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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Parts 223 and 224

[Docket No. 0911231415-2625-02]

0648-XT12

Endangered and Threatened Wildlife and Plants: Proposed Listing Determinations for 82 Reef-building Coral Species; Proposed Reclassification of Acropora palmata and Acropora cervicornis from Threatened to Endangered.

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Proposed rule; request for comments.

SUMMARY: We, NMFS, have completed comprehensive status reviews under the Endangered Species Act (ESA) of 82 reef-building coral species in response to a petition submitted by the Center for Biological Diversity (CBD) to list the species as either threatened or endangered. We have determined, based on the best scientific and commercial data available and efforts being made to protect the species, that 12 of the petitioned coral species warrant listing as endangered (five Caribbean and seven Indo-Pacific), 54 coral species warrant listing as threatened (two Caribbean and 52 Indo-Pacific), and 16 coral species (all Indo-Pacific) do not warrant listing as threatened or endangered under the ESA. Additionally, we have determined, based on the best scientific and commercial information available and efforts undertaken to protect the species, two Caribbean coral species currently listed warrant reclassification from threatened to

endangered. We are announcing that 18 public hearings will be held during the public comment period to provide additional opportunities and formats to receive public input. See SUPPLEMENTARY INFORMATION for public hearing dates, times, and locations.

DATES: Comments on this proposal must be received by [INSERT DATE 90 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]. See SUPPLEMENTARY INFORMATION for public hearing dates, times, and locations.

ADDRESSES: You may submit comments on this document, identified by NOAA-NMFS-2010-0036, by any of the following methods:

- Electronic Submission: Submit all electronic public comments via the Federal e-Rulemaking Portal www.regulations.gov. To submit comments via the e-Rulemaking Portal, first click the "submit a comment" icon, then enter NOAA-NMFS-2010-0036 in the keyword search. Locate the document you wish to comment on from the resulting list and click on the "Submit a Comment" icon on the right of that line.
- Mail: Submit written comments to Regulatory Branch Chief, Protected Resources Division, National Marine Fisheries Service, Pacific Islands Regional Office, 1601 Kapiolani Blvd., Suite 1110, Honolulu, HI, 96814; or Assistant Regional Administrator, Protected Resources, National Marine Fisheries Service, Southeast Regional Office, 263 13th Avenue South, Saint Petersburg, FL, 33701, Attn: 82 coral species proposed listing.
- Fax: 808-973-2941; Attn: Protected Resources Regulatory Branch Chief; or 727-824-5309; Attn: Protected Resources Assistant Regional Administrator.

Instructions: You must submit comments by one of the above methods to ensure that we receive, document, and consider them. Comments sent by any other method, to any other address or individual, or received after the end of the comment period, may not be considered. All comments received are a part of the public record and will generally be posted for public viewing on www.regulations.gov without change. All personal identifying information (e.g., name, address, etc.) you submit will be publicly accessible. Do not submit confidential business information, or otherwise sensitive or protected information. We will accept anonymous comments (enter "N/A" in the required fields if you wish to remain anonymous). Attachments to electronic comments will be accepted in Microsoft Word or Excel, WordPerfect, or Adobe PDF file formats only.

You can obtain the petition and reference materials regarding this determination via the NMFS Pacific Island Regional Office website: http://www.fpir.noaa.gov/PRD/PRD_coral.html; NMFS Southeast Regional Office website: http://sero.nmfs.noaa.gov/pr/esa/82CoralSpecies.htm; NMFS HQ website: http://www.nmfs.noaa.gov/stories/2012/11/82corals.html; or by submitting a request to the Regulatory Branch Chief, Protected Resources Division, National Marine Fisheries Service, Pacific Islands Regional Office, 1601 Kapiolani Blvd., Suite 1110, Honolulu, HI, 96814, Attn: 82 coral species. See SUPPLEMENTARY INFORMATION for public hearing dates, times, and locations.

FOR FURTHER INFORMATION CONTACT: Chelsey Young, NMFS, Pacific Islands Regional Office, 808-944-2137; Lance Smith, NMFS, Pacific Island Regional Office, 808-944-2258; Jennifer Moore, NMFS, Southeast Regional Office, 727-824-5312; or Marta Nammack, NMFS, Office of Protected Resources, 301-427-8469.

SUPPLEMENTARY INFORMATION:

Background

On October 20, 2009, the Center for Biological Diversity (CBD) petitioned us to list 83 reef-building coral species as either threatened or endangered under the ESA and to designate critical habitat. The 83 species included in the petition are: Acanthastrea brevis, Acanthastrea hemprichii, Acanthastrea ishigakiensis, Acanthastrea regularis, Acropora aculeus, Acropora acuminata, Acropora aspera, Acropora dendrum, Acropora donei, Acropora globiceps, Acropora horrida, Acropora jacquelineae, Acropora listeri, Acropora lokani, Acropora microclados, Acropora palmerae, Acropora paniculata, Acropora pharaonis, Acropora polystoma, Acropora retusa, Acropora rudis, Acropora speciosa, Acropora striata, Acropora tenella, Acropora vaughani, Acropora verweyi, Agaricia lamarcki, Alveopora allingi, Alveopora fenestrata, Alveopora verrilliana, Anacropora puertogalerae, Anacropora spinosa, Astreopora cucullata, Barabattoia laddi, Caulastrea echinulata, Cyphastrea agassizi, Cyphastrea ocellina, Dendrogyra cylindrus, Dichocoenia stokesii, Euphyllia cristata, Euphyllia paraancora, Euphyllia paradivisa, Galaxea astreata, Heliopora coerulea, Isopora crateriformis, Isopora cuneata, Leptoseris incrustans, Leptoseris yabei, Millepora foveolata, Millepora tuberosa, Montastraea annularis, Montastraea faveolata, Montastraea franksi, Montipora angulata, Montipora australiensis, Montipora calcarea, Montipora caliculata, Montipora dilatata, Montipora flabellata, Montipora lobulata, Montipora patula, Mycetophyllia ferox, Oculina varicosa, Pachyseris rugosa, Pavona bipartita, Pavona cactus, Pavona decussata, Pavona diffluens, Pavona venosa, Pectinia alcicornis, Physogyra lichtensteini, Pocillopora danae, Pocillopora elegans, Porites horizontalata, Porites napopora, Porites nigrescens, Porites pukoensis, Psammocora stellata, Seriatopora aculeata, Turbinaria mesenterina, Turbinaria peltata, Turbinaria reniformis, and Turbinaria stellulata.

Eight of the petitioned species occur in the Caribbean and 75 of the petitioned species occur in the Indo-Pacific region. Most of the 83 species can be found in the United States, its territories (Puerto Rico, U.S. Virgin Islands, Navassa, Northern Mariana Islands, Guam, American Samoa, Pacific Remote Island Areas), or its freely associated states (Republic of the Marshall Islands, Federated States of Micronesia, and Republic of Palau), though many occur more frequently in other countries.

On February 10, 2010, we published a positive 90–day finding (75 FR 6616; February 10, 2010) in which we described our determination that the petition contained substantial scientific and commercial information indicating that the petitioned actions may be warranted for all of the petitioned species except the Caribbean species Oculina varicosa. Subsequently, we announced the initiation of a formal status review of the remaining 82 species (hereinafter referred to as "candidate species") as required by section 4(b)(3)(A) of the ESA. Concurrently, we solicited input from the public on six categories of information: (1) historical and current distribution and abundance of these species throughout their ranges (U.S. and foreign waters); (2) historical and current condition of these species and their habitat; (3) population density and trends; (4) the effects of climate change on the distribution and condition of these coral species and other organisms in coral reef ecosystems over the short and long term; (5) the effects of all other threats including dredging, coastal development, coastal point source pollution, agricultural and land use practices, disease, predation, reef fishing, aquarium trade, physical damage from boats and anchors, marine debris, and aquatic invasive species on the distribution and abundance of these coral species over the short and long term; and (6) management programs for conservation of these species, including mitigation measures related to any of the threats listed under (5) above.

The ESA requires us to make determinations on whether species are threatened or endangered "solely on the basis of the best scientific and commercial data available ... after conducting a review of the status of the species..." (16 U.S.C. 1533). Further, consistent with case law, our implementing regulations specifically direct us not to take possible economic or other impacts of listing species into consideration (50 CFR 424.11(b)). In order to conduct a comprehensive status review for this petition, given the number of species, the geographic scope and issues surrounding coral biology and extinction risk, we convened a Coral Biological Review Team (BRT) composed of seven Federal scientists from NMFS' Pacific Islands, Northwest, and Southeast Fisheries Science Centers, as well as the U.S. Geological Survey and National Park Service. The members of the BRT are a diverse group of scientists with expertise in coral biology, coral ecology, coral taxonomy, physical oceanography, global climate change, and coral population dynamics. The BRT's comprehensive, peer-reviewed Status Review Report (SRR, Brainard et al., 2011) incorporates and summarizes the best available scientific and commercial information as of August 2011 on the following topics: (1) long-term trends in abundance throughout each species' range; (2) potential factors for any decline of each species throughout its range (human population, ocean warming, ocean acidification, overharvesting, natural predation, disease, habitat loss, etc.); (3) historical and current range, distribution, and habitat use of each species; (4) historical and current estimates of population size and available habitat; and (5) knowledge of various life history parameters (size/age at maturity, fecundity, length of larval stage, larval dispersal dynamics, etc.). The SRR evaluates the status of each species, identifies threats to the species, and estimates the risk of extinction for each of the candidate species out to the year 2100. The BRT also considered the petition, comments we received as a result of the 90-day Finding (75 FR 6616; February 10, 2010), and the results of the peer review of the draft SRR, and incorporated relevant information from these sources into the final SRR. Given the scope of the undertaking to gather and evaluate biological information for an 82-species status review, the BRT elected not to evaluate adequacy of existing regulatory mechanisms and conservation efforts in addressing threats to the 82 coral species. Thus, we developed a supplementary, peer-reviewed Draft Management Report (NMFS, 2012a) to identify information relevant to factor 4(a)(1)(D), inadequacy of existing regulatory mechanisms, and protective efforts that may provide protection to the corals pursuant to ESA section 4(b). We combined the information from the SRR and the Draft Management Report to develop and apply the listing Determination Tool (discussed below).

On April 17, 2012, we published a Federal Register notice announcing the availability of the SRR and the Draft Management Report. The response to the petition to list 83 coral species is one of the broadest and most complex listing reviews we have ever undertaken. Given the petition's scale and the precedential nature of the issues, we determined that our decision-making process would be strengthened if we took additional time to allow the public, non-federal experts, non-governmental organizations, state and territorial governments, and academics to review and provide information related to the SRR and the Draft Management Report prior to issuing our 12-month finding. We specifically requested information on the following: (1) Relevant scientific information collected or produced since the completion of the SRR or any relevant scientific information not included in the SRR; and (2) Relevant management information not included in the Draft Management Report, such as descriptions of regulatory mechanisms for greenhouse gas emissions globally, and for local threats in the 83 foreign countries and the U.S. (Florida, Hawaii, Puerto Rico, U.S. Virgin Islands, Guam, American Samoa, and Northern Mariana Islands), where the 82 coral species collectively occur. Further, in June 2012, we held listening sessions and scientific workshops in the Southeast region and Pacific Islands region to engage the scientific community and the public in person. During this public engagement period, which ended on July 31, 2012, we received over 42,000 letters and emails. Also, we were provided or we identified approximately 400 relevant scientific articles, reports, or presentations either produced since the SRR was finalized or not originally included in the SRR. We compiled and synthesized all relevant information that we identified or received into the Supplemental Information Report (SIR; NMFS, 2012b). Additionally, we incorporated all relevant management and conservation information into the Final Management Report (NMFS, 2012c).

Therefore, the 82 candidate coral species comprehensive status review consists of the SRR (Brainard et al., 2011), the SIR (NMFS, 2012b), and the Final Management Report (NMFS, 2012c). The findings on the petition described in this notice are based on the information contained within these reports.

Listing Species under the Endangered Species Act

We are responsible for determining whether each of the 82 candidate corals are threatened or endangered under the ESA (16 U.S.C. 1531 et seq.) We first must consider whether each candidate species meets the definition of a "species" in section 3 of the ESA, then whether the status of each species qualifies it for listing as threatened or endangered under the

ESA. As described above, we convened the BRT which produced the SRR (Brainard et al., 2011), then a public engagement period was opened which led to the SIR and Final Management Report (NMFS, 2012b; NMFS, 2012c). We developed a Determination Tool to consistently interpret and apply the information in the three reports to the definitions of "endangered" and "threatened" species in the ESA, in order to produce proposed listing determinations for each of the 82 species (the Determination Tool is introduced and described in the Risk Analyses section below). The BRT participated in the implementation of the Determination Tool, and concurred that its inputs (demographic, spatial, and threat vulnerability ratings for each species) are the best available information. Further, the BRT believes our listing determinations for the 82 candidate species are consistent with their extinction risk analyses.

This finding begins with an overview of coral biology, ecology, and taxonomy in the Introduction to Corals and Coral Reefs section below, which also discusses whether each candidate species meets the definition of a "species" for purposes of the ESA. Other relevant background information in this section includes the general characteristics of the habitats and environments in which the 82 candidate species are found. The finding then summarizes information on factors adversely affecting and posing extinction risk to corals in general in the Threats to Coral Species section. The Risk Analyses section then describes development and application of the Determination Tool that resulted in proposed listing statuses for the 82 candidate species.

Introduction to Corals and Coral Reefs

Corals are marine invertebrates in the phylum Cnidaria that occur as polyps, usually forming colonies of many clonal polyps on a calcium carbonate skeleton. The Cnidaria include true stony corals (class Anthozoa, order Scleractinia), the blue coral (class Anthozoa, order Helioporacea), and fire corals (class Hydrozoa, order Milleporina). Members of these three orders are represented among the 82 candidate coral species (79 Scleractinia, one Helioporacea, and two Milleporina). All 82 candidate species are reef-building corals, because they secrete massive calcium carbonate skeletons that form the physical structure of coral reefs. Reef-building coral species collectively produce coral reefs over time in high-growth conditions, but these species also occur in non-reef habitats (i.e., they are reef-building, but not reef-dependent). There are approximately 800 species of reef-building corals in the world.

Most reef-building coral species are in the order Scleractinia, consisting of over 25 families, 100 genera, and the great majority of the approximately 800 species. Most Scleractinian corals form complex colonies made up of a tissue layer of polyps (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. Scleractinian corals are characterized by polyps with multiples of six tentacles around the mouth for feeding and capturing prey items in the water column. In contrast, the blue coral, Heliopora coerulea, is characterized by polyps always having eight tentacles, rather than the multiples of six that characterize stony corals. The blue coral is the only species in the suborder Octocorallia (the "octocorals") that forms a skeleton, and as such is the primary octocoral reef-building species. Finally, Millepora fire corals are also reef-building species, but unlike the scleractinians and octocorals, they have near microscopic polyps containing tentacles with stinging cells.

Reef-building coral species are capable of rapid calcification rates because of their symbiotic relationship with single-celled dinoflagellate algae, zooxanthellae, which occur in great numbers within the host coral tissues. Zooxanthellae photosynthesize during the daytime, producing an abundant source of energy for the host coral that enables rapid growth. At night, polyps extend their tentacles to filter-feed on microscopic particles in the water column such as zooplankton, providing additional nutrients for the host coral. In this way, reef-building corals obtain nutrients autotrophically (i.e., via photosynthesis) during the day, and heterotrophically (i.e., via predation) at night. In contrast, non-reef-building coral species do not contain zooxanthellae in their tissues, and thus are not capable of rapid calcification. Unlike reef-building corals, these "azooxanthellate" species are not dependent on light for photosynthesis, and thus are able to occur in low-light habitats such as caves and deep water. We provide additional information in the following sections on the biology and ecology of reef-building corals and coral reefs.

Taxonomic Uncertainty in Reef-building Corals

In addressing the species question, the BRT had to address issues related to the considerable taxonomic uncertainty in corals (e.g., reliance on morphological features rather than genetic and genomic science to delineate species) and corals' evolutionary history of reticulate processes (i.e., individual lineages showing repeated cycles of divergence and convergence via hybridization). To address taxonomic uncertainty, except as described below where there was genetic information available, the BRT accepted the nominal species designation as listed in the petition, acknowledging that future research may result in taxonomic reclassification of some of the candidate species. Additionally, to address complex reticulate processes in corals, the BRT attempted to distinguish between a "good species" that has a hybrid history – meaning it may display genetic signatures of interbreeding and back-crossing in its evolutionary history – and a "hybrid species" that is composed entirely of hybrid individuals (as in the case of Acropora prolifera, discussed in the status review of acroporid corals in the Caribbean; Acropora Biological Review Team, 2005). The best available information indicates that, while several of the candidate species have hybrid histories, there is no evidence to suggest any of them are "hybrid species" (all individuals of a species being F1 hybrids); thus, they were all considered to meet the definition of a "species".

Studies elucidating complex taxonomic histories were available for several of the genera addressed in the status review, and the BRT was able to incorporate those into their species determinations. Thus, while the BRT made species determinations for most of the 82 candidate coral species on the nominal species included in the petition, it deliberated on the proper taxonomic classification for the candidate species Montipora dilatata and M. flabellata; Montipora patula; and Porites pukoensis based on genetic studies; and Pocillopora elegans because the two geographically-distant populations have different modes of reproduction. The BRT decided to subsume a nominal species (morpho-species) into a larger clade whenever genetic studies failed to distinguish between them (e.g., Montipora dilatata, M. flabellata and M. turgescens (not petitioned) and Porites Clade 1 forma pukoensis). Alternatively, in the case of Pocillopora elegans, the BRT identified likely differentiation within the nominal species. So, for the purposes of this status review, the BRT chose to separate P. elegans into two geographic subgroups, considered each subgroup as a species as defined by the ESA, and estimated extinction risk separately for each of the two subgroups (eastern Pacific and the Indo-Pacific). The combining of nominal species (i.e., Montipora spp. and Porites spp.) and the separation of geographically isolated populations of another species (P. elegans) resulted in 82 candidate species being evaluated for ESA listing status; however, these are not the same 82 “species” included in the petition in that: Montipora dilatata and M. flabellata were combined into one species; and P. elegans was separated into two. The combining of the petitioned species Montipora patula with the non-petitioned species P. verrilli did not affect the number of candidate species. We did not receive any additional information suggesting alteration to the BRT’s species delineation nor indicating any of the other 82 candidates should be separated or combined. We have made listing determinations on the 82 candidate species identified by the BRT in the SRR. Finally, a coral is a marine invertebrate, and as such, we cannot subdivide it into DPSs (16 U.S.C. 1532(15)).

Reproductive Life History of Reef-building Corals

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. Strategies for fertilization are either by “brooding” or “broadcast spawning” (i.e., internal or external fertilization, respectively). Brooding is relatively more common in the Caribbean, where nearly 50 percent of the species are brooders, compared to less than 20 percent of species in the Indo-Pacific. Asexual reproduction in coral species most commonly involves fragmentation, where colony pieces or fragments are dislodged from larger colonies to establish new colonies, although the budding of new polyps within a colony can also be considered asexual reproduction. In many species of branching corals, fragmentation is a common and sometimes dominant means of propagation.

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, planula larvae presumably experience considerable mortality (up to 90 percent or more) from predation or other factors prior to settlement and metamorphosis. (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. The documented maximum larval life span is 244 days (Montastraea magnistellata), suggesting that the potential for long-term dispersal of coral larvae, at least for some species, may be substantially greater than previously thought and may partially explain the large geographic ranges of many species.

The spatial and temporal patterns of coral recruitment have been studied extensively. Biological and physical factors that have been shown to affect spatial and temporal patterns of coral recruitment include substratum 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.

In general, on proper stimulation, coral larvae, whether brooded by parental colonies or developed in the water column, settle and metamorphose on appropriate substrates. Some evidence indicates that chemical cues from crustose coralline algae, microbial films, and/or other reef organisms or acoustic cues from reef environments stimulate settlement behaviors. Initial calcification ensues with the forming of the basal plate. Buds formed on the initial corallite develop into daughter corallites. Once larvae are able to settle 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. Once recruits reach about 1 to 2 years post-settlement, growth and mortality rates appear similar across species. 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.

Distribution and Abundance of Reef-Building Corals

Corals need hard substrate on which to settle and form; however, only a narrow range of suitable environmental conditions allows the growth of corals and other reef calcifiers to exceed loss from physical, chemical, and biological erosion. While corals do live in a fairly wide temperature range across geographic locations, accomplished via either adaptation (genetic changes) or acclimatization (physiological or phenotypic changes), reef-building corals do not thrive outside of an area characterized by a fairly narrow mean temperature range (typically 25°C–30°C). Two other important factors influencing suitability of habitat are light and water quality. Reef-building corals require light for photosynthetic performance of their zooxanthellae, and poor water quality can negatively affect both coral growth and recruitment. Deep distribution of corals is generally limited by availability of light. Hydrodynamic condition (e.g., high wave action) is another important habitat feature, as it influences the growth, mortality, and reproductive rate of each species adapted to a specific hydrodynamic zone.

The 82 candidate coral species are distributed throughout the wider-Caribbean (i.e., the tropical and sub-tropical waters of the Caribbean Sea, western Atlantic Ocean, and Gulf of Mexico; herein referred to collectively as "Caribbean"), the Indo-Pacific biogeographic region (i.e., the tropical and sub-tropical waters of the Indian Ocean, the western and central Pacific Ocean, and the seas connecting the two in the general area of Indonesia), and the tropical and sub-tropical waters of the eastern Pacific Ocean. The 82 candidate species occur in 84 countries. Seven of the 82 candidate species occur in the Caribbean (Agaricia lamarcki, Dendrogyra cylindrus, Dichocoenia stokesii, Montastraea annularis, Montastraea franksi, Montastraea faveola and Mycetophyllia ferox) in the United States (Florida, Puerto Rico, U.S. Virgin islands (U.S.V.I.), Navassa), Antigua and Barbuda, Bahamas, Barbados, Belize, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, France (includes Guadeloupe, Martinique, St. Barthelemy, and St. Martin), Grenada, Guatemala, Haiti, the Netherlands (includes Aruba, Bonaire, Curaçao, Saba, St. Eustatius, and Saint Maarten), Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, the United Kingdom (includes British territories of Anguilla, British Virgin Islands, Cayman Islands, Montserrat, and Turks and Caicos Islands), and Venezuela. The remaining 75 species occur across the Indo-Pacific region in the United States (Hawaii, Commonwealth of the Northern Mariana Islands, Territories of Guam and American Samoa, and the U.S. Pacific Island Remote Area), Australia (includes Australian colonies of Cocos-Keeling Islands, Christmas

Island, and Norfolk Island), Bahrain, Brunei, Cambodia, Chile, China, Colombia, Comoros Islands, Costa Rica, Djibouti, Ecuador, El Salvador, Egypt, Eritrea, Federated States of Micronesia, Fiji, France (includes French territories of New Caledonia, French Polynesia, Mayotte, Reunion, and Wallis and Futuna), Guatemala, Honduras, India, Indonesia, Iran, Israel, Japan, Jordan, Kenya, Kiribati, Kuwait, Madagascar, Malaysia, Maldives, Marshall Islands, Mauritius, Mexico, Mozambique, Myanmar, Nauru, New Zealand (includes New Zealand colonies of Cook Islands and Tokelau), Nicaragua, Niue, Oman, Palau, Pakistan, Panama, Papua New Guinea, Philippines, Qatar, Samoa, Saudi Arabia, Seychelles, Singapore, Solomon Islands, Somalia, South Africa, Sri Lanka, Sudan, Taiwan, Tanzania, Thailand, Timor-Leste, Tonga, Tuvalu, United Arab Emirates, the United Kingdom (includes British colonies of Pitcairn Islands and British Indian Ocean Territory), Vanuatu, Vietnam, and Yemen.

