NPDES programs, while the Puerto Rico program is administered by EPA. Absent a federal nexus associated with issuance of a permit in Florida and the USVI, Section 7 consultation regarding corals and their habitat is expected to be limited to the triennial review of water quality standards, which involves EPA oversight. In Puerto Rico, however, to the extent that EPA determines that issuance of individual NPDES permits may affect corals or their critical habitat, Section 7 consultation is required.

A review of the Section 7 consultation history from 2010 to 2020 identified 14 consultations related to water quality management activities, including 11 in Puerto Rico, 1 in the USVI, and 2 in Texas (FGB). In addition to EPA consultations regarding water quality standards, these have included consultations on upland and nearshore restoration projects, and, as noted, issuance of NPDES discharge permits in Puerto Rico.

10.1.3.5 Protected Area Management – NOAA National Ocean Service, DOI National Park Service

A number of protected areas overlap with the specific areas under consideration for the 5 corals critical habitat. These protected areas include federal marine sanctuaries, parks, monuments, and wildlife refuges. The primary threat to the 5 corals associated with protected areas relates to human use of the areas. Many of the protected areas overlapping the final critical habitat are popular tourist destinations for activities such as boating, fishing, and diving. As a result, there is the potential for inadvertent damage to the substrate aspect of the essential feature of critical habitat from vessel anchoring or grounding, and certain fishing and diving practices.

Table 9 lists these protected areas as well as the associated management agency, and where readily available, a list of existing measures that may be protective of corals and their habitat. These protected areas are guided by formal management plans implemented by federal agencies. When a federal agency is involved, such as the National Park Service, revisions to these management plans may require Section 7 consultation. From 2010 to 2020, protected area management led to 1 programmatic consultation and 1 informal consultation. The informal consultation was related to a management plan at the Key Biscayne Special Management Zone.

While human use of protected areas has the potential to adversely impact coral critical habitat, many protected areas provide specific regulations to protect coral reefs. The level of protection differs between protected areas, as detailed in Table 9, but some examples of regulations include:

- Restrictions on vessel anchoring and requiring use of mooring buoys;
- Prohibiting activities such as mining, drilling and construction of structures on the seabed;
- Prohibiting destroying or removing hard substrate;
- Prohibiting discharges into the waters; and
- Prohibiting fishing with bottom longline, bottom trawl, dredge, pot, or trap.

Table 9. FEDERAL PROTECTED AREAS WITHIN THE FINAL CRITICAL HABITAT

PROTECTED AREA	LAND MANAGER	PROTECTION LEVEL[8]	KEY BASELINE PROTECTIONS
Florida Keys National Marine Sanctuary	NOAA, National Marine Sanctuaries	Zoned w/No Take Areas	Prohibited: Moving, removing, taking, harvesting, damaging, disturbing, breaking, cutting, or otherwise injuring, or possessing (regardless of where taken from) any living or dead coral or coral formation, or attempting any of these activities, except as permitted; and drilling into, dredging, or otherwise altering the seabed of the Sanctuary.[1]
Biscayne National Park	National Park Service	Zoned Multiple Use	Several areas are closed year-round to public entry to protect sensitive resources and wildlife. Beaching or anchoring of vessels is prohibited in several areas of the Park.[2]
Dry Tortugas National Park	National Park Service	Zoned w/No Take Areas	Prohibits extractive activities in the Research Natural Area, including fishing; commercial fishing within Dry Tortugas National Park is prohibited; fish traps in the Tortugas region are prohibited; boats may only anchor on sand within one nautical mile of the Fort Jefferson Harbor Light; and vessel discharges are prohibited.[3]
Flower Garden Banks National Marine Sanctuary	National Marine Sanctuaries	Zoned Multiple Use	Prohibited: Injuring or removing, or attempting to injure or remove, any coral or other bottom formation; drilling into, dredging, or otherwise altering the seabed of the Sanctuary; and anchoring any vessel within the Sanctuary.[4]
Buck Island Reef National Monument	National Park Service	No Take	Prohibited: dredging and filling; boat operation that damages underwater features; and anchoring other than in deep sand bottom areas.[5]
Virgin Islands National Park	National Park Service	Zoned w/No Take Areas	Prohibited: dredging and filling; boat operation that damages underwater features; and anchoring except in emergency situations.[6]
Virgin Islands Coral Reef National Monument	National Park Service	Zoned Multiple Use	Prohibited: Collecting coral, dead or alive; dredging, excavating, or filling operations; and anchoring is restricted.[7]
Sources: [1] 15 CFR 922.163, [2] 16 USC § 410gg, [3] 36 CFR 7.274, [4] 15 CFR 922.122., [5] 36 CFR 7.73., [6] 36 CFR 7.74., [7] 36 CFR 7.46.			

10.1.3.6 Fishery Management – NMFS

Fishing may affect the substrate essential feature of the 5 corals critical habitat. There are a number of fisheries within the final critical habitat which are regulated through Fisheries Management Plans (FMPs) developed under the Magnuson-Stevens Fishery Conservation and Management Act. The FMPs are designed and implemented by NMFS through regional Fisheries Management Councils. Revisions to FMPs resulted in 12 formal consultations and 13 informal consultations from 2010 to 2020 relevant to the final critical habitat areas.

The 2 federally-managed fisheries with the greatest potential to adversely affect the 5 corals critical habitat are Reef Fish and Spiny Lobster. The spiny lobster fishery, located in the South Atlantic, Gulf of Mexico, and Caribbean, is primarily a trap fishery, and thus has the potential to directly cause physical damage to corals. However, the trap gear is unlikely to damage critical habitat when corals are not present (National Marine Fisheries Service 2009; NMFS-SERO personnel A. Herndon 2015). A 2009 consultation on the South Atlantic/Gulf of Mexico Spiny Lobster FMP states, “we believe that trap impacts to *Acropora* critical habitat will be temporary and of such limited scope, that any adverse effects will be insignificant” (National Marine Fisheries Service 2009). Even as the FMP has undergone revisions over the past decade, including protections specific to the listing of the 5 corals, it is unlikely that designation of the 5 corals critical habitat will result in any additional closures during the revision of the FMP. The spiny lobster fishery exists primarily in shallower waters already considered for closure to protect the 2 acroporids.

The Caribbean spiny lobster fishery, which is smaller than its Atlantic/Gulf of Mexico counterpart, is managed separately but also largely overlaps areas covered by *Acropora* critical habitat. As of 2020, management of the fishery is distributed across three independent island-based FMPs (the Puerto Rico FMP, St. Thomas/St. John FMP, and the St. Croix FMP), replacing the previous FMP for the Spiny Lobster of Puerto Rico and the U.S. Virgin Islands (National Marine Fisheries Service 2020). The latest consultation on this fishery was conducted in 2020 and found that the FMP was not likely to destroy or adversely affect the substrate feature comprising *Acropora* critical habitat. The consultation further concluded that trap deployment would only temporarily affect the functionality of the essential feature and would not destroy or adversely modify critical habitat (National Marine Fisheries Service 2020.

The Caribbean reef fish fishery, managed under the same island-based FPMs as the Caribbean spiny lobster fishery, also implements potentially damaging fishing practices, such as traps, but also presents a threat due to the removal of herbivorous fishes that remove macroalgae from potential coral settlement substrate. The harvest of reef fish reduces herbivory, leading to increased populations of macroalgae, which can put competitive pressure on corals (National Marine Fisheries Service 2011). However, a 2020 biological opinion completed in conjunction with the consultation recommending the shift to the island-based FMPs states that “the available information on the growth and spread of macroalgae in the U.S. Caribbean indicates that herbivorous fish harvest is contributing very minimally to its growth” (National Marine Fisheries Service 2020). Moreover, the new FMPs maintain previously enacted measures likely leading to increased grazing of herbivorous fish and include additional prohibitions against the fishing for or possession of species of sea urchins, “which is expected to improve the algae grazing dynamics occurring in [*Acropora*]critical habitat” (National Marine Fisheries Service 2020).

In order to provide context for the analysis, including the benefits discussed in Section 10, Table 10 and Table 11 display the annual landings and economic value of the reef fish and spiny lobster fisheries. As illustrated in these exhibits, the fishery with the highest value is Florida’s spiny lobster fishery, totaling over $32 million in 2019. The 2019 value of landings in the Caribbean spiny lobster fishery was approximately $3.2 million. The Caribbean reef fish fishery was valued at approximately $3.9 million in Puerto Rico and $1.4 million in the USVI in 2019.

Table 10. ANNUAL LANDINGS AND VALUE OF THE SPINY LOBSTER FISHERY

FISHERY	LOCATION	2019 LANDINGS (POUNDS)	2019 VALUE (DOLLARS)
Spiny Lobster	Florida East Coast	343,903	$2,630,116
	Florida West Coast	3,775,800	$29,506,058
	Florida Total	**4,119,703**	**$32,136,486**
	Puerto Rico	330,585	2,254,095
	USVI	106,117	960,883
	Caribbean Total	**436,702**	**$3,214,978**
Source: NMFS Southeast Fisheries Science Center (SEFSC) personnel K. Johnson 2021.			

Table 11. ANNUAL LANDINGS AND VALUE OF THE CARIBBEAN REEF FISH FISHERY

REEF FISH	PUERTO RICO		USVI	
	2019 LANDINGS (POUNDS)	2019 VALUE (DOLLARS)	2019 LANDINGS (POUNDS)	2019 VALUE (DOLLARS)
Goatfish	2,818	$7,726	284	1,639
Groupers	46,175	161,112	37,126	218,961
Grunts	17,509	33,675	23,843	142,009
Hogfish	39,505	159,553	2,659	15,955
Jacks	42,642	262,013	22,686	141,630
Parrotfish	24,586	51,142	31,752	189,140
Scup or porgy	11,227	21,399	5,126	30,743
Snappers	596,717	3,044,655	47,836	294,994
Squirrelfish	1,781	3,682	5,443	26,724
Surgeonfish	-	-	13,406	79,132
Triggerfish	38,663	73,370	36,518	218,134
Trunkfish (boxfish)	29,559	84,900	4,920	9,329
TOTAL	**851,182**	**3,903,227**	**231,599**	**1,368,389**
Source: NMFS SEFSC personnel K. Johnson 2021.				

The regional Fisheries Management Councils are responsible for delineating Essential Fish Habitat (EFH) for federally managed fisheries. Similar to ESA Section 7 consultation for listed species and critical habitats, an EFH consultation with NMFS is required whenever an activity with a federal nexus has the potential to adversely affect EFH. The existence of EFH for corals and other species, and that coral reefs constitute EFH for many species, provides some level of baseline protection against damages to coral habitat from fishing activity. However, EFH alone is not likely to provide sufficient protection to the 5 corals critical habitat because the conservation recommendations that result from EFH consultations are not compulsory (National Marine Fisheries Service 2015a). Information is not readily available to estimate how frequently EFH recommendations are implemented, because this information is not tracked.

Additionally, as discussed above, there are several protected areas within the final critical habitat that provide baseline levels of protection against potentially damaging fishing activities. Some protected areas, such as the Florida Keys National Marine Sanctuary and the Buck Island Reef National Monument, do not allow fishing within certain special restriction zones. Other protected areas permit fishing, but prohibit potentially ecologically damaging techniques such as bottom longline, bottom trawl, dredge, pot, or trap.

10.1.3.7 Aquaculture – NMFS

Aquaculture also presents a potential threat to the essential features of the 5 corals critical habitat (National Marine Fisheries Service 2014a). Aquaculture infrastructure, such as net pens and fixed structures, has the potential to physically damage hardbottom habitat. Additionally, aquaculture facilities have the potential to reduce the water quality of surrounding areas by increasing sediment, nutrient, and pathogen concentrations. NMFS is responsible for considering and preventing and/or mitigating the potential adverse environmental impacts of planned and existing marine aquaculture facilities in federal waters through the development of FMPs, sanctuary management plans, permit actions, proper siting, and consultations with other regulatory agencies at the federal, state, and local levels (National Oceanic and Atmospheric Administration 2011).

Between 2010 and 2020, there were 5 informal consultations related to aquaculture activity, with 4 in Florida and 1 in the Gulf of Mexico. While an FMP has been developed for aquaculture activity in the Gulf of Mexico, neither the South Atlantic nor Caribbean Fisheries Management Councils has any plans to develop aquaculture FMPs. As such, consultations are not anticipated in these areas. In the areas where aquaculture activity is contemplated, impacts to critical habitat are considered unlikely due to existing baseline protections, as discussed in a 2009 informal consultation on the Gulf of Mexico Aquaculture FMP (Gulf of Mexico Fishery Management Council 2009). Specifically, this proposed FMP for aquaculture prohibits siting offshore aquaculture facilities in coral areas, including hardbottom areas (81 FR 1762, January 13, 2016). The Section 7 consultation on the proposed FMP determined that aquaculture activity was not likely to adversely affect acroporid corals due to these existing siting requirements. This consultation did not consider *Acropora* critical habitat, because none exists in the Gulf of Mexico. However, the siting requirements that avoid impacts to the 2 corals would also avoid impacts to the 5 corals, as affirmed in a recent Section 7 informal consultation (National Marine Fisheries Service 2015b), as well as the final critical habitat. Given that these baseline siting requirements are already being implemented where future aquaculture activities are contemplated in the 5 corals critical habitat, it is not expected to result in incremental impacts to aquaculture activities.

10.1.3.8 Military Activities – DOD

Military activities encompass all activities conducted by the Department of Defense. Several military installations throughout the final critical habitat areas conduct activities with the potential to damage critical habitat. Training activities conducted by the Navy present the primary threat to both essential features of coral critical habitat. Activities that may result in attaching cables or pipelines to the seafloor, ships dragging anchors, or ammunition landing on the ocean floor have the potential to physically damage critical habitat. Ammunition training may also reduce water quality by generating turbidity, or lead to sedimentation of coral critical habitat. Between 2010 and 2020, NMFS conducted 7 informal consultations related to Navy activities in the final critical habitat areas, 4 of which were in Puerto Rico and 3 in Florida. One of these consultations, regarding the U.S. Navy's Atlantic Fleet Training and Testing Activities from November 2013 to November 2018, evaluated potential effects to the 5 corals, and *Acropora* critical habitat. The consultation determined that military expended materials and seafloor devices may affect, but are not likely to adversely affect, listed coral species and *Acropora* critical habitat. All other potential stressors related to Navy training and testing activities were determined to have no effect on coral species (National Marine Fisheries Service 2013).

Two consultations, in 2011 and 2013, were for the installation of cables within the Navy's South Florida Ocean Measuring Facility (discussed in Section 10.2). These consultations did not affect any coral species, because the cables were routed to avoid corals. These consultations did not consider effects to *Acropora* critical habitat because the area was excluded based on national security impacts. However, installation of the cables would have affected the substrate essential feature.

10.1.3.9 Oil and Gas and Renewable Energy Development – BOEM

The development of offshore oil, natural gas, and renewable energy resources is regulated by the BOEM. As discussed in the following subsections, based on our review of the consultation history and discussions with state and federal agencies, no oil and gas activity within or affecting the final critical habitat is anticipated. Due to new authorities in the Inflation Reduction Act of 2022 (IRA), some offshore wind activity within or affecting the final critical habitat is anticipated.

OIL AND GAS EXPLORATION AND DEVELOPMENT

The Bureau of Ocean Energy Management (BOEM) grants leases for the development of offshore oil and gas resources. Development of oil and gas resources has the potential to damage coral critical habitat through several pathways. Oil and gas platforms and ships have the potential to physically damage corals or hardbottom habitat, and may reduce water quality through increased sedimentation and turbidity. Additionally, an oil spill from a wellhead or transport vessel could damage the final critical habitat.

The majority of the 5 corals critical habitat occurs within the BOEM Straits of Florida planning area. There are no active oil and gas leases within this planning area, and the area wasis not included in the 2017-2022 lease sale program. It is unlikely that the Straits of Florida planning area will be included in future programs either, as there have been no commercial discoveries along the east coast of Florida, and the area has not been included in a lease program since 1987-1992 (BOEM 2021).

Discussion with BOEM indicates that oil and gas development is highly unlikely within the final critical habitat within the next ten years. Specifically, due to a lack of political and regional support for oil and gas exploration, it is unlikely that any new leases would be included for the Florida Straits area in the in the anticipated 2024-2029 National OCS Oil and Gas Leasing Program. The IRA extended new authority to BOEM to lease areas offshore the U.S. Territories for wind development, including offshore Puerto Rico and the U.S. Virgin Islands. The IRA also included a mandate that BOEM publish a Call for Information and Nominations, a key step in the offshore leasing process, by September 2025. BOEM does not have authority to lease for oil and gas development offshore the U.S. territories.