Determining abundance of the 82 candidate coral species presented a unique challenge because corals are clonal, colonial invertebrates, and colony growth occurs by the addition of new polyps. Colonies can exhibit partial mortality in which a subset of the polyps in a colony dies, but the colony persists. Colonial species present a special challenge in determining the appropriate unit to evaluate for status (i.e., abundance). In addition, new coral colonies, particularly in branching species, can be added to a population by fragmentation (breakage from an existing colony of a branch that reattaches to the substrate and grows) as well as by sexual reproduction (see above, and Fig. 2.2.1 in SRR). Fragmentation results in multiple, genetically identical colonies (ramets) while sexual reproduction results in the creation of new genetically distinct individuals (genotypes or genets). Thus, in corals, the term “individual” can be interpreted as the polyp, the colony, or the genet.

Quantitative abundance estimates were available for only a few of the candidate species. In the Indo-Pacific, many reports and long-term monitoring programs describe coral percent cover only to genus level because of the substantial diversity within many genera and difficulties in field identification among congeneric species. In the Caribbean, most of the candidate species are either too rare to document meaningful trends in abundance from literature reports (e.g., Dendrogyra cylindrus), or commonly identified only to genus (Mycetophyllia and Agaricia spp.), or potentially misidentified as another species. The only comprehensive abundance data in the Caribbean were for the three Montastraea species, partially because they historically made up a predominant part of live coral cover. Even for these species, the time series data are often of very short duration (they were not separated as sibling species until the early 1990s and many surveys continue to report them as Montastraea annularis complex) and cover a very limited portion of the species range (e.g., the time series only monitors a sub-section of a single national park). In general, the available quantitative abundance data were so limited or compromised due to factors such as small survey sample sizes, lack of species-specific data, etc., that they were considerably less informative for evaluating the risk to species than other data, and were therefore generally not included as part of the BRT individual species extinction risk evaluations. Thus, qualitative abundance characterizations (e.g., rare, common), available for all species, were considered in the BRT's individual species extinction risk evaluations.

Coral Reefs, Other Coral Habitats, and Overview of Candidate Coral Environments

A coral reef is a complex three-dimensional structure providing habitat, food, and shelter for numerous marine species and, as such, fostering exceptionally high biodiversity. Scleractinian corals produce the physical structure of coral reefs, and thus are foundational species for these generally productive ecosystems. It has been estimated that coral reef ecosystems harbor around one-third of all marine species even though they make up only 0.2 percent in area of the marine environment. Coral reefs serve the following essential functional roles: primary production and recycling of nutrients in relatively nutrient poor (oligotrophic) seas, calcium carbonate deposition yielding reef construction, sand production, modification of near-field or local water circulation patterns, and habitat for secondary production, including fisheries. These functional roles yield important ecosystem services in addition to direct economic benefits to human societies such as traditional and cultural uses, food security, tourism, and potential biomedical compounds. Coral reefs protect shorelines, coastal ecosystems, and coastal inhabitants from high seas, severe storm surge, and tsunamis.

As described above in Distribution and Abundance, reef-building corals have specific habitat requirements, including hard substrate, narrow mean temperature range, adequate light, and adequate water flow. These habitat requirements most commonly occur on shallow tropical and subtropical coral reefs, but also occur in non-reefal and mesophotic areas (NMFS 2012b, SIR Section 4.3). While some reef-building corals do not require hard substrates, all of the 82 candidate species in this status review do require hard substrates. Thus, in this finding, "non-reefal habitat" refers to hard substrates where reef-building corals can grow, including marginal habitat where conditions prevent reef development (e.g., turbid or high-latitude or upwelling-influenced areas) and recently available habitat (e.g., lava flows). The term "mesophotic habitat" refers to hard substrates between approximately 30 m and 100 m of depth. The total area of non-reefal and mesophotic habitats is greater than the total area of shallow coral reefs within the ranges of the 82 species, as described in more detail below (NMFS, 2012b, SIR Section 4.3).

The Caribbean and Indo-Pacific basins contrast greatly both in size and in condition. The Caribbean basin is geographically small and partially enclosed, has high levels of connectivity, and has relatively high human population densities. The wider-Caribbean occupies five million square km of water and has 55,383 km of coastline, including approximately 5,000 islands. Shallow coral reefs occupy approximately 25,000 square km (including ≈2,000 square km within US waters), or about 10 percent of the total shallow coral reefs of the world. The amount of non-reefal and mesophotic habitat that could potentially be occupied by corals in the Caribbean is unknown, but is likely greater than the area of shallow coral reefs in the Caribbean (NMFS 2012b, SIR Section 4.3).

The Caribbean region has experienced numerous disturbances to coral reef systems throughout recorded human history. Fishing has affected Caribbean reefs since before European contact. Beginning in the early 1980s, a series of basin-scale disturbances has led to altered community states, and a loss of resilience (i.e., inability of corals and coral communities to recover after a disturbance event). Massive, Caribbean-wide mortality events from disease conditions of both the keystone grazing urchin Diadema antillarum and the dominant branching coral species Acropora palmata and Acropora cervicornis precipitated widespread and dramatic changes in reef community structure. None of the three important keystone species (Acropora palmata, Acropora cervicornis, and Diadema antillarum) have shown much recovery over decadal time scales. In addition, continuing coral mortality from periodic acute events such as hurricanes, disease outbreaks, and bleaching events from ocean warming have added to the poor state of Caribbean coral populations and yielded a remnant coral community with increased dominance by weedy brooding species, decreased overall coral cover, and increased macroalgal cover. Additionally, iron enrichment in the Caribbean may predispose the basin to algal growth. Further, coral growth rates in the Caribbean have been declining over decades.

Caribbean-wide meta-analyses suggest that the current combination of disturbances, stressful environmental factors such as elevated ocean temperatures, nutrients and sediment loads, and reduced observed coral reproduction and recruitment have yielded poor resilience, even to natural disturbances such as hurricanes. Coral cover (percentage of reef substrate occupied by live coral) across the region has declined from approximately 50 percent in the 1970s to approximately 10 percent in the early 2000s (i.e., lower densities throughout the range, not range contraction), with concurrent changes between subregions in overall benthic composition and variation in dominant species. Further, a recent model suggests coral cover is likely to fall below five percent in the Southeastern Caribbean by 2100, even with accounting for potential adaptation by corals to increasing ocean temperatures caused by any warming scenario (NMFS, 2012b, SIR Section 3.2.2). These wide-scale changes in coral populations and communities have affected habitat complexity and may have already reduced overall reef-fish abundances; the trends are expected to continue. In combination, these regional factors are considered to contribute to elevated extinction risk for all Caribbean species.

With the exception of coral reefs in the eastern Pacific, ocean basin size and diversity of habitats, as well as some vast expanses of ocean area with only very local, spatially-limited, direct human influences, have provided substantial buffering of Indo-Pacific corals from many of the threats and declines manifest across the Caribbean. The Indo-Pacific is enormous (Indian and Pacific Oceans) and hosts much greater coral diversity than the Caribbean region (~700 species compared with 65 species). The Indo-Pacific region encompasses the tropical and sub-tropical waters of the Indian Ocean, the western and central Pacific Ocean, and the seas connecting the two in the general area of Indonesia. This vast region occupies at least 60 million square km of water (more than ten times larger than the Caribbean), and includes 50,000 islands and over 40,000 km of continental coastline, spanning approximately 180 degrees of longitude and 60 degrees of latitude. There are approximately 240,000 square km of shallow coral reefs in this vast region, which is more than 90 percent of the total coral reefs of the world. In addition, the Indo-Pacific includes abundant non-reefal habitat, as well as vast but scarcely known mesophotic areas that provide coral habitat. The amount of non-reefal and mesophotic habitat that could potentially be occupied by corals in the Indo-Pacific is unknown, but is likely greater than the area of shallow coral reefs in the Indo-Pacific (NMFS, 2012b; SIR Section 4.3).

While the reef communities in the Caribbean have lost resilience, the reefs in the central Pacific (e.g., American Samoa, Moorea, Fiji, Palau, and the Northwestern Hawaiian Islands) appear to remain relatively resilient despite major bleaching events from ocean warming, hurricanes, and crown-of-thorns seastar (COTS, Acanthaster planci) predation outbreaks. That is, even though the reefs have experienced significant impacts, corals have been able to recover. Several factors likely result in greater resilience in the Indo-Pacific than in the Caribbean: (1) The Indo-Pacific is more than 10-fold larger than the Caribbean, including many remote areas; (2) the Indo-Pacific has approximately 10-fold greater diversity of reef-building coral species than the Caribbean; (3) broad-scale Caribbean reef degradation likely began earlier than in the Indo-Pacific; (4) iron enrichment in the Caribbean may predispose it to algal growth; (5) there is greater coral cover on mesophotic reefs in the Indo-Pacific than in the Caribbean; and (6) there is greater resilience to algal phase shifts in the Indo-Pacific than in the Caribbean.

Even given the relatively higher resilience in the Indo-Pacific as compared to the Caribbean, meta-analysis of overall coral status throughout the Indo-Pacific indicates that substantial loss of coral cover (i.e., lower densities throughout the range, not range contraction) has already occurred in most subregions. As of 2002–2003, the Indo-Pacific had an overall average of approximately 20 percent live coral cover, down from approximately 50 percent, compared to an overall average of approximately 10 percent live coral cover in the Caribbean at the same time. This indicates that both basins have experienced conditions leading to coral mortality and prevention of full recovery; however, the Caribbean has been more greatly impacted. While basin-wide averages are useful for large scale comparisons, they do not describe conditions at finer, regional scales. For example, decreases in overall live coral cover have occurred since 2002 in some areas, such as on the Great Barrier Reef, while increases have occurred in other areas, such as in American Samoa.

In the eastern Pacific (from Mexico in the north to Ecuador in the south, and from the coast west out to the remote Revillagigedo, Clipperton, Cocos, Malpelo, and Galápagos Islands), coral reefs are exposed to a number of conditions that heighten extinction risk. Compared to the Caribbean, coral reefs in the eastern Pacific have approximately one third as many genera, less than half the species, less reef area, and strong regional climate variability. Severe climate swings typical of the region continue to be a hindrance to reef growth today, with major losses of coral cover and even entire reefs lost from Mexico to the Galápagos Islands. Regional climatic variability not only has killed corals in recent decades, it has resulted in major loss of reef structure. This regional climatic variability produces extreme temperature variability (both extreme upwelling and high temperatures during El Niño), storm events, and changes in the abundance, distribution, and behavior of both corallivores and bioeroders. Eastern Pacific reefs have been among the slowest in the world to recover after disturbance. Additionally, the naturally low calcium carbonate saturation state of eastern Pacific waters has made these reefs among the most fragile and subject to bioerosion in the world. In conclusion, there have been declines in coral cover in all basins. However, thus far, the Indo-Pacific has been less affected as a whole, due to the differentiating factors described above. The Caribbean and Eastern Pacific basins continue to experience more severe adverse conditions than the Indo-Pacific.

Threats Evaluation

Section 4(a)(1) of the ESA and NMFS's implementing regulations (50 CFR 424) state that the agency must determine whether a species is endangered or threatened because of any one or a combination of five factors: (A) present or threatened destruction, modification, or curtailment of habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. The BRT evaluated factors A, B, C, and E in the SRR; the "Inadequacy of Regulatory Mechanisms" (factor D) is evaluated separately in this 12-month Finding and is informed by the Final Management Report. Our consideration of the five factors was further informed by information received during the public engagement period and provided in the SIR, as explained in more detail below. The BRT identified factors acting directly as stressors to the 82 coral species (e.g., sedimentation and elevated ocean temperatures) as distinct from the sources responsible for those factors (e.g., land management practices and climate change) and qualitatively evaluated the impact each threat has on the candidate species' extinction risk over the foreseeable future, defined as the year 2100 as described below.

We established that the appropriate period of time corresponding to the foreseeable future is a function of the particular type of threats, the life-history characteristics, and the specific habitat requirements for coral species under consideration. The timeframe established for the foreseeable future takes into account the time necessary to provide for the conservation and recovery of each threatened species and the ecosystems upon which they depend, but is also a function of the reliability of available data regarding the identified threats and extends only as far as the data allow for making reasonable predictions about the species' response to those threats. As described below, the more vulnerable a coral species is to the threats with the highest influence on extinction risk (i.e., "high importance threats"; ocean warming, diseases, ocean acidification), the more likely the species is at risk of extinction. The BRT determined that ocean warming and related impacts of climate change have already created a clear and present threat to many corals, that will continue into the future; the threat posed by the most optimistic scenarios of greenhouse gas emissions in the 21st century and even the threat posed by unavoidable warming due to emissions that have already occurred represents a plausible extinction risk to the 82 candidate coral species. We agree with the BRT's judgment that the threats related to global climate change (e.g., bleaching from ocean warming, ocean acidification) pose the greatest potential extinction risk to corals and have been assessed with sufficient certainty out to the year 2100. Therefore, we have determined the foreseeable future for the 82 candidate species to be to the year 2100.

The BRT qualitatively ranked each threat as high, medium, low, or negligible (or combinations of two; e.g., "low-medium") importance in terms of their contribution to extinction risk of all coral species across their ranges. The BRT considered the severity, geographic scope, the level of certainty that corals in general are affected (given the paucity of species-level information) by each threat, the projections of potential changes in the threat, and the impacts of the threat on each species. The BRT determined that global climate change directly influences two of the three highest ranked threats, ocean warming and ocean acidification, and indirectly (through ocean warming) influences the remaining highest ranked threat, disease.

Overall, the BRT identified 19 threats (see Table 1) as posing either current or future extinction risk to the 82 corals. Of these, the BRT considers ocean warming, ocean acidification, and disease to be overarching and influential in posing extinction risk to each of the 82 candidate coral species. These impacts are or are expected to become ubiquitous, and pose direct population disturbances (mortality and/or impaired recruitment) in varying degrees to each of the candidate coral species. There is also a category of threats (some of which have been responsible for great coral declines in the past) that the BRT considers important to coral reef ecosystems, but of medium influence in posing extinction risk because their effects on coral populations are largely indirect and/or local to regional in spatial scale. This category includes fishing, sea level rise, and water quality issues related to sedimentation and nutrification. The remaining threats can be locally acute, but because they affect limited geographic areas, are considered to be of minor overall importance in posing extinction risk. Examples in this category are predator outbreaks or collection for the ornamental trade. These types of threats, although minor overall, can be important in special cases, such as for species with extremely narrow geographic ranges and/or those species at severely depleted population levels. Based on the BRT's characterization of the threats to corals, the most important threats to the extinction risk of reef-building corals are shown in Table 1 below, and described below. The description of the remaining ten threats can be found in the SRR and SIR. While these ten threats did not rank highly in their contribution to extinction risk, they do adversely affect the species.

Table 1. All threats considered by the BRT in assessing extinction risks to the 82 candidate coral species. The table is ordered by the BRT estimate of the threat's importance to extinction risk for corals in general. The threat is paired with its corresponding ESA section 4 factor in the last column. The nine threats included in the Threats Evaluation are shown in **bold**.

Threat	**Importance**	**Section 4 Factor**
Ocean Warming	High	E
Disease	High	C
Ocean Acidification	Medium-High	E
Trophic Effects of Fishing	Medium	A
Sedimentation	Low-Medium	A and E
Nutrients	Low-Medium	A and E
Sea-Level Rise	Low-Medium	A
Toxins	Low	E
Changing Ocean Circulation	Low	E
Changing Storm Tracks/Intensities	Low	E
Predation	Low	C
Reef Fishing—Destructive Fishing Practices	Low	A
Collection and Trade	Low	B
Natural Physical Damage	Low	E
Human-induced Physical Damage	Negligible-Low	A and E
Aquatic Invasive Species	Negligible-Low	E
Salinity	Negligible	E
African/Asian Dust	Negligible	E
Changes in Insolation	Probably Negligible	E

While we received and collected numerous sources of information during the public engagement period pertaining to the 19 threats identified in the SRR, no new threats were identified, and no new information suggested changes to their relative importance. However, some of the new information is relevant to characterizing the important threats, particularly those related to Global Climate Change, and is included in the sections below.

Global Climate Change – General Overview

Several of the most important threats contributing to the extinction risk of corals are related to global climate change. Thus, we provide a general overview of the state of the science related to climate change before discussing each threat and its specific impacts on corals. The main concerns regarding impacts of climate change on coral reefs generally, and on the 82 candidate coral species in particular, are the magnitude and the rapid pace of change in greenhouse gas (GHG) concentrations (e.g., carbon dioxide) and atmospheric warming since the Industrial Revolution in the mid-19th century. These changes are increasing the warming of the global climate system and altering the carbonate chemistry of the ocean (ocean acidification), which affects a number of biological processes in corals including secretion of their skeletons. The atmospheric concentration of the main GHG, carbon dioxide (CO_2), has steadily increased from ~ 280 parts per million (ppm) at the start of the Industrial Revolution to over 390 ppm in 2009. Rates of human-induced emissions of CO_2 are also accelerating, rising from 1.5 ppm/yr during 1990–1999 to 2.0 ppm/yr during 2000–2007. Furthermore, GHG emissions are expected to continue increasing and atmospheric and ocean warming are likely to accelerate. Moreover, because GHGs can remain in the atmosphere for exceptionally long periods of time, even if all anthropogenic sources of GHG emissions ceased immediately, at least another 1.0 °C of atmospheric warming will occur as a result of past emissions, and at our current emissions rate, the earth's atmosphere is expected to warm 4°C (likely range 2.4°C –6.4°C), and waters around coral reefs are expected to warm 2.8°C–3.6°C by the year 2100 (NMFS 2012b, SIR Section 3.2.2). As discussed below, temperature increases of this magnitude can have severe consequences for corals, including bleaching and colony death.

Supplemental information gathered during the public engagement period shows that global temperatures continue to increase and that temperature patterns differ regionally. New models (Representative Concentration Pathways or RCPs) developed for the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (due to publish in 2014) result in a larger range of temperature estimates than the range of scenarios IPCC Fourth Assessment Report (Special Reports on Emission Scenarios or SRES), but the global mean temperature projections by the end of the twenty-first century for the RCPs are very similar to those of their closest SRES counterparts. Another study used the second-generation Canadian earth system model (CanESM2) to project future warming under three of the new RCPs and found simulated atmospheric warming of 2.3°C over the time period 1850-2100 in the lowest RCP emissions scenario (RCP2.6) and up to 4.9°C in the highest (RCP8.5; NMFS 2012b, SIR Section 3.2.2).

Nine Most Important Threats to Reef-building Corals

As described above and shown in Table 1, the BRT considered nine threats to be the most important to the current or expected future extinction risk of reef-building corals: ocean warming, coral disease, ocean acidification, trophic effects of reef fishing, sedimentation, nutrients, sea-level rise, predation, and collection and trade. Vulnerability of a coral species to a threat is a function of susceptibility and exposure, considered at the appropriate spatial and temporal scales. In this finding, the spatial scale is the current range of the species, and the temporal scale is from now until the year 2100. Susceptibility, exposure, and vulnerability are described generally below, and species-specific threat vulnerabilities are described in the Vulnerability to Threats under Risk Analyses below.

Susceptibility refers to the response of coral colonies to the adverse conditions produced by the threat. Susceptibility of a coral species to a threat is primarily a function of biological processes and characteristics, and can vary greatly between and within taxa (i.e., family, genus, or species). Susceptibility depends on direct effects of the threat on the species, and it also depends on the cumulative (i.e., additive) and interactive (i.e., synergistic or antagonistic) effects of multiple threats acting simultaneously on the species. For example, ocean warming affects coral colonies through the direct effect of bleaching, together with the interactive effect of bleaching and disease, because bleaching increases disease susceptibility. We discuss how cumulative and interactive effects of threats affected individual threat susceptibilities in the Vulnerability to Threats under Risk Analyses section below.

Vulnerability of a coral species to a threat also depends on the proportion of colonies that are exposed to the threat. Exposure is primarily a function of physical processes and characteristics that limit or moderate the impact of the threat across the range of the species. For example, prevailing winds may moderate exposure of coral colonies on windward sides of islands to ocean warming, tidal fluctuations may moderate exposure of coral colonies on reef flats to ocean acidification, and large distances of atolls from runoff may moderate exposure of the atoll's coral colonies from sedimentation.

Vulnerability of a coral species to a threat is a function of susceptibility and exposure, considered at the spatial scale of the entire current range of the species, and the temporal scale of from now to the year 2100. For example, a species that is highly susceptible to a threat is not necessarily highly vulnerable to the threat, if exposure is low over the appropriate spatial and temporal scales. Consideration of the appropriate spatial (range of species) and temporal (to 2100) scales is particularly important, because of high variability in the threats over the large spatial scales, and the predictions in the SRR that nearly all threats are likely to increase over the large temporal scale. The nine most important threats are summarized below, including general descriptions of susceptibility and exposure. Species-specific threat vulnerabilities are described in the Vulnerability to Threats under the Risk Analyses section.

Ocean Warming (High Importance Threat, ESA Factor E)

Ocean warming is considered under ESA Factor E – other natural or manmade factors affecting the continued existence of the species – because the effect of the threat results from human activity and affects individuals of the species directly, and not their habitats. 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. More importantly, the frequency of warm-season temperature extremes (warming events) in reef-building coral habitat in both the Caribbean and Indo-Pacific has increased during the past two decades, and is also predicted to increase between now and 2100.

Ocean warming is one of the most important threats posing extinction risks to the 82 candidate coral species; however, individual susceptibility varies among species. The primary observable coral response to ocean warming is bleaching of adult coral colonies, wherein corals expel their symbiotic zooxanthellae in response to stress. For corals, an episodic increase of only 1°C–2°C above the normal local seasonal maximum ocean temperature can induce bleaching. Corals can withstand mild to moderate bleaching; however, severe, repeated, or prolonged bleaching can lead to colony death. While coral bleaching patterns are complex, with several species exhibiting seasonal cycles in symbiotic dinoflagellate density, thermal stress has led to bleaching and associated mass mortality in many coral species during the past 25 years. In addition to coral bleaching, other effects of ocean warming detrimentally affect virtually every life-history stage in reef-building corals. Impaired fertilization, developmental abnormalities, mortality, impaired settlement success, and impaired calcification of early life phases have all been documented.

In evaluating extinction risk from ocean warming, the BRT relied heavily on the IPCC Fourth Assessment Report because the analyses and synthesis of information developed for it are the most thoroughly documented and reviewed assessments of future climate and represent the best available scientific information on potential future changes in the earth's climate system. Emission rates in recent years have met or exceeded levels found in the worst-case scenarios considered by the IPCC, resulting in all scenarios underestimating the projected climate condition. Further, newer studies have become available since the completion of the SRR. New information suggests that regardless of the emission concentration pathway, more than 97 percent of reefs will experience severe thermal stress by 2050. However, new information also highlights the spatial and temporal "patchiness" of warming, as described in the next paragraph. This patchiness has the potential to provide refugia for the species from thermal stress if the temperature patches are spatially and temporally consistent, but the distributional nature of the patchiness is not currently well understood (NMFS 2012b, SIR Section 3.2.2).

Spatially, exposure of colonies of a species to ocean warming can vary greatly across its range, depending on colony location (e.g., latitude, depth, bathymetry, habitat type, etc.) and physical processes that affect seawater temperature and its effects on coral colonies (e.g., winds, currents, upwelling shading, tides, etc.). Colony location can moderate exposure of colonies of the species to ocean warming by latitude or depth, because colonies in higher latitudes and/or deeper areas are usually less affected by warming events. Also, some locations are blocked from warm currents by bathymetric features, and some habitat types reduce the effects of warm water, such as highly-fluctuating environments. Physical processes can moderate exposure of colonies of the species to ocean warming in many ways, including processes that increase mixing (e.g., wind, currents, tides), reduce seawater temperature (e.g., upwelling, runoff), or increase shading (e.g. turbidity, cloud cover). For example, warming events in Hawaii in 1996 and 2002 resulted in variable levels of coral bleaching because colony exposure was strongly affected by winds, cloud cover, complex bathymetry, waves, and inshore currents (NMFS 2012b, SIR Section 3.2.2).

Temporally, exposure of colonies of a species to ocean warming between now and 2100 will likely vary annually and decadally, while increasing over time, because: (1) numerous annual and decadal processes that affect seawater temperatures will continue to occur in the future (e.g., inter-decadal variability in seawater temperatures and upwelling related to El-Niño Southern Oscillation); and (2) ocean warming is predicted to substantially worsen by 2100. While exposure of the 82 candidate coral species to ocean warming varies greatly both spatially and temporally, exposure is expected to increase for all species across their ranges between now and 2100 (NMFS 2012b, SIR Section 3.2.2).

Multiple threats stress corals simultaneously or sequentially, whether the effects are cumulative (the sum of individual stresses) or interactive (e.g., synergistic or antagonistic).

Ocean warming is likely to interact with many other threats, especially considering the long-term consequences of repeated thermal stress, and ocean warming is expected to continue to worsen over the foreseeable future. Increased seawater temperature interacts with coral diseases to reduce coral health and survivorship. Coral disease outbreaks often have either accompanied or immediately followed bleaching events, and also follow seasonal patterns of high seawater temperatures. The effects of greater ocean warming (i.e., increased bleaching, which kills or weakens colonies) are expected to interact with the effects of higher storm intensity (i.e., increased breakage of dead or weakened colonies) in the Caribbean, resulting in an increased rate of coral declines. Likewise, ocean acidification and nutrients may reduce thermal thresholds to bleaching, increase mortality and slowing recovery.

There is also mounting evidence that warming ocean temperatures can have direct impacts on early life stages of corals, including abnormal embryonic development at 32°C and complete fertilization failure at 34°C for one Indo-Pacific Acropora species. In addition to abnormal embryonic development, symbiosis establishment, larval survivorship, and settlement success have been shown to be impaired in Caribbean brooding and broadcasting coral species at temperatures as low as 30°C–32°C. Further, the rate of larval development for spawning species is appreciably accelerated at warmer temperatures, which suggests that total dispersal distances could also be reduced, potentially decreasing the likelihood of successful settlement and the potential for replenishment of extirpated areas.

Finally, warming is and will continue causing increased stratification of the upper ocean, because water density decreases with increasing temperature. Increased stratification results in decreased vertical mixing of both heat and nutrients, leaving surface waters warmer and nutrient-poor. While the implications for corals and coral reefs of these increases in warming-induced stratification have not been well studied, it is likely that these changes will both exacerbate the temperature effects described above (i.e., increase bleaching and decrease recovery) and decrease the overall net productivity of coral reef ecosystems (i.e., fewer nutrients) throughout the tropics and subtropics.

Overall, there is ample evidence that climate change (including that which is already committed to occur from past GHG emissions and that which is reasonably certain to result from continuing and future emissions) will follow a trajectory that will have a major impact on corals. If many coral species are to survive anticipated global warming, corals and their zooxanthellae will have to undergo significant acclimatization and/or adaptation. There has been a recent research emphasis on the processes of acclimatization and adaptation in corals, but, taken together, the body of research is inconclusive on how these processes may affect individual corals' extinction risk, given the projected intensity and rate of ocean warming (NMFS 2012b, SIR Section 3.2.2.1). In determining extinction risk for the 82 candidate coral species, the BRT was most strongly influenced by observations that corals have been bleaching and dying under ocean warming that has already occurred. Thus, the BRT determined that ocean warming and related impacts of global climate change are already having serious negative impacts on many corals, and that ocean warming is one of the most important threats posing extinction risks to the 82 candidate coral species between now and the year 2100 (Brainard et al. 2011). These conclusions are reinforced by the new information in the SIR (NMFS 2012b, SIR Section 3.2.2.1).

Disease (High Importance Threat, ESA Factor C)

Disease is considered under ESA Factor C – disease or predation. Disease adversely affects various coral life history events, including causing adult mortality, reducing sexual and asexual reproductive success, and impairing colony growth. A diseased state results from a complex interplay of factors including the cause or agent (e.g., pathogen, environmental toxicant), the host, and the environment. In the case of corals, the host is a complex community of organisms, referred to as a holobiont, which includes the coral animal, the dinoflagellates, and their microbial symbionts. All impacts incorporated and ranked as "coral disease" in this status review are presumed infectious diseases or those attributable to poorly-described genetic defects and often associated with acute tissue loss. Other manifestations of disease in the broader sense, such as coral bleaching from ocean warming, are incorporated under other factors (i.e., manmade factors such as ocean warming as a result of climate change).

Coral diseases are a common and significant threat affecting most or all coral species and regions to some degree, although the scientific understanding of individual disease causes in corals remains very poor. The incidence of coral disease appears to be expanding geographically in the Indo-Pacific and there is evidence that massive coral species are not recovering from disease events in certain locations. The prevalence of disease is highly variable between sites and species. There is documented increased prevalence and severity of diseases with increased water temperatures, which may correspond to increased virulence of pathogens, decreased resistance of hosts, or both. Moreover, the expanding coral disease threat has been suggested to result from opportunistic pathogens that become damaging only in situations where the host integrity is compromised by physiological stress and/or immune suppression. Overall, there is mounting evidence that warming temperatures and coral bleaching responses are linked (albeit with mixed correlations) with increased coral disease prevalence and mortality. Complex aspects of temperature regimes, including winter and summer extremes, may influence disease outbreaks. Bleaching and coral abundance seem to increase the susceptibility of corals to disease contraction. Further, most recent research shows strong correlations between elevated human population density in close proximity to reefs and disease prevalence in corals.

Although disease causes in corals remain poorly understood, some general patterns of biological susceptibility are beginning to emerge. There appear to be predictable patterns of immune capacity across coral families, corresponding with trade-offs with their life history traits, such as reproductive output and growth rate. Acroporidae, representing the largest number of candidate species, has low immunity to disease. Likewise, Pocilloporidae has low immunity; however, both of these families have intermediate/high reproductive outputs. Both Faviidae and Mussidae are intermediate to high in terms of disease immunity and reproductive output. Finally, while Poritidae has high immunity to disease, it has a low reproductive output. Overall, disease represents a high importance threat in terms of extinction risk posed to coral species; however, individual susceptibility varies among the 82 candidate species.

As with ocean warming, the effects of coral disease depend on exposure of the species to the threat, which can vary spatially across the range of the species, and temporally between now and 2100. Spatially, exposure to coral disease in the Caribbean is moderated by distance of some coral habitats from the primary causes of most disease outbreaks, such as stressors resulting from sedimentation, nutrient over-enrichment, and other local threats. Exposure to coral disease for some species in the Indo-Pacific may be somewhat more moderated spatially than in the

Caribbean, due to a greater proportion of reef-building coral habitats located in remote areas that are much farther away from local sources of disease outbreaks. Exposure to coral disease can also be moderated by depth of many habitats in both regions, but again more so in the Indo-Pacific than in the Caribbean. Deep habitats are generally less affected by disease outbreaks associated with stressors resulting from ocean warming, especially in the Indo-Pacific. Disease exposure in remote areas and deep habitats appears to be low but gradually increasing. Temporally, exposure to coral disease will increase as the causes of disease outbreaks (e.g., warming events) increase over time (NMFS, 2012b, SIR Section 3.3.2).

As explained above, disease may be caused by a threat such as ocean warming and bleaching, nutrients, toxins, etc. However, interactive effects are also important for this threat, because diseased colonies are more susceptible to the effects of some other threats. For example, diseased or recovering colonies may be more quickly stressed than healthy colonies by land-based sources of pollution (sedimentation, nutrients, and toxins), more quickly succumb to predators, and more easily break during storms or as a result of other physical impacts. There are likely many other examples of cumulative and interactive effects of disease with other threats to corals.

Ocean Acidification (Medium-High Importance Threat, ESA Factor E)

Ocean acidification is considered under ESA Factor E – other natural or manmade factors affecting the continued existence of the species – because the effect is a result of human activity and affects individuals of the coral species, not their habitats. As with ocean warming, ocean acidification is a result of global climate change caused by increased GHG accumulation in the atmosphere. Reef-building corals produce skeletons made of the aragonite form of calcium carbonate; thus, reductions in aragonite saturation state caused by ocean acidification pose a major threat to these species and other marine calcifiers. Ocean acidification has the potential to cause substantial reduction in coral calcification and reef cementation. Further, ocean acidification adversely affects adult growth rates and fecundity, fertilization, pelagic planula settlement, polyp development, and juvenile growth. The impacts of ocean acidification can lead to increased colony breakage and fragmentation and mortality. Based on observations in areas with naturally low pH, the effects of increasing ocean acidification may also include potential reductions in coral size, cover, diversity, and structural complexity.

As CO_2 concentrations increase in the atmosphere, more CO_2 is absorbed by the oceans, causing lower pH and reduced availability of carbonate ions, which in turn results in lower aragonite saturation state in seawater. Because of the increase in CO_2 and other GHGs in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans, including in the Caribbean and Indo-Pacific, and is predicted to considerably worsen between now and 2100. Along with ocean warming and disease, the BRT considered ocean acidification to be one of the most important threats posing extinction risks to coral species between now and the year 2100; however, individual susceptibility varies among the 82 candidate species.

Numerous laboratory and field experiments have shown a relationship between elevated CO_2 and decreased calcification rates in particular corals and other calcium carbonate secreting organisms. However, because only a few species have been tested for such effects, it is uncertain how most will fare in increasingly acidified oceans. In addition to laboratory studies, recent field studies have demonstrated a decline in linear growth rates of some coral species, suggesting that ocean acidification is already significantly reducing growth of corals on reefs. However, this has not been shown for all corals at all reefs, indicating that all corals may not be affected at the same rate or that local factors may be ameliorating the saturation states on reefs. A potential secondary effect is that ocean acidification may reduce the threshold at which bleaching occurs. Overall, the best available information demonstrates that most corals exhibit declining calcification rates with rising CO_2 concentrations, declining pH, and declining carbonate saturation state – although the rate and mode of decline can vary among species. Recent publications also discuss the physiological effects of ocean acidification on corals and their responses. Corals are able to regulate pH within their tissues, maintaining higher pH values in their tissues than the pH of surrounding waters. This is an important mechanism in naturally highly fluctuating environments (e.g., many backreef pools have diurnally fluctuating pH) and suggests that corals have some adaptive capacity to acidification. However, as with ocean warming, there is high uncertainty as to whether corals will be able to adapt commensurate with the rate of acidification.

In addition to the direct effects on coral calcification and growth, ocean acidification may also affect coral recruitment, reef cementation, and other important reef-building species like crustose coralline algae (CCA). Studies suggest that the low pH associated with ocean acidification may impact coral larvae in several ways, including reduced survival and recruitment. Ocean acidification may influence settlement of coral larvae on coral reefs more by indirect alterations of the benthic community, which provides settlement cues, than by direct physiological disruption. A major potential impact from ocean acidification is a reduction in the structural stability of corals and reefs, which results both from increases in bioerosion and decreases in reef cementation. As atmospheric CO_2 rises globally, reef-building corals are expected to calcify more slowly and become more fragile. Increased bioerosion of coral reefs from ocean acidification may be facilitated by declining growth rates of CCA. Recent studies demonstrate that ocean acidification is likely having a great impact on corals and reef communities by affecting community composition and dynamics, exacerbating the effects of disease and other stressors (e.g., temperature), contributing to habitat loss, and affecting symbiotic function. Some studies have found that an atmospheric CO_2 level twice as high as pre-industrial levels will start to dissolve coral reefs; this level could be reached as early as the middle of this century. Further, the rate of acidification may be an order of magnitude faster than what occurred 55 million years ago during the Paleocene-Eocene Thermal Maximum (Brainard et al. 2011; NMFS, 2012b, SIR Section 3.2.3).

Spatially, while CO_2 levels in the surface waters of the ocean are generally in equilibrium with the lower atmosphere, there can be considerable variability in seawater pH across reef-building coral habitats, resulting in colonies of a species experiencing high spatial variability in exposure to ocean acidification. The spatial variability in seawater pH occurs from reef to global scales, driven by numerous physical and biological characteristics and processes, including at least seawater temperature, proximity to land-based runoff and seeps, proximity to sources of oceanic CO_2, salinity, nutrients, photosynthesis, and respiration. CO_2 absorption is higher in colder water, causing lower pH in colder water. Land-based runoff decreases salinity and increases nutrients, both of which can raise pH. Local sources of oceanic CO_2 like upwelling and volcanic seeps lower pH. Photosynthesis in algae and seagrass beds draws down CO_2, raising pH. These are just some of the sources of spatial variability in pH, which results in high spatial variability in ocean acidification across the ranges of the 82 species (NMFS, 2012b, SIR Section 3.2.3).

Temporally, high variability over diurnal to decadal time-scales is produced by numerous processes, including diurnal cycles of photosynthesis and respiration, seasonal variability in seawater temperatures, and decadal cycles in upwelling. Temporal variability in pH can be very high diurnally in highly-fluctuating or semi-enclosed habitats such as reef flats and back-reef pools, due to high photosynthesis during the day (pH goes up) and high respiration during the night (pH goes down). In fact, pH fluctuations during one 24-hr period in such reef-building coral habitats can exceed the magnitude of change expected by 2100 in open ocean subtropical and tropical waters. As with spatial variability in exposure to ocean warming, temporal variability in exposure to ocean acidification is a combination of high variability over short time-scales together with long-term increases. While exposure of the 82 candidate coral species to ocean acidification varies greatly both spatially and temporally, exposure is expected to increase for all species across their ranges between now and 2100 (NMFS, 2012b, SIR Section 3.2.3).

Acidification is likely to interact with other threats, especially considering that acidification is expected to continue to worsen over the foreseeable future. For example, acidification may reduce the threshold at which bleaching occurs, increasing the threat posed by ocean warming. One of the key impacts of acidification is reduced calcification, resulting in reduced skeletal growth and skeletal density, which may lead to numerous interactive effects with other threats. Reduced skeletal growth compromises the ability of coral colonies to compete for space against algae, which grows more quickly as nutrient over-enrichment increases. Reduced skeletal density weakens coral skeletons, resulting in greater colony breakage from natural and human-induced physical damage.

Trophic Effects of Fishing (Medium Importance Threat, ESA Factor A)

Trophic effects of fishing is considered under ESA Factor A – the present or threatened destruction, modification, or curtailment of its habitat or range – because the main effect of concern is to limit availability of habitat for corals. Fishing, particularly overfishing, can have large scale, long-term ecosystem-level effects that can change ecosystem structure from coral-dominated reefs to algal-dominated reefs ("phase shifts"). Fishing pressure alters trophic interactions that are particularly important in structuring coral reef ecosystems. These trophic interactions include reducing population abundance of herbivorous fish species that control algal growth, limiting the size structure of fish populations, reducing species richness of herbivorous fish, and releasing corallivores from predator control. Thus, an important aspect of maintaining resilience in coral reef ecosystems is to sustain populations of herbivores, especially the larger scarine herbivorous wrasses such as parrotfish.

On topographically complex reefs, population densities can average well over a million herbivorous fishes per km^2, and standing stocks can reach 45 metric tons per km^2. In the Caribbean, parrotfishes can graze at rates of more than 150,000 bites per square meter per day, and thereby remove up to 90 – 100 percent of the daily primary production (e.g., algae). Under these conditions of topographic complexity with substantial populations of herbivorous fishes, as long as the cover of living coral is high and resistant to mortality from environmental changes, it is very unlikely that the algae will take over and dominate the substratum. However, if herbivorous fish populations, particularly large-bodied parrotfish, are heavily fished and a major mortality of coral colonies occurs, then algae can grow rapidly and prevent the recovery of the coral population. The ecosystem can then collapse into an alternative stable state, a persistent phase shift in which algae replace corals as the dominant reef species. Although algae can have negative effects on adult coral colonies (i.e., overgrowth, bleaching from toxic compounds), the ecosystem-level effects of algae are primarily from inhibited coral recruitment. Filamentous algae can prevent the colonization of the substratum by planula larvae by creating sediment traps that obstruct access to a hard substratum for attachment. Additionally, macroalgae can suppress the successful colonization of the substratum by corals through occupation of the available space, shading, abrasion, chemical poisoning, and infection with bacterial disease.

Overfishing can have further impacts on coral mortality via trophic cascades. In general larger fish are targeted, resulting in fish populations of small individuals. For parrotfishes, the effect of grazing by individuals greater than 20 cm in length is substantially greater than that of smaller fish. Up to 75 individual parrotfishes with lengths of about 15 cm are necessary to have the same effect on reducing algae and promoting coral recruitment as a single individual 35 cm in length. Species richness of the herbivorous fish population is also necessary to enhance coral populations. Because of differences in their feeding behaviors, several species of herbivorous fishes with complementary feeding behaviors can have a substantially greater positive effect than a similar biomass of a single species on reducing the standing stock of macroalgae, of increasing the cover of CCA, and increasing live coral cover.

Spatially, exposure to the trophic effects of fishing in the Caribbean is moderated by distance of some coral habitats from fishing effort. Exposure to the trophic effects of fishing in the Indo-Pacific is somewhat more moderated by distance than in the Caribbean, due to a greater proportion of reef-building coral habitats located in remote areas that are much farther away from fishing effort. Exposure to the trophic effects of reef fishing is also moderated by depth of many habitats in both regions, but again more so in the Indo-Pacific than in the Caribbean. Deep habitats are generally less affected by the trophic effects of fishing especially in the Indo-Pacific. Temporally, exposure to the trophic effects of fishing will increase as the human population increases over time (NMFS, 2012b, SIR Section 3.3.4).

The trophic effects of fishing are likely to interact with many other threats, especially considering that fishing impacts are likely to increase within the ranges of many of the 82 species over the foreseeable future. For example, when carnivorous fishes are overfished, corallivore populations may increase, resulting in greater predation on corals. Further, overfishing appears to increase the frequency of coral disease. Fishing activity usually targets the larger apex predators. When the predators are removed, corallivorous butterfly fishes become more abundant and can transmit disease from one coral colony to another as they transit and consume from each coral colony. With increasing abundance, they transmit disease to higher proportions of the corals within the population.

<u>Sedimentation (Low-Medium Importance Threat, ESA Factors A and E</u>)

Sedimentation is considered under ESA Factor A – the present or threatened destruction, modification, or curtailment of its habitat or range – and ESA Factor E – other natural or manmade factors affecting the continued existence of the species –because the effect of the threat, resulting from human activity, is both to limit the availability of habitat for corals and directly impact individuals of coral species. Impacts from land-based sources of pollution include sedimentation, nutrients, toxicity, contaminants, and changes in salinity regimes. The

BRT evaluated the extinction risk posed by each pollution component individually. Only the stressors of sedimentation and nutrients were considered low-medium threats to corals, although the 82 candidate species vary in susceptibility. The BRT considered contaminants, despite their primarily local sources and impacts, to pose low, but not negligible, extinction risks, and salinity effects to be a local and negligible overall contributor to extinction risk to the 82 candidate coral species; however, individual species vary in susceptibility. All four threats associated with land-based sources of pollution are described in the SRR, and sedimentation and nutrients are considered separately below. Human activities in coastal watersheds introduce sediment into the ocean by a variety of mechanisms, including river discharge, surface runoff, groundwater seeps, and atmospheric deposition. Humans introduce sewage into coastal waters through direct discharge, treatment plants, and septic leakage; agricultural runoff brings additional nutrients from fertilizers. Elevated sediment levels are generated by poor land use practices, and coastal and nearshore construction. Additionally, as coastal populations continue to increase, it is likely that pollution from land-based sources will also increase.

The most common direct effect of sedimentation is deposition of sediment on coral surfaces as sediment settles out from the water column. Corals with certain morphologies (e.g., mounding) can passively reject settling sediments. In addition, corals can actively displace sediment by ciliary action or mucous production, both of which require energetic expenditures. Corals with large calices (skeletal component that holds the polyp) tend to be better at actively rejecting sediment. Some coral species can tolerate complete burial for several days. Corals that are unsuccessful in removing sediment will be smothered and die. Sediment can also induce sublethal effects, such as reductions in tissue thickness, polyp swelling, zooxanthellae loss, and excess mucus production. In addition, suspended sediment can reduce the amount of light in the water column, making less energy available for coral photosynthesis and growth. Finally, sediment impedes fertilization of spawned gametes and reduces larval settlement, as well as the survival of recruits and juveniles.

Although it is difficult to quantitatively predict the extinction risk that sedimentation poses to the 82 candidate coral species, human activity has resulted in quantifiable increases in sediment inputs in some reef areas. Continued increases in coastal populations combined with poor land use and nearshore development practices will likely increase sediment delivery to reef systems. Nearshore sediment levels will also likely increase with sea level rise. Greater inundation of reef flats can erode soil at the shoreline and resuspend lagoon deposits, producing greater sediment transport and potentially leading to leeward reefs being flooded with turbid lagoon waters or buried by off-bank sediment transport. Finally, while some corals may be more tolerant of elevated short-term levels of sedimentation, sediment stress and turbidity can induce bleaching. Sedimentation is a low-medium importance threat of extinction risk to corals; however, individual susceptibility varies among the 82 candidate species.

The BRT acknowledged that individual land-based sources of pollution interact in complex ways, and therefore also considered the holistic nature of this type of threat (i.e., sedimentation, nutrient over-enrichment, and contaminants). All land-based sources of pollution act primarily at a local level and have direct linkage to human population, consumption of resources, and land use within the local area. This linkage is supported by correlative and retrospective studies of both threat dosage of and coral response to land-based sources of pollution. Therefore, land-based sources of pollution would pose a substantial extinction risk only to species with extremely limited distributions. However, local stresses can still be sufficiently severe to cause local extirpation and interact with global stresses to increase extinction risk.