As mentioned above, oil spills have the potential to affect the 5 corals critical habitat.[4] For example, an oil spill could cover or shade the substrate, depending on the density of the oil spilled. However, consultations pertaining to oil spills would focus on any federal response action involved. The U.S. Coast Guard (USCG) is responsible for implementing the Oil Pollution Act, including responding to oil spills and vessel groundings that pose a threat of oil releases. In reviewing the Section 7 consultation history, only 1 consultation related to oil spill response planning or emergency response activities was identified within the final critical habitat area; this consultation has been categorized under water quality since it related to the Caribbean Regional Response Team policy for the use of dispersants during oil spill response activities. While the policy preauthorized the use of dispersants in some Caribbean waters, the policy did not preauthorize the use of dispersants in waters containing coral reefs without further consultation with NMFS (Caribbean Regional Response Team 2012). Future consultations of this type are expected to be infrequent and unpredictable.

[4] Note that while oil spills and vessel groundings may affect critical habitat, these activities would not be authorized or conducted by a federal agency and as such would not require section 7 consultation.

RENEWABLE ENERGY PROJECTS

Due to the favorable flow of the Gulf Stream through the Straits of Florida planning area, there is some interest in developing ocean current power in the region. BOEM granted a limited ocean power lease to Florida Atlantic University in 2014 to allow for testing of the technology (BOEM 2014). The lease was located 10 to 12 nautical miles offshore of Fort Lauderdale, several miles farther out to sea than the boundary of the 5 corals critical habitat. Discussion with BOEM indicates that the shallowest area for consideration for hydrokinetic energy offshore southeast Florida in the Gulf Stream would be 200 meters, outside of the final critical habitat (BOEM personnel G. Boland 2015a).

We note that interest in developing hydrokinetic power in the Straits of Florida was demonstrated by a proposed hydrokinetic project in the Florida Keys. The project received permits from USACE and the Florida DEP, but it appears this project never came to fruition (McLean 2009). While this project demonstrated the potential for future interest in hydrokinetic projects, based on discussion with BOEM, it is unlikely any hydrokinetic projects will occur within the final critical habitat within the next ten years (BOEM personnel G. Boland 2015b).

10.1.3.10 Activities that Lead to or Address Greenhouse Gas Emissions or Global Climate Change

Activities that lead to global climate change (e.g. greenhouse gas emissions) may affect the final critical habitat's temperature and aragonite saturation parameters of the water quality essential feature. Such activities have the potential to increase water temperature and decrease the aragonite saturation state. Regulation of greenhouse gas emissions is the most-likely activity with a federal nexus. However, there is no record of consultations on federal activities related to greenhouse gas emissions. Further, the Environmental Protection Agency recently reiterated its analysis that Section 7 consultation is not required for regulations that address emissions because "any potential for a specific impact on listed species in their habitats associated with these very small changes in average global temperature and ocean pH is too remote to trigger the threshold for ESA section 7(a)(2)" (80 FR 64509; October 23, 2015).

Based on the lack of historical consultations and EPA's opinion that Section 7 consultation is not triggered by regulation of greenhouse gas emissions, we have no basis to project future consultations that may affect the final critical habitat. Therefore, this analysis will not include this category of activities in the estimation of incremental costs.

10.1.4 Projection of Future Section 7 Consultations

This section discusses the methods applied to forecast the quantity and distribution of future Section 7 consultations that will consider the 5 corals critical habitat. This section focuses on the forecast number of consultations; the methods for determining incremental project modifications are discussed in the next section. Because the entire critical habitat designation is broadly considered to have corals present, and therefore would already trigger Section 7 consultation under the baseline, we did not identify that this designation would likely result in incremental consultations solely as a result of the designation of critical habitat for the 5 corals. However, there may be incremental costs associated with those consultations as a result of administrative and project modification costs.

Significant uncertainty exists with respect to the levels and locations of future projects and activities that may require Section 7 consultation considering critical habitat for the 5 corals. Absent better information, our analysis bases forecasts of future Section 7 consultations on historical information. This may overstate impacts to the extent NMFS handles more consultations on a programmatic basis, or it may understate impacts if more formal consultations are required as a result of critical habitat designation. However, this analysis provides a signal of costs likely to occur in a given area. This analysis relies on the best available information to forecast future projects and activities, including:

1. Targeted interviews with key federal action agencies and relevant local government agencies to identify anticipated future projects that may affect critical habitat for the 5 corals; and
2. Information on the historical frequency and location of projects with a federal nexus as indicated by the following key sources:
    a. NMFS Public Consultation Tracking System (PCTS) and NMFS Environmental Consultation Organizer (ECO) Section 7 consultation history from 2010 to 2020. The PCTS and ECO were queried to identify consultations on all species in NMFS Southeast Region that involved activities with the potential to affect the essential features of the 5 corals critical habitat. Some of the projects associated with identified consultations occurred outside of the final critical habitat area but had the potential to result in impacts within the critical habitat area (e.g., sedimentation resulting from a beach nourishment project).
    b. USACE's Jacksonville permit application database from 2010 to 2020 (USACE Jacksonville District 2021). The USACE permit application database was queried to identify all permit applications located within the final critical habitat area. The data was then refined to only include those activities that may affect the final critical habitat.

Our forecast assumes that trends in the location and frequency of consultations over the next ten years will be similar to the past approximately ten years. To verify that this was a reasonable approach for estimating future Section 7 consultation efforts that would need to consider impacts to the 5 corals critical habitat, we undertook the following steps:

- **Compared the numbers of known upcoming Section 7 consultations and re-initiations to the forecasts** based on discussions with USACE personnel regarding ongoing and planned navigation channel dredging projects and beach nourishment/shoreline protection projects in the final critical habitat area.[5] In addition, EPA provided information about ongoing and upcoming consultations related to water quality standards, and other permitting agencies we spoke with mentioned potential future consultation efforts. Based on this comparison, we believe the

[5] Email communication between NMFS and G. Ehlinger, Jacksonville District Civil Works Division, USACE Jacksonville District Civil Works Division personnel G. Ehlinger. 2021. Email communication. NMFS, editor provided information regarding the frequency of channel dredging and shoreline stabilization projects within the proposed critical habitat. Additional information on the frequency of beach nourishment projects was found in the FLDEP Strategic Beach Management Plan Florida Department of Environmental Protection. 2020. Strategic Beach Management Plan. The historical frequency of beach nourishment/shoreline stabilization projects identified through these sources was roughly comparable to the historical frequency of section 7 consultations. However, the historical frequency of channel dredging projects indicated by USACE was greater than the frequency suggested by the section 7 consultation history. This may be because a single consultation (e.g., a regional or programmatic consultation) with NMFS can address multiple maintenance dredging projects. As a result, this analysis assumes that the section 7 consultation history is the best predictor of future consultations on channel dredging

forecasts are adequate and likely account for all known upcoming consultations, including expected re-initiations.

Reviewed historical Section 7 consultation history from NMFS and permit data from USACE to identify any potential trends in levels or locations of consultations that should be considered in our forecast. This analysis identified that the number of Section 7 consultations spiked in 2013, but otherwise was fairly stable. Thus, we did not identify any predictable trends in consultation activity and find that applying an average annual rate of consultations based on the recent past is most representative of the likely future activity levels.

- This analysis assumes that the Section 7 consultation history, combined with the USACE permit data, provide a complete view of historical activities within the 5 corals critical habitat which would trigger Section 7 consultation if they are implemented in the 5 corals critical habitat in the future.[6] The Section 7 consultation history represents past activity only in areas with existing listed species or critical habitat. Existing critical habitat, including habitat designated for acroporid corals, loggerhead sea turtle, green sea turtle, hawksbill sea turtle, and leatherback sea turtle, overlaps the majority of the final 5 corals critical habitat. The only areas of the final critical habitat that do not overlap with existing critical habitat are portions of the US Caribbean at depths greater than 30 meters, and some areas north of the Florida Keys, and between Key West and the Dry Tortugas at all water depths. The USACE permit data, which was used to supplement the NMFS consultation data for forecasting informal consultation, spans all geographic areas. A review of the USACE data suggests that the only projects that take place in the deeper areas (greater than 30 meters) are projects such as pipeline and cable, mooring buoy or artificial reef installation, which are not expected to require formal or programmatic consultations, based on past consultations. Also, as noted above, we do not anticipate that the final critical habitat will result in any new consultations that would not have occurred absent critical habitat.

While the historical consultation rate is likely to be an imperfect predictor of the number of future actions, the designation of critical habitat for the 5 corals is not expected to result in any new Section 7 consultations that would not have already been expected to occur absent designation (i.e., triggered solely by the designation of critical habitat). This is because, given the listing of the 5 corals, and the fact that the final critical habitat overlaps with consultation areas for other listed species (e.g., green, hawksbill, leatherback, and loggerhead sea turtles) and critical habitats, Section 7 consultations are already likely to occur. However, the need to evaluate impacts to the final critical habitat in future consultations will add an incremental administrative burden, in consultations in areas outside of designated *Acropora* critical habitat and consultations that affect water temperature.

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[6] The designation of critical habitat for the 5 corals is not expected to generate an increase in consultation frequency because the *Acropora* critical habitat would already have triggered consultation with NMFS in the area where the majority of activity is expected to occur (e.g., areas less than 30 meters)..

10.1.4.1 Projected Formal and Programmatic Consultations

Between 2010 and 2020, NMFS completed 41 formal consultations and 4 programmatic consultations in the areas being considered for the 5 corals critical habitat designation. The formal consultations involved construction activities, beach nourishment projects, and fishery management plans. Programmatic consultations involved general construction permits, oil and gas exploration and development, water quality regulations, and management of protected areas.

To forecast the location of future consultations, we identified the critical habitat unit associated with each historical formal or programmatic consultation. We then projected the future number of consultations expected to occur in each critical habitat unit, based on the trends established in the consultation history. Because impacts of the designation only stem from incremental costs, we only present the numbers of consultations likely to result in incremental costs in the following projections. In other words, there will likely be many more consultations that occur within and may affect the 5 corals critical habitat, but only those that would not have already considered *Acropora* critical habitat are projected in the following sections. As discussed previously, known upcoming Section 7 consultations were compared to the forecasts based on historical information. This comparison indicated that the currently planned projects are likely to be captured in the forecasts based on the historical frequency of programmatic and formal Section 7 consultations.

Based on the historical rate of consultations, we project that approximately 2 programmatic consultations will be conducted that may affect the 5 corals critical habitat in the next ten years and result in incremental impacts. Previous locations of programmatic consultations suggest that these consultations are most likely to occur in Florida and FGB, as shown in Table 1. It should be noted, however, that there is a high degree of uncertainty with respect to both the volume and geographic scope of future programmatic consultations that would result in incremental costs.

Table 12. PROJECTED QUANTITY AND DISTRIBUTION OF INCREMENTAL PROGRAMMATIC SECTION 7 CONSULTATIONS (2022- 2031)

PROGRAMMATIC CONSULTATIONS	
Critical Habitat Unit	**Consultations**
Florida	1.0
Puerto Rico	0.0
STT/STJ	0.0
St. Croix	0.0
Navassa	0.0
FGB	1.0
TOTAL	2.0

In addition to the 2 programmatic consultations, as shown in Table 13, we project that approximately 2 formal consultations are likely to incrementally consider the 5 corals critical habitat in the next ten years. We project that these consultations will likely occur in Florida, Puerto Rico, and FGB.

Where a project is expected to overlap multiple critical habitat units, we divide the expected number of future consultations across the relevant units. In some areas, the consultation forecast in this table is presented as a fraction (e.g., 0.5). This does not imply that we anticipate a fraction of a consultation will occur in this area. Rather, these fractions result from apportioning a single consultation to a particular unit when it may cover multiple geographic areas. In these instances, the consultation (and associated cost) is divided across the relevant units. This is particularly relevant in the case of programmatic or formal consultations that cover a larger geographic scope than a project-specific consultation.

Table 13. PROJECTED QUANTITY AND DISTRIBUTION OF INCREMENTAL FORMAL SECTION 7 CONSULTATIONS (2022 – 2031)

FORMAL CONSULTATIONS	
Critical Habitat Unit	**Consultations**
Florida	0.5
Puerto Rico	1.0
STT/STJ	0.0
St. Croix	0.0
Navassa	0.0
FGB	0.5
TOTAL	2.0

10.1.4.2 Projected Informal Consultations

Future informal consultations were projected based on the frequency and distribution of informal consultations conducted from 2010 to 2020 as well as a review of USACE permit applications over the same time frame (USACE Jacksonville District 2021). The USACE database sorts each permit application into 1 of 5 categories: Nationwide General Permit, Regional General Permit, Standard Individual Permit, Letter of Permission, or Pre-Application Consultation. This analysis assumes that permit applications listed as Standard Individual Permits or Letters of Permission would have required informal Section 7 consultations with NMFS. Permit applications listed as Nationwide General Permits, Regional General Permits, or Pre-Application Consultations are assumed to require lower levels of administrative effort, and thus are treated as technical assistance consultations and not included in this analysis.

Review of USACE permit application data is particularly useful because the database encompasses activities that may not have been consulted on in the past if they were outside of previously designated critical habitats or areas containing species protected under the ESA. For example, areas within the 5 corals critical habitat that do not overlap critical habitat for any other species include areas off Puerto Rico and the USVI deeper than 30 meters, and certain areas between Key West and the Dry Tortugas. In these deeper waters, the majority of projects encompass activities such as placement of buoys and artificial reefs. As discussed previously, these projects are unlikely to require formal and programmatic consultations, but they are still likely to require informal consultations. As a result, for these areas, the USACE permit application data can be compared to the Section 7 consultation history to assess the latter's completeness.

Comparison of the NMFS consultation history and USACE permit history confirmed that the relative distributions of consultation activity across critical habitat units were comparable between the 2 data sources, thereby validating use of the NMFS consultation database to project future informal consultations on USACE projects.

Projections of informal consultations with action agencies other than the USACE were also based on information from the NMFS consultation database. Water quality consultations with the EPA and fishery management consultations constituted just over half of the informal consultations that did not have a USACE nexus. Most of the water quality consultations were related to NPDES permits in Puerto Rico. The remaining informal consultations that did not have a USACE nexus comprised coastal and in-water construction and military activities and were spread across nine federal agencies, including the Department of Defense, Federal Emergency Management Agency, U.S. Fish and Wildlife Service , and National Park Service.

We expect that approximately 31 informal consultations will be incrementally impacted by the 5 corals critical habitat within the next ten years (2022 – 2031). We expect 13 of these consultations will occur in Florida, 15 will occur in Puerto Rico, 2 in St. Thomas and St. John, 1 in St. Croix, 0 in Navassa Island, and 0 in FGB. For each critical habitat unit, Table 14 provides a detailed summary of the expected number of informal consultations.

Table 14. PROJECTED QUANTITY AND DISTRIBUTION OF INFORMAL SECTION 7 CONSULTATIONS (2022-2031)

INFORMAL CONSULTATIONS	
Critical Habitat Unit	**Consultations**
Florida	13
Puerto Rico	15
STT/STJ	2
St. Croix	1
Navassa	0
FGB	0
TOTAL	31

As exhibited in Table 15, informal consultations are projected to account for 31 out of 35 total consultations that will be incrementally impacted by the 5 corals critical habitat designation within the next ten years. Informal consultations on coastal- and in-water construction activities are anticipated to comprise 66% of incrementally impacted consultations, with the remaining incrementally impacted consultations distributed across beach nourishment/shoreline protection, channel dredging, water quality management, military, and energy development activities. As discussed in Section 10.1.3, the 5 corals critical habitat designation is not likely to incur incremental costs for consultations involving protected area management, fishery management, or aquaculture activities.

Table 15. FORECAST of SECTION 7 CONSULTATIONS THAT WOULD AFFECT THE FIVE CORALS' CRITICAL HABITAT, but NOT AFFECT ACROPORA CRITICAL HABITAT, BY ACTIVITY AND TYPE (2022 – 2031)

Consultation Type	Coastal & In-water Const.	Beach Nourish-ment	Channel Dredging	Water Quality Mgmt.	Military	Energy Devel.	Total
Programmatic	0	0	0	1	0	1	2
Formal	0	0	1	0	0	1	2
Informal	23	5	1	1	2	0	31
TOTAL	23	5	2	2	2	2	35
% of Total	66%	13%	5%	5%	5%	5%	100%
Note: Informal consultations by activity do not sum to total due to rounding.							

10.1.5 Potential Project Modifications

Next we evaluate whether and where the 5 corals critical habitat designation may generate project modifications above and beyond those undertaken under the baseline, for example, to avoid jeopardy to the 5 corals or to protect other co-located species and habitats. Through discussions with the federal agencies, and various county and state level agencies, we have identified the types of project modifications that would likely be undertaken to avoid adverse modification or destruction of the 5 corals critical habitat. This section provides an overview of potential project modifications and identifies whether those project modifications would be expected to be incremental (e.g., would not be required in the absence of critical habitat designation).