Spatially, exposure to sedimentation in the Caribbean can be moderated by distance of some coral habitats from areas where sedimentation is chronically or sporadically heavy (i.e., heavily populated areas), resulting in some areas of coral habitats being unaffected or very lightly affected by sedimentation. Exposure to sedimentation can be more moderated in the Indo-Pacific by the large distances of many coral habitats from areas where sedimentation is chronically or sporadically heavy (i.e., heavily populated areas), resulting in vast areas of coral habitats and areas being unaffected or very lightly affected by sedimentation. Exposure to sedimentation for particular species could also be moderated by depth of many habitats in both regions, but again more so in the Indo-Pacific than in the Caribbean. Deep habitats are generally less affected by sedimentation, especially in the Indo-Pacific. Temporally, exposure to sedimentation will increase as human activities that produce sedimentation increase over time, but in the Indo-Pacific will still be strongly moderated for certain species by distance (NMFS, 2012b, SIR Section 3.3.1).

Sedimentation is also likely to interact with many other threats, especially considering that sedimentation is likely to increase across the ranges of many of the 82 species over the foreseeable future. For example, when coral communities that are chronically affected by sedimentation experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by sedimentation.

Nutrients (Low-Medium Importance Threat, ESA Factors A and E)

Nutrient enrichment is considered under ESA Factor A – the present or threatened destruction, modification, or curtailment of its habitat or range – and ESA Factor E – other natural or manmade factors affecting the continued existence of the species – because the effect of the threat, resulting from human activity, is both to limit the availability of habitat for corals and directly impact individuals of coral species. The impacts of nutrient over-enrichment were determined by the BRT to be of low-medium importance in terms of posing extinction risk to coral species; however, individual susceptibility varies among the 82 candidate species. Elevated nutrients affect corals through two main mechanisms – direct impacts on coral physiology and indirect effects through nutrient-stimulation of other community components (e.g., macroalgal turfs and seaweeds, and filter feeders) that compete with corals for space on the reef. Increased nutrients can decrease calicification; however, nutrients may also enhance linear extension, but reduce skeletal density. Either condition results in corals that are more prone to breakage or erosion. Notably, individual species have varying tolerance to increased nutrients. The main vectors of anthropogenic nutrients are point-source discharges (such as rivers or sewage outfalls) and surface runoff from modified watersheds. Natural processes, such as in situ nitrogen fixation and delivery of nutrient-rich deep water by internal waves and upwelling, bring nutrients to coral reefs as well. Nutrient over-enrichment has low-medium importance to the extinction risk of all 82 corals species.

Spatially, exposure to nutrients is moderated by distance of some coral habitats from areas where nutrients are chronically or sporadically heavy (i.e., heavily populated areas). However, nutrient over-enrichment can result from very small human populations, and nutrients can be quickly transported large distances; thus, distance is less of a moderating factor for nutrients than for sedimentation. Similarly, although nutrient exposure may also be moderated by depth of some habitats, nutrient impacts can reach much farther than sedimentation impacts. Temporally, exposure to nutrients will increase as human activities that produce nutrients increase over time (NMFS, 2012b, SIR Section 3.3.1).

Nutrients are likely to interact with many other threats, especially considering that nutrient over-enrichment is likely to increase across the ranges of many of the 82 candidate species over the foreseeable future. For example, when coral communities that are chronically affected by nutrients experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by nutrients.

Sea-Level Rise (Low-Medium Threat, ESA Factor A)

Sea-level rise is considered under ESA Factor A – the present or threatened destruction, modification, or curtailment of its habitat or range – because the effect of the threat is to availability of corals' habitat and not directly to the species themselves. The effects of sea-level rise may affect various coral life history events, including larval settlement, polyp development, and juvenile growth, and contribute to adult mortality and colony fragmentation, mostly due to increased sedimentation and decreased water quality (reduced light availability) caused by coastal inundation. The best available information suggests that sea level will continue to rise due to thermal expansion and the melting of land and sea ice. Theoretically, any rise in sea-level could potentially provide additional habitat for corals living near the sea surface. Many corals that inhabit the relatively narrow zone near the ocean surface have rapid growth rates when healthy, which allowed them to keep up with sea-level rise during the past periods of rapid climate change associated with deglaciation and warming. However, depending on the rate and amount of sea level rise, rapid rises can lead to reef drowning. Rapid rises in sea level could affect many of the candidate coral species by both submerging them below their common depth range and, more likely, by degrading water quality through coastal erosion and potentially severe sedimentation or enlargement of lagoons and shelf areas. Rising sea level is likely to cause mixed responses in the 82 candidate coral species depending on their depth preferences, sedimentation tolerances, growth rates, and the nearshore topography. Reductions in growth rate due to local stressors, bleaching, infectious disease, and ocean acidification may prevent the species from keeping up with sea level rise (e.g., from growing at a rate that will allow them to continue to occupy their preferred depth range despite sea-level rise).

The rate and amount of future sea level rise remains uncertain. Until the past few years, sea level rise was predicted to be in the range of only about one half meter by 2100. However, more recent estimated rates are higher, based upon evidence that the Greenland and Antarctic ice sheets are much more vulnerable than previously thought. Hence, there is large variability in predictions of the sea-level rise, but the IPCC Fourth Assessment Report likely underestimated the rates.

Fast-growing branching corals were able to keep up with the first 3 m of sea level rise during the warming that led to the last interglacial period. However, whether the 82 candidate coral species will be able to survive 3 m or more of future sea level rise will depend on whether growth rates are reduced as a result of other risk factors, such as local environmental stressors, bleaching, infectious disease, and ocean acidification. Additionally, lack of suitable new habitat, limited success in sexual recruitment, coastal runoff, and coastal hardening will compound some corals' ability to survive rapid sea level rise.

This threat is expected to disproportionately affect shallow areas adjacent to degraded coastlines, as inundation results in higher levels of sedimentation from the newly-inundated coastlines to the shallow areas. Spatially, exposure to sea-level rise will be moderated by horizontal and vertical distances of reef-building coral habitats from inundated, degraded coastlines. Temporally, exposure to sea-level rise will increase over time as the rate of rise increases (NMFS, 2012b, SIR Section 3.2.4).

Sea-level rise is likely to interact with other threats, especially considering that sea-level rise is likely to increase across the ranges of the 82 candidate species over the foreseeable future. For example, the inundation of developed areas (e.g., urban and agricultural areas) and other areas where shoreline sediments are easily eroded by sea-level rise is likely to degrade water quality of adjacent coral habitat, through increased sediment and nutrient runoff, and the potential release of toxic contamination.

Predation (Low Threat, ESA Factor C)

Predation is considered under ESA Factor C – disease or predation. While the BRT ranked predation as having low importance to the extinction risk of corals in general, predation on some coral genera by many corallivorous species of fish and invertebrates (e.g., snails and seastars) is a chronic, though occasionally acute, energy drain. It is a threat that has been identified for most coral life stages. Thus, predation factored into the extinction risk analysis for each of the 82 candidate species. Numerous studies have documented the quantitative impact of predation by various taxa on coral tissue and skeleton. Predators can indirectly affect the distribution of corals by preferentially consuming faster-growing coral species, thus allowing slower-growing corals to compete for space on the reef. The most notable example of predation impacts in the Indo-Pacific are from large aggregations of crown-of-thorns seastar (Acanthaster planci; COTS), termed outbreaks; the specific causative mechanism of COTS outbreaks is unknown. COTS can reduce living coral cover to less than one percent during outbreaks, change coral community structure, promote algal colonization, and affect fish population dynamics. Therefore, predation, although considered to be of low importance to the extinction risk of corals in general, can be significant to individual species.

Spatially, exposure to predation by corallivores is moderated by presence of predators of the corallivores (i.e., predators of the predators). For example, corallivorous reef fish prey on corals, and piscivorous reef fish and sharks prey on the corallivores; thus, high abundances of piscivorous reef fish and sharks moderates coral predation. Abundances of piscivorous reef fish and sharks vary spatially because of different ecological conditions and human exploitation levels. Spatially, exposure to predation is also moderated by distance from physical conditions that allow corallivore populations to grow. For example, in the Indo-Pacific, high nutrient runoff from continents and high islands improves reproductive conditions for COTS, thus coral predation by COTS is moderated by distance from such conditions. Predation can also be moderated by depth of many habitats because abundances of many corallivorous species decline with depth. Temporally, exposure to predation will increase over time as conditions change, but will still be strongly moderated by distance and depth for certain species, depending upon the distribution and abundances of a species' populations, relative to this threat (NMFS, 2012b, SIR Section 3.3.3).

Predation of coral colonies can increase the likelihood of the colonies being infected by disease, and likewise diseased colonies may be more likely to be preyed upon. There are likely other examples of cumulative and interactive effects of predation with other threats to corals.

Collection and Trade (Low Threat, ESA Factor B)

Collections and trade is considered under ESA Factor B – overutilization for commercial, recreational, scientific, or educational purposes. While the BRT ranked collection and trade as having low importance to the extinction risk of corals in general, particular species are preferentially affected; therefore, the BRT considered collection and trade when evaluating the extinction risk of individual species. Globally, 1.5 million live stony coral colonies are reported to be collected from at least 45 countries each year, with the United States consuming the largest portion of live corals (64 percent) and live rock (95 percent) for the aquarium trade. The imports of live corals taken directly from coral reefs (not from aquaculture) increased by 600 percent between 1988 and 2007, while the global trade in live coral increased by nearly 1,500 percent. Harvest of stony corals is usually highly destructive, and results in removing and discarding large amounts of live coral that go unsold and damaging reef habitats around live corals. While collection is a highly spatially focused impact, it can result in significant impacts and was considered to contribute to individual species' extinction risk.

Spatially, exposure to collection and trade is moderated by demand, and can be moderated by distance and depth. Demand is highly species-specific, resulting in variable levels of collection pressure. However, even for heavily-collected species, geographic and depth distributions strongly moderate collection because distance from land and depth create barriers to human access. Temporally, exposure to collection and trade may increase over time, but will still continue to be strongly moderated by demand, distance, and depth (NMFS, 2012b, SIR Section 3.3.6).

Collection and trade of coral colonies can increase the likelihood of the colonies being infected by disease, due to both the directed and incidental breakage of colonies, which are then more easily infected. There are likely other examples of cumulative and interactive effects of collection and trade with other threats to corals.

<u>Inadequacy of Existing Regulatory Mechanisms (ESA Factor D)</u>

As we previously described, the SRR does not assess the contribution of "inadequacy of regulatory mechanisms" to the extinction risk of corals. Therefore, we developed a Draft Management Report that identifies: (1) existing regulatory mechanisms relevant to threats to the 82 candidate coral species; and (2) conservation efforts with regard to the status of the 82 candidate coral species. This Draft was peer reviewed and released with the SRR in April 2012, with a request for any information that we may have omitted. The information that we received was incorporated into the Final Management Report, which forms the basis of our evaluation of this factor's effect on the extinction risk of the 82 candidate coral species.

The relevance of existing regulatory mechanisms to extinction risk for an individual species depends on the vulnerability of that species to each of the threats identified under the other factors of ESA Section 4, and the extent to which regulatory mechanisms could or do control the threats that are contributing to the species' extinction risk. If a species is not currently, and not expected within the foreseeable future to become, vulnerable to a particular threat, it is not necessary to evaluate the adequacy of existing regulatory mechanisms for addressing that threat. Conversely, if a species is vulnerable to a particular threat (now or in the foreseeable future), we do evaluate the adequacy of existing measures, if any, in controlling or mitigating that threat. In the following paragraphs, we will discuss existing regulatory mechanisms for addressing the threats to corals, generally, and assess their adequacy for controlling those threats. In the Risk Analyses section, we determine if the inadequacy of regulatory mechanisms is a contributing factor to an individual species' status as threatened or endangered because the existing regulatory mechanisms fail to adequately control or mitigate the underlying threats.

As shown in Table 1 above, we identified 19 threats affecting all coral species in general. Of the 19 threats, ocean warming, coral disease, and ocean acidification are the most serious threats to coral species. As described in the SRR, the SIR and the Final Management Report, ocean warming and ocean acidification are directly linked, and disease is indirectly linked, to increasing anthropogenic GHGs in the atmosphere. The 19 threats to the 82 candidate coral species also include threats from more localized human activities, such as reef fishing, sedimentation, collection, physical damage, and other threats (see Table 1). The Final Management Report identifies existing regulatory mechanisms that are relevant to the threats to the 82 candidate coral species and is organized in two sections: (1) existing regulatory mechanisms that are relevant to addressing global-scale threats to corals linked to GHG emissions; and (2) existing regulatory mechanisms that are relevant to addressing other threats to corals. A summary of the information in the report is provided below.

GHG emissions are regulated through agreements, at the international level, and through statutes and regulations, at the national, state, or regional level. These two levels of regulation are interrelated because climate change is a global phenomenon in which emissions anywhere in the world mix in the global atmosphere. Reflecting this interdependency of nations, often the national laws are enacted as a result of commitments to international agreements. The information presented in the Management Report (NMFS, 2012c; Final Management Report, Section 2.1.3) suggests that existing regulatory mechanisms with the objective of reducing GHG emissions are inadequate to prevent the impacts to corals and coral reefs from ocean warming, ocean acidification, and other climate change-related threats described above.

One of the key international agreements relevant to attempts to control GHG emissions, the Copenhagen Accord, was developed in 2009 by the Conference of Parties to the United Nations Framework Conventions on Climate Change. The Copenhagen Accord identifies specific information provided by Parties on quantified economy-wide emissions targets for 2020 and on nationally appropriate mitigation actions to the goal of capping increasing average global temperature at 2°C above pre-industrial levels. Annex I countries are developed nations and Annex II countries are developing nations. In terms of coral reef protection, even if participating countries were reducing emissions enough and at a quick enough rate to meet the goal of capping increasing average global temperature at 2°C above pre-industrial levels, there would still be moderate to severe consequences for coral reef ecosystems. Tipping points analyses indicate that rising atmospheric CO_2 concentrations and climate change could lead to major biodiversity transformations at levels near or below the 2°C global warming defined by the IPCC as "dangerous," including widespread coral reef degradation (Leadley et al., 2010). While there will be spatial variation in climate warming throughout the globe, according to the SRR, at the current rate of CO_2 emissions, a further temperature increase in waters around coral reefs of 2.8-3.6°C is expected during this century, depending on the ocean basin. The global atmospheric

CO_2 concentration was up to 387 ppm by the end of 2009, 39% above the concentration at the start of the industrial revolution (about 280 ppm in 1750). The present concentration is the highest during at least the last 2 million years (Global Carbon Project, 2010). It has been estimated in some reports that atmospheric CO_2 must be reduced to levels similar to those present in the 1970's (or below 340 ppm) to ensure healthy coral growth over the long term (Brainard et al., 2011).

In addition to the insufficiency of the 2°C target (and the associated estimated peak in atmospheric CO_2 concentration) in terms of preventing widespread damage to coral reefs, several analyses show that pledges made under the Copenhagen Accord are not sufficient to achieve even this target. Rogelj et al. (2010) state that higher ambitions for 2020 are necessary to keep the options for 2° and 1.5°C viable without relying on potentially infeasible reduction rates after 2020. According to the IPCC Fourth Assessment report, Annex I emission reduction targets of 25 to 40% below 1990 levels in 2020 would be consistent with stabilizing long-term greenhouse gas concentration levels at 450 ppm CO_2 equivalent, which corresponds to 1.2° to 2.3°C in global warming over the next 100 years (Cubasch et al. 2001). The aggregated reduction target by 2020 of all Annex I pledges under the Copenhagen Accord ranges from 12 to 18% relative to the 1990 level which is insufficient to stabilize GHG concentrations and achieve the desired range of maximum warming (den Elzen and Höhne, 2008; Gupta et al., 2007; Pew Center for Global Climate Change, 2010). Even in the high pledge scenario of the Copenhagen Accord, this reduction goal will not be met (den Elzen et al., 2010). Note, again, that even at this range of warming, full protection of coral reefs is probably not feasible (O'Neill and Oppenheimer, 2002). In terms of global emissions, Copenhagen Accord pledges of Annex I countries and the action plans of the seven major emerging economies would lead to a gap towards the 2°C target of between 3 and 9 Gt CO_2 equivalents (den Elzen et al., 2010; Light, 2010; UNEP, 2010c). Anticipated global efforts toward GHG emission reduction are unlikely to close this gap and may even be insufficient to prevent warming of 3°C or more (Parry, 2010). With or without this gap, studies indicate that steep emission reductions are needed post 2020 in order to maintain the feasibility of limiting warming to 2°C or 1.5°C (UNEP, 2010).

The Climate Change Performance Index (Burck et al., 2010) evaluates and compares the climate protection performance of the top 60 GHG emitting countries that are together responsible for more than 90% of global energy-related CO_2 emissions. Performance rankings are based on an index including emissions level, emissions trend, and national and international climate change policy in each country. Each year, the top three ranks are reserved for countries that have reduced per capita emissions enough to meet the requirements to keep the increase in global temperature below 2°C. According to the 2011 report, no countries are meeting those criteria. Importantly, the performance of the top 10 emitters that account for over 60% of global emissions is of particular concern as all but three of them are ranked as either 'poor' or 'very poor' in overall performance (Burck et al., 2010). In particular, the U.S. and China both contribute the largest proportions to global emissions and both have 'very poor' ranks in the 2011 Climate Change Performance Index. It is important to note that even the most aggressive actions to reduce emissions will only slow warming, not prevent it.

The evidence presented here suggests that existing regulatory mechanisms at the global scale in the form of international agreements to reduce GHG emissions are insufficient to prevent widespread impacts to corals. It appears unlikely that Parties will be able to collectively achieve, in the near term, climate change avoidance goals outlined via international agreements. Additionally, none of the major global initiatives to date appear to be ambitious enough, even if all terms were met, to reduce GHG emissions to the level necessary to minimize impacts to coral reefs and prevent what are predicted to be severe consequences for corals worldwide.

Existing regulatory mechanisms directly or indirectly addressing all of the localized threats identified in the SRR (i.e., those threats not related to GHGs and global climate change) are primarily national and local fisheries, coastal, and watershed management laws and regulations in the 84 countries within the collective ranges of the 82 coral species. Because of the large number of threats, and the immense number of regulatory mechanisms in the 84 countries, a regulation-by-regulation assessment of adequacy was not possible. Furthermore, there is not enough information available to determine the effects of specific regulatory mechanisms on individual coral species given the lack of information on specific locations of individual species. We have information on the overall distribution of the species from range maps and literature that identify particular locations where the species have been observed, but this information is not sufficient to do a species by species, regulation by regulation evaluation of inadequacy. However, general patterns include: (1) fisheries management regimes regulate reef fishing in many parts of the collective ranges of the 82 candidate coral species albeit at varying levels of success; (2) laws addressing land-based sources of pollution are less effective than those regulating fisheries; (3) coral reef and coastal marine protected areas have increased several-fold in the last decade, reducing some threats through regulation or banning of fishing, coastal development, and other activities contributing to localized threats; and (4) the most effective regulatory mechanisms address the threats other than climate change, i.e., laws regulating destructive fishing practices, physical damage, and collection. Because the local threats have impacted and continue to impact corals across their ranges, we can generally conclude that, collectively, the existing regulations are not preventing or controlling local threats. However, we do not have sufficient information to determine if an individual species' extinction risk is increased or exacerbated by inadequacy of individual existing regulations.

Based on the Final Management Report, we conclude that existing regulatory mechanisms for GHG emissions are inadequate to prevent threats related to GHG emissions from worsening anywhere within the range of the 82 candidate species and within the foreseeable future. These threats include the three most important threats to the 82 candidate coral species: bleaching from ocean warming, coral disease related to ocean warming, and ocean acidification. In the Risk Analyses section, we determine if the inadequacy of existing regulatory mechanisms for GHG emissions is a contributing factor to an individual species' status as threatened or endangered because the existing regulatory mechanisms fail to adequately control or mitigate these three threats.

Risk Analyses

We developed a Determination Tool to consistently interpret the information in the SRR, Final Management Report, and SIR, in order to produce proposed listing determinations for each of the 82 species. The Determination Tool provides a replicable method to distill relevant information that contributes to each species' extinction risk and listing status, and contains justifications for the assigned ranking for each factor for each species. Copies of the entire Determination Tool are available at http://www.nmfs.noaa.gov/stories/2012/11/82corals.html. The following discussion provides the basis and rationale for our development of the

Determination Tool instead of directly assigning endangered, threatened, or not warranted status to the extinction risk determinations of the BRT.

In the SRR, the BRT evaluated the status of each species, identified threats to the species corresponding to four of the five factors identified in ESA section 4(a)(1), and estimated the risk of extinction for each of the candidate species out to the year 2100. Predicting risk of absolute extinction (i.e., when there will be zero living members of a species) is extremely challenging. In typically clonal organisms like corals, where colonies can be very long-lived (many hundreds of years), a species may be functionally unviable long before the last colony dies. Further, problems associated with low density may render a species at severely elevated risk well before extinction. Rather than try to predict risk of absolute extinction, the BRT estimated the likelihood that a population would fall below a Critical Risk Threshold (CRT) within a specified period of time. The CRT was not quantitatively defined. Rather, the BRT defined the CRT as a condition where a species is of such low abundance, or so spatially disrupted, or at such reduced diversity, that the species is at extremely high risk of extinction with little chance for recovery (a condition we consider to be worse than "endangered"; discussed below). Through a structured expert opinion process, the BRT assigned a category describing the likelihood of each of the 82 species falling below the CRT by 2100. The category boundaries and labels the BRT used for this review were based on those used by the IPCC for summarizing conclusions about climate change research, and are, in order of most severe to least severe: virtually certain (>99%); very likely (90-99%); likely (66-90%), more likely than not (50-66%); less likely than not (33-50%); unlikely (10-33%); very unlikely (1-10%), and exceptionally unlikely (<1%). The BRT provided a summary of votes by each expert (tallied in each risk likelihood category), mean (and standard error) likelihood of falling below the CRT by 2100, and the mean likelihood range for each of the 82 candidate coral species, ranked by mean likelihood. To read a summary of how the BRT ranked these species, see pages xxxv – xxxvii in the SRR.

While the BRT's review of the 82 candidates' status was rigorous and extensive, the framework used does not allow us to easily or clearly translate a particular BRT category of a certain likelihood of falling below the CRT to an ESA listing status. Structured expert opinion is a valid and commonly used method of evaluating extinction risk; however, the scoring methods used by this BRT created a number of issues that we must address to make listing determinations. For example, some species with the same mean score might have widely different ranges in the scores, suggesting differences in confidence within or between BRT members. Additionally, the BRT scoring was based on qualitative risk categories, which were then quantified and summarized statistically. Thus, there is likely no precisely describable distinction between two species with mean scores of 49 and 50, even though one species' score would seem to place it in a higher risk category. In addition, in our judgment, the CRT approach used for this status review does not correlate well with the ESA's definitions of endangered and threatened.

The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." The CRT, as defined by the BRT, is a condition worse than endangered, because it essentially precludes recovery. In developing our Determination Tool discussed below, we carefully examined the definitions of endangered and threatened species pursuant to section 3 of the ESA, wherein (1) "endangered species" is defined as "any species which is in danger of extinction throughout all or a significant portion of its range", and (2) "threatened species" is defined as "any species which is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532 (6) and (20)). Recent case law (In Re Polar Bear Endangered Species Act Listing and § 4(d) Rule Litigation, 794 F. Supp.2d 65 (D.D.C. 2011); 748 F.Supp.2d 19 (D.D.C. 2010)) regarding FWS' listing of the polar bear as threatened provides a thorough discussion of the ESA's definitions and the Services' broad discretion to determine on a case-by-case basis whether a species is in danger of extinction. The Court determined that the phrase "in danger of extinction" is ambiguous. The Court held that there is a temporal distinction between endangered and threatened species in terms of the proximity of the "danger" of extinction, noting that the definition of "endangered species" is phrased in the present tense, whereas a threatened species is "likely to become" so in the future. However, the Court also ruled that neither the ESA nor its legislative history compels the interpretation of "endangered" as a species being in "imminent" risk of extinction. Thus, in the context of the ESA, a key statutory difference between a threatened and endangered species is the timing of when a species may be in danger of extinction, either now (endangered) or in the foreseeable future (threatened). The Court ruled that although imminence of harm is clearly one factor that the Services weigh in their decision-making process, it is not necessarily a limiting factor, and that Congress did not intend to make any single factor controlling when drawing the distinction between endangered and threatened species. In many cases, the Services might appropriately find that the imminence of a particular threat is the dispositive factor that warrants listing a species as 'threatened' rather than 'endangered,' or vice versa. Nevertheless, as discussed in the supplemental explanation filed by FWS to further explain its decision to list the polar bear, to be listed as endangered does not require that extinction be certain or probable, and that it is possible for a species validly listed as "endangered" to actually persist indefinitely. These considerations were incorporated into our identification of the appropriate information that makes a species in danger of extinction now, likely to become in danger of extinction in the foreseeable future, or not warranting listing. For example, two major factors determining the immediacy of the danger of extinction for corals are the certainty of impacts from high importance threats and a species' current or future capacity to resist adverse effects. While a threatened species may be impacted by the same threats as an endangered species, a threatened species is less exposed, less susceptible, or has a buffering capacity, which results in a temporal delay in extinction risk. Thus, there is a temporal distinction between endangered and threatened species in terms of the proximity of the "danger" of extinction.

Development of the Determination Tool involved 3 major steps: 1) identification of information elements that are significant in determining and differentiating extinction risk for the candidate coral species; 2) determining the conditions under which the elements contribute to a species being endangered or threatened, or under which the elements moderate extinction risk; and 3) developing appropriate values to represent the state of the elements for each of the candidate species.

For the first major step, the main components of the Determination Tool were derived from the specific elements that the BRT identified in the SRR as significant in terms of increasing or decreasing a species' extinction risk, and refined by information in the SIR. These elements were grouped into 3 categories as follows: vulnerability to threats (susceptibility and exposure), demography (rangewide abundance, trends in abundance, and relative recruitment rate), and spatial structure (overall distribution and ocean basin). Certain combinations of these elements pose more immediate danger of extinction for corals. For example, based on the analyses by the BRT, a coral species with characteristics such as high vulnerability to bleaching from ocean warming, narrow overall distribution, and rare abundance would have an increased likelihood of extinction. In contrast, a species that has low vulnerability to bleaching, wide overall distribution, and common abundance would have a low likelihood of extinction. Thus, in step 2 of developing the Determination Tool, we determined the particular combinations of threat vulnerabilities, demographic information, and spatial information that correspond to a particular proposed listing status. Endangered species are species with a current high extinction risk; they are highly vulnerable to one or more of the high importance threats and have either already been seriously adversely affected by one of these threats, as evidenced by a declining trend, and high susceptibility to that threat, or they lack a buffer to protect them from serious adverse effects from these threats in the future (e.g., rare abundance or narrow overall distribution). Threatened species are species that are not currently in danger of extinction, but are likely to become so within the foreseeable future. The Determination Tool evaluates species' extinction risk over the foreseeable future, to the year 2100, through the identification of specific threat vulnerabilities, demographic traits, and distributional states. There are two ways in which a species can warrant listing as threatened. Threatened coral species are highly or moderately vulnerable to one or more of the high importance threats or highly vulnerable to one or more of the lower importance threats, but have either not yet exhibited effects in their populations (e.g., stable or increasing trend), or they have the buffering protection of a more common abundance or wider overall distribution.

Notably, one major distinction between endangered and threatened status for corals is based on the certainty of impacts from high importance threats and a species' current or future capacity to resist adverse effects. This is closely linked to the species' exposure and susceptibility to these threats, as well as their demographic and spatial elements. While a threatened species may be impacted by the same threats as an endangered species, a threatened species is less exposed, less susceptible, or has a buffering capacity, which results in a temporal delay in extinction risk. Given the certainty that the climate threats are increasing, and the particular combinations of species-specific elements, a threatened species will be in danger of extinction by 2100. Thus, there is a temporal distinction between endangered and threatened species in terms of the proximity of the "danger" of extinction.

Species that do not warrant listing are species that are found not to be in danger of extinction currently and not likely to become so by 2100 because they have: low vulnerability to the high importance threats, or low or moderate vulnerability to all the lower importance threats, and common abundance or wide overall distribution. Species that are not warranted for listing are distinguished from threatened and endangered species because they have a lower susceptibility to threats and the buffering capacity to resist adverse effect on their status now and into the future, meaning few individuals are affected by threats (lower vulnerability) and the high abundance and wide range buffers the species from declines. Thus there is low extinction risk for these species, which supports their not warranted status.

In the third step of the risk analysis we developed a range of values for each of the information elements comprising the Determination Tool, to provide an adequate description of that elements' contribution to each species' extinction risk, and to allow evaluation of meaningful distinctions between species. For example, rangewide abundance is rated as rare, uncommon, or common; depth distribution is shallow, moderate or wide; threat susceptibilities are rated as high, moderate or low, or as intermediate values. These values for each of the Determination Tool elements are summarized in Table 3D below.

Detailed Description of Determination Tool Elements

As mentioned above, the Determination Tool uses three categories of information for evaluating the status of each of the 82 candidate species: vulnerability to threats, demography and spatial structure (Table 2). These three categories were selected based on the influence this particular type of information has on the extinction risk of corals. There are specific elements within each of these categories with which we populated the Determination Tool. The following is a list of the specific elements in their categories:

(1) vulnerability to threats – (each of the nine most important threats described in the Threats Evaluation section above) based on a species' susceptibility and exposure to each of the threats;

(2) demography – abundance, trends in abundance, relative recruitment rate; and

(3) spatial structure – overall distribution (which is a combination of geographic and depth distributions), and ocean basin.

Where data were available within these elements for a particular species, the Determination Tool provided a consistent method to consider those elements for classifying each species in terms of its listing status. However, if data were unavailable (i.e., no inference could be made from the genus or family) on a particular element for a species, that element had no effect on listing status (i.e., no available information on which to identify contribution to extinction risk). Notably, there were available data for at least one element in each of the categories for each species to adequately populate the Determination Tool for a listing status. Summaries of each element considered in the Determination Tool, and its effect on listing status, are shown in Table 2 below. In all cases, the effect on listing shown in the table is a generality that depends on other elements, because each outcome depends on a combination of the vulnerability, demographic, and spatial structure ratings. Detailed descriptions of each of the elements, and how they are rated in the Determination Tool, follow after Table 2.

Table 2. Summary of each element considered in the Determination Tool, and its effect on listing status. The corresponding ESA section 4 listing factor is listed in parentheses after each threat in the Element column. "E" means "endangered" and "T" means "threatened.

Category	**Element**	**Definition**	**Species-Specific Classification**	**Effect on Listing Status**
Vulnerability to High Importance Threats	Ocean Warming (E)	Elevation of ocean temperatures above tolerated range resulting primarily in bleaching (expulsion of symbiotic algae) and other detrimental physiological responses	high, moderate, low	high contributes to E or T depending on other elements moderate contributes to T depending on other elements
	Disease (C)	Presumed infectious diseases often associated with acute tissue loss.	high, moderate, low	high contributes to E or T depending on other elements moderate contributes to T depending on other elements
	Ocean Acidification (E)	Increased CO_2 in the surface ocean, resulting in reduced pH and reduced availability of carbonate ions.	high, moderate, low	high contributes to E or T depending on other elements moderate contributes to T depending on other elements
Vulnerability to Lower Importance Threats	Reef Fishing Impacts (Trophic Cascades) (A)	The alteration (through the removal of fish biomass) of trophic interactions that is particularly important in structuring coral reef ecosystems.	high, moderate, low	high or moderate contributes to E or T depending on other elements
	Sedimentation (A & E)	Delivery of terrestrial sediments and re-mobilization of in situ sediments.	high, moderate, low	high contributes to T depending on other elements

	Nutrient Over-enrichment (A & E)	An overabundance of chemicals that organisms need to live and grow, which results in detrimental physiological or ecological imbalances.	high, moderate, low	high contributes to T depending on other elements
	Sea-level Rise (A & E)	Increase of observed sea level due to thermal expansion and the melting of both land and sea ice as direct consequences of increases in atmospheric greenhouse gases.	high, moderate, low	high contributes to T depending on other elements
	Predation (C)	The feeding on corals by fish or invertebrates.	high, moderate, low	high contributes to T depending on other elements
	Collection and Trade (B)	The removal and transport of coral colonies.	high, moderate, low	high contributes to T depending on other elements
Demographic	Qualitative Range-wide Abundance (E)	A qualitative estimate of the abundance of a species.	rare, uncommon, common	rare or uncommon contributes to E depending on other elements rare contributes to T depending on other elements
	Trends in Abundance (E)	A quantitative or qualitative indicator of a species' trajectory; represents realized productivity.	decreasing, stable, increasing	decreasing contributes to E depending on other elements
	Relative Recruitment Rate (E)	Number of recruits per spawner.	low, moderate, high	low contributes to E or T depending on other elements
Spatial Structure	Overall Distribution (E)	The latitudinal, longitudinal, habitat, and depth extent occupied by the species.	narrow, moderate, wide	narrow contributes to E or T depending on other elements moderate or wide contributes to T depending on other elements
	Ocean Basin (E)	The restriction of a species to a particular ocean basin.	Caribbean, Eastern Pacific, Indo-Pacific	Restriction to Caribbean or Eastern Pacific contributes to E or T depending on other elements

Vulnerability to Threats

The first information category in the Determination Tool is vulnerability of coral species to the most important threats. The future trajectories of the 82 candidate coral species will largely depend on their vulnerabilities to these threats, thus threat vulnerability is the key component to the 82 extinction risk analyses. As described in the Threats to Coral Species section above, vulnerability of a coral species to a threat is a function of susceptibility and exposure, where susceptibility refers to the response of coral colonies to the adverse conditions produced by the threat, and exposure refers to the proportion of colonies that come into contact with the threat across the range of the species. Vulnerability applies to large spatial and temporal scales – for each species and each threat, susceptibilities and exposures are considered for its entire range, from now to the year 2100. Species-specific ratings of susceptibilities and exposures were made in the Determination Tool, leading to species-specific vulnerability ratings, as described in more detail below.

Susceptibility generally refers to the response of coral colonies to the adverse conditions produced by the threat. Susceptibility of a coral species to a threat is primarily a function of biological processes and characteristics, and can vary greatly between and within taxa (i.e., family, genus, and species). In the Determination Tool, susceptibility of each of the 82 candidate corals species to each of the nine threats was rated as high, high-moderate, moderate, moderate-low, or low, based on the information in the SRR and SIR. Susceptibility of a species to a threat depends on the combination of: (1) direct effects of the threat on the species; and (2) the cumulative (i.e., additive) and interactive (i.e., synergistic or antagonistic) effects of the threat with the effects of other threats on the species. Therefore, when rating the susceptibilities to each threat, we specifically considered how the cumulative or interactive effects, for which we have information, altered the rating that would be assigned to a threat susceptibility in isolation. In many cases the interactive and cumulative effects of threats increased a species' susceptibility rating to a particular threat, specifically when the species has moderate or high susceptibilities to the individual threats. Further, species with low susceptibilities to individual threats are not expected to have increased susceptibilities when considering cumulative or interactive effects, because low susceptibility means that few individuals of the species exhibit adverse impacts to the threat. Thus, there is a low likelihood of multiple low susceptibility threats affecting the same individuals either cumulatively or interactively. The threat susceptibility ratings from the Determination Tool for each of the candidate species for each threat are shown in Table 3. In addition, the Determination Tool includes a justification sheet that provides the rationale for each of the susceptibility ratings. In the justifications sheet, we identify the complete basis on which we assigned a ranking, including cumulative and interactive effects of threats. Copies of the entire Determination Tool are available at http://www.nmfs.noaa.gov/stories/2012/11/82corals.html.

As described above, vulnerability of a coral species to a threat also depends on the proportion of colonies that are exposed to the threat. Exposure is primarily a function of physical processes and characteristics that limit or moderate the impact of the threat across the range of the species. In the Determination Tool, exposure of each of the 82 candidate corals species to each of the nine threats was rated as high, high-moderate, moderate, moderate-low, or low, based on the information in the SRR and SIR. Exposure of a species to a threat depends on the spatial and temporal scales over which exposure to the threat is being considered. As explained above, the appropriate spatial scale is the entire current range of the species, and the appropriate temporal scale is from now to the year 2100. The threat exposure ratings from the Determination Tool for each of the candidate species for each threat are shown in Table 3. In addition, the Determination Tool includes a justification sheet that provides the rationale for each of the exposure ratings.

Vulnerability of a coral species to a threat is a function of susceptibility and exposure. Thus, in the Determination Tool, the vulnerability rating for each species to each threat is determined by the sum of the susceptibility and exposure ratings, resulting in a threat vulnerability rating that we ranked as high, moderate, or low. The threat vulnerability ratings from the Determination Tool for each of the candidate species for each threat are shown in Table 3.

The three most important threats that contribute to a species' extinction risk are ocean warming, disease, and ocean acidification. We considered these threats to be the most significant threats posing extinction risk to the 82 candidate coral species currently and out to the year 2100. Thus, vulnerability to these threats highly influenced the listing status for each of the 82 coral species. Threats of lower importance – trophic effects of reef fishing, sedimentation, nutrients, sea-level rise, predation, and collection and trade – were also considered as contributing to extinction risks, but to a lesser extent. Therefore, the vulnerability to the lower importance threats only contributed to threatened or endangered status if the species had a high vulnerability to that threat. Last, the threats not considered in the tool, or those that have moderate or low ranking, may still have negative effects on individual species, just not enough to significantly affect extinction risk.

Demography (ESA Factor E)

Demographic elements that cause a species to be at heightened risk of extinction, alone or in combination with threats under other listing factors, are considered under ESA Factor E – other natural or manmade factors affecting the continued existence of the species. Because the demographic elements of abundance and productivity have such interactive effects on extinction risk and because they are often both estimated from the same time series data, we address these two parameters together. Information related to coral abundance and productivity can be divided into several qualitative and quantitative metrics. However, abundance and trend data for the 82 coral species are limited; the data that do exist suffer from substantial uncertainties (see Section 4.2 of the SRR). Therefore, the Determination Tool relies on the qualitative rangewide abundance and qualitative trends in abundance.

Species-specific qualitative abundance estimates, coded as “common”, “uncommon”, or “rare” for the candidate species, are based on information in Sections 6 and 7 of the SRR and SIR. A qualitative rangewide abundance estimate was the only abundance metric that was available for all of the 82 candidate species. In general, “rare” or “uncommon” species are more vulnerable than common ones, although some species are naturally rare and have likely persisted in that rare state for tens of thousands of years or longer. However, naturally rare species may generally be at greater risk of extinction than naturally more common species when confronted with global threats to which they are vulnerable. Thus, in the Determination Tool, rarity or uncommonness increased extinction risk and contributed to an endangered or threatened status. Trends in abundance directly demonstrate how the focal species responds under current or recent-past conditions. Trend data for the 82 species were scarce; however, a declining trend increased extinction risk and contributed to endangered status in the Determination Tool.

Productivity is perhaps a more important indicator of extinction risk than commonness. Productivity is defined here as the tendency of the population to increase in abundance if perturbed to low numbers and is often expressed as "recruits per spawner," although the term "recruit" can be difficult to apply in the case of corals, which reproduce both sexually and asexually (see Section 2.2.1 of the SRR). Many of the 82 candidate coral species are long-lived, with low or episodic productivity, making them highly vulnerable to trends of increased mortality or catastrophic mortality events. As an example of the high influence recruitment rate has on extinction risk, the BRT considered a species that has lost the ability for successful recruitment of sexually-produced progeny to be below the CRT, even if it can still reproduce asexually; thus such a species would be at high risk of extinction. Recruitment rate estimates for the 82 candidate species were scarce; however, in the Determination Tool, where estimates were available, low relative recruitment rates increased the extinction risk and contributed to endangered or threatened status.

Spatial Structure (ESA Factor E)

Spatial elements that cause a species to be at heightened risk of extinction, alone or in combination with threats under other listing factors, are considered under ESA Factor E – other natural or manmade factors affecting the continued existence of the species. Spatial structure is important at a variety of scales. At small spatial scales within a single population, issues of gamete density and other Allee effects (when, in small populations, the reproduction and survival rates of individuals decreases with declining population density) can have significant impacts on population persistence. A wide geographic distribution can buffer a population or a species from environmental fluctuations or catastrophic events; it “spreads the risk” among multiple populations (see Section 4.3 of the SRR). We explicitly described how exposure to individual threats varies at different spatial scales in the Threats Evaluation section above. The extent to which an individual species’ extinction risk is contributed to or moderated by those spatial aspects is considered in exposure. Here, we are identifying the general area a species may occupy across its geographic and depth distributions. Generally, having a wide geographic or depth distribution provides more potential area to occupy. However, if populations are too isolated (even within a large distribution), gene flow and larval connectivity may be reduced, making the species less likely to recover from mortality events. Thus, a robust spatial structure includes a wide geographic distribution, with substantial connectivity to maintain proximity of populations and individuals within the range. We considered the geographic (including longitudinal, latitudinal, and habitat) distribution and depth distribution in rating the overall distribution for each species. Based on the information above on how distribution influences extinction risk, a narrow overall distribution increases extinction risk. However, in some cases a moderate or wide distribution is not sufficient to reduce extinction risk to a level that the species would not warrant listing.

We also considered the ocean basin in which a species exists under spatial structure in the Determination Tool. The Caribbean basin is geographically small and partially enclosed, biologically well-connected, and has relatively high human population densities with a long history of adversely affecting coral reef systems across the basin. The eastern Pacific basin is geographically isolated from the Indo-Pacific and has an environment that may be one of the least hospitable to reef development and coral biodiversity. Further, since 1980, six of the 40 known reef-building scleractinian and hydrocoral species in the eastern Pacific may have become extinct or locally extirpated. The eastern Pacific contains approximately one third of the number of genera and less than half the number of species compared to the Caribbean, less reef area than in the Caribbean, and strong climate variability. If a species is restricted to one of these basins, its extinction risk is significantly increased, and thus contributed to a status of endangered or threatened.

In the Determination Tool, the geographic distribution ratings are defined as follows: All Caribbean species are rated as "narrow; in the Indo-Pacific, "narrow" is a portion of the Coral Triangle, or the eastern Pacific, or the Hawaiian archipelago, or a similarly small portion of the Indian and Pacific Oceans; "moderate" is somewhat restricted latitudinally or longitudinally in the Indo-Pacific, but not as much as the narrow species (e.g., species distributed throughout the Coral Triangle are rated as moderate, not narrow); and "wide" is broadly distributed latitudinally and longitudinally throughout most of the Indo-Pacific. For all species, the depth distribution ratings are defined as: "shallow" is near the surface to approximately 15 m, "moderate" is near the surface to approximately 50 m, and "wide" is near the surface to approximately 100 m. Species that are found predominantly in deeper water potentially occur near the surface in low-light environments (e.g., turbid habitats, overhangs, caves, etc.). Overall distribution ratings are simply sums of the geographic and depth ratings; thus, justifications for the overall distribution ratings are not provided in the Determination Tool.

Summary of the Determination Tool

As discussed above and described in the outline below, particular combinations of threat vulnerabilities, demographic information, and spatial information result in a particular proposed listing status. The outline below is the textual description of the Determination Tool. A graphical depiction of the Determination Tool is available at http://www.nmfs.noaa.gov/stories/2012/11/82corals.html. The 82 outcomes are provided in the Listing Determinations section that follows.

1) A species warrants listing as endangered if:
   a) It is highly vulnerable to any high importance threat and
   b) It has any of the following demographic elements:
      i) Rare or uncommon abundance; or
      ii) Declining trend; or
      iii) Low recruitment rate; and
   c) It has any of the following spatial elements:
      i) Narrow overall distribution or
      ii) Occurs only in the E Pacific or Caribbean; and
   d) The existing regulatory mechanisms are inadequately regulating the high importance threats contributing to the species' status.
2) A species warrants listing as threatened if:

a) It is highly vulnerable to any high importance threat, but does not have both one of the demographic elements and one of the spatial elements listed under 1b and 1c above, or

b) It is moderately vulnerable to any high importance threat, or highly vulnerable to any lower importance threat, and

  i) It has any of the following qualities:

    (1) Rare abundance or

    (2) Narrow overall distribution; and

c) The existing regulatory mechanisms are inadequately regulating the threats contributing to the species' status.

3) A species does not warrant listing as threatened or endangered if:

  a) It is not highly or moderately vulnerable to any high importance threat, nor highly vulnerable to any lower importance threat, and

  b) It has one of the following qualities:

    i) Uncommon or common abundance and moderate or wide overall distribution; or

    ii) The existing regulatory mechanisms are adequately regulating the threats contributing to the species' status

Tables 3A – 3D: The four tables below show all demographic (3A), spatial (3A), and threat vulnerability (3B & 3C) data for each of the 84 species considered in the Determination Tool. Keys to the data are shown in Table 3D. Copies of the entire Determination Tool are available at http://www.nmfs.noaa.gov/stories/2012/11/82corals.html.

Table 3A. Demographic and spatial data for each of the 84 species considered in the Determination Tool. A key for the ratings is provided in Table 3D below.