Because of the nature of the essential features and location of the critical habitat for the 5 corals, project modifications to protect the species and habitat are generally similar for many of the potentially affected activities. For example, whether the project involves construction of a dock, marina or port expansion, dredging, or installation of a cable or pipeline, permits for all of these in-water activities are likely to include requirements for surveying, sediment and turbidity control measures, and conditions monitoring. Further, the project modifications that would be necessary to avoid adverse effects to the species and *Acropora* critical habitat are the same as those for the final critical habitat. Even with the addition of a water quality essential feature in the final critical habitat, the project modifications would be the same because federal actions causing adverse effects to the benthic feature would also adversely affect the water quality feature (e.g., turbidity in the water column leads to sedimentation on the substrate). However, there is one exception: the final critical habitat includes temperature as a parameter of the water quality essential feature. Federal actions that may cause changes in water temperature may affect the final critical habitat but would not adversely affect the *Acropora* critical habitat substrate feature. Thus, for projects that may affect water temperature, in which the corals are not present, additional project modifications may be required. Notably, however, no projected future consultations within the 5 corals critical habitat on projects that would change water temperature are projected over the next ten years.

As part of reviewing CWA Section 404 permit applications, USACE reviews the potential effects of the proposed action and includes conditions in the permit to avoid or minimize potential impacts to corals (i.e., designated essential fish habitat and those listed under the ESA) from the proposed action.

According to the USACE, commonly utilized project modifications (USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers 2015b; USACE personnel J. Cedeño-Maldonado 2015a) related to corals and coral habitat include:

- Limiting work and anchoring to areas devoid of coral colonization and hardbottom;
- Installation of on-land and/or in-water turbidity and sediment barriers;
- Use of appropriate anchoring systems;
- Monitoring turbidity and sedimentation levels and stopping all work if levels exceed pre-established parameters; and,
- Implementation of dock construction guidelines to prevent shading impact over coral resources.

Table 16 summarizes project modifications that may be considered to protect the 5 corals critical habitat. This list was generated based on a review of the Final Endangered Species Act 4(b)(2) Report for Elkhorn and Staghorn Corals Critical Habitat, as well as discussions with and information provided by federal action agencies and various state level permitting agencies. Table 16 includes many project modifications that may be recommended to avoid destruction or adverse modification of critical habitat, regardless of whether they would also be recommended under other baseline regulations.

Depending on the circumstances, these project modifications may be considered baseline (i.e., would be required regardless of critical habitat designation) or incremental (i.e., resulting from critical habitat designation). We identified those project modifications likely to be recommended specifically due to the presence of critical habitat for the 5 corals based on: 1) geographic location; 2) activity type; and 3) results of surveys to determine the potential presence of the 5 corals.

- **Geographic location**: As previously noted, where the final critical habitat for the 5 corals overlaps existing *Acropora* critical habitat, incremental project modification recommendations are unlikely. This is because project modification recommendations made to avoid jeopardy to listed corals or adverse modification of *Acropora* critical habitat would also result in avoidance of destruction or adverse modification of critical habitat for the 5 corals. One exception is projects that may increase water temperature. Because temperature increases would not affect the *Acropora* critical habitat essential feature, there would be no baseline project modifications for these activities.
- **Activity type**: To identify activities likely to be subject to additional project modifications, we identified those activities likely to be occurring in the areas outside of *Acropora* critical habitat or that would affect water temperature, based on a review of historical activity. For that subset of activities, we spoke with permitting agencies to determine whether additional project modifications would be recommended beyond those that might already be in place due to other baseline protections, such as typical permit conditions required by USACE. Based on this research, certain types of activity are unlikely to be subject to incremental project modifications due to existing baseline regulatory protections, including the listing of the 5 corals. These include:
    - **Aquaculture**. Aquaculture activity is not expected to affect the 5 corals critical habitat due to existing siting requirements that prohibit siting offshore aquaculture facilities on coral reef areas where aquaculture activity is contemplated within the final critical habitat.17

- **Fishery Management**. It is unlikely that consultation on fishery management plans within the next ten years will result in additional project modifications due to the designation of critical habitat for the 5 corals because any project modifications would be co-extensive with the listing of the 5 corals.
- **Military Activities**: Military training activities are not expected to affect the final critical habitat based on the nature of the activities. However, the activities (e.g., cable laying) that occur at the SFOMF may affect the final critical habitat by directly covering it. These impacts are discussed in Section 10.2 National Security Impacts, and are not considered further in this section.
- **Protected Area Management**. Consultations related to protected area management over the next ten years are not expected to result in incremental project modifications as these protected areas generally provide specific regulations to protect coral reefs; however, some minor adverse effects may be unavoidable.
- **Water quality**. It is unlikely that consultation on projects that could affect water quality within the final critical habitat will result in incremental project modifications, as no projects with a federal nexus are anticipated to affect water temperature. Any project modifications that would be necessary to achieve water quality standards would be required regardless of the 5 corals critical habitat designation.

- **Results of surveys**: Where surveys indicate the presence of 1 or more of the 5 corals, project modifications recommended to avoid jeopardy to the species are most likely to result in the project avoiding adverse modification of critical habitat. That is, where the species are identified at a project or activity site, critical habitat designation is unlikely to result in incremental project modification recommendations. Where species are not detected during surveys, however, project modifications may be incremental effects of the critical habitat designation.

Table 16 indicates whether each type of project modification is likely to be considered incremental, and explains the rationale for those types of project modifications we do not expect to be incremental, even in cases where the 5 corals are not present.

In addition, it is unlikely that additional benthic surveying efforts would be requested as a result of critical habitat designation for the 5 corals; the coral listing would trigger a need for surveying the project area for all projects and activities occurring within the final critical habitat area. Furthermore, most companies operating in deeper areas already conduct surveys that are sufficient to identify hardbottom substrate (NMFS-Caribbean Field Office personnel L. Carrubba 2015; USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers 2015b).

Table 16. SUMMARY OF POTENTIAL PROJECT MODIFICATIONS

POTENTIAL PROJECT MODIFICATIONS[1]	AFFECTED ACTIVITIES	BASE-LINE	INCRE-MENTAL	RATIONALE
Surveying (e.g., benthic characterization, water quality characterization)	Coastal and In-water Construction; Channel Dredging; Beach Nourishment/ Shoreline Protection; Aquaculture; Military Activities; Water Quality Management, Oil and Gas and Renewable Energy Development	✓		NMFS and USACE have indicated that it is unlikely that additional surveying efforts would result from critical habitat designation for the 5 corals; the listing would trigger a need for surveying the project area across all of the areas in the critical habitat designation.(2, 3) Furthermore, most companies operating in deeper areas already conduct surveys which are sufficient to identify hardbottom substrate.(3)
Conditions Monitoring (e.g., monitoring environmental conditions such as turbidity, sediment load and rate, and nutrients, to avoid adverse effects to corals or habitat)	Coastal and In-water Construction; Channel Construction; Channel Dredging; Beach Nourishment/ Shoreline Protection, Water Quality Management	✓	✓	In areas outside of *Acropora* critical habitat, where surveys do not indicate the presence of any of the 5 corals, these types of project modifications may be incremental as they may not be recommended absent critical habitat for the 5 corals. Specifically, USACE has indicated that a commonly utilized “avoidance and minimization condition” tailored to each project includes monitoring turbidity and sedimentation levels and stopping all work if levels exceed pre-established parameters.(7) While many projects likely already implement some form of conditions monitoring, baseline protections may not always be sufficient to protect the 5 corals critical habitat from adverse modification;(8) thus, in some instances the existence of critical habitat may result in the need for additional conditions monitoring.

POTENTIAL PROJECT MODIFICATIONS[1]	AFFECTED ACTIVITIES	BASE-LINE	INCRE-MENTAL	RATIONALE
Project Relocation (e.g., changes to the footprint of the project)	Coastal and In-water Construction;Channel Dredging; Beach Nourishment/ Shoreline Protection; Aquaculture; Military Activities; Water Quality Management, Oil and Gas and Renewable Energy Development	✓		While critical habitat does not create a protected area that precludes economic activities, projects occurring within critical habitat must avoid adverse modification of the essential features. Projects involving in-water activities are already likely to avoid areas of hardbottom substrate in the areas that overlap the final critical habitat due to existing practices and baseline protections (i.e., EFH). Specifically, in instances where relocation of project activities would be recommended to avoid adverse modification of critical habitat, relocation would already be likely to occur due to EFH consultation recommendations or USACE avoidance and minimization measures, regardless of the presence of critical habitat for the 5 corals.(2) Given the expanse of the final critical habitat for the 5 corals, it is highly unlikely that any projects would be recommended for relocation outside of the critical habitat boundaries. While critical habitat may provide additional justification for a minor project relocation recommendation within critical habitat boundaries, the critical habitat designation alone is unlikely to trigger project relocations.In addition, for many of the types of projects occurring in deeper waters (e.g., outside of *Acropora* critical habitat) such as laying pipeline, cables, and fiber optic cables, proponents will often attempt to follow established routes, which generally attempt to avoid coral reefs, and do not cause adverse effects to the substrate.(3)(4) Further, baseline regulations restrict siting of aquaculture facilities in coral areas (defined to include marine habitat in the Gulf or South Atlantic EEZ where coral growth abounds including patch reefs, outer bank reefs, deep water banks, and hard bottoms).(6)Based on these existing baseline protections, we do not expect that that project relocation would be recommended solely due to the presence of critical habitat.

POTENTIAL PROJECT MODIFICATIONS[1]	AFFECTED ACTIVITIES	BASE-LINE	INCRE-MENTAL	RATIONALE
Sediment and Turbidity Control Barriers (e.g., silt curtains to contain the sediment or turbidity plume)	Coastal and In-water Construction; Channel Dredging; Beach Nourishment/ Shoreline Protection, Water Quality Management	✓	✓	In areas that do not overlap *Acropora* critical habitat and where surveys do not indicate the presence of any of the 5 corals, these types of project modifications may be incremental. Discussions with USACE and review of USACE permits indicate that these types of project modifications would likely be recommended in critical habitat areas where the species are not present (i.e., specifically due to the presence of critical habitat).(8) For example, a recent Biological Opinion related to shoreline stabilization and breakwater construction activities that considered effects to *Acropora* critical habitat included the following measure: (9) • Sediment control measures shall be designed and implemented based on the physical and oceanographic characteristics of the site to reduce sediment resuspension and transport during all in-water construction activities and minimize the potential for impacts such as burial, smothering, abrasion, and scouring to listed corals and their ESA-designated critical habitat.We further note, to avoid impacts to corals and coral habitat, many USACE permits include the following conditions: (8)(10) • Permittee shall install floating turbidity barriers with weighted skirts that extend to within 1 foot of the bottom around all work areas. • Permittee shall install erosion control measures along the perimeter of all work areas to prevent the displacement of fill material outside the work area.While many projects may already incorporate sediment and turbidity control barriers, we recognize that there is some uncertainty regarding the consistency with which these types of permit conditions would be required by USACE in areas where the corals are not present.(7) Thus, in some instances the existence of critical habitat may result in the need for additional sediment and turbidity control barriers.
Pipe Collars/Cable Anchoring (e.g., methods to anchor pipe or cable to the substrate to avoid damage that could occur from unexpected movement of the pipe or cable, such as during a storm event)	Coastal and In-water Construction	✓	✓	In areas that do not overlap *Acropora* critical habitat where surveys do not indicate the presence of any of the 5 corals, these types of project modifications may be incremental. Discussions with USACE indicate that these types of project modifications would likely be recommended even in areas where the species are not present in order to avoid destruction or adverse modification of critical habitat.(8)

POTENTIAL PROJECT MODIFICATIONS[1]	AFFECTED ACTIVITIES	BASE-LINE	INCRE-MENTAL	RATIONALE
Diver Assisted Anchoring/Mooring Buoy Use	Coastal and In-water Construction; Channel Dredging; Beach Nourishment/ Shoreline Protection	✓	✓	In areas that do not overlap *Acropora* critical habitat where surveys do not indicate the presence of any of the 5 corals, these types of project modifications may be incremental. For example, information provided by USACE indicates that the following conditions have previously been included in permits: "The permittee shall use a marine biologist to survey the area where turbidity barriers will be anchored, to ensure no anchors are placed on corals or critical habitat."(8)While many projects may already incorporate diver assisted anchoring/mooring buoy use, there is some uncertainty regarding consistency with which these types of permit conditions would be required by USACE in areas where the corals are not present. Thus, in some instances the existence of critical habitat may result in the need for additional assisted anchoring/mooring buoy use.
Potential restrictions on fishing gear, and methods in fishery management plans	Fishery Management	✓		For the fisheries of concern in the areas outside of *Acropora* critical habitat (e.g., spiny lobster and reef fish), these types of project modifications would be recommended due to concerns about jeopardy, not adverse modification of the critical habitat.(11)
Funding additional fisheries research, assessment and monitoring efforts	Fishery Management	✓		These types of project modifications may be broadly recommended via Section 7 consultation but not specifically due to critical habitat. (11)
Revisions to annual catch limits in fisheries management plans	Fishery Management	✓		NMFS considered the addition of incremental areas beyond the *Acropora* critical habitat in its revised analysis to the Caribbean Reef Fish Fisheries Management Plan. However, given the area of overlap between *Acropora* critical habitat and the final critical habitat for the 5 corals, it is unlikely that additional changes will result from designation of critical habitat for the 5 corals.

POTENTIAL PROJECT MODIFICATIONS[1]	AFFECTED ACTIVITIES	BASE-LINE	INCRE-MENTAL	RATIONALE
Thermal Discharge Dissipation (i.e., reducing the temperature of a thermal discharge through technologies such as multiple port diffusers or effluent blending)	Water Quality Management	✓	✓	In areas where surveys do not indicate the presence of any of the 5 corals, and regardless of overlap with *Acropora* critical habitat, this type of project modification may be incremental. That is, changes in water temperature would not affect the *Acropora* critical habitat essential feature, thus consultation would not result in any project modifications. Baseline regulations do require a maximum temperature of the effluent, but may not be protective enough to avoid adverse effects to the final critical habitat.
Water Quality Standard Modification	Water Quality Management	✓		Water quality standards are currently being reviewed in light of measures that would be considered protective for corals and their habitat, and more stringent standards have recently been implemented in USVI. However, EPA indicated that the revised standards in the USVI were set at a more stringent level to provide protection for corals and their habitat and, thus, independently of the final 5 corals critical habitat designation. (12) In, addition, FLDEP indicates that the process and considerations for setting water quality standards would likely not be affected by the designation of critical habitat. Florida is currently undertaking studies with NOAA to understand what water quality standards may be needed to protect corals and coral habitat in deeper areas, using remote sensing. In recent consultations with respect to numerical nutrient standards, based on input from NMFS, FLDEP (on behalf of EPA) set standards equal to existing conditions for areas where the presence of listed coral species indicated water quality conditions were protective of corals.(13) USVI DPNR indicates that the current process for setting water quality standards is based on physical and human health risks, but they are working (as part of the Section 7 consultations between EPA and NMFS) to consider standards that would be ecosystem based.(14)Because of the typical scope of projects related to water quality standards, it is likely that both the corals and essential feature would be present within the same action area, thus the potential project modifications would likely remain the same for both the species and the final critical habitat.(15) Thus, changes to water quality standards, and the ultimate impacts of changing those standards, are considered baseline impacts for purposes of this analysis.

POTENTIAL PROJECT MODIFICATIONS[(1)]	AFFECTED ACTIVITIES	BASE-LINE	INCRE-MENTAL	RATIONALE

Notes:

(1) Potential project modifications were identified through discussions with USACE, and other state and local agencies, and from the Final Endangered Species Act Section 4(b)(2) Report Impact Analysis for Critical Habitat Designation for Threatened Elkhorn & Staghorn Corals.
(2) USACE Jacksonville District Civil Works Division personnel T. Jordan-Sellers (2015b).
(3) NMFS-Caribbean Field Office personnel L. Carrubba (2015).
(4) Puerto Rico Department of Natural and Environmental Resources personnel E. Diaz (2015).(5) U.S. Army Corps of Engineers (2014). (6) 50 CFR 622.2.(7) USACE personnel J. Cedeño-Maldonado (2015a).
(5) U.S. Army Corps of Engineers (2014).
(6) 50 CFR 622.2.
(7) USACE personnel J. Cedeño-Maldonado (2015a).
(8) USACE personnel J. Cedeño-Maldonado (2015b).
(9) National Marine Fisheries Service (2012).
(10) U.S. Army Corps of Engineers (2013).
(11) NMFS-SERO personnel A. Herndon (2015).
(12) EPA Region 2 and 4 personnel I. Wojtenko C. Harper and L. Petter (2015); NMFS-Caribbean Field Office personnel L. Carrubba 2015; NMFS ESA Interagency Cooperation Division personnel H. Nash and P. Shaw-Allen (2015).
(13) FLDEP personnel K. Weaver and M. Seeling (2015).
(14) USVI DPNR personnel J. P. Oriol (2015).
(15) NMFS ESA Interagency Cooperation Division personnel H. Nash and P. Shaw-Allen (2015).

Based on the above, with respect to incremental project modifications and associated costs (Section 10.1.6), this analysis accordingly focuses on informal and formal coastal and in-water construction, channel dredging, and beach nourishment/shoreline protection activities in areas outside of *Acropora* critical habitat where the 5 corals are not present. It also focuses on informal and formal water quality management (i.e., thermal discharges) where the 5 corals are not present, regardless of overlap with *Acropora* critical habitat.

As detailed in Table 16, these are the project modifications that could potentially be incremental (i.e., recommended as a result of the final critical habitat for the 5 corals). Where both the baseline and incremental columns are checked in Table 17, the project modification is expected to be baseline in some areas (i.e., *Acropora* critical habitat) but potentially incremental in others. Unit-cost information for these types of incremental project modifications is included in Table 17.

Table 17. COST OF POTENTIALLY INCREMENTAL PROJECT MODIFICATIONS (2021$)

Potential project modification	Cost Description	Average Per Project Cost[1]
Conditions Monitoring (*e.g.*, monitoring environmental conditions such as turbidity, sediment load and rate, and nutrients, to avoid adverse effects to corals or habitat)	Per day costs of monitoring range from $1,200 per day[2] for small projects such as inshore/nearshore projects that require only one person and no diving to monitor turbidity, water quality, and protected species, to $8,000 per day[3] for a larger (5 person minimum) dive team to conduct more extensive monitoring. For purposes of cost estimation, projects are assumed to last 5 days, based on the types of projects where incremental costs are expected to occur.[4]	$25,000 per project
Sediment and Turbidity Control Barriers (*e.g.*, silt curtains to contain the sediment or turbidity plume)	Applications for barriers are almost exclusively restricted to inshore waters or protected nearshore waters. For purposes of cost estimation we applied costs for application of barriers for a small project (150 ft. perimeter curtain) of $4,900 [5], which occur with the highest frequency. Costs of sediment and turbidity control barriers ranges from roughly $43,000 per mile [6] for silt curtains, to $58,000 per mile [7] for turbidity control barriers.	$5,400 per project
Pipe Collars/Cable Anchoring (*e.g.*, methods to anchor pipe or cable to the substrate to avoid damage that could occur from unexpected movement of the pipe or cable, such as during a storm event)	$1,200 every 20 meters of reef.[8] Estimated simplified per-project cost for a single crossing of an entire reef ranges from $12,000 - $120,000.[9]	$73,000 per project

Potential project modification	Cost Description	Average Per Project Cost(1)
Diver Assisted Anchoring/Mooring Buoy Use	In-water construction projects that would require diver assisted anchoring would likely already require conditions monitoring by a diver who could assist with anchoring if needed; thus, the analysis assumes any incremental costs associated with diver assisted anchoring are captured in the incremental costs of conditions monitoring. Mooring buoy use is assumed to consist of use of existing moorings; as such, no additional cost would be incurred.	N/A
Thermal Discharge Dissipation (*i.e.*, reducing the temperature of a thermal discharge through technologies such as multiple port diffusers or effluent blending)	Costs depend on volume and temperature of effluent, diameter of the discharge pipe, and temperature of receiving water body. Costs range from $200/ft to $1,500/ft. For purposes of cost estimation, an average of 100 feet was assumed.	$94,000 per project

Sources: NMFS analysis of data from National Marine Fisheries Service 2008 and Tetra Tech Inc. 2015.

Notes:

(1) Total per project costs have been inflated to 2021 dollars using the Bureau of Economic Analysis Gross Domestic Product Price Deflator index.

(2) Rates based on 2015 Tetra Tech Inc. contract with National Park Service for reef and seagrass monitoring in inshore/nearshore waters of Biscayne National Park.

(3) Rates valid for 2015 Tetra Tech Inc. contract with Great Lakes Dredge and Dock for Port of Miami Expansion.

(4) The majority of projects where incremental costs are expected to occur and include primarily small scale construction projects involving docks, buoy installation, and artificial reefs. A few channel dredging and beach renourishment projects are anticipated as well.

(5) Estimate based on email communication from Tetra Tech to IEc, June 15, 2015. Note that for large-scale projects (which would likely undergo formal consultation), costs of sediment and turbidity control barriers could be on the scale of 2 to 3 times more than average costs estimated here.

(6) This cost estimate was included in NMFS (2008) Final Endangered Species Act Section 4(b)(2) Report Impact Analysis for Critical Habitat Designation for Threatened Elkhorn & Staghorn Corals, based on costs associated with the Broward County Beach Renourishment Segment II project. These represent costs of a silt curtain capable of low-spec compliance (13 to 29 NTU above background) for a project in water at least 10 feet deep. Tetra Tech confirmed these costs were reasonable in 2015.

(7) Based on Tetra Tech reference projects using turbidity control barrier capable of high-spec compliance (2 NTU above background), in water at least 10 feet deep.

(8) This cost estimate was included in NMFS (2008) Final Endangered Species Act Section 4(b)(2) Report Impact Analysis for Critical Habitat Designation for Threatened Elkhorn & Staghorn Corals. Tetra Tech confirmed these costs were reasonable in 2015.

(9) $1,200 per collar/anchor is reasonable based on Tetra Tech experience 2006-2015. Actual costs vary depending on design and installation requirements of the unit. Simple anchors drilled 2 ft. into rock and set in concrete can be completed at a rate of approximately 10 per day in depths of 0-30 meters using a 5- person diving team. Most reefs in the 0-30 m depth range are approximately linear and parallel to shore. Crossings in the depth range 0-30 m are on the order of 200-2000 meters.

10.1.6 Estimated Incremental Costs

As discussed previously, this analysis considers both direct and indirect impacts of the critical habitat designation. Direct impacts include the costs associated with additional administrative effort required to conduct Section 7 consultations as well as the direct costs associated with project modifications that would not have been required under the baseline “without critical habitat for the 5 corals” scenario.

Indirect impacts are those changes in economic behavior that may occur due to critical habitat designation for reasons other than direct ESA requirements, i.e., those impacts which are “triggered” by critical habitat designation through other federal, state, or local actions, or which are otherwise unintended. Some common types of indirect impacts include time delays, regulatory uncertainty, and stigma effects.

To calculate present value and annualized impacts, guidance provided by OMB specifies the use of a real annual discount rate of 7%. In addition, OMB recommends sensitivity analysis using other discount rates, such as 3%, which some economists believe better reflects the social rate of time preference (i.e., the willingness of society to exchange the consumption of goods and services now for the consumption of goods and services in the future). Accordingly, this section presents results at 7% and a sensitivity analysis is included in Appendix A that presents impacts assuming a discount rate of 3%.

10.1.6.1 Administrative Section 7 Costs

The effort required to address adverse effects to the final critical habitat is assumed to be the same, on average, across categories of activities. Informal consultations are expected to require comparatively low levels of administrative effort, while formal and programmatic consultations are expected to require comparatively higher levels of administrative effort. For all formal and informal consultations, we anticipate that incremental administrative costs will be incurred by NMFS, a federal action agency, and, potentially, a third party. For programmatic consultations, we anticipate that costs will be incurred by NMFS and a federal action agency. For future consultations that may occur within previously designated *Acropora* critical habitat, we assume that there will be no incremental administrative cost due to designating the new critical habitat. The administrative effort to address the final critical habitat will replace the administrative effort required to address *Acropora* critical habitat. Therefore, incremental administrative costs are only expected for consultations that occur outside of *Acropora* critical habitat. We also include administrative costs for 5 formal consultations with EPA on NPDES permits for thermal discharges in Puerto Rico, because that type of analysis was not conducted on *Acropora* critical habitat.

Incremental administrative costs per consultation effort are expected on average to be $9,800 for programmatic, $5,300 for formal consultations, and $2,600 for informal consultations (see Table 18).[7]

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[7] While the estimated level of effort per consultation is based on a 2002 survey, through the course of gathering information to inform this analysis, we discussed potential levels of effort with NMFS and key stakeholders. In this case, stakeholders generally agreed with the average levels of effort presented, and, in the case of the USACE, anticipated the level of effort per consultation may be high. Accordingly, as noted in Table 18, the use of historical level of effort per consultation may overestimate federal action agency costs for consultations initiated by USACE.

Table 18. INCREMENTAL COSTS PER CONSULTATION RESULTING FROM THE ADDITIONAL ADMINISTRATIVE EFFORT TO ADDRESS ADVERSE MODIFICATION FOR ACTIVITIES IN 5 CORALS CRITICAL HABITAT (2021$)

CONSULTATION TYPE	NMFS	FEDERAL ACTION AGENCY[1]	THIRTY PARTY	BIOLOGICAL ASSESSMENT COST	TOTAL COST
Informal	$680	$870	$510	$500	$2,600
Formal	$1,500	$1,700	$880	$1,200	$5,300
Programmatic	$4,600	$3,800	NA	$1,400	$9,800

Source: IEc analysis of full administrative costs which was based on data from the federal Government Schedule Rates, and a review of consultation records from several Service field offices across the country conducted in 2002; revised by NMFS to reflect current federal Government Schedule Rates (U.S. Office of Personnel Management 2021).

Notes:

(1) We note that USACE provided estimates of administrative effort per consultation that are lower than our estimates of the costs of federal action agency effort (USACE personnel J. Cedeño-Maldonado 2015a; USACE personnel K. Sabin 2021). This may be explained by the fact that USACE conducts a large number of consultations, many of which involve re-occurring activity types with standard permit conditions (*e.g.*, dock construction), allowing them a good understanding of potential effects. To the extent that estimated federal action agency costs per consultation are overstated for consultations initiated by USACE, the analysis is likely to overestimate administrative costs.

We estimate the incremental administrative costs of Section 7 consultation by applying these per-consultation costs to the forecast number of consultations (presented earlier in Section 10.1.4); the resulting costs, by unit, are presented in Table 19. We anticipate that there will be 2 programmatic consultations, 2 formal consultations, and 31 informal consultations which will require incremental administrative effort. Incremental administrative costs are expected to total approximately $76,000 over the next ten years, an annualized cost of $11,000 (discounted at 7%). Table 19 presents incremental administrative costs by activity type. The incremental administrative costs are driven by future consultations that will require new analysis for the 5 corals critical habitat in areas outside *Acropora* critical habitat (i.e., deeper than 30 m and in some discrete geographies).

Table 19. INCREMENTAL ADMINISTRATIVE COSTS, BY ACTIVITY TYPE 2022-2031 ($2021)

Unit	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total
FL	$13,400	$6,600	$0	$6,300	$1,700	$3,300	$31,700	$1,900	$950	$0	$890	$240	$470	$4,400
PR	$23,000	$1,700	$5,000	$1,700	$0	$0	$32,000	$3,300	$240	$720	$240	$0	$0	$4,500
STT/STJ	$3,300	$0	$0	$0	$0	$0	$3,300	$470	$0	$0	$0	$0	$0	$470
STX	$1,700	$0	$0	$0	$0	$0	$1,700	$240	$0	$0	$00	$0	$0	$240
Nav	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FGB	$0	$0	$0	$0	$7,900	$0	$7,900	$0	$0	$0	$0	$1,100	$0	$1,100
TOTAL	$42,000	$8,300	$5,000	$7,900	$9,600	$3,300	$76,000	$5,900	$1,200	$720	$1,100	$1,400	$470	$11,000

Note: The estimates may not sum to the totals reported due to rounding.

10.1.6.2 Project Modification Costs

To evaluate incremental project modification costs, information is required regarding the extent to which the forecast activities that may require project modifications are expected to occur outside of those areas subject to sufficient baseline protection (i.e., outside of *Acropora* critical habitat, and where the 5 corals are not present). The project modification recommendations that would result from the listing of the species (i.e., to avoid jeopardy to the species) are likely to be similar to project modifications that would be undertaken to avoid adverse modification of critical habitat. Thus, incremental project modifications would only be expected to occur where the species are not present. However, information is not available to determine where the 5 corals may be located as part of a project or activity survey within the boundaries of the final critical habitat. Treatment of this uncertainty is discussed below. As discussed earlier, *Acropora* critical habitat likely provides sufficient protection for the 5 corals critical habitat, with the exception of projects with temperature effects. As such, our analysis of incremental project modification costs focuses on the areas of critical habitat for the 5 corals that do not overlap *Acropora* corals critical habitat and those future consultations that may result in increased water temperature.

Table 20 details the projected level of activity in the areas that do not overlap with *Acropora* critical habitat and that would potentially be subject to project modifications. Overall, 28 consultations with potential project modifications and associated costs are projected to occur in areas outside of or that will not affect *Acropora* critical habitat over the next ten years.

As illustrated in Table 20, approximately 81% of the consultations forecast to be subject to potential incremental project modifications as a result of the 5 corals critical habitat designation are related to construction activities, including mooring buoys, artificial reefs, seawalls, marinas, and roads/bridges. Based on forecast consultations, the other activities occurring outside of *Acropora* critical habitat that are projected to result in potential incremental project modifications are channel dredging and beach nourishment activities.

Table 20. FORECAST SECTION 7 CONSULTATIONS BY ACTIVITY THAT WOULD NOT AFFECT ACROPORA CRITICAL HABITAT AND WOULD BE SUBJECT TO POTENTIAL PROJECT MODIFICATIONS (2022 – 2031)[8]

Unit	Coastal & In-water Const. (USACE) [2]	Channel Dredging (USACE)	Beach Nourishment (USACE)	Total
FL	7	0	4	11
PR	13	1	1	15
STT/STJ	2	0	0	2
STX	1	0	0	1
Nav	0	0	0	0
FGB	0	0	0	0
TOTAL	23	1	5	28
% of Total	81%	3%	16%	100%

Notes: Columns may not sum to totals due to rounding.

1. The consultations included in this table are only those related to activities in areas which are located outside of *Acropora* critical habitat where future consultations are forecast to occur.
2. Construction includes the following activities: Artificial reef, buoy, marina, road/bridge, and seawall, as well as several uncategorized consultations for which not enough information was available to identify an activity.

The project modification recommendations that would result from the listing of the species (i.e., to avoid jeopardy to the species) are likely to be similar to project modifications that would be undertaken to avoid adverse modification of critical habitat. Thus, as discussed above, incremental project modifications would only be expected to occur where the species are not present, but information is not available to determine where the 5 corals may be located as part of a project or activity survey within the boundaries of the final critical habitat.11

To reflect the uncertainties regarding whether forecast activities outside of *Acropora* critical habitat would be subject to additional project modification recommendations, we estimate a range of impacts that may result from the final critical habitat.

- **Low-end incremental impacts** reflect the assumption that none of the projects outside of *Acropora* critical habitat would be subject to incremental project modification recommendations either because the species would be present, or because baseline permit conditions/regulations would provide sufficient protection to avoid adverse modification of critical habitat.

[8] The abundance and distribution of the 5 corals is not well understood throughout the proposed critical habitat.

- **High-end incremental impacts** reflect the conservative assumption that all the forecast activities that would not affect *Acropora* critical habitat may be subject to incremental project modifications.

In section 10.1.5, types of potentially incremental project modifications and their associated per project costs were presented (summarized in Table 17). To project the incremental impacts of the final critical habitat, we apply these per-project costs to the types of activities in our consultation forecast with the potential to result in incremental project modifications, as shown in Table 21.

Table 21. INCREMENTAL PROJECT MODIFICATIONS BY ACTIVITY

		APPLICABLE ACTIVITIES		
POTENTIAL PROJECT MODIFICATION	AVERAGE PER PROJECT COST (2021$)	Coastal & In-water Construction (USACE)	Channel Dredging (USACE)	Beach Nourishment (USACE)
Conditions Monitoring (*e.g.*, monitoring environmental conditions such as turbidity, sediment load and rate, and nutrients, to avoid adverse effects to corals or habitat)	$25,000 per project	✓	✓	✓
Sediment and Turbidity Control Barriers (*e.g.*, silt curtains)	$5,400 per project	✓	✓	✓
Sources: NMFS analysis of data from National Marine Fisheries Service 2008 and Tetra Tech Inc. 2015.				