SRR Order	Species	Demographic (E)			Spatial (E)				
		Generalized Rangewide Abundance	Trends in Abundance	Relative Recruitment Rate	Geographic Distribution	Depth Distribution	Overall Distribution	Restricted to Caribbean	Restricted to Eastern Pacific
0	Acropora cervicornis	2	1	1	1	1	2	Y	N
0	Acropora palmate	2	1	1	1	2	3	Y	N
1	Agaricia lamarcki	3	2	1	1	3	4	Y	N
2	Mycetophyllia ferox	1	1	1	1	3	4	Y	N
3	Dendrogyra cylindrus	1	n/a	1	1	2	3	Y	N
4	Dichocoenia stokesii	3	n/a	2	1	3	4	Y	N
5	Montastraea faveolata	3	1	1	1	3	4	Y	N
6	Montastraea franksi	3	1	1	1	3	4	Y	N
7	Montastraea annularis	3	1	1	1	2	3	Y	N
8	Millepora foveolata	2	n/a	3	1	1	2	N	N
9	Millepora tuberosa	3	n/a	3	1	1	2	N	N
10	Heliopora coerulea	3	n/a	2	3	3	6	N	N
11	Pocillopora danae	2	n/a	n/a	2	2	4	N	N
12	Pocillopora elegans (East Pacific)	3	n/a	1	1	3	4	N	Y
13	Pocillopora elegans (Indo-Pacific)	3	n/a	n/a	3	3	6	N	N
14	Seriatopora aculeata	2	n/a	n/a	2	2	4	N	N
15	Acropora aculeus	3	n/a	n/a	3	2	5	N	N
16	Acropora acuminata	2	n/a	2	3	2	5	N	N
17	Acropora aspera	3	n/a	n/a	2	1	3	N	N
18	Acropora dendrum	1	n/a	n/a	2	2	4	N	N
19	Acropora donei	2	n/a	n/a	2	2	4	N	N
20	Acropora globiceps	3	n/a	n/a	2	1	3	N	N

21	Acropora horrida	2	n/a	n/a	3	2	5	N	N
22	Acropora jacquelineae	1	n/a	n/a	1	2	3	N	N
23	Acropora listeri	2	n/a	n/a	3	1	4	N	N
24	Acropora lokani	1	n/a	n/a	1	2	3	N	N
25	Acropora microclados	2	n/a	n/a	3	2	5	N	N
26	Acropora palmerae	2	n/a	n/a	2	2	4	N	N
27	Acropora paniculata	2	n/a	n/a	3	2	5	N	N
28	Acropora pharaonis	3	n/a	n/a	1	2	3	N	N
29	Acropora polystoma	2	n/a	n/a	3	1	4	N	N
30	Acropora retusa	2	n/a	n/a	3	1	4	N	N
31	Acropora rudis	2	n/a	n/a	1	1	2	N	N
32	Acropora speciosa	2	n/a	n/a	2	2	4	N	N
33	Acropora striata	2	n/a	n/a	2	2	4	N	N
34	Acropora tenella	2	n/a	n/a	2	3	5	N	N
35	Acropora vaughani	2	n/a	2	3	2	5	N	N
36	Acropora verweyi	3	n/a	n/a	3	1	4	N	N
37	Anacropora puertogalerae	2	n/a	n/a	2	2	4	N	N
38	Anacropora spinosa	2	n/a	n/a	1	1	2	N	N
39	Astreopora cucullata	2	n/a	n/a	3	1	4	N	N
40	Isopora crateriformis	3	n/a	n/a	2	2	4	N	N
41	Isopora cuneata	3	n/a	3	3	1	4	N	N
42	Montipora angulata	2	n/a	2	3	2	5	N	N
43	Montipora australiensis	2	n/a	2	3	2	5	N	N
44	Montipora calcarea	2	n/a	2	3	2	5	N	N
45	Montipora caliculata	2	n/a	2	3	2	5	N	N
46	Montipora dilatata/flabellata(/turgescens)	3	n/a	n/a	3	2	5	N	N
47	Montipora lobulata	2	n/a	2	3	2	5	N	N
48	Montipora patula(/verrilli)	3	n/a	2	1	2	3	N	N
49	Alveopora allingi	2	n/a	n/a	3	1	4	N	N
50	Alveopora fenestrata	2	n/a	n/a	3	2	5	N	N
51	Alveopora verrilliana	2	n/a	2	3	3	6	N	N
52	Porites horizontalata	3	n/a	n/a	3	2	5	N	N
53	Porites napopora	3	n/a	n/a	2	1	3	N	N
54	Porites nigrescens	3	n/a	n/a	3	2	5	N	N
55	Porites	3	n/a	n/a	3	2	5	N	N

	(Clade 1 forma pukoensis)								
56	Psammocora stellata	2	n/a	n/a	2	2	4	N	N
57	Leptoseris incrustans	2	n/a	n/a	3	3	6	N	N
58	Leptoseris yabei	2	n/a	n/a	3	3	6	N	N
59	Pachyseris rugosa	3	n/a	n/a	3	2	5	N	N
60	Pavona bipartite	2	n/a	n/a	3	2	5	N	N
61	Pavona cactus	3	n/a	n/a	3	2	5	N	N
62	Pavona decussata	3	n/a	n/a	3	2	5	N	N
63	Pavona diffluens	2	n/a	n/a	1	2	3	N	N
64	Pavona venosa	2	n/a	n/a	3	2	5	N	N
65	Galaxea astreata	3	n/a	n/a	3	3	6	N	N
66	Pectinia alcicornis	2	n/a	n/a	3	2	5	N	N
67	Acanthastrea brevis	2	n/a	n/a	3	2	5	N	N
68	Acanthastrea hemprichii	2	n/a	n/a	3	2	5	N	N
69	Acanthastrea ishigakiensis	2	n/a	n/a	3	1	4	N	N
70	Acanthastrea regularis	2	n/a	n/a	2	2	4	N	N
71	Barabattoia laddi	2	n/a	n/a	2	1	3	N	N
72	Caulastrea echinulata	2	n/a	n/a	1	2	3	N	N
73	Cyphastrea agassizi	2	n/a	n/a	3	2	5	N	N
74	Cyphastrea ocellina	2	n/a	n/a	3	2	5	N	N
75	Euphyllia cristata	2	n/a	n/a	2	2	4	N	N
76	Euphyllia paraancora	2	n/a	n/a	2	3	5	N	N
77	Euphyllia paradivisa	2	n/a	n/a	1	2	3	N	N
78	Physogyra lichtensteini	3	n/a	n/a	3	2	5	N	N
79	Turbinaria mesenterina	3	n/a	3	3	2	5	N	N
80	Turbinaria peltata	3	n/a	n/a	3	2	5	N	N
81	Turbinaria reniformis	3	n/a	n/a	3	2	5	N	N
82	Turbinaria stellulata	2	n/a	n/a	3	2	5	N	N

Table 3B. Exposure (Exp.), Susceptibility (Susc.), and Vulnerability (Vul.) ratings for five threats for each of the 84 species considered in the Determination Tool. A key for the ratings is provided in Table 3D below.

SRR Order	Species	High Importance Threats									Medium and Low Importance Threats					
		Ocean Warming			Disease			Ocean Acidification			Trophic Effects of Reef Fishing			Sedimentation		
		Exp.	Susc.	Vul.	Exp.	Susc.	Vul.	Exp.	Susc.	Vul.	Exp.	Susc.	Vul.	Exp.	Susc.	Vul.
0	Acropora cervicornis	1.5	1	2.5	1.5	1	2.5	1.5	1.5	3	1.5	2	3.5	2	1	3
0	Acropora palmate	1.5	1	2.5	1.5	1	2.5	1.5	1.5	3	1.5	2	3.5	2	1	3
1	Agaricia lamarcki	1.5	2	3.5	1.5	2	3.5	1.5	2	3.5	1.5	2	3.5	2	2	4
2	Mycetophyllia ferox	1.5	3	4.5	1.5	1	2.5	1.5	2	3.5	1.5	2	3.5	2	2	4
3	Dendrogyra cylindrus	1.5	2	3.5	1.5	1	2.5	1.5	2	3.5	1.5	2	3.5	2	2	4
4	Dichocoenia stokesii	1.5	3	4.5	1.5	1	2.5	1.5	2	3.5	1.5	2	3.5	2	1.5	3.5
5	Montastraea faveolata	1.5	1	2.5	1.5	1	2.5	1.5	1.5	3	1.5	2	3.5	2	1	3
6	Montastraea franksi	1.5	1	2.5	1.5	1	2.5	1.5	1.5	3	1.5	2	3.5	2	1	3
7	Montastraea annularis	1.5	1	2.5	1.5	1	2.5	1.5	1.5	3	1.5	2	3.5	2	1	3
8	Millepora foveolata	1.5	1	2.5	2	2	4	1.5	2	3.5	2	2	4	3	2	5
9	Millepora tuberosa	1.5	1	2.5	2	2	4	1.5	2	3.5	2	2	4	3	2	5
10	Heliopora coerulea	1.5	3	4.5	2	3	5	1.5	2	3.5	2	2	4	3	3	6
11	Pocillopora danae	1.5	1.5	3	2	2.5	4.5	1.5	2	3.5	2	2	4	3	2.5	5.5
12	Pocillopora elegans (East Pacific)	1.5	1.5	3	2	2.5	4.5	1.5	2	3.5	2	2	4	3	2.5	5.5
13	Pocillopora elegans (Indo-Pacific)	1.5	1.5	3	2	2.5	4.5	1.5	2	3.5	2	2	4	3	2.5	5.5
14	Seriatopora aculeata	1.5	1.5	3	2	2.5	4.5	1.5	2	3.5	2	2	4	3	2.5	5.5
15	Acropora aculeus	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
16	Acropora acuminata	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
17	Acropora aspera	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
18	Acropora dendrum	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
19	Acropora donei	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
20	Acropora globiceps	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
21	Acropora horrida	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
22	Acropora jacquelineae	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
23	Acropora listeri	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
24	Acropora lokani	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
25	Acropora microclados	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
26	Acropora palmerae	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5

27	Acropora paniculata	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
28	Acropora pharaonis	1.5	1	2.5	2	1	3	1.5	2	3.5	2	2	4	3	2.5	5.5
29	Acropora polystoma	1.5	1	2.5	2	1	3	1.5	2	3.5	2	2	4	3	2.5	5.5
30	Acropora retusa	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
31	Acropora rudis	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
32	Acropora speciosa	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
33	Acropora striata	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
34	Acropora tenella	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
35	Acropora vaughani	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
36	Acropora verweyi	1.5	1	2.5	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
37	Anacropora puertogalerae	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2	5
38	Anacropora spinosa	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
39	Astreopora cucullata	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2	5
40	Isopora crateriformis	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2	5
41	Isopora cuneata	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2	5
42	Montipora angulata	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2	5
43	Montipora australiensis	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2	5
44	Montipora calcarea	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2	5
45	Montipora caliculata	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2	5
46	Montipora dilatata/flabellata(/turgescens)	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2	5
47	Montipora lobulata	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2	5
48	Montipora patula(/verrilli)	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	1.5	4.5
49	Alveopora allingi	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
50	Alveopora fenestrata	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
51	Alveopora verrilliana	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
52	Porites horizontalata	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
53	Porites napopora	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
54	Porites nigrescens	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	2.5	5.5
55	Porites (Clade 1 forma pukoensis)	1.5	2	3.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
56	Psammocora stellata	1.5	2.5	4	2	2.5	4.5	1.5	2	3.5	2	2	4	3	2.5	5.5
57	Leptoseris incrustans	1.5	3	4.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
58	Leptoseris yabei	1.5	3	4.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
59	Pachyseris rugosa	1.5	1.5	3	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
60	Pavona bipartite	1.5	2	3.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5

61	Pavona cactus	1.5	2	3.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
62	Pavona decussata	1.5	2	3.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
63	Pavona diffluens	1.5	2	3.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
64	Pavona venosa	1.5	2	3.5	2	2	4	1.5	2	3.5	2	2	4	3	2.5	5.5
65	Galaxea astreata	1.5	2	3.5	2	2.5	4.5	1.5	2	3.5	2	2	4	3	3	6
66	Pectinia alcicornis	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	3	6
67	Acanthastrea brevis	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	3	6
68	Acanthastrea hemprichii	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	3	6
69	Acanthastrea ishigakiensis	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	3	6
70	Acanthastrea regularis	1.5	1.5	3	2	1.5	3.5	1.5	2	3.5	2	2	4	3	3	6
71	Barabattoia laddi	1.5	2.5	4	2	2	4	1.5	2	3.5	2	2	4	3	n/a	n/a
72	Caulastrea echinulata	1.5	2.5	4	2	2	4	1.5	2	3.5	2	2	4	3	n/a	n/a
73	Cyphastrea agassizi	1.5	2.5	4	2	2	4	1.5	2	3.5	2	2	4	3	n/a	n/a
74	Cyphastrea ocellina	1.5	2.5	4	2	2	4	1.5	2	3.5	2	2	4	3	n/a	n/a
75	Euphyllia cristata	1.5	1.5	3	2	2.5	4.5	1.5	2.5	4	2	2	4	3	2.5	5.5
76	Euphyllia paraancora	1.5	1.5	3	2	2.5	4.5	1.5	2.5	4	2	2	4	3	2.5	5.5
77	Euphyllia paradivisa	1.5	1.5	3	2	2.5	4.5	1.5	2.5	4	2	2	4	3	2.5	5.5
78	Physogyra lichtensteini	1.5	1.5	3	2	2	4	1.5	2.5	4	2	2	4	3	2.5	5.5
79	Turbinaria mesenterina	1.5	3	4.5	2	2	4	1.5	2.5	4	2	2	4	3	2.5	5.5
80	Turbinaria peltata	1.5	3	4.5	2	2	4	1.5	2.5	4	2	2	4	3	2.5	5.5
81	Turbinaria reniformis	1.5	3	4.5	2	2	4	1.5	2.5	4	2	2	4	3	2.5	5.5
82	Turbinaria stellulata	1.5	3	4.5	2	2	4	1.5	2.5	4	2	2	4	3	2.5	5.5

Table 3C. Exposure (Exp.), Susceptibility (Susc.), and Vulnerability (Vul.) ratings for four threats for each of the 84 species considered in the Determination Tool, and Regulatory Mechanisms results. A key for the ratings is provided in Table 3D below.

SRR Order	Species	Medium and Low Importance Threats												Inadequacy of Regulatory Mechanisms?
		Nutrients			Sea-level Rise			Predation			Collection & Trade			
		Exp.	Susc.	Vul.	Exp.	Susc.	Vul.	Exp.	Susc.	Vul.	Exp.	Susc.	Vul.	
0	Acropora cervicornis	2	1	3	3	2	5	3	1.5	4.5	3	3	6	YES
0	Acropora palmata	2	1	3	3	2	5	3	1.5	4.5	3	3	6	YES
1	Agaricia lamarcki	2	2	4	3	2	5	3	n/a	n/a	3	3	6	YES
2	Mycetophyllia ferox	2	1	3	3	2	5	3	3	6	2.5	2.5	5	YES
3	Dendrogyra cylindrus	2	1.5	3.5	3	2	5	3	3	6	2.5	2.5	5	YES
4	Dichocoenia stokesii	2	n/a	n/a	3	2	5	3	2.5	5.5	3	3	6	YES
5	Montastraea faveolata	2	1	3	3	2	5	3	2.5	5.5	3	3	6	YES
6	Montastraea franksi	2	1	3	3	2	5	3	2.5	5.5	3	3	6	YES
7	Montastraea annularis	2	1	3	3	2	5	3	2.5	5.5	3	3	6	YES
8	Millepora foveolata	2	2	4	3	2	5	3	2	5	3	3	6	YES
9	Millepora tuberosa	2	2	4	3	2	5	3	2	5	3	3	6	YES
10	Heliopora coerulea	2	2.5	4.5	3	2	5	3	3	6	3	3	6	NO
11	Pocillopora danae	2	2	4	3	2	5	3	2	5	3	3	6	YES
12	Pocillopora elegans (East Pacific)	2	2	4	3	2	5	3	2	5	3	3	6	YES
13	Pocillopora elegans (Indo-Pacific)	2	2	4	3	2	5	3	2	5	3	3	6	YES
14	Seriatopora aculeata	2	2	4	3	2	5	3	1.5	4.5	3	3	6	YES
15	Acropora aculeus	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
16	Acropora acuminata	2	2.5	4.5	3	2	5	3	3	6	3	3	6	YES
17	Acropora aspera	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
18	Acropora dendrum	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
19	Acropora donei	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
20	Acropora globiceps	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
21	Acropora horrida	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
22	Acropora jacquelineae	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
23	Acropora listeri	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES

24	Acropora lokani	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
25	Acropora microclados	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
26	Acropora palmerae	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
27	Acropora paniculata	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
28	Acropora pharaonis	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
29	Acropora polystoma	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
30	Acropora retusa	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
31	Acropora rudis	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
32	Acropora speciosa	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
33	Acropora striata	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
34	Acropora tenella	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
35	Acropora vaughani	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
36	Acropora verweyi	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
37	Anacropora puertogalerae	2	2	4	3	2	5	3	1.5	4.5	3	3	6	YES
38	Anacropora spinosa	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
39	Astreopora cucullata	2	2	4	3	2	5	3	1.5	4.5	3	3	6	YES
40	Isopora crateriformis	2	2	4	3	2	5	3	1.5	4.5	3	3	6	YES
41	Isopora cuneata	2	2	4	3	2	5	3	1.5	4.5	3	3	6	YES
42	Montipora angulata	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
43	Montipora australiensis	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
44	Montipora calcarea	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
45	Montipora caliculata	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
46	Montipora dilatata/flabellata(/turgescens)	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
47	Montipora lobulata	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
48	Montipora patula(/verrilli)	2	2.5	4.5	3	2	5	3	1.5	4.5	3	3	6	YES
49	Alveopora allingi	2	2.5	4.5	3	2	5	3	2	5	3	3	6	YES
50	Alveopora fenestrata	2	2.5	4.5	3	2	5	3	2	5	3	3	6	YES
51	Alveopora verrilliana	2	2.5	4.5	3	2	5	3	2	5	3	3	6	YES
52	Porites horizontalata	2	2.5	4.5	3	2	5	3	2	5	3	3	6	YES
53	Porites napopora	2	2.5	4.5	3	2	5	3	2	5	3	3	6	YES
54	Porites nigrescens	2	2.5	4.5	3	2	5	3	2	5	3	3	6	YES
55	Porites (Clade 1 forma pukoensis)	2	2.5	4.5	3	2	5	3	2	5	3	3	6	NO
56	Psammocora stellata	2	2	4	3	2	5	3	2	5	3	3	6	NO
57	Leptoseris incrustans	2	n/a	n/a	3	2	5	3	2	5	3	3	6	NO

58	Leptoseris yabei	2	n/a	n/a	3	2	5	3	2	5	3	3	6	NO
59	Pachyseris rugosa	2	n/a	n/a	3	2	5	3	2	5	3	3	6	YES
60	Pavona bipartita	2	n/a	n/a	3	2	5	3	2	5	3	3	6	NO
61	Pavona cactus	2	n/a	n/a	3	2	5	3	2	5	3	3	6	NO
62	Pavona decussata	2	n/a	n/a	3	2	5	3	2	5	3	3	6	NO
63	Pavona diffluens	2	n/a	n/a	3	2	5	3	2	5	3	3	6	YES
64	Pavona venosa	2	n/a	n/a	3	2	5	3	2	5	3	3	6	NO
65	Galaxea astreata	2	n/a	n/a	3	2	5	3	3	6	3	3	6	NO
66	Pectinia alcicornis	2	3	5	3	2	5	3	1	4	3	3	6	YES
67	Acanthastrea brevis	2	n/a	n/a	3	2	5	3	n/a	n/a	3	3	6	YES
68	Acanthastrea hemprichii	2	n/a	n/a	3	2	5	3	n/a	n/a	3	3	6	YES
69	Acanthastrea ishigakiensis	2	n/a	n/a	3	2	5	3	n/a	n/a	3	3	6	YES
70	Acanthastrea regularis	2	n/a	n/a	3	2	5	3	n/a	n/a	3	3	6	YES
71	Barabattoia laddi	2	2	4	3	2	5	3	n/a	n/a	3	3	6	YES
72	Caulastrea echinulata	2	2	4	3	2	5	3	n/a	n/a	3	3	6	YES
73	Cyphastrea agassizi	2	2	4	3	2	5	3	n/a	n/a	3	3	6	NO
74	Cyphastrea ocellina	2	2	4	3	2	5	3	n/a	n/a	3	3	6	NO
75	Euphyllia cristata	2	2.5	4.5	3	2	5	3	n/a	n/a	3	2	5	YES
76	Euphyllia paraancora	2	2.5	4.5	3	2	5	3	n/a	n/a	3	2	5	YES
77	Euphyllia paradivisa	2	2.5	4.5	3	2	5	3	n/a	n/a	3	2	5	YES
78	Physogyra lichtensteini	2	2.5	4.5	3	2	5	3	n/a	n/a	3	3	6	YES
79	Turbinaria mesenterina	2	2.5	4.5	3	2	5	3	3	6	3	3	6	NO
80	Turbinaria peltata	2	2.5	4.5	3	2	5	3	3	6	3	3	6	NO
81	Turbinaria reniformis	2	2.5	4.5	3	2	5	3	3	6	3	3	6	NO
82	Turbinaria stellulata	2	2.5	4.5	3	2	5	3	3	6	3	3	6	NO

Table 3D. Guide to values for the Determination Tool's element ratings.	
Family	Taxonomic Family to which the species belongs
SRR order	Order in which the species occurs in the Status Review Report
CRT score	The score assigned to each species indicating the mean likelihood that the species would fall below the critical risk threshold (CRT) by 2100. The CRT is defined as a condition where a species is of such low abundance, or so spatially disrupted, or at such reduced diversity, that the species is at extremely high risk of extinction with little chance for recovery.
CRT Mode	The mode of the likelihood that the species would fall below the CRT by 2100
Proposed Listing Status Oct 2012	The listing status determined by the determination tool as populated in October 2012
Generalized Rangewide Abundance	
	Scale (based on SRR's Abundance rating, unless otherwise noted in the Justification):
	1 = rare
	2 = uncommon
	3 = common
Trends in abundance	
	Scale:
	1 = decreasing
	2 = stable
	3 = increasing
Relative Recruitment Rate	
	Scale:
	1 = low
	2 = moderate
	3 = high
Geographic Distribution	
	Scale:
	1 = narrow (Caribbean or restricted to a portion of the Coral Triangle, or the eastern Pacific, or the Hawaiian archipelago, or a similarly small portion of the Indian and Pacific Oceans)
	2 = moderate (somewhat restricted latitudinally or longitudinally in the Indo-Pacific, but not as much as the narrow species (e.g., species distributed throughout the Coral Triangle are rated as moderate, not narrow)

	3 = wide (broadly distributed latitudinally and longitudinally
Predominant Depth Distribution	
	Scale:
	1 = shallow (near surface to approximately 15 m)
	2 = moderate (near the surface to approximately 50 m)
	3 = wide (near the surface to approximately 100 m)
Overall distribution	Characterization of the total possible area the species can occupy. Rated by adding the geographic distribution rating to the depth distribution rating.
	Scale:
	2-3 = narrow
	4 = moderate
	5-6 = wide
Restricted to Caribbean Sea	Identification of the species' restriction to relatively small, partially enclosed, highly-disturbed wider-Caribbean as Y or N
Restricted to Eastern Pacific	Identification of the species' restriction to the highly-vulnerable Eastern Pacific as Y or N
Threat Exposure	Exposure of colonies of a species to a particular threat varies greatly across its range, depending on colony location (e.g., latitude, depth, bathymetry, habitat type, etc.), and physical processes that affect seawater temperature and its effects on coral colonies (e.g., winds, currents, upwelling, shading, tides, etc.). Exposure of colonies to a particular threat also varies temporally daily, seasonally, and annually, and is assessed now and within the foreseeable future. Last, species may be exposed to multiple threats simultaneously or sequentially. For most threats exposure will increase over time.
	Scale:
	1 = high
	1.5 = high-to-moderate
	2 = moderate
	2.5 = moderate-to-low
	3 = low
Threat Susceptibility	Susceptibility to a particular threat is a function of the species' initial response to a threat and its capacity to recover. Susceptibility to a particular threat is also affected by the interactive or cumulative effects of other threats by altering the organism or its environment biologically, chemically, or physically.
	Scale:
	1 = high
	1.5 – high-to-moderate
	2 = moderate
	2.5 = moderate-to-low

	3 = low
Threat Vulnerability	Species-specific vulneratbility to each threat is a function of the species-specific exposure and susceptibility. It is assessed by adding the species-specific exposures and susceptibilities.
	Scale:
	2-3 = high
	3.5-4.5 = moderate
	5-6 = low
Inadequacy of Regulatory Mechanisms (D)	Evaluates if ESA Factor D – Inadequacy of regulatory mechanisms is contributing to the listing status because regulations are intended to control threats that contribute to listing status are inadequate.
	Scale:
	Y = Yes – Factor D contributes to listing status
	N = No – Factor D does not contribute to listing status
	n/a = not applicable because species is not endangered

Significant Portion of its Range

The listing determination process described above was based on applying the Determination Tool to each candidate species throughout its range. The ESA requires that a species be listed if it is threatened or endangered throughout all or in a significant portion of its range (SPOIR) (16 U.S.C. Section 1532(6)). However, the ESA does not provide a definition of the phrase “significant portion of its range.” Therefore, we (with the U.S. Fish and Wildlife Service) have proposed a “Draft Policy on Interpretation of the Phrase ‘Significant Portion of Its Range’ in the Endangered Species Act’s Definitions of ‘Endangered Species’ and ‘Threatened Species’” (76 FR 76987; December 9, 2011), which is consistent with our past practice as well as our understanding of the statutory framework and language. While the Draft Policy remains in draft form, the Services are to consider the interpretations and principles contained in the Draft Policy as non-binding guidance in making individual listing determinations, while taking into account the unique circumstances of the species under consideration.