Under the low-end scenario, incremental project modification costs are zero and the incremental effects of critical habitat designation are limited to additional administrative effort to consider effects on critical habitat as part of Section 7 consultation (i.e., administrative Section 7 costs). Table 22 presents the high-end incremental project modification costs, by unit and activity category, which could occur as a result of the final critical habitat. Estimated high-end incremental project modification costs total $610,000 over 10 years, or an annualized cost of $87,000 (discounted at 7%). Similar to the projected administrative costs, the majority of the project modification costs are associated with coastal and in-water construction.

Table 22. HIGH-END INCREMENTAL PROJECT MODIFICATION COSTS, BY ACTIVITY TYPE, 2022-2031 ($2021, 7% DISCOUNT RATE)

	Present Value Impacts				Annualized Impacts			
Unit	Coastal & In-water Construction (USACE) (5)	Channel Dredging (USACE)	Beach Nourishment (USACE)	Total	Coastal & In-water Construction (USACE) (5)	Channel Dredging (USACE)	Beach Nourishment (USACE)	Total
Florida	$160,000	$0	$79,000	$240,000	$22,000	$0	$11,000	$34,000
Puerto Rico	$280,000	$20,000	$20,000	$310,000	$39,000	$2,800	$2,800	$45,000
STT/STJ	$39,000	$0	$0	$39,000	$5,600	$0	$0	$5,600
St. Croix	$20,000	$0	$0	$20,000	$2,800	$0	$0	$2,800
Navassa	$0	$0	$0	$0	$0	$0	$0	$0
FGB	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL	**$490,000**	**$20,000**	**$98,000**	**$610,000**	**$70,000**	**$2,800**	**$14,000**	**$87,000**
% of Total	80%	3%	16%	100%				

Note: Estimates may not sum to totals due to rounding.

Given that we are unable to predict exactly where the 5 corals are located, and thus, which projected activities may result in incremental project modifications, the cost results presented should not be viewed as a precise accounting of the costs of critical habitat designation. Rather, these cost results should be viewed as an indication of the potential order of magnitude of costs, and of the relative costs of critical habitat designation across particular areas of final critical habitat.

SUMMARY OF INCREMENTAL COSTS

Total incremental costs resulting from the 5 corals critical habitat are estimated to range from $76,000 to $690,000 over ten years, or an annualized cost of $11,000 to $198,000 (discounted at 7%). The low-end costs are a result of the increased administrative effort to analyze impacts to the final critical habitat in future consultations that would not have affected *Acropora* critical habitat (i.e., in areas outside the boundaries). The high-end costs are a result of the increased administrative effort (i.e., low-end costs) plus the incremental project modification costs. Incremental project modification costs are a result of future consultations that would not have had effects on *Acropora* critical habitat. The high-end costs also assume that the project modifications would be solely due to the final critical habitat. However, this is likely an overestimate because an undetermined number of future consultations will have the same project modification as a result of avoiding adverse effects to one or more of the 5 corals, or overalp with other species critical habitats. Nearly 90% of total high-end incremental costs result from project modifications, primarily for coastal and in- water construction and beach nourishment activities.

Table 23 and Table 24 present total low and high-end incremental costs by activity type. Coastal and in-water construction accounts for the highest costs, ranging from $42,000 to $530,000 over ten years (discounted at 7%). The high-end projection represents approximately 78% of total costs. When measured by unit, projected high-end costs are heavily concentrated in Puerto Rico and Florida, with these units accounting for approximately 51% and 39% of total high-end costs, respectively.

Table 23. LOW-END TOTAL INCREMENTAL COSTS (ADMINISTRATIVE), BY ACTIVITY TYPE, 2022-2031 ($2021, 7% DISCOUNT RATE)

Unit	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total
FL	$13,400	$6,600	$0	$6,300	$1,700	$3,300	$31,700	$1,900	$950	$0	$890	$240	$470	$4,400
PR	$23,000	$1,700	$5,000	$1,700	$0	$0	$32,000	$3,300	$240	$720	$240	$0	$0	$4,500
STT/STJ	$3,300	$0	$0	$0	$0	$0	$3,300	$470	$0	$0	$0	$0	$0	$470
STX	$1,700	$0	$0	$0	$0	$0	$1,700	$240	$0	$0	$00	$0	$0	$240
Nav	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FGB	$0	$0	$0	$0	$7,900	$0	$7,900	$0	$0	$0	$0	$1,100	$0	$1,100
TOTAL	**$42,000**	**$8,300**	**$5,000**	**$7,900**	**$9,600**	**$3,300**	**$76,000**	**$5,900**	**$1,200**	**$720**	**$1,100**	**$1,400**	**$470**	**$11,000**

Note: The estimates may not sum to the totals reported due to rounding.

Table 24. HIGH-END TOTAL INCREMENTAL COSTS (ADMINISTRATIVE AND PROJECT MODIFICATION), BY ACTIVITY TYPE, 2022-2031 ($2021, 7% DISCOUNT RATE)

Unit	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total
FL	$170,000	$85,000	$0	$6,300	$1,700	$3,300	$270,000	$24,000	$12,000	$0	$890	$240	$470	$38,000
PR	$300,000	$21,000	$25,000	$1,700	$0	$0	$350,000	$43,000	$3,000	$3,500	$240	$0	$0	$49,000
STT/STJ	$43,000	$0	$0	$0	$0	$0	$43,000	$6,100	$0	$0	$0	$0	$0	$6,100
STX	$21,000	$0	$0	$0	$0	$0	$21,000	$3,000	$0	$0	$0	$0	$0	$3,000
Nav	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FGB	$0	$0	$0	$0	$7,900	$0	$7,900	$0	$0	$0	$0	$1,100	$0	$1,100
TOTAL	**$530,000**	**$110,000**	**$25,000**	**$7,900**	**$9,600**	**$3,300**	**$690,000**	**$76,000**	**$15,000**	**$3,500**	**$1,100**	**$1,400**	**$470**	**$98,000**

Note: The estimates may not sum to the totals reported due to rounding.

10.1.6.3 Indirect Costs

Project proponents may experience indirect effects of the designation including costs associated with project delay due to the increased length of time it will take for review of projects. For example, the USVI DPNR indicated that the designation of *Acropora* critical habitat has affected the time it takes to get in-water construction projects reviewed. One example provided included delays to dredging the Charlotte Amalie Harbor in St. Thomas due to a lengthy permit approval process, which USVI DPNR attributed to the presence of EFH and *Acropora* critical habitat. According to the USVI DPNR, the Virgin Islands Port Authority was unable to obtain timely approval of its dredging permit, which caused them to lose 15 port calls during the 2014-2015 cruise ship season. The USVI DPNR is concerned that the addition of the 5 corals critical habitat may add additional review time and delay projects further at an economic cost to the project proponents (USVI DPNR personnel J. P. Oriol 2015).

Another potential indirect effect of critical habitat relates to the ability of the USVI and Puerto Rico to compete with other Caribbean islands for business. According to the USVI DPNR, companies shy away from doing business in the territory because of the regulatory burdens imposed by *Acropora* critical habitat designation; for example, hotels may be discouraged from locating in the USVI due to the length of time that may be required to add an amenity such as a dock (USVI DPNR personnel J. P. Oriol 2015). Forecasting the costs associated with the regulatory uncertainty and potential project delays resulting from the designation of critical habitat for the 5 corals is too speculative to be quantified in this analysis. However, for most projects, delays attributable to the additional time to consider the 5 corals critical habitat as part of future Section 7 consultations are expected to be minor given that most projects would already have to consider *Acropora* species and critical habitat. Throughout the final critical habitat, only 35 Section 7 consultations are forecast related to activities occurring outside of *Acropora* critical habitat; only 3 of these are in the USVI.

10.1.6.4 Caveats and Uncertainties

There are several important uncertainties underlying the calculation of incremental costs that could result from the designation of critical habitat for the 5 corals. These uncertainties, and their significance with respect to the results, are summarized in Table 25. In general, these uncertainties are not expected to significantly influence the results of the analysis.

Table 25. SUMMARY OF UNCERTAINTIES

Assumption/Source of Uncertainty	Direction of Potential Bias	Likely Significance with Respect to Estimated Impacts
This analysis relies on patterns of Section 7 consultation and USACE permit applications within the past ten years to forecast future rates and locations of consultation activity, specifically those consultations expected to occur outside of *Acropora* critical habitat. The analysis assumes that past consultation rates provide a good indication of future activity levels and distribution of activities.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** Data are not available to determine whether the rates or locations of activities subject to consultation are likely to change over time. To the extent that activities increase over the next ten years, or if more activities occur outside of *Acropora* critical habitat than anticipated, our analysis may underestimate incremental costs. Further, if designation of critical habitat for the 5 corals leads NMFS to determine that activities which previously required informal consultation now require formal consultation, our analysis may understate the number of future formal consultations, and overstate future informal consultation efforts. To the extent NMFS handles more consultations on a programmatic basis our forecast of consultations may lead us to overestimate formal and informal consultation levels, thus overstating administrative impacts. The estimated incremental impacts per consultation are, however, relatively minor, and we accordingly do not anticipate variations in consulting rates or locations to significantly change the finding of our analysis.
The analysis assumes that baseline protections outside of *Acropora* critical habitat (*e.g.*, typical USACE permit conditions or project modifications recommended due to presence of 5 corals) may not provide sufficient protection to avoid adverse modification of the 5 corals critical habitat, or may not be consistently applied to all projects within final critical habitat.	**N/A.** Range of results captures this uncertainty.	**N/A.** To represent this uncertainty, the analysis presents a range of incremental costs. At the low end, assuming none of the projects require additional project modifications may understate impacts. At the high end, assuming baseline protections are not sufficient, and additional project modifications are required for certain types of activities occurring outside of *Acropora* critical habitat may overstate impacts. However, the range captures the entire scope of possibilities with respect to how much baseline protection may be available.

Assumption/Source of Uncertainty	Direction of Potential Bias	Likely Significance with Respect to Estimated Impacts
The analysis assumes that where consultations are occurring in *Acropora* critical habitat or where the 5 corals are present, additional project modifications would not be recommended.	May result in an **underestimate** of costs.	**Potentially major.** NMFS anticipates that it is unlikely that critical habitat designation will generate additional or different recommendations for project modifications for activities occurring within *Acropora* critical habitat, or where the 5 corals are present. However, NMFS will review each individual project or activity at the time of consultation to determine whether additional project modifications may be needed to avoid adverse modification of critical habitat. If projects in *Acropora* critical habitat were to require additional project modifications, our analysis may underestimate costs.
The analysis considers potential future changes to water quality standards, and the ultimate impacts of changing those standards, to be baseline impacts.	May result in an **underestimate** of costs.	**Potentially major.** Discussions with EPA and NMFS indicate that recommendations that result from Section 7 consultation on water quality standards may result in more stringent water quality standards; however, this would likely occur regardless of critical habitat designation for the 5 corals due to the presence of multiple listed coral species. NMFS believes that, the recommendations would likely remain the same. However, if this critical habitat designation generates additional or more stringent recommendations to avoid adverse modification of the final critical habitat, impacts of the critical habitat designation may be understated.

Assumption/Source of Uncertainty	Direction of Potential Bias	Likely Significance with Respect to Estimated Impacts
This analysis assumes that inclusion of the 5 corals critical habitat in future consultations will always result in additional administrative costs in areas outside of *Acropora* critical habitat.	May result in an **overestimate** of costs.	**Likely minor**. While the critical habitat designation may provide additional information that assists in the analysis of adverse effects to both the species and the critical habitat, each consultation will still need to include both analyses where the listed species are present. To the extent that new information in the critical habitat designation provides justification for effects analysis, administrative costs may be overstated. While the estimated level of effort per consultation is based on a 2002 survey of federal agencies, through the course of gathering information to inform this analysis we discussed potential levels of effort with key stakeholders. In this case, stakeholders generally agreed with the average levels of effort presented, and, in the case of the USACE, anticipated the level of effort per consultation may be high. Accordingly, as noted in Table 18, the use of historical level of effort per consultation may overestimate federal action agency costs for consultations initiated by USACE.
This analysis makes assumptions regarding distribution of certain types of past consultations across units.	**Unknown**. May overestimate or underestimate incremental impacts in a given area.	**Likely minor**. Because fisheries, water quality, and protected area management activities are not confined to a specific geographic location, this analysis makes assumptions regarding the critical habitat units included in historical consultations, and how those costs are distributed across relevant units. Variations in the locations of future consultations from the past or in how past consultations are assigned to critical habitat units are unlikely to significantly change the overall findings of our analysis, but may over or underestimate the costs assigned to any given habitat unit.

Assumption/Source of Uncertainty	Direction of Potential Bias	Likely Significance with Respect to Estimated Impacts
The analysis assumes no new consultations will be triggered by the designation of critical habitat for the 5 corals.	May **underestimate** incremental impacts.	**Likely minor**. Consultations which cover activities occurring in areas outside of other critical habitat designations, where listed species are not present, are unlikely to occur solely in these areas. However, to the extent that any Section 7 consultations occur related to activities solely in these areas, critical habitat may trigger new consultations, leading us to understate incremental impacts.
This analysis does not quantify potential indirect impacts associated with time delay.	May result in an **underestimate** of costs.	**Likely minor**. For new projects, the USACE will be required to consult with NMFS due to the presence of the 5 corals or other listed species or critical habitat. Therefore, the indirect incremental impact associated with time delay on new projects would be limited to any costs (*e.g.*, additional cost of renting equipment) incurred specifically during the additional time necessary to complete the analysis of adverse modification of the final critical habitat. The bulk of any time delays would be expected to occur regardless of this final critical habitat.

10.1.7 Economic Impacts Summary

In summary, there are significant baseline protections that exist in the areas being designated for the 5 corals critical habitat designation. The incremental impacts for the final designation are projected to result from consultations for projects where the 5 corals are not present and that would not affect the 2008 *Acropora* critical habitat designation. Taking into consideration several assumptions and uncertainties, the range of total incremental cost are $76,000 to $690,000 over the next ten years[9] ($11,000 to $98,000 annualized). Notwithstanding the uncertainty underlying the projection of incremental costs, the results provide an indication of the potential activities that may be affected, the relative costs of critical habitat designation across particular areas of critical habitat, and a reasonable projection of future costs.

[9] Cost estimates are expressed in 2021 dollars. Present values are calculated over ten years (2022 – 2031) assuming a 7% discount rate.

10.2 National Security Impacts

Previous critical habitat designations recognized that impacts to national security may result if a designation would trigger future ESA Section 7 consultations because a proposed military activity “may affect” the physical or biological feature(s) essential to the listed species' conservation. Anticipated interference with mission-essential training or testing or unit readiness, through the additional commitment of resources to an adverse modification analysis and expected requirements to modify the action to prevent adverse modification of critical habitat, has been identified as a negative impact of critical habitat designations.

As identified in Section 10.1.3.8, there are several military activities that may affect the final critical habitat and require consultation. However, only a limited number of future actions are expected to incur incremental impacts, based on location and nature of the activity. Thus, this section provides a summary of the information on national security impacts of the final critical habitat designation.

We requested the DOD provide us with information on military activities that may affect the final critical habitat and whether the final critical habitat posed a national security impact due to the requirement to consult on those activities. The Navy responded that activities associated with the designated restricted area managed by the South Florida Ocean Measuring Facility, defined in 33 CFR 334.580, located offshore of Dania, Florida (SFOMF-RA) may affect the final critical habitat. This assertion was verified by the 2 previous consultations on cable-laying activities in the SFOMF-RA over the past 10 years.

The SFOMF-RA contains underwater cables and benthic sensor systems that enable real-time data acquisition from Navy sensor systems used in Navy exercises. The previous consultations, in 2011 and 2013, were for the installation of new cables. These consultations did not affect any coral species, because the cables were routed to avoid the corals. These consultations did not consider effects to *Acropora* critical habitat because the area was excluded based on national security impacts in the 2008 designation. However, installation of the cables would have affected the substrate feature. Because the installation of new cables in the future may affect the 5 corals critical habitat substrate feature, and the area was excluded from *Acropora* critical habitat, the designation of the 5 corals critical habitat may result in incremental impacts to the Navy. The impact would result from the added administrative effort to consider impacts to the final critical habitat and project modifications to avoid adverse effects to the substrate feature. These impacts would not likely be co-extensive with the listing of the 5 corals. The Navy has conducted extensive benthic surveys in the SFOMF-RA and has mapped the locations of all listed corals. Thus, they would be able avoid impacts to the listed corals from the installation of new cables. However, if the cables were laid over the 5 corals critical habitat’s substrate feature, the cable would make the substrate unavailable for settlement and recruitment. Thus, we would require consultation to evaluate the impact of this adverse effect to the essential feature. The administrative and project modification costs would be incremental impacts of the final critical habitat.

10.3 Other Relevant Impacts

Past critical habitat designations have identified three broad categories of other relevant impacts: conservation benefits, both to the species and to society, and impacts on governmental or private entities that are implementing existing management plans that provide benefits to the listed species.

10.3.1 Conservation Benefits

This section considers the potential benefits resulting from the designation of critical habitat for the 5 corals. First, we introduce economic methods employed to quantify benefits of species and habitat conservation, and discuss the availability of existing literature to support valuation in the context of this critical habitat designation. We then discuss the potential categories of direct species conservation benefits and ancillary ecosystem service benefits that may result from the designation.[10]

ESTIMATING ECONOMIC BENEFITS OF SPECIES AND HABITAT CONSERVATION

Commensurate with the analysis of the costs of critical habitat designation, this evaluation of the benefits of the designation appropriately focuses on the incremental benefits specifically generated by implementation of the critical habitat designation. The primary intended benefit of critical habitat is to support the conservation of threatened and endangered species, such as the 5 corals.[11] That is, in protecting the essential features that are, by definition, essential to the conservation of the species, critical habitat directly contributes to the conservation and recovery of the species. Thus, attempts to develop monetary estimates of the benefits of this critical habitat designation focus primarily on the public's willingness to pay to achieve the conservation benefits to the coral species resulting from this designation. In the context of welfare economics, value is most frequently measured in terms of people's "willingness-to-pay" (WTP) for a good or service, where WTP is the maximum amount (typically in monetary terms) that an individual would be willing to pay rather than do without a particular benefit. OMB recognizes WTP as the appropriate measure for valuing costs and benefits in the context of regulatory analysis (U.S. Office of Management and Budget 2003). The analytic methods characterized below accordingly describe the various means by which economists may estimate WTP.

Quantification and monetization of conservation benefits for listed species requires two primary pieces of information: (1) data on the incremental change in the species population or in the probability of species recovery that is expected to result from the designation; and (2) data on the public's willingness to pay for this incremental change. Neither data element is readily available for this analysis; thus, we do not monetize the conservation benefits of this critical habitat designation.

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[10] The U.S. Office of Management and Budget (OMB) guidelines on conducting regulatory analysis direct agencies to consider both the direct and ancillary costs and benefits of regulatory actions. An ancillary benefit is defined as "a favorable impact of the rule that is typically unrelated or secondary to the statutory purpose of the rulemaking..." (OMB, Circular A-4, 2003). In this analysis, we characterize the benefits that flow from the increased probability of conservation and recovery as the direct benefits of the rulemaking, and the broader ecosystem service benefits stemming from the implementation of the critical habitat rule as ancillary benefits.

[11] The term "conservation" means "the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary" (16 U.S.C.
1532).

SUMMARY OF BENEFITS DISCUSSION

This analysis contemplates two broad categories of benefits of critical habitat designation:

1. **Increased probability of conservation and recovery of the 5 corals**: The most direct benefits of the critical habitat designation stem from the enhanced probability of conservation and recovery of the 5 corals. From an economics perspective, the appropriate measure of the value of this benefit is people's "willingness-to-pay" for the incremental change. While the existing economics literature is insufficient to provide a quantitative estimate of the extent to which people value incremental changes in recovery potential, the literature does evidence that people have a positive preference for listed species conservation, even beyond any direct (e.g., recreation such as viewing the species while snorkeling or diving) or indirect (reef fishing that is supported by the presence of healthy reef ecosystems) use.
2. **General ecosystem service benefits of coral reef conservation:** Overall, coral reef ecosystems, including those comprising populations of the 5 corals, provide important ecosystem services of value to individuals, communities, and economies. These include recreational opportunities (and associated tourism spending in the regional economy), habitat and nursery functions for recreationally and commercially valuable fish species, shoreline protection in the form of wave attenuation and reduced beach erosion, and climate stabilization via carbon sequestration. Efforts to conserve the 5 corals also benefit the broader reef ecosystems, thereby preserving or improving these ecosystem services.

Critical habitat most directly influences the recovery potential of the species and protects coral reef ecosystem services by the protections afforded under section 7 of the ESA. That is, these benefits stem from implementation of project modifications undertaken to avoid destruction and adverse modification of critical habitat. Accordingly, critical habitat designation is most likely to generate benefits discussed in those areas expected to be subject to additional recommendations for project modifications (above and beyond any conservation measures that may be implemented in the baseline due to the listing status of the species or for other reasons).

Determining the incremental effect of critical habitat on coral species conservation and recovery is complicated. Such an evaluation would require the ability to isolate and quantify the effect of the designated critical habitat separately from all other ongoing or planned conservation efforts for these coral species, in particular, and coral reef ecosystems in the final critical habitat area, in general. As described in the previous sections, in most areas, critical habitat is not expected to change how a project or activity is implemented due to the significant protections afforded these areas by the listing status of the 5 corals and the presence of critical habitat for other listed coral species. In some geographic areas, in particular where critical habitat for the 5 corals does not overlap the existing critical habitat for other coral species, NMFS may determine that a project or activity may adversely modify critical habitat and recommend additional conservation, above and beyond what would be recommended to avoid jeopardy or take of the species.

While consultations considering effects of projects and activities on critical habitat are anticipated to occur across all of the areas being designated as critical habitat, Section 10.1.5 describes that only a fraction of these consultations may potentially result in recommendations for additional project modifications. Specifically, coastal and in-water construction, channel dredging, and beach nourishment/shoreline protection projects occurring outside of existing *Acropora* critical habitat are most likely to be subject to additional project modification recommendations explicitly to avoid adverse modification of critical habitat. Designation of these areas is therefore most likely to generate incremental economic benefits (both in terms of enhanced probability of conservation and recovery of the species and in protecting coral reef ecosystem services, in general, as described in the following section).

Even in the case that existing information were sufficient to determine the effect of critical habitat designation on the conservation and recovery of the 5 corals, it is uncertain whether the existing economics literature would support valuation of that change. A number of published studies highlight that the public does value protecting coral species.[12] While these studies support the conclusion that the public receives a benefit from the protection of these species and their broader reef ecosystems, they do not provide the necessary information to develop a reliable quantitative estimate of the value of that benefit.

In the remainder of this section, we provide a more detailed description of the economic techniques that economists employ to monetize these types of conservation benefits. We also present a brief review of the existing literature valuing coral reef ecosystems. These studies provide evidence that regulatory and other efforts to increase the recovery probability of coral species — including critical habitat designation —benefit societal well-being.

ECONOMIC METHODS APPLIED TO ESTIMATE USE AND NON-USE VALUES OF SPECIES AND HABITAT CONSERVATION

Various economic benefits, measured in terms of social welfare (i.e., people's well-being as measured in terms of producer and consumer surplus) or regional economic performance (e.g., regional income or employment), may result from conservation efforts for listed species. The benefits can be placed into two broad categories: (1) those associated with the primary goal of species conservation (i.e. direct benefits), and (2) those additional beneficial services derived from the project modifications resulting from the designation, but which are not the primary purpose of the ESA (i.e., ecosystem service benefits, such as shoreline protection, support of reef fisheries, or recreational opportunities).

Because the purpose of the ESA is to provide for the conservation of endangered and threatened species, the benefits of actions taken under the ESA are often measured in terms of the value placed by

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[12] See, for example, the summary in Richardson, L. and J. Loomis (2009). The total economic value of threatened, endangered and rare species: An updated meta-analysis. Ecological Economics 68(5):1535-1548.

the public on species preservation (e.g., avoidance of extinction, and/or increase in a species' population). Such social welfare values for a species may reflect both use and non-use values for the species. Use values derive from a direct use for a species, such as commercial harvesting or wildlife-viewing opportunities, such as snorkeling or diving. Non-use values are not derived from direct use of the species, but instead reflect the utility the public derives from knowledge that a species continues to exist (e.g., existence or cultural values).

As a result of actions taken to preserve endangered and threatened species, various other benefits may accrue to the public. For example, project modifications undertaken to avoid adverse modification of critical habitat may result in improved or preserved environmental quality (e.g., reduced sediment or nutrient levels in water), which in turn may have collateral human health or recreational use benefits. In addition, conservation efforts undertaken for the benefit of a threatened or endangered species may enhance shared habitat for other wildlife. Such benefits may result directly from modifications to projects, or may be collateral to such actions. For example, in the case of the 5 corals, the water quality improvements associated with additional sediment and turbidity controls may result in healthier reef ecosystems overall, which in turn promote shoreline stabilization and benefit coastal property values.

Economists apply a variety of approaches to estimate both use and non-use values for species and for habitat improvements, including stated preference and revealed preference methods. Stated preference techniques include such tools as the contingent valuation method, conjoint analysis, or contingent ranking methods. In simplest terms, these methods employ survey techniques, asking respondents questions that provide insight into what they would be willing to pay for a resource or for programs designed to protect a resource. A substantial body of literature has been developed that describes the application of this technique to the valuation of natural resource assets, and contingent valuation studies have frequently been employed to estimate values of coral reef ecosystems.

More specific to use values for species or habitats, revealed preference techniques examine individuals' behavior in markets in response to changes in environmental or other amenities (i.e., people "reveal" their value through their behavior). For example, travel cost models are frequently applied to value access to recreational opportunities, as well as to value changes in the quality and characteristics of these opportunities. Basic travel cost models are rooted in the idea that the value of a recreational resource can be estimated by analyzing the travel and time costs incurred by individuals visiting the site. Another revealed preference technique is hedonic analysis, which is often employed to determine the effect of site-specific characteristics on property values.

Use and Non-Use Valuation Studies

Numerous published studies estimate individuals' willingness-to-pay to protect endangered species.[13] The economic values reported in these studies reflect various groupings of benefit categories (including both use and non-use values). For example, these studies assess public willingness to pay for wildlife-viewing opportunities, for the option of seeing or experiencing the species in the future, to assure that the species will exist for future generations and simply knowing a species exists, among other values.

An ideal study to apply in valuing the use and non-use values that may derive from critical habitat designation for the 5 corals would: (1) be specific to the species; (2) be specific to the policy question at hand (implementation of the particular project modifications associated with critical habitat

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[13] See, for example, the summary in Richardson, L. and J. Loomis (2009). The total economic value of threatened, endangered and rare species: An updated meta-analysis. Ecological Economics 68(5):1535-1548.

designation); and (3) provide insight into the relevant population holding such values (e.g., citizens of the coastal counties and regions abutting the final critical habitat or of the United States as a whole). No such study has been undertaken to date for these coral species.

Absent primary research specific to the policy question (societal benefits of critical habitat designation for the 5 coral species), resource management decisions can often be informed by applying the results of existing valuation research to a new policy question – a process known to economists as benefit transfer. Benefit transfer involves the application of unit value estimates, functions, data, and/or models from existing studies to estimate the benefits associated with the resource under consideration.

OMB has written guidelines for conducting credible benefit transfers. The important steps in the OMB guidance are: (1) specify the value to be estimated for the rulemaking; and (2) identify appropriate studies to conduct benefits transfer based on the following criteria:

- The selected studies should be based on adequate data, sound and defensible empirical methods and techniques;
- The selected studies should document parameter estimates of the valuation function;
- The study and policy contexts should have similar populations (e.g., demographic characteristics). The market size (e.g., target population) between the study site and the policy site should be similar;
- The good, and the magnitude of change in that good, should be similar in the study and policy contexts;
- The relevant characteristics of the study and policy contexts should be similar;
- The distribution of property rights should be similar so that the analysis uses the same welfare measure (i.e., if the property rights in the study context support the use of willingness-to-accept measures while the rights in the rulemaking context support the use of willingness-to-pay measures, benefits transfer is not appropriate); and
- The availability of substitutes across study and policy contexts should be similar.

Available Literature Valuing Coral Species

While the existing economics literature on values for listed species reflects a relatively narrow subset of species and species types, a significant body of research is devoted to evaluating the benefits of coral reefs in the United States and its territories.[14] A 2013 literature review and synthesis (Brander and van Beukering 2013) by the NOAA Coral Reef Conservation Program summarized existing economic studies focused on values of U.S. coral reefs. The review identifies valuation studies for all states and territories that contain coral reefs. The overarching objective of the study was to estimate an aggregate total economic value of coral reefs in the U.S., and to use the literature to estimate a value function that may be used to value a reef at a particular site. The literature summary estimates the total economic value of reefs in the U.S. at approximately $4.3 billion per year (2021 dollars).[15] The study asserts that this should be considered a lower bound on

[14] Notably, the 2 Caribbean acroporids and 3 Orbicella spp. were the most dominant species of corals which developed Caribbean reef over the past ~5,000 years.

[15] The literature summary presented results in 2007 dollars. For consistency with the critical habitat cost analysis, we have adjusted these estimates to 2021 dollars using the Bureau of Economic Analysis' Gross Domestic Product Price Deflator.

the total value as it does not cover all known coral reef sites and not all studies were inclusive of both use and non-use values.

Table 27 summarizes the findings of valuation studies relevant to regions that overlap the final critical habitat for the 5 corals. The NOAA literature review ultimately translates this information into annual values per hectare of coral cover. While these values are relevant indicators of why and to what extent people benefit from the presence of coral reefs, they reflect the value of the reefs in their current state (or rather, their state at the time of the study) and are not estimates of the economic benefits of the critical habitat designation for the corals. In the case that a given reef area would be destroyed (i.e., provide no ecosystem services) but for the presence of critical habitat, the use and non-use values of this area of reef would reflect a benefit of critical habitat designation. In many cases, however, critical habitat designation results in an improvement in habitat quality to support the reef ecosystem. In this case, the more relevant measure of the benefit of critical habitat is the change in value associated with the improved quality of the reef habitat (i.e., the improvement or avoided degradation of ecosystem services).

The studies described in Table 27 do not offer information on: (1) how values may differ across different coral species or assemblages; and therefore, how these 5 corals contribute to these values; and (2) how these values may be affected by changes in the quality of habitat to support the reef ecosystem, or by the probability of recovery for listed coral species. This information would be required in order to translate these values into an estimate of the benefits of the final critical habitat designation.

A number of additional studies have likewise evaluated social welfare values of coral reef ecosystems. For example, Table 27 of NMFS' Section 4(b)(2) Report for *Acropora* corals summarizes economic valuation literature related to coral reefs (National Marine Fisheries Service 2008). In addition to these social welfare values, a number of studies have estimated the regional economic contribution of the recreational and commercial uses of coral reefs. Johns et al. (2003), for example, calculated the impact of visitor spending on reef-related recreational activities on the regional economy. The study estimates that visitors to natural reefs in Miami-Dade County, Florida between June 2000 and May 2001 generated $1.03 billion in sales and $582 million in income (2021 dollars) across the County and supported over 11,000 full time and part time jobs; visitors to Broward County generated $1.38 billion in sales and $773 million in income and supported just under 17,000 jobs; and visitors to Palm Beach County generated $313 million in sales and $175 in income and supported over 3,500 jobs (Johns et al. 2003).[16] Overall, these numbers evidence the significant value of reef-related tourism in Southeast Florida.

The timing and extent to which the 5 corals populations would be expected to recover, and the extent to which this recovery would be associated with the critical habitat-related conservation efforts, are not known. Absent this information, conducting a credible benefit transfer analysis that quantifies benefits of this critical habitat designation on the 5 corals use and non-use values is not possible. The information in this discussion is therefore provided for context and to demonstrate that the public holds a positive and likely significant value for conservation of the coral species. Furthermore, while we have summarized these studies in order to provide general information on previous research regarding economic values of corals, we neither promote a particular estimate nor offer judgments regarding the quality of the underlying valuation studies.

[16] The study results are presented in 2000 dollars. For consistency with the critical habitat cost analysis, we have adjusted these estimates to 2021 dollars using the Bureau of Economic Analysis' Gross Domestic Product Price Deflator.

Table 26. RELEVANT ECONOMIC VALUE ESTIMATES FOR CORAL REEFS

Region	Economic Value of coral reefs (2021 $/year)	Types of Values Included
Southeast Florida (Broward, Palm Beach, Miami-Dade, and Monroe Counties)	$217 million	Contingent valuation study estimated only the direct recreational use of reefs for fishing, diving, snorkeling, and viewing from glass-bottomed boats. Value reflects willingness-to-pay of residents and visitors to maintain natural reefs. Value does not consider existence values or other ecosystem service values of reefs, including support for commercial fisheries or coastal protection.
Eastern Puerto Rico (Fajardo, the Cordillera reef system, Culebra, and Vieques)	$1.37 billion	Study references market data, and applies travel cost and contingent valuation methods to estimate a total economic value inclusive of small scale fishing, recreation and tourism, coastal protection, education and research, biodiversity, and non-use values. The non-use portion of the value may not be additive with the other services and reflects non-use values held by the Puerto Rican population.
U.S. Virgin Islands	$234 million	Study applied a variety of methods to estimate coral reef values related to tourism, recreation, amenity values, coastal protection, and commercial fisheries.