The Draft Policy provides that: (1) if a species is found to be endangered or threatened in only a significant portion of its range, the entire species is listed as endangered or threatened, respectively, and the Act’s protections apply across the species’ entire range; (2) a portion of the range of a species is “significant” if its contribution to the viability of the species is so important that, without that portion, the species would be in danger of extinction; (3) the range of a species is considered to be the general geographical area within which that species can be found at the time FWS or NMFS makes any particular status determination; and (4) if the species is not endangered or threatened throughout all of its range, but it is endangered or threatened within a significant portion of its range, and the population in that significant portion is a valid DPS, we will list the DPS rather than the entire taxonomic species or subspecies. As discussed above, dividing invertebrate species such as corals into DPSs is not authorized by the ESA.

As explained in the Draft Policy, the analysis of a species' listing status begins with an assessment of status throughout its range, and this analysis generally will be determinative unless there is particular information in the record to suggest that a particular portion of the range warrants further consideration (76 FR 76987 at 77002; December 9, 2011). Because a listing decision can be driven by considerations of status in a portion of the species' range only where the portion is both "significant" and more imperiled than the species overall, we only need to conduct detailed analysis of portions where there is substantial information to suggest both of these criteria might be met. Thus, where there are no facts in the record to suggest that the members of the species in a particular geographic area are either of high biological significance or subject to a higher risk of extinction (due to concentration of threats in the particular geographic area), the agencies' risk analysis is properly concluded after assessing rangewide status.

The BRT did not identify any particular populations or portions of ranges for any of the 82 coral species as being significant or at a higher extinction risk, largely due to a lack of information regarding abundance and geographic distributions. No additional information on this topic was provided during the public engagement period. Because there is a general lack of species-specific data regarding quantitative abundance, distribution, diversity, and productivity of coral species, we are not able to identify any populations or portions of any of the "threatened" or "not warranted" candidate species' ranges that can be considered unusually biologically significant. Further, we have no information to indicate that particular local threats are more severe in a particular portion of an individual species' range. We do not have any information that would help elucidate whether any species has significant populations nor whether any species is at higher exposure to threats in a particular area of its range. That is not to say that these conditions do not exist. It is just that we do not have any information on which to base a determination that any of the 82 candidates are at elevated risk within a SPOIR. Further, we were not able to identify any portion of the species' range where threats are so actute or concentrated that, if the species were removed from that portion, would so impair the abundance, spatial distribution, productivity, and diversity of the species in its remaining range that it would be in danger of extinction. Thus, we did not identify any significant portions of any of the candidate species' ranges and our determinations on the entire species are based on the best available information.

Conservation Efforts

Section 4(b)(1)(A) of the ESA requires the Secretary, when making a listing determination for a species, to take into account those efforts, if any, being made by any State or foreign nation to protect the species. In judging the efficacy of protective efforts, we rely on the Services' joint ''Policy for Evaluation of Conservation Efforts When Making Listing Decisions'' (''PECE;'' 68 FR 15100; March 28, 2003). The PECE is designed to guide determinations on whether any conservation efforts that have been recently adopted or implemented, but not yet proven to be successful, will result in recovering the species to the point at which listing is not warranted or contribute to forming a basis for listing a species as threatened rather than endangered. The purpose of the PECE is to ensure consistent and adequate evaluation of future or recently implemented conservation efforts identified in conservation agreements, conservation plans, management plans, and similar documents when making listing decisions. The PECE provides direction for the consideration of such conservation efforts that have not yet been implemented, or have been implemented but have not yet demonstrated effectiveness. The policy is expected to facilitate the development by states and other entities of conservation efforts that sufficiently improve a species' status so as to make listing the species as threatened or endangered unnecessary. The PECE established two basic criteria: (1) The certainty that the conservation efforts will be implemented, and (2) the certainty that the efforts will be effective. Satisfaction of the criteria for implementation and effectiveness establishes a given protective effort as a candidate for consideration, but does not mean that an effort will ultimately change the risk assessment for the species. Overall, the PECE analysis ascertains whether the formalized conservation effort improves the status of the species at the time a listing determination is made.

Existing and planned protective efforts and their effectiveness with regard to the status of the 82 candidate coral species were thoroughly identified and are summarized in the Final Management Report. The report acknowledges innumerable conservation initiatives, projects, agreements, etc., that are either currently in place or planned in the future to address global and local threats to the 82 candidate coral species.

Various partnerships and initiatives exist to address climate change at the global level, as well as regionally throughout the world. While varying approaches are being used via conservation efforts, they share a common objective of reducing GHG emissions in participating countries. Therefore, their overall effectiveness can be inferred from an evaluation of the progress made thus far in reducing GHG emissions, both at the national level and in aggregate globally. Globally, GHG emissions have increased approximately 38 percent from 1990 to 2008. Based on the current state of international laws, regulations, and non-regulatory protective efforts, total world GHG emissions are projected to increase to 97 percent above 1990 levels by 2035. Additionally, there are no foreseen conservation efforts for global threats that will significantly contribute to improved status of the 82 candidate species.

The number of coral reef conservation programs and projects addressing local threats to the 82 candidate species continues to increase and expand. Many international agreements and conventions have been signed and ratified to assist in the recovery of coral reef resources. Additionally, voluntary marine protected areas have been established in numerous areas, outreach and education programs are increasingly growing in developing nations, and active coral reef restoration projects are becoming increasingly popular as a management tool. In many cases, the most effective conservation projects being conducted are non-governmental organization-sponsored coral reef management programs. In addition, most of the conservation efforts do an excellent job of raising awareness about the status of coral reefs around the world. However, although there are many laudable coral conservation efforts being implemented on a local level, these activities are only addressing minor anthropogenic threats that were ranked as either low or negligible in terms of their level of impact and extinction risk to corals (e.g., anchor damage, vessel strikes, and tourism). We therefore conclude that conservation efforts on global or local scales do not change the status determined for the 82 candidate species as a result of application of the Determination Tool.

Listing Determinations

As described above in the Risk Analyses section, each of the 82 listing decisions is based on the threat vulnerabilities, demography, and spatial structure for each species, which are in turn based on the information in the SRR, and SIR, and Final Management Report. The threat vulnerabilities, demography, and spatial structure for each of the 82 candidate species are summarized below, along with the proposed listing status for each species. The relevant ESA section 4 factor is included in parentheses following the associated threat element.

While we did not directly relate an ESA listing status to specific ranges of CRT scores that resulted from the BRT's extinction risk analysis, the CRT scores do provide a qualitative indication of relative extinction risk. There is agreement between the relative ranking of species according to CRT score and our determinations. Minor inconsistencies are a result of information not considered by the BRT for a particular species that either increased or decreased extinction risk. The BRT reviewed the Determination Tool and the inputs to the tool, and concurs that it is populated with the best available information. Note that we determine if the inadequacy of existing regulatory mechanisms is a contributing factor to a species' extinction risk (factor D) because the existing regulatory mechanisms fail to adequately control or mitigate the relevant high importance threats caused by global climate change.

Caribbean Species: Listing Determinations

The seven Caribbean species are listed below by genus (five genera). A summary of the supporting data for the determinations and proposed listing status for each species is provided, with the relevant ESA factors noted (A, B, C, D, or E).

<u>Agaricia</u> (1 species)

Elements that contribute to Agaricia lamarcki's status are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); low relative recruitment rate (E); moderate overall distribution (based on narrow geographic distribution and wide depth distribution; E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, A. lamarcki warrants listing as threatened because of ESA factors C, D, and E.

Mycetophyllia (1 species)

Elements that contribute to Mycetophyllia ferox's status are: high vulnerability to disease (C); moderate vulnerability to ocean warming (E) and acidification (E); high vulnerability to nutrient over-enrichment (A and E); rare general rangewide abundance (E); decreasing trend in abundance (E); low relative recruitment rate (E); moderate overall distribution (based on narrow geographic distribution and wide depth distribution (NMFS, 2012b, SIR Section 6.2.1); E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, M. ferox warrants listing as endangered because of ESA factors A, C, D, and E.

Dendrogyra (1 species)

Elements that contribute to Dendrogyra cylindrus' status are: high vulnerability to disease (C); moderate vulnerability to ocean warming (E) and acidification (E); rare general rangewide abundance (E); low relative recruitment rate (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, D. cylindrus warrants listing as endangered because of ESA factors C, D, and E.

Dichocoenia (1 species)

Elements that contribute to Dichocoenia stokesii's status are: high vulnerability to disease (C); moderate vulnerability to ocean warming (E) and acidification (E); moderate overall distribution (based on narrow geographic distribution and wide depth distribution; E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, D. stokesii warrants listing as threatened because of ESA factors C, D, and E.

Montastraea (3 species)

Elements that contribute to Montastraea faveolata's status are: high vulnerability to ocean warming (E) disease (C), and ocean acidification (E); high vulnerability to sedimentation (A and E) and nutrient over-enrichment (A and E); decreasing trend in abundance (E); low relative recruitment rate (E); moderate overall distribution (based on narrow geographic distribution and wide depth distribution (NMFS, 2012b, SIR Section 6.5); E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, M. faveolata warrants listing as endangered because of ESA factors A, C, D, and E.

Elements that contribute to Montastraea franksi's status are: high vulnerability to ocean warming (E) disease (C), and ocean acidification (E); high vulnerability to sedimentation (A and E) and nutrient over-enrichment (A and E); decreasing trend in abundance (E); low relative recruitment rate (E); moderate overall distribution (based on narrow geographic distribution and wide depth distribution (NMFS, 2012b, SIR Section 6.5); E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, M. franksi warrants listing as endangered because of ESA factors A, C, D, and E.

Elements that contribute to Montastraea annularis's status are: high vulnerability to ocean warming (E) disease (C), and ocean acidification (E); high vulnerability to sedimentation

(A and E) and nutrient over-enrichment (A and E); decreasing trend in abundance (E); low relative recruitment rate (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); restriction to the Caribbean; and inadequacy of regulatory mechanisms (D). Therefore, M. annularis warrants listing as endangered because of ESA factors A, C, D, and E.

Indo-Pacific Species: Listing Determinations

The 75 Indo-Pacific species are listed below by genus (24 genera). A summary of the supporting data for the determinations for each of the 75 species is provided, with the relevant ESA factors noted (A, B, C, D, or E).

Millepora (2 species)

Elements that contribute to Millepora foveolata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. foveolata warrants listing as endangered due to ESA factors C, D, and E.

Elements that contribute to Millepora tuberosa's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. tuberosa warrants listing as threatened due to ESA factors C, D, and E.

Heliopora (1 species)

Elements that contribute to Heliopora coerulea's status are: moderate vulnerability to ocean warming (E) and acidification (E); low vulnerability to disease (C); common generalized range wide abundance (E); and wide overall distribution (based on wide geographic distribution and wide depth distribution, E). Therefore, H. coerulea is not warranted for listing under the ESA.

Pocillopora (3 species)

Elements that contribute to Pocillopora danae's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. danae warrants listing as threatened due to ESA factors C, D and E.

Elements that contribute to P. elegans' (East Pacific) status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); overall moderate distribution (based on narrow geographic distribution and wide depth distribution; E); restricted to the eastern Pacific; E; low relative recruitment rate (E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. elegans (East Pacific) warrants listing as endangered due to ESA factors C, D and E.

Elements that contribute to P. elegans' (Indo-Pacific) status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and wide depth distribution; E); and inadequacy of existing regulatory mechanisms

(D). Therefore, P. elegans (Indo-Pacific) warrants listing as threatened due to ESA factors C, D and E.

Seriatopora (1 species)

Elements that contribute to Seriatopora aculeata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, S. aculeata warrants listing as threatened due to ESA factors C, D and E.

Acropora (22 species)

Elements that contribute to Acropora aculeus' status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. aculeus warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora acuminata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. acuminata warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora aspera's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); narrow overall distribution (based on moderate geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. aspera warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora dendrum's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); rare generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms. Therefore, A. dendrum warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora donei's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. donei warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora globiceps' status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); narrow overall distribution (based on moderate geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. globiceps warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora horrida's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance; E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. horrida warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora jacquelineae's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); rare generalized range wide abundance (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. jacquelineae warrants listing as endangered due to ESA factors C, D, and E.

Elements that contribute to Acropora listeri's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized range wide abundance (E); overall moderate distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. listeri warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora lokani's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); rare generalized range wide abundance (E); overall narrow distribution (based on narrow geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. lokani warrants listing as endangered due to ESA factors C, D, and E.

Elements that contribute to Acropora microlados' status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. microclados warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora palmerae's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. palmerae warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora paniculata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. paniculata warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora pharaonis' status are: high vulnerability to ocean warming (E) and disease (C); moderate vulnerability to acidification (E); common generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. pharaonis warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora polystoma's status are: high vulnerability to ocean warming (E) and disease (C); moderate vulnerability to acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. polystoma warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora retusa's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. retusa warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora rudis' status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. rudis warrants listing as endangered due to ESA factors C, D, and E.

Elements that contribute to Acropora speciosa's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. speciosa warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora striata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. striata warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora tenella's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on moderate geographic distribution and wide depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. tenella warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora vaughani's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. vaughani warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Acropora verweyi's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. verweyi warrants listing as threatened due to ESA factors C, D, and E.

Anacropora (2 species)

Elements that contribute to Anacropora puertogalerae's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. puertogalerae warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to A. spinosa's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. spinosa warrants listing as endangered due to ESA factors C, D, and E.

Astreopora (1 species)

Elements that contribute to Astreopora cucullata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms. Therefore, A. cucullata warrants listing as threatened due to ESA factors C, D, and E.

Isopora (2 species)

Elements that contribute to Isopora crateriformis's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, I. crateriformis warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to I. cuneata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms. Therefore, I. cuneata warrants listing as threatened due to ESA factors C, D, and E.

Montipora (7 species)

Elements that contribute to Montipora angulata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. angulata warrants listing as threatened due to ESA factors C, D, and E.

Factors that contribute to M. australiensis' status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. australiens warrants listing as threatened due to ESA factors C, D, and E.

Factors that contribute to M. calcarea's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms. Therefore, M. calcarea warrants listing as threatened due to ESA factors C, D, and E.

Factors that contribute to M. caliculata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. caliculata warrants listing as threatened due to ESA factors C, D, and E.

Factors that contribute to the status of Montipora dilatata/flabellata/turgescens are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized range wide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. dilatata/flabellata/turgescens warrants listing as threatened due to ESA factors C, D, and E.

Factors that contribute to M. lobulata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); overall wide distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, M. lobulata warrants listing as threatened due to ESA factors C, D, and E.

Factors that contribute to the status of Montipora patula (/verrili) are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common relative rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, Montipora patula (/verrili) warrants listing as threatened due to ESA factors C, D, and E.

Alveopora (3 species)

Elements that contribute to Alveopora allingi's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon relative rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. allingi warrants listing as threatened due to ESA factors D and E.

Elements that contribute to Alveopora fenestrata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon relative rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. fenestrata warrants listing as threatened due to ESA factors C, D and E.

Elements that contribute to Alveopora verrilliana's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification; uncommon relative rangewide abundance (E); wide overall distribution (based on wide geographic distribution and wide depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. verrilliana warrants listing as threatened due to ESA factors C, D and E.

Porites (4 species)

Elements that contribute to Porites horizontilata's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. horizontilata warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Porites napapora's status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); narrow overall distribution (based on moderate geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. napapora warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to Porites nigrescens' status are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. nigrescens warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to the status of Porites (Clade 1 forma pukoensis) are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, Porites (Clade 1 forma pukoensis) is not warranted for listing under the ESA.

Psammocora (1 species)

Elements that contribute to Psammocora stellata's status are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E). Therefore, P. stellata is not warranted for listing under the ESA.

Leptoseris (2 species)

Elements that contribute to the status of Leptoseris incrustans are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and wide depth distribution; E). Therefore, L. incrustans is not warranted for listing under the ESA.

Elements that contribute to the status of L. yabei are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and wide depth distribution; E). Therefore, L. yabei is not warranted for listing under the ESA.

Pachyseris (1 species)

Elements that contribute to the status of Pachyseris rugosa are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. rugosa warrants listing as threatened due to ESA factors C, D, and E.

Pavona (5 species)

Elements that contribute to Pavona bipartita's status are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic range and moderate depth distribution; E). Therefore, P. bipartita is not warranted for listing under the ESA.

Elements that contribute to the status of P. cactus are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic range and moderate depth distribution; E). Therefore, P. cactus is not warranted for listing under the ESA.

Elements that contribute to the status of P. decussata are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic range and moderate depth distribution; E). Therefore, P. decussata is not warranted for listing under the ESA.

Elements that contribute to the status of P. diffluens are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic range and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. diffluens warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to the status of P. venosa are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic range and moderate depth distribution; E). Therefore, P. venosa is not warranted for listing under the ESA.

Galaxea (1 species)

Elements that contribute to the status of Galaxea astreata are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and wide depth distribution (NMFS 2012b, SIR Section 7.16); E). Therefore, G. astreata is not warranted for listing under the ESA.

Pectinia (1 species)

Elements that contribute to the status of Pectinia alcicornis are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic range and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. alcicornis warrants listing as threatened due to ESA factors C, D, and E.

Acanthastrea (4 species)

Elements that contribute to the status of Acanthatsrea brevis are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic range and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. brevis warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to the status of Acanthastrea hemprichii are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on wide geographic range and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. hemprichii warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to the status of A. ishigakiensis are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on wide geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. ishigakiensis warrants listing as threatened due to ESA factors C, D, and E.

Elements that contribute to the status of Acanthastrea regularis are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, A. regularis warrants listing as threatened due to ESA factors C, D, and E.

Barabattoia (1 species)

Elements that contribute to the status of Barabattoia laddi are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on moderate geographic distribution and shallow depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, B. laddi warrants listing as threatened due to ESA factors C, D, and E.

Caulastrea (1 species)

Elements that contribute to Caulastrea echinulata's status are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, C. echinulata warrants listing as threatened due to ESA factors C, D, and E.

Cyphastrea (2 species)

Elements that contribute to Cyphastrea agassizi's status are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, C. agassizi is not warranted for listing under the ESA.

Elements that contribute to C. ocellina's status are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, C. ocellina is not warranted for listing under the ESA.

Euphyllia (3 species)

Elements that contribute to the status of Euphyllia cristata are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); moderate overall distribution (based on moderate geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, E. cristata warrants listing as threatened due to ESA factors C, D and E.

Elements that contribute to the status of E. paraancora are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); wide overall distribution (based on moderate geographic distribution and wide depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, E. paraancora warrants listing as threatened due to ESA factors C, D and E.

Elements that contribute to the status of E. paradivisa are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); uncommon generalized rangewide abundance (E); narrow overall distribution (based on narrow geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, E. paradivisa warrants listing as endangered due to ESA factors C, D and E.

Physogyra (1 species)

Elements that contribute to the status of Physogyra lichtensteini are: high vulnerability to ocean warming (E); moderate vulnerability to disease (C) and acidification (E); common generalized rangewide abundance (E); wide overall distribution (based on wide geographic distribution and moderate depth distribution; E); and inadequacy of existing regulatory mechanisms (D). Therefore, P. lichtensteini warrants listing as threatened due to ESA factors C, D and E.

Turbinaria (4 species)

Elements that contribute to the status of Turbinaria mesenterina are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, T. mesenterina is not warranted for listing under the ESA.

Elements that contribute to the status of T. peltata are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, T. peltata is not warranted for listing under the ESA.

Elements that contribute to the status of T. reniformis are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); common generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, T. reniformis is not warranted for listing under the ESA.

Elements that contribute to the status of T. stellulata are: moderate vulnerability to ocean warming (E), disease (C), and acidification (E); uncommon generalized rangewide abundance (E); and wide overall distribution (based on wide geographic distribution and moderate depth distribution; E). Therefore, T. stellulata is not warranted for listing under the ESA.

Reclassification of Acropora palmata and Acropora cervicornis

After reviewing the status of the 82 candidate species, we also evaluated the current status of the two threatened corals in the Caribbean, Acropora palmata and A. cervicornis. The two species were listed as threatened in May 2006 due to a combination of factors including disease, elevated sea surface temperature, and hurricanes (70 FR 24359; May 9, 2006). The species were listed as threatened because we determined they were likely to become in danger of extinction within the foreseeable future, as defined in that case. We based our determination on the information available at that time, including the high number of colonies of the species, the species' large geographic ranges that remained intact, and the fact that asexual reproduction provided a source for new colonies that can buffer natural demographic and environmental variability. We concluded that both species would retain significant potential for persistence and they were not in danger of extinction throughout their ranges at that time.

This BRT, during its deliberation on developing its method for evaluating the 82 candidate species, evaluated the likelihood of A. palmata and A. cervicornis falling below the CRT by 2050 as 75 percent and 73 percent, respectively. The BRT based this evaluation on its general knowledge of the current status of the two species and the threats affecting them, but it did not specifically collect the best available scientific and commercial data available as it did for the 82 candidate species. The relatively high likelihoods of the two species falling below the

CRT by 2050, along with new understanding of the impacts of some threats on these species, led us to re-evaluate the two species' status. We collected the best available scientific and commercial information on the status of the two species. We also relied on the information in the SRR and SIR on the characteristics shared by all species in the genus Acropora (described above). Specifically, the genus Acropora is highly susceptible to bleaching from ocean warming, ocean acidification, disease, and most local threats. Those susceptibilities coupled with relatively high exposure rates lead to high vulnerabilities to the threats that increase extinction risk for both these species.