Source: Brander and van Beukering (2013) describes the specific studies relied upon to estimate the use and non-use values of coral reefs.

Note: While we have summarized the information from these studies in order to provide general information on previous research regarding economic values of corals, we do not promote a particular estimate, nor offer judgments regarding the quality of the underlying valuation studies. This study presented results in 2007 dollars. For consistency with the critical habitat cost analysis, we have adjusted these estimates to 2021 dollars using the Bureau of Economic Analysis' Gross Domestic Product Price Deflator.

As described above, an ideal study for estimating economic use and non-use values of critical habitat designation would be specific to the species in question (or would address a closely related species), would consider valuation in a context close to the policy issues in question (i.e., economic benefits of implementing the conservation efforts associated with designating critical habitat for this species), and would address a relevant population holding these values (citizens of the United States). While the studies identified and described above are specific to coral species and address willingness to pay across relevant populations, none consider valuation in the context of the specific project modifications that may be associated with critical habitat designation.

A study by Richardson and Loomis (2009) estimates a model (i.e., a willingness-to-pay function) to value threatened or endangered species based on estimates from multiple studies. This meta-analysis is based on 31 studies with 67 willingness-to-pay observations published from 1985 to 2005 evaluating economic values of endangered, threatened or rare species primarily applying contingent valuation methods. The economic values expressed in the studies that inform the model reflect primarily recreational use, as well as nonuse values. Some of the studies, however, are solely focused on the nonuse component of the economic value. The species included in the study are primarily marine and riverine species (whales, dolphins, seals, otters, sea lions, sea turtles, salmon, and other listed fish species), as well as some avian and other species; the meta-analysis does not, however, integrate any studies valuing coral species.

Overall, the studies identified through our literature review provide some indication of the values to humans of coral populations in relevant areas of the United States and its territories. The absence of quantitative information on the effect of the designation on the coral populations, however, precludes direct application of these values to estimate a monetary public willingness-to-pay for coral species critical habitat.

ECOSYSTEM SERVICE BENEFITS RELATED TO CRITICAL HABITAT DESIGNATION FOR THE 5 CORALS

The economic valuation studies described provide insight into why healthy coral reefs benefit people. In particular, coral reefs are associated with the following ecosystem service benefits:

- **Shoreline protection**: Reefs help protect both natural and developed shoreline from wave action and reduce beach erosion (Burke and Maidens 2004).
- **Provide essential habitat and nursery functions for recreationally and commercially valuable fish species**: Reefs in the final critical habitat area support valuable fish and shellfish populations. For example, Table 10 and Table 11 highlight the landings values for some of these species. In addition, the regional commercial fishing industry, as well as tourists engaged in recreational fishing, purchase goods and services to support their activities, contributing to robust regional economies.
- **Increased quality or quantity of reef-related recreational opportunities**: Reefs provide sources of enjoyment for residents and tourists, through activities such as diving and snorkeling. Entertainment and tourism-related sectors are key sources of income and employment in Florida, Puerto Rico, and the USVI.
- **Property value**: In reducing potential damage to properties from wave action, storm surge, and coastal erosion, benefits of healthy reef ecosystems may be realized as a premium on property values (as compared with areas with degraded or no reefs).
- **Carbon sequestration/climate mitigation**: Coral reefs remove carbon from the atmosphere, mitigating damaging effects of climate change (Conservation International 2008).

The benefits of coral reefs to the protection of shorelines and shoreline property, in particular, has gained increasing attention in recent years. A recent study (2021) by Roguero et al. combined engineering, ecologic, social, and economic models to provide a quantitative valuation of the coastal protection benefits of coral reefs off populated coastlines of the U.S. and its Trust territories. The study's probabilistic risk-modelling framework used high-resolution data on bathymetry, topography, coral distribution and cover, and socioeconomics together with physics-based hydrodynamic models to quantify flood hazard zones, the role of coral reefs in reducing flooding, and the averted economic and social consequences. Risk reduction benefits were calculated as the averted impacts between present-day coral reefs and a scenario assuming a 1 meter reduction in reef height. The study estimates that the flood hazard risk reduction benefits of U.S. coral reefs exceed $1.8 billion annually, including $826 in avoided direct damages to buildings and just under $1 billion in additional avoided economic impacts.

The study estimates that average annual flood risk reduction benefits of coral reefs to Florida, Puerto Rico, and USVI total $674 million, $182 million, and $47 million, respectively.

In contributing to the conservation of the listed coral species, the critical habitat designation contributes to the provision of these types of values across the final critical habitat area. In addition, the particular incremental project modifications generated by the critical habitat for the 5 corals, as discussed in the previous sections, may engender other, ancillary ecosystem service benefits, in addition to those noted above, as follows:

- **Preserved or improved water quality:** In providing additional monitoring of water quality effects, and increasing efforts to reduce nutrients, sediments, and turbidity associated with construction and dredging projects, regional water quality may be preserved or improved. This in turn may enhance regional recreational opportunities (outside of the reef-related recreational activities) and have additional human or ecological health benefits.
- **Enhanced marine habitat:** The improved water quality and reduced hard bottom disturbance realized due to critical habitat for the 5 coral species may also result in improvements to ecosystem health that are shared by other, coexisting species (including other endangered or threatened species), such as reef fish or other corals. The maintenance or enhancement of use and non-use values for these other species, or for biodiversity in general, may also result from these project modifications.

As previously noted, the critical habitat designation primarily contributes to conservation and recovery and generates incremental ecosystem service benefits where incremental project modifications are undertaken. Our analysis finds incremental project modifications are only expected in the high-end cost scenario described in Section 10.1.5. That is, uncertainty exists with respect to whether these project modifications would only be implemented in the case that critical habitat for the 5 corals is present. In the case that these project modifications are implemented due to the 5 corals critical habitat (i.e., high-end cost scenario), the designation protects the types of ecosystem service benefits described.

10.3.2 Impacts to Governmental and Private Entities

There is the potential for education and awareness benefits arising from the critical habitat designation. This potential stems from two sources: (1) entities that engage in section 7 consultation and (2) members of the general public interested in coral conservation. The former potential exists from parties that alter their activities to benefit the species or essential features because they are made aware of the critical habitat designation through the section 7 consultation process. The latter may engage in similar efforts because they learn of the critical habitat designation through outreach materials. For example, we have been contacted by diver groups in the Florida Keys who are specifically seeking the 2 Caribbean acroporids corals on dives and report locations to NMFS, which will be of assistance to us in planning and implementing coral conservation and management activities. In our experience, designation raises the public’s awareness that there are areas afforded special consideration.

Similarly, state and local governments may be prompted to enact laws or rules to complement the critical habitat designation and benefit the listed corals. Those laws would likely result in additional impacts of the designation. However, we are not aware of any state of local laws that will likely stem from this particular critical habitat designation. It is also not possible to quantify the beneficial effects of the awareness gained through or the secondary impacts from state and local regulations resulting from the critical habitat designation.

Many previous criticalcritical habitat impact analyses evaluated the impacts of the designation on relationships with, or the efforts of, private and public entities that are involved in management or conservation efforts benefiting listed species. These analyses found that the additional regulatory layer of a designation could negatively impact the conservation benefits provided to the listed species by existing or proposed management or conservation plans. Negative impacts to these entities could result if the designation interferes with these agencies' ability to provide for the conservation of the species, or otherwise hampers management of these areas.

Impacts on entities responsible for natural resource management, conservation plans, or the functioning of those plans depend on the type and number of Section 7 consultations that may result from the designation in the areas covered by those plans, as well as any potential project modifications recommended by these consultations. As described in section 10.1.3.5, there were 2 past consultations on management plans (1 programmatic, 1 informal) within areas being designated as critical habitat. The informal consultation was related to a management plan for the Key Biscayne Special Management Zone.

Existing management plans and associated regulations protect existing coral reef resources, but they do not specifically protect the substrate and water quality features for purposes of increasing listed coral abundance and eventual recovery. Thus, the 5 corals critical habitat designation would provide unique benefits for the corals, beyond the benefits provided by existing management plans. However, the identified areas contain not only the essential features, but also one or more of the 5 corals, and overlap with *Acropora* critical habitat. In addition, consultations related to protected area management over the next ten years are not expected to result in incremental project modifications as these protected areas generally provide specific regulations to protect coral reefs. Hence, any section 7 impacts will likely be limited to administrative costs. Because we identified that resource management was a category of activities that may affect both the 5 corals and the critical habitat, these impacts would not be incremental. In addition, we found no evidence that relationships would be negatively affected or that negative impacts to other agencies' ability to provide for the conservation of the listed coral species would result from designation.

11 Conclusion

Based on the information provided in this Final Report, we identified a total of 28 specific areas occupied by the 5 threatened corals in Florida, Puerto Rico, US Virgin Island, Navassa Island, and the Flower Garden Banks that contain the essential feature. Within 4 of the Florida species-specific areas (*O. annularis, O. faveolata, O.franksi, and M. ferox*), the area covered by the NAS Key West INRMP is ineligible for designation as critical habitat due to the conservation benefit that the INRMP provides to the corals. Based on the 4(b)(2) impact analyses, no exclusions should be made based on economic impacts. However, the Navy's South Florida Ocean Measuring Facility complex in Florida should be excluded because of impacts on national security.

Appendix A. Incremental Cost Sensitivity Results

Exhibit A 1. LOW- END TOTAL INCREMENTAL COSTS (ADMINISTRATIVE AND PROJECT MODIFICATION), BY ACTIVITY TYPE, 2022 - 2031 ($2021, 3% DISCOUNT RATE)

Unit	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total
FL	$16,000	$8,100	$0	$7,600	$2,100	$4,000	$38,000	$1,900	$950	$0	$890	$240	$470	$4,400
PR	$28,000	$2,000	$6,100	$2,000	$0	$0	$38,000	$3,300	$240	$720	$240	$0	$0	$4,500
STT/STJ	$4,000	$0	$0	$0	$0	$0	$4,000	$470	$0	$0	$0	$0	$0	$470
STX	$2,000	$0	$0	$0	$0	$0	$2,000	$240	$0	$0	$00	$0	$0	$240
Nav	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FGB	$0	$0	$0	$0	$9,700	$0	$9,700	$0	$0	$0	$0	$1,100	$0	$1,100
TOTAL	**$50,000**	**$10,000**	**$6,100**	**$9,600**	**$12,000**	**$4,000**	**$92,000**	**$5,900**	**$1,200**	**$720**	**$1,100**	**$1,400**	**$470**	**$11,000**

Note: The estimates may not sum to the totals reported due to rounding.

Exhibit A 2. HIGH- END TOTAL INCREMENTAL COSTS (ADMINISTRATIVE AND PROJECT MODIFICATION), BY ACTIVITY TYPE, 2022 - 2031 ($2021, 3% DISCOUNT RATE)

Unit	Coastal & In-water Const. (USACE)	Beach Nourish-ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total	Coastal & In-water Const. (USACE)	Beach Nourish - ment (USACE)	Channel Dredging (USACE)	Water Quality Mgmt. (EPA)	Energy Dev. (BOEM)	Military (NAVY)	Total
FL	$210,000	$100,000	$0	$7,600	$2,100	$4,000	$320,000	$24,000	$12,000	$0	$890	$240	$470	$38,000
PR	$360,000	$26,000	$30,000	$2,000	$0	$0	$420,000	$43,000	$3,000	$3,500	$240	$0	$0	$49,000
STT/STJ	$52,000	$0	$0	$0	$0	$0	$52,000	$6,100	$0	$0	$0	$0	$0	$6,100
STX	$26,000	$0	$0	$0	$0	$0	$26,000	$3,000	$0	$0	$0	$0	$0	$3,000
Nav	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FGB	$0	$0	$0	$0	$9,700	$0	$9,700	$0	$0	$0	$0	$1,100	$0	$1,100
TOTAL	**$650,000**	**$130,000**	**$30,000**	**$9,600**	**$12,000**	**$3,300**	**$830,000**	**$76,000**	**$15,000**	**$3,500**	**$1,100**	**$1,400**	**$470**	**$98,000**

Note: The estimates may not sum to the totals reported due to rounding.

Appendix B. Impacts on Small Businesses

The Regulatory Flexibility Act (RFA) establishes a principle that agencies shall endeavor, consistent with the objectives of a rule and applicable statutes, to fit regulatory and informational requirements to the scale of businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration. A draft Initial Regulatory Flexibility Analysis (IRFA) was prepared for this final rule pursuant to Sec. 603 of the RFA. An IRFA does not contain any decision criteria; instead, the purpose of an IRFA is to inform the agency, as well as the public, of the expected economic impacts of the final action and to ensure that the agency considers alternatives that minimize the expected impacts while meeting the goals and objectives of the final action and applicable statutes.

This final regulatory flexibility analysis (FRFA) considers the extent to which the potential economic impacts associated with the designation of critical habitat for the 5 corals could be borne by small businesses. The FRFA presented is conducted pursuant to the Regulatory Flexibility Act (RFA) as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996. Information for this analysis was gathered from the Small Business Administration (SBA), U.S. Census Bureau, and the Dun and Bradstreet Hoovers Database.

The analysis of impacts to small entities relies on the estimated incremental impacts resulting from the final critical habitat designation. Incremental impacts are detailed in Section 10.1.6 of this analysis.

This FRFA uses the best available information to identify the potential impacts of critical habitat designation on small entities. However, there are uncertainties that complicate quantification of these impacts, particularly with respect to the extent to which the quantified impacts may be borne by small entities. As a result, this FRFA employs a conservative approach (i.e., more likely to overestimate than underestimate impacts to small entities) in assuming that the quantified costs that are not borne by the Federal Government are generally borne by small entities. This analysis focuses on small entities located in Broward, Martin, Miami-Dade, Monroe, and Palm Beach Counties in Florida; Puerto Rico; St. Thomas and St. John; and St. Croix.

Summary of Findings

Consultations on in-water and coastal construction, beach nourishment and shoreline protection, and channel dredging have the potential to involve third parties. For purposes of determining potential impacts to small entities, these activities were combined into a single industry category: In-Water and Coastal Construction and Dredging. Information presented in Section 10.1.3 of this report demonstrates that third parties would not be involved in consultations on the effects of water quality management, protected area management, fishery management, aquaculture, military activities, and oil and gas and renewable energy development. Unlike in-water and coastal construction projects, consultations on these activities would be conducted directly between NMFS and the respective federal action agency.

Exhibit B-1 presents a summary of estimated impacts to small entities. The maximum total annualized impacts to small entities are estimated to be $88,000, which represents approximately 90% of the total quantified incremental impacts forecast to result from the Final Rule. This assumes that all of the third party entities involved in future projects will be small entities. These impacts are anticipated to be borne by the small entities in each industry that obtain permits from federal agencies that consult with NMFS regarding the 5 coral species' critical habitat over the next ten years. Given the uncertainty regarding which small entities in a given industry will need to consult with NMFS, this analysis estimates impacts to small entities under two different scenarios. These scenarios are intended to reflect the range of uncertainty regarding the number of small entities that may be affected by the designation and the potential impacts of critical habitat designation on their annual revenues.

Under Scenario 1, this analysis assumes that all third parties participating in future consultations are small, and that incremental impacts are distributed evenly across all of these entities. Scenario 1 accordingly reflects a high estimate of the number of potentially affected small entities and a low estimate of the potential effect in terms of percent of revenue. This scenario therefore overstates the number of small entities likely to be affected by the rule and potentially understates the revenue effect. This analysis anticipates that 28 small entities engaged in coastal and in-water construction and dredging activities will incur approximately $88,000 in annualized costs under Scenario 1. However, because these costs are shared among 28 entities, annualized impacts of the rule are estimated to make up less than 1% of annual revenues for each affected small entity.

Under Scenario 2, this analysis assumes costs associated with each consultation action are borne to a single small entity within an industry. This method understates the number of small entities affected but overstates the likely impacts on an entity. As such, this method arrives at a low estimate of potentially affected entities and a high estimate of potential effects on revenue, assuming that quantified costs represent a complete accounting of the costs likely to be borne by private entities. For the coastal and in-water construction and dredging industry, this scenario forecasts $88,000 in annualized impacts would be borne by a single small entity. Though this estimate is almost certainly an overstatement of the costs borne by a single small entity, the impact is, nonetheless, expected to result in impacts that are less than 5% of the average annual revenues for a small entity in this industry.[17]

While these scenarios present a broad range of potentially affected entities and the associated revenue effects, we expect the actual number of small entities affected and revenue effects will be somewhere in the middle. In other words, some subset greater than 2 and less than 28 of the small entities will participate in section 7 consultations on the 5 corals and bear associated impacts annually. Regardless, our analysis demonstrates that, even if we assume a low-end estimate of affected small entities, the greatest potential revenue effect is still less than 5%.