Our final determination to list A. palmata and A. cervicornis as threatened, made over 8 years ago, found that the species were not yet in danger of extinction, but were likely to become so within the next 30 years, citing the large number of remaining individuals, their large, intact geographic ranges, and their ability to reproduce through fragmentation. Since then population declines have continued to occur, with certain populations of both species decreasing up to an additional 50 percent or more since the time of listing (Lundgren, 2008; Muller et al. 2008; Williams et al. unpubl. data; Williams et al., 2008; Colella et al., 2012; Rogers and Muller et al., 2012). Further, there are documented instances of recruitment failure in some populations (Williams, et al., 2008). In addition, minimal levels of thermal stress (e.g., 30 degrees C) have been shown to impair larval development, larval survivorship, and settlement success of A. palmata (Randall and Szmant, 2009) and near-future levels of acidification have been demonstrated to impair fertilization, settlement success, and post-settlement growth rates in A. palmata (Albright et al., 2012). We also understand that on average 50 percent of the colonies are clones, meaning the effective number of genetic individuals is half the total population size

(Baums et al., 2006). The species' ranges are not known to have contracted, but with continued declines local extirpations are likely, resulting in a reduction of absolute range size. Furthermore, we are taking into account that the BRT identified restriction to the Caribbean as a spatial factor increasing extinction risk. Also, while asexual reproduction (fragmentation) provides a source for new colonies (albeit clones) that can buffer natural demographic and environmental variability remains true, reliance on asexual reproduction is not sufficient to prevent extinction of the species. Last, the previous status review and listing determination underestimated the global climate change-associated impacts to A. palmata and A. cervicornis, based on our current knowledge of trends in emissions, likely warming scenarios, and ocean acidification. In particular, in the previous determination, we identified ocean acidification only as a factor that "may be contributing" to the status of two species, in comparison to our current understanding that ocean acidification is one of the three highest order threats affecting extinction risk for corals.

Elements that contribute to Acropora palmata's status are: high vulnerability to ocean warming (E); ocean acidification (E) and disease (C); high vulnerability to sedimentation (A and E) and nutrient over-enrichment (A and E); uncommon abundance (E); decreasing trend in abundance (E); low relative recruitment rate (E); narrow overall distribution (E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, A. palmata warrants listing as endangered because of ESA factors A, C, D, and E.

Elements that contribute to Acropora cervicornis' status are: high vulnerability to ocean warming (E); ocean acidification (E) and disease (C); high vulnerability to sedimentation (A and E) and nutrient over-enrichment (A and E); uncommon abundance (E); decreasing trend in abundance (E); low relative recruitment rate (E); narrow overall distribution (E); restriction to the Caribbean (E); and inadequacy of regulatory mechanisms (D). Therefore, A. cervicornis warrants listing as endangered because of ESA factors A, C, D, and E.

Summary of Determinations

We are responsible for determining whether each of the 82 candidate coral species are threatened or endangered under the ESA (16 U.S.C. 1531 et seq.). Section 4(b)(1)(A) of the ESA requires us to make listing determinations based solely on the best scientific and commercial data available after conducting reviews of the statuses of the species and after taking into account efforts being made by any state or foreign nation to protect the species. We concluded that conservation efforts are not protecting the candidate coral species in a way that alters our determination that these corals are endangered or threatened. Finally, section 4(b)(1)(B) of the ESA requires us to give consideration to species which (1) have been designated as requiring protection from unrestricted commerce by any foreign nation, or (2) have been identified as in danger of extinction, or likely to become so within the foreseeable future, by any state agency or by any agency of a foreign nation. All stony corals are listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which regulates international trade of species to ensure survival. Thus, the proposed listing is consistent with the Convention's classification. Dendrogyra cylindrus is listed as threatened by the State of Florida and all stony corals are protected under the U.S. Virgin Islands Indigenous and Endangered Species Act of 1990. All the proposed corals are listed in the IUCN Red List of Threatened Species as vulnerable, endangered, or critically endangered. Thus, the proposed listing is consistent with these classifications.

We have determined that the following 12 species warrant listing as endangered: In the Caribbean (five): Dendrogyra cylindrus, Montastraea annularis, Montastraea faveolata, Montastraea franksi, and Mycetophyllia ferox; and in the Indo-Pacific (seven): Millepora foveolata, Pocillopora elegans (eastern Pacific), Acropora jacquelineae, Acropora lokani, Acropora rudis, Anacropora spinosa, and Euphyllia paradivisa. The following 54 species warrant listing as threatened: In the Caribbean (two), Agaricia lamarcki and Dichocoenia stokesii; and in the Indo-Pacific (52): Millepora tuberosa, Pocillopora danae, Pocillopora elegans (Indo-Pacific), Seriatopora aculeata, Acropora aculeus, Acropora acuminata, Acropora aspera, Acropora dendrum, Acropora donei, Acropora globiceps, Acropora horrida, Acropora listeri, Acropora microclados, Acropora palmerae, Acropora paniculata, Acropora pharaonis, Acropora polystoma, Acropora retusa, Acropora speciosa, Acropora striata, Acropora tenella, Acropora vaughani, Acropora verweyi, Anacropora puertogalerae, Astreopora cucullata, Isopora crateriformis, Isopora cuneata, Montipora angulata, Montipora australiensis, Montipora calcarea, Montipora caliculata, Montipora dilatata/flabellata/turgescens, Montipora lobulata, Montipora patula/verrilli, Alveopora allingi, Alveopora fenestrata, Alveopora verrilliana, Porites horizontalata, Porites napopora, Porites nigrescens, Acanthastrea brevis, Acanthastrea hemprichii, Acanthastrea ishigakiensis, Acanthastrea regularis, Pachyseris rugosa, Pectinia alcicornis, Barabattoia laddi, Pavona diffluens, Caulastrea echinulata, Euphyllia cristata, Euphyllia paraancora, and Physogyra lichtensteini. Two species in the Caribbean currently listed as threatened warrant reclassification as endangered: Acropora palmata and Acropora cervicornis. A total of 16 candidate species (all in the Indo-Pacific) do not warrant listing as endangered or threatened: Heliopora coerulea, Cyphastrea agassizi, Cyphastrea ocellina, Galaxea astreata, Leptoseris incrustans, Leptoseris yabei, Pavona bipartita, Pavona cactus, Pavona decussata, Pavona venosa, Porites (Clade 1 forma pukoensis), Psammocora stellata, Turbinaria mesenterina, Turbinaria peltata, Turbinaria reniformis, and Turbinaria stellulata.

Effects of Listing

Conservation measures provided for species listed as endangered or threatened under the ESA include recovery plans (16 U.S.C. 1553(f)), critical habitat designations, Federal agency consultation requirements (16 U.S.C. 1536), and prohibitions on taking (16 U.S.C. 1538). Recognition of the species' plight through listing promotes conservation actions by Federal and state agencies, private groups, and individuals, as well as the international community. Should the proposed listing be made final, a recovery program could be implemented, and critical habitat will be designated to the maximum extent prudent and determinable. We anticipate that protective regulations for threatened corals and recovery programs for all the proposed corals may need to be developed in the context of conserving aquatic ecosystem health. The cooperation and participation of many Federal, state and private sector actors will be needed to effectively and efficiently conserve the listed coral species and the ecosystems upon which they depend.

Should the proposed reclassification of Acropora palmata and A. cervicornis become final, the existing critical habitat designation (50 CFR 226.216) would remain valid, as the bases for the critical habitat designated for these species are not changed by revising their status from threatened to endangered. The specific areas within the species' occupied geographical area that contain the substrate feature that is essential to the conservation of the species and which may require special management considerations or protection have not changed since designation.

The existing protective regulations promulgated pursuant to ESA section 4(d) (50 CFR 223.208) for Acropora palmata and A. cervicornis would no longer be valid because such rules apply only to threatened species. The take prohibition of ESA Section 9 instead applies directly to endangered species. Therefore, should the proposed reclassification become final, we would revoke the existing regulations.

Identifying Section 7 Conference and Consultation Requirements

Section 7(a)(4) of the ESA and NMFS/FWS regulations require Federal agencies to confer with us on actions likely to jeopardize the continued existence of species proposed for listing, or likely to result in the destruction or adverse modification of proposed critical habitat. If a proposed species is ultimately listed, Federal agencies must consult under section 7 on any action they authorize, fund, or carry out if those actions may affect the listed species or designated critical habitat. Based on currently available information, we can conclude that examples of Federal actions that may affect the 68 coral species proposed to be listed or reclassified include, but are not limited to: energy projects, discharge of pollution from point sources, non-point source pollution, dredging, pile-driving, setting of water quality standards, vessel traffic, aquaculture facilities, military activities, and fisheries management practices.

Critical Habitat

Critical habitat is defined in section 3 of the ESA 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 1533 of this title, 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 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species" (16 U.S.C. 1532(5)(A)). "Conservation" means the use of all methods and procedures needed to bring the species to the point at which listing under the ESA is no longer necessary (16 U.S.C. 1532(3)). Section 4(a)(3)(A) of the ESA requires that, to the maximum extent prudent and determinable, critical habitat be designated concurrently with the final listing of a species (16 U.S.C. 1533(a)(3)(A)(i)). To the maximum extent prudent and determinable, we will publish a proposed designation of critical habitat for the coral species in a separate rule. Designations of critical habitat must be based on the best scientific data available and must take into consideration the economic, national security, and other relevant impacts of specifying any particular area as critical habitat. Once critical habitat is designated, section 7 of the ESA requires Federal agencies to ensure that they do not fund, authorize, or carry out any actions that are likely to destroy or adversely modify that habitat. This requirement is in addition to the section 7 requirement that Federal agencies ensure that their actions do not jeopardize the continued existence of listed species.

Section 9 Take Prohibitions

Because we are proposing to list seven Caribbean species, one in the Eastern Pacific, and six in the Indo-Pacific as endangered, all of the take prohibitions of section 9(a)(1) of the ESA will apply to those particular species if they become listed as endangered. These include prohibitions against importing, exporting, engaging in foreign or interstate commerce, or "taking" of the species. "Take" is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." These prohibitions apply to all persons subject to the jurisdiction of the United States, including in the United States, its territorial sea, or on the high seas.

The ESA section 9 prohibitions do not automatically apply to threatened species listed by NMFS. Therefore, pursuant to ESA section 4(d), we will evaluate whether there are protective regulations we deem necessary and advisable to the conservation of any of the candidate species listed as threatened in the final listing rule, including application of some or all of the take prohibitions.

Identification of Those Activities That Would Constitute a Violation of Section 9 of the ESA

On July 1, 1994, NMFS and FWS published a policy (59 FR 34272) that requires us to identify, to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the ESA. The intent of this policy is to increase public awareness of the effect of a listing on proposed and ongoing activities within a species' range. Based on available information, we believe the following categories of activities are those most likely to result in a violation of the ESA section 9 prohibitions. We emphasize that whether a violation results from a particular activity is entirely dependent upon the facts and circumstances of each incident. The mere fact that an activity may fall within one of these categories does not mean that the specific activity will cause a violation; due to such factors as location and scope, specific actions may not result in direct or indirect adverse effects on the species. Further, an activity not listed may in fact result in a violation. However, based on currently available information, we conclude that the following types of activities are those that may be most likely to violate the prohibitions in section 9:

1. Activities that result in elevated water temperatures in coral habitat that causes bleaching or other degradation of physiological function of listed corals.

2. Activities that result in water acidification in coral habitat that causes reduced calcification, reproductive impairment, or other degradation of physiological function of listed corals.

3. Removing, damaging, poisoning, or contaminating listed corals.

4. Removing, poisoning, or contaminating plants, wildlife, or other biota required by listed corals for feeding, sheltering, or completing other essential life history functions.

5. Harm to the species' habitat resulting in injury or death of the species, such as removing or altering substrate, vegetation, or other physical structures.

6. Altering water flow or currents to an extent that impairs spawning, feeding, or other essential behavioral patterns of listed corals.

7. Discharging pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water, including sewage water, into listed corals' habitat to an extent that harms or kills listed corals.

8. Releasing non-indigenous or artificially propagated species into listed corals' habitat or locations resulting in mortality or harm to listed corals.

9. Interstate and foreign commerce dealing in listed corals, and importing or exporting listed corals.

10. Shoreline and riparian disturbances (whether in the riverine, estuarine, marine, or floodplain environment) that may harm or kill listed corals, for instance by disrupting or preventing the reproduction, settlement, reattachment, development, or normal physiology of

listed corals. Such disturbances could include land development, run-off, dredging, and disposal activities that result in direct deposition of sediment on corals, shading, or covering of substrate for fragment reattachment or larval settlement.

11. Activities that modify water chemistry in coral habitat to an extent that disrupts or prevents the reproduction, development, or normal physiology of listed corals.

This list provides examples of the types of activities that could have the potential to cause a violation, but it is not exhaustive. It is intended to help people avoid violating the ESA should these proposed listings become final after public comment. Further, the scientific research community is encouraged to submit applications for research to be conducted within the United States on the seven Caribbean species and the seven Indo-Pacific species being proposed as endangered so that the research can continue uninterrupted should they become listed as endangered.

Policies on Role of Peer Review

In December 2004, the Office of Management and Budget (OMB) issued a Final Information Quality Bulletin for Peer Review establishing minimum peer review standards, a transparent process for public disclosure of peer review planning, and opportunities for public participation. The OMB Bulletin, implemented under the Information Quality Act (Public Law 106-554) is intended to enhance the quality and credibility of the Federal government's scientific information, and applies to influential or highly influential scientific information disseminated on or after June 16, 2005. To satisfy our requirements under the OMB Bulletin, the BRT obtained independent peer review of the draft Status Review Report, and NMFS obtained independent peer review of the draft Management Report. Independent specialists were selected from the academic and scientific community, Federal and state agencies, and the private sector for this review. All peer reviewer comments were addressed prior to dissemination of the final Status Review Report and publication of this proposed rule.

On July 1, 1994, the Services published a policy for peer review of scientific data (59 FR 34270). The intent of the peer review policy is to ensure that listings are based on the best scientific and commercial data available. Prior to a final listing, we will solicit the expert opinions of three qualified specialists, concurrent with the public comment period. Independent specialists will be selected from the academic and scientific community, Federal and State agencies, and the private sector.

Public Comments Solicited

To ensure that any final action resulting from this proposal will be as accurate and effective as possible, we are soliciting comments from the public, other concerned governmental agencies, the scientific community, industry, and any other interested parties. We must base our final determination on the best available scientific and commercial information when making listing determinations. We cannot, for example, consider the economic effects of a listing determination. Final promulgation of any regulation(s) on these species or withdrawal of this listing proposal will take into consideration the comments and any additional information we receive, and such communications may lead to a final regulation that differs from this proposal or result in a withdrawal of this listing proposal.

Solicitation of Information

In addition to comments on the proposed rule, we are soliciting information on features and areas that may support designations of critical habitat for the coral species newly proposed to be listed. As to Acropora palmata and A. cervicornis, for which critical habitat has already been designated, we have broad discretion to revise existing designations from time to time as appropriate, and we may decide to exercise this discretion based on information received and available on potential critical habitat features for the other coral species. Information provided should identify the physical and biological features essential to the conservation of the species and areas that contain these features for the coral species proposed to be listed. Areas outside the occupied geographical area should also be identified if such areas themselves are essential to the conservation of the species. Essential features may include, but are not limited to, features specific to individual species' ranges, habitats and life history characteristics within the following general categories of habitat features: (1) space for individual growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for reproduction and development of offspring; and (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of the species (50 CFR 424.12(b)). ESA implementing regulations at 50 CFR 424.12(h) specify that critical habitat shall not be designated within foreign countries or in other areas outside of U.S. jurisdiction. Therefore, we request information only on potential areas of critical habitat within waters in U.S. jurisdiction.

For features and areas potentially qualifying as critical habitat, we also request information describing: (1) activities or other threats to the essential features or activities that could be affected by designating them as critical habitat, and (2) the positive and negative economic, national security and other relevant impacts, including benefits to the recovery of the species, likely to result if these areas are designated as critical habitat.

Public Hearing Dates and Locations

Public hearings will be held at 20 locations in Puerto Rico, the U.S. Virgin Islands, Florida, Hawaii, Guam, the Northern Mariana Islands, and American Samoa, during the public comment period. The public hearings in Hawaii, Guam, the Northern Mariana Islands, and American Samoa will be held from 6:30 p.m. to 9:30 p.m. to gather formal public comments on this proposed rule, preceded by town hall meetings from 5:00 p.m. to 6:30 p.m. to provide information about the proposed rule. The specific dates and locations of these meetings are listed below:

1) Monday, January 14, 2013, at the Nova Southeastern University Center of Excellence for Coral Reef Ecosystem Science, 8000 North Ocean Drive, Dania Beach, FL 33004, 7-9 p.m.
2) Tuesday, January 15, 2013, at the John Pennekamp State Park Visitors Center, 102601 Overseas Highway, Key Largo, Florida 33037, 7-9 p.m.
3) Wednesday, January 16, 2013, at the Florida Keys Eco-Discovery Center, 35 East Quay Road, Key West, FL 33040, 7-9 p.m.
4) Monday, February 4, 2013, at the Department of Natural and Environmental Resources, 4th Floor Conference Room, Road 8838, km. 6.3, Sector El Cinco, Río Piedras, Puerto Rico, 6-8 p.m.
5) Tuesday, February 5, 2013, at the University of Puerto Rico - Mayagüez Campus, Salas Eugene Francis, Physics Building, Room # 229, Mayagüez, Puerto Rico, 6-8 p.m.
6) Wednesday, February 6, 2013, at the Buck Island Reef National Monument, 2100 Church Street, #100, Christiansted, St. Croix, U.S. Virgin Islands , 7-9 p.m.

7) Thursday, February 7, 2013, at the Windward Passage Hotel, Veterans Drive, Charlotte Amalie, St. Thomas, U.S. Virgin Islands, 7-9 p.m.

8) Tuesday, January 22, 2013, at the Mokupapapa Discovery Center, 308 Kamehameha Ave., Hilo, HI, 96720, 5-9:30 p.m.

9) Thursday, January 24, 2013, at the Kahakai Elementary School, 76147 Royal Poinciana Drive, Kailua Kona, HI 96740, 5-9:30 p.m.

10) Monday, January 28, 2013, at the Mitchell Pauole Center, 90 Ainoa Street Kaunakakai, Molokai, HI 96748, 5-9:30 p.m.

11) Wednesday, January 30, 2013, at the J. Walter Cameron Center, 95 Mahalani St., Wailuku, HI 96796, 5-9:30 p.m.

12) Monday, February 4, 2013, at the Kauai Veteran's Center, 3125 Kapule Highway, Lihue, HI 96766, 5-9:30 p.m.

13) February 7, 2013, at the Tokai University, 2241 Kapiolani Blvd., Honolulu, HI 96826, 5-9:30 p.m.

14) Monday, February 11, 2013, at the Guam Hilton, 202 Hilton Road, Tumon Bay, Hagatna, 96913, Guam, 5-9:30 p.m.

15) Tuesday, February 12, 2013, at the Multipurpose Center, Beach Road, Susupe Saipan, 96950, MP, 5-9:30 p.m.

16) Tuesday, February 13, 2013, at Sadie’s by the Sea, Main Rd., Pago Pago, Tutuila 96799, American Samoa, 5-9:30 p.m.

17) Wednesday, February 13, 2013, at the Fleming Hotel, P.O. Box 68, Tinian, 96952, MP, 5-9:30 p.m.

18) Friday, February 15, 2013, at the Mayor's Office, Tatachog Rd., Rota, 96961, MP, 5-9:30 p.m.

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The NMFS reports referenced above are available at:

http://www.nmfs.noaa.gov/stories/2012/11/82corals.html

Classification

National Environmental Policy Act

The 1982 amendments to the ESA, in section 4(b)(1)(A), restrict the information that may be considered when assessing species for listing. Based on this limitation of criteria for a listing decision and NOAA Administrative Order 216-6 (Environmental Review Procedures for Implementing the National Environmental Policy Act), we have concluded that ESA listing actions are not subject to requirements of the National Environmental Policy Act.

Executive Order 12866, Regulatory Flexibility Act, and Paperwork Reduction Act

As noted in the Conference Report on the 1982 amendments to the ESA, economic impacts cannot be considered when assessing the status of a species. Therefore, the economic analysis requirements of the Regulatory Flexibility Act are not applicable to the listing process. In addition, this proposed rule is exempt from review under Executive Order 12866. This proposed rule does not contain a collection-of-information requirement for the purposes of the Paperwork Reduction Act.

Executive Order 13132, Federalism

In accordance with E.O. 13132, we have made a preliminary determination that this proposed rule does not have significant Federalism effects and that a Federalism assessment is not required. In keeping with the intent of the Administration and Congress to provide continuing and meaningful dialogue on issues of mutual state and Federal interest, this proposed rule will be given to the relevant state agencies in each state in which the species is believed to occur, and those states will be invited to comment on this proposal. As we proceed, we intend to continue engaging in informal and formal contacts with the state, and other affected local or regional entities, giving careful consideration to all written and oral comments received.

Executive Order 12898, Environmental Justice

Executive Order 12898 requires that Federal actions address environmental justice in the decision-making process. In particular, the environmental effects of the actions should not have a disproportionate effect on minority and low-income communities. This proposed rule is not expected to have a disproportionately high effect on minority populations or low-income populations.

Coastal Zone Management Act (16 U.S.C. 1451 et seq.)

Section 307(c)(1) of the Federal Coastal Zone Management Act (CZMA) of 1972 requires that all Federal activities that affect any land or water use or natural resource of the coastal zone be consistent with approved state coastal zone management programs to the maximum extent practicable. We have preliminarily determined that this action is consistent to the maximum extent practicable with the enforceable policies of approved CZMA programs of each of the states within the range of the 49 proposed coral species. Letters documenting NMFS' proposed determination, along with the proposed rule, will be sent to the coastal zone management program offices in each affected state. A list of the specific state contacts and a copy of the letters are available upon request.

List of Subjects in 50 CFR Part 224

Administrative practice and procedure; Endangered and threatened species; Exports; Imports; Reporting and recordkeeping requirements; Transportation.

List of Subjects in 50 CFR Part 223

Endangered and threatened species; Exports; Imports; Transportation.

Dated: NOV 2 9 2012

Alan D. Risenhoover,
Director, Office of Sustainable Fisheries,
performing the functions and duties of the
Deputy Assistant Administrator for Regulatory Programs

For the reasons set out in the preamble, 50 CFR part 223 is proposed to be amended as follows:

PART 223—THREATENED MARINE AND ANADROMOUS SPECIES

1. The authority citation for part 223 continues to read as follows:

Authority: 16 U.S.C. 1531-1543; subpart B, § 223.201-202 also issued under 16 U.S.C. 1361 et seq.; 16 U.S.C. 5503(d) for § 223.206(d)(9).

2. In § 223.102, in the table, amend paragraph (d) by removing existing paragraphs (d)(1) and (d)(2) and adding paragraphs (d)(1) through (a)(59) to read as follows:

§ 223.102 Enumeration of threatened marine and anadromous species.

* * * * *

Species[1]		Where listed	Citation(s) for listing determination(s)	Citation(s) for critical habitat designation(s)
Common name	Scientific name			
* * * * * * *				
(d) * * *				
(1)	Acropora aculeus	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(2)	Acropora acuminata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(3)	Acropora aspera	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(4)	Acropora dendrum	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(5)	Acropora donei	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(6)	Acropora globiceps	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A	NA