[17] Impacts to individual small entities will vary depending on an entity's particular circumstances, such as level of revenues; however, the analysis does not attempt to forecast which specific entities could be affected, rather, it conservatively focuses on average impacts as compared to a maximum revenue based on SBA's small business standards.

Exhibit B 1. SUMMARY OF ESTIMATED IMPACTS TO SMALL ENTITIES BY ACTIVITY TYPE

Metric	Coastal & In-Water Construction and Dredging
Total annualized impacts of the Rule to small entities[1]	$88,000
Estimated average annual revenues for small entities[2]	$1,250,000
Estimated number of small entities conducting activities in critical habitat areas being considered[22]	1,100
Scenario 1: Assumes that all small entities bear an equal share of costs	
Estimated maximum number of small entities subject to consultation annually[3]	3
Percent of small businesses potentially subject to incremental costs	2.5%
Estimated impact per small entity	$3,100
Estimated impact per small entity as a percentage of revenues	0.2%
Scenario 2: Assumes that one small entity bears all costs	
Estimated impact per small entity	$88,000
Estimated impact per small entity as a percentage of revenues	4.2%

Notes:

1. These values represent total administrative and project modification costs expected to be borne by third parties in each industry. This analysis conservatively assumes that all project modification costs are borne by third parties rather than Federal agencies.
2. The quantity and revenues of small entities were estimated through queries of the Dun and Bradstreet Hoovers Database. Small entities were identified based on the industry-specific criteria outlined in Exhibit B-2.
3. The estimated maximum number of small entities subject to consultation annually reflects the total number of consultations forecast to occur annually within each industry. This assumes that each consultation within an industry is conducted by a unique small entity.

FRFA Requirements

The Regulatory Flexibility Act, passed in 1980, requires Federal agencies to consider the impacts of regulations on small entities. When a final regulation is published for public comment in the Federal Register, it must be accompanied by an FRFA. As described in 5 U.S. Code § 604, each FRFA is required to contain:

1. a succinct statement of the need for, and objectives of, the rule;
2. a summary of the significant issues raised by the public comments in response to the initial regulatory flexibility analysis, a summary of the assessment of the agency of such issues, and a statement of any changes made in the final rule as a result of such comments;
3. a description of and, where feasible, an estimate of the number of small entities to which the final rule will apply or an explanation of why no such estimate is available;

4. a description of the projected reporting, recordkeeping, and other compliance requirements of the final rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and
5. a description of the steps the agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected.

Need for, and Objectives of, the Rule

In 2014, 5 coral species were listed as threatened under the ESA (79 FR 53851; September 10, 2014). Concurrenly, the 2 Caribbean acroporids listed as threatened in 2006 were confirmed as threatened. As a requirement of the ESA, critical habitat must be designated for all species listed as threatened or endangered (50 CFR 424.12). Designation of critical habitat for the 5 corals is being designated in order to fulfill this legal requirement of the ESA.

The objective of this critical habitat rule is to use the best scientific data available to designate critical habitat for 5 corals listed as threatened under the ESA. The designation is designed to meet the conservation needs of the 5 corals and ultimately aid in species recovery. The ESA defines critical habitat as:

1. "The specific areas within the geographical area currently occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (i) essential to the conservation of the species and (ii) that may require special management considerations or protection, and;
2. Specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species." (50 CFR 424.02)

Summary of Significant Issues Raised in Public Comment in Response to the IRFA

Only 2 public comments on the IRFA were received during public comment period. One commenter stated that, since the proposed critical habitat rule could have effects on the full suite of activities profiled in Section 10.1.3 of this report, impacts to small entities should be estimated across all industries comprising these activities. As the final rule would only have the potential to incrementally impact small entities engaged in coastal and in-water construction, channel dredging, and beach nourishment/shoreline protection activities, this analysis only profiles (in Exhibit B-2) and estimates impacts to (in Exhibit B-1) small entities within the industries engaged in this subset of activities.

Another commenter stated that the no-action alternative, in which critical habitat for the 5 corals would not be designated, is not a feasible alternative under the RFA. However, NMFS may not designate critical habitat if it not prudent and advisable to do so; thus, a no-action alternative is viable.

Description and Estimate of the Number of Small Entities to Which the Final Rule Will Apply

The RFA defines three types of small entities:

- **Small Business**. Section 601(3) of the RFA defines a small business according to the definition of a small business concern provided in section 3 of the Small Business Act (SBA). The SBA broadly defines a small business concern as a business which is "independently owned and operated and which is not dominant in its field of operation." (15 USC § 632) The SBA provides industry-specific criteria based on either revenues or number of employees that delineate which businesses meet this definition.
- **Small Organization**. Section 601(4) of the RFA defines a small organization as a non-profit enterprise that is independently owned and operated and not dominant in its field.
- **Small Governmental Jurisdiction**. Section 601(5) of the RFA defines a small government jurisdiction as a government of a county, city, town, township, village, school district, or special district, with a population less than 50,000.

The RFA requires consideration of direct impacts to small entities that may result from the final rule. For critical habitat designation, all potential direct impacts are incurred through the section 7 consultation process. Though section 7 of the ESA only applies to activities with a federal nexus, small entities may be involved through projects that are funded or permitted through federal agencies.

Indirect impacts of critical habitat are unintended changes in economic behavior that may occur outside of the ESA, through other federal or non-federal actions, and that are caused by the designation of critical habitat. Economic effects expected to occur regardless of critical habitat designation are considered baseline impacts. While it is possible that indirect impacts to small entities may occur as a result of the final rule, these impacts are not quantified in this IRFA.

The regulatory mechanism through which critical habitat protections are enforced is section 7 of the ESA, which directly regulates only those activities carried out, funded, or authorized by a federal agency. By definition, federal agencies are not considered small entities, although the activities they may fund or permit may be proposed or carried out by small entities. Given the SBA guidance described above, this analysis considers the extent to which this designation could potentially affect small entities, regardless of whether these entities would be directly regulated by a rule or by a delegation of impact from the directly regulated entity.

This FRFA focuses on identifying small entities that may bear the incremental impacts of this rulemaking. In addition to the administrative costs of participating in consultations, section 10.1.3 of the economic impact analysis report identifies the following economic activities as potentially requiring ESA section 7 consultation because they may affect the essential features of the 5 corals critical habitat. These activities are:

- Coastal and In-water Construction
- Channel Dredging
- Beach Nourishment/Shoreline Protection
- Water Quality Management
- Protected Area Management
- Fishery Management
- Aquaculture
- Military Activities
- Oil & Gas and Renewable Energy Development

Though there is significant uncertainty regarding which future section 7 consultations will involve third parties, the activity categories described in Section 10.1.3 of the report provide some indication of the probability of third party involvement. As described in Section 10.1, only a subset of these categories of activities are anticipated to have incremental impacts due to the final critical habitat designation: coastal and in-water construction, channel dredging, beach nourishment/shoreline protection, and water quality management. Given the uncertainty regarding the proportion of consultations on these activities that will involve third parties, this analysis conservatively assumes that all future consultations on these activities will involve third parties.

These activities that may involve third parties are categorized into a single broad industries that may experience impacts to small entities: Coastal and In-Water Construction and Dredging. This category encompasses coastal and in-water construction, channel dredging, and beach nourishment activities.

Exhibit B-2 lists potentially affected industries by North American Industry Classification System (NAICS) code and SBA size standard. Consultation can result in two primary costs:

- Administrative Costs. Section 7 consultations are likely to involve written and verbal communication with NMFS and other Federal action agencies. The cost associated with these administrative efforts is estimated separately for informal, formal, and programmatic consultations.
- Project Modifications. Due to the considerable baseline protections existing for the 5 corals critical habitat, project modifications only have the potential to occur in a limited number of geographic areas. Out of the consultations forecasted due to the 5 corals critical habitat in the next ten years, only 28 are expected to have the potential to result in incremental project modifications. For purposes of this FRFA, the analysis conservatively assumes that all 28 of these consultations result in project modifications, and that the full cost of these project modifications are borne by small entities.

Ideally, this FRFA would directly identify the number of small entities which may be affected by authorizing or funding federal agencies' consultation with NMFS regarding potential effects of projects and activities on 5 coral species critical habitat. However, significant uncertainty exists regarding what future projects may involve which small entities. Absent specific knowledge regarding which small entities may engage in consultation with NMFS over the next ten years, this analysis relies on industry and location-specific information on small businesses available through the Dun and Bradstreet Hoovers database. Exhibit B-2 summarizes the NAICS codes that were identified as relevant to the major activity categories discussed above. The Dun and Bradstreet database was used to identify small businesses classified with these NAICS codes that operate within counties or territories that share a coastline with the final critical habitat. All of the counties and territories that share a coastline with the final critical habitat have populations of more than 50,000, so no impacts to small governmental jurisdictions are expected as a result of the critical habitat designation.

We encouraged all small businesses, small governmental jurisdictions, and other small entities that may be affected by this rule to provide comment on the potential economic impacts of the designation, such as anticipated costs of consultation and potential project modifications, to improve the above analysis. We did not receive any pertinent comment to inform our analysis.

Major Relevant Activity	Description of Included Industry Sectors	NAICS Code	SBA Size Standard
Coastal & In-Water Construction and Dredging	County Governments (to the extent that they undertake dredging, bridge-building, utility, or other construction activities)	N/A	Population of 50,000
	Highway, Street, and Bridge Construction-- This industry comprises establishments primarily engaged in the construction of highways (including elevated), streets, roads, airport runways, public sidewalks, or bridges.	237310	$39,500,000
	Other Heavy and Civil Engineering Construction -- This industry comprises establishments primarily engaged in heavy and engineering construction projects (excluding highway, street, bridge, and distribution line construction).	237990	$39,500,000
	Dredging and Surface Cleanup Activities (a subset of Other Heavy and Civil Engineering Construction, above)	237990	$39,500,000
Source: (U.S. Small Business Administration 2019).			

Description of Reporting and Recordkeeping Efforts

The RFA requires consideration of alternative rules that would minimize impacts to small entities. We considered the following alternatives when developing the final critical habitat rule.

ALTERNATIVE 1: NO ACTION ALTERNATIVE

No action (status quo): We would not designate critical habitat for the 5 corals. Under this alternative, conservation and recovery of the listed species would depend exclusively upon the protection provided under the "jeopardy" provisions of section 7 of the ESA. Under the status quo, there would be no increase in the number of ESA consultations or project modifications in the future that would not otherwise be required due to the listing of the corals. However, we have determined that the physical feature forming the basis for our critical habitat designation is essential to the corals' conservation, and conservation for these species will not succeed without this feature being available. Thus, the lack of protection of the critical habitat feature from adverse modification could result in continued declines in abundance of the 5 corals, and loss of associated economic and other values these corals provide to society, such as recreational and commercial fishing and diving services, and shoreline protection services. Small entities engaged in some coral reef-dependent industries would be adversely affected by the continued declines in the 5 corals. Thus, the no action alternative is not necessarily a "no cost" alternative for small entities.

ALTERNATIVE 2: PREFERRED ALTERNATIVE

Under this alternative, the areas designated are generally all waters from 0.5 to 40 m deep in Florida (Martin through Monroe Counties), Puerto Rico, USVI, Navassa, and FGB. An analysis of the costs and benefits of the preferred alternative designation is presented in Section 10.1. Relative to the no action alternative, this alternative will likely involve an increase in administrative and project modification costs for those section 7 consultations required to avoid adverse impacts to critical habitat, above and beyond those required due to the corals' listing alone. We have determined that no categories of activities would require consultation, and no categories of project modifications would be required in the future solely due to this rule and the need to prevent adverse modification of critical habitat. All categories of activities have similar potential to adversely impact corals and critical habitat, and the same project modifications would remedy both sets of adverse effects. However, due to the greater abundance of the critical habitat feature relative to the abundance of 5 corals (or all coral species combined), specific future Federal actions within those categories will likely have greater potential to adversely affect the critical habitat, in which case consultation and project modification costs, and the costs small entities might incur, would be an incremental impact of this rule. On the other hand, because projects with larger or more diffuse action areas are more likely to impact both the corals and the critical habitat, consultation and project modification costs associated with those projects would more likely be coextensive with the coral listings or another regulatory requirement.

The preferred alternative was selected because it best implements the critical habitat provisions of the ESA by including the single, well-defined environmental feature we can clearly state is essential to the species' conservation, and due to the important conservation benefits that will result from this alternative relative to the no action alternative.

ALTERNATIVE 3: DIFFERENT GEOGRAPHIC BOUNDARIES

We considered a third alternative that would have limited the designations to a single depth contour for all species, either 30 m, 60 m, or 90 m. We evaluated this alternative based on our experience with the 2008 *Acropora* critical habitat designation, which created a single designation for both species from 0 to 30 m depth, generally. Therefore, we considered replicating this approach in this designation. In this scenario, The boundaries for all the 5 corals' units would be formed by the same depth contour. We considered using either 30 m, 60 m, or 90 m as the offshore limit based on the available data on both species and essential feature distribution. However, each of the 5 corals occurs in a particular depth swath (e.g., *Dendrogyra cylindrus* – 1 to 25 m, verses *Mycetophyllia ferox* – 5 to 90 m). Under this alternative, if a future action occurred in an area with a particular depth in which one or more of the species would not occur, but may affect the 5 corals critical habitat, we would evaluate the effects to the conservation value of each of the 5 species' critical habitat. That would not be prudent, though, because the species would not occupy that habitat and thus any adverse effects would not adversely affect the conservation value for that particular species. Thus, we rejected this alternative because it does not ultimately provide for the conservation of the species. This alternative may have resulted in fewer future consultations, and thus fewer small entities affected, had the 30 m depth contour been selected as the offshore boundary. However, in that case, the conservation of the species whose depth ranges extend beyond 30 m would not have been realized. If the 60 m or 90 m depth contour were selected, the number of consultations and small entities would likely be the same as or more than the preferred alternative due to the maximum depth limit in Florida of 40 m.

Appendix C. Data and Assumptions for Estimating Administrative Costs of Section 7 Consultations

This analysis projected administrative costs of section 7 consultations based on a model developed by Industrial Economics, Incorporated (IEc) in 2002 to inform economic analyses of critical habitat rules. Considered by NMFS to represent the best available information on administrative costs for its critical habitat rulemakings, the model's development relied on interviews with Federal agency staff with significant experience implementing section 7 consultations and has been adjusted over the course of dozens of rulemakings, as appropriate, by NMFS biologists and Federal agency staff.

The estimated level of effort for time spent on consultations reflects Federal agency staff estimates of hours or days spent by task and consultation type, as well as the staff level (in terms of the Federal General Schedule (GS) level) typically assigned to these tasks. To account for variable complexity across consultations, the interviewees described time estimates and GS level assignments at low and high levels of effort for each consultation type. Separately, the model considers the number of hours and hourly rate to conduct Biological Assessments.

Wages for Federal agency employees reflect the midpoint between Step 1 and Step 10 within each GS level using the GS Hourly Rates and assume an overhead multiplier of 2.5.

Exhibit C.1 describes the resulting key assumptions related to total hours and wage level for consultations and technical assistances that consider both the listing of the species (jeopardy) and critical habitat (adverse modification). Adverse modification costs are assumed to be 25 percent of total consultation costs. The consultation costs in Table 18 of this analysis reflect the average of the low and high levels of effort by consultation type and entity.

Exhibit B 2. SUMMARY OF ESTIMATED IMPACTS TO SMALL ENTITIES BY ACTIVITY TYPE

Consultation Type	Effort Level	FWS/NMFS		Federal Action Agency		Third Party		Biological Assessments	
		Total Hours	GS Level	Total Hours	GS Level	Total Hours	GS Level	Total Hours	GS Level
Technical Assistance	Low	5	GS-10			6	$100		
	High	13	GS-10			15	$100		
Informal Consultation	Low	19	GS-10			12	$100	0	$100
	High	45	GS-12	56	GS-12	29	$100	40	$100
Formal Consultation	Low	45	GS-12	56	GS-12	29	$100	56	$100
	High	74	GS-13	94	GS-12	41	$100	56	$100
Programmatic Consultation	Low	200	GS-11	160	GS-11			56	$100
	High	280	GS-11	240	GS-11			56	$100
Source: Industrial Economics, Incorporated. Final Economic Analysis of Critical Habitat Designation for Humpback Whales. 2020.									

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16 USC § 1532. Definitions in: Title 16 Chapter 35 - Endangered Species.

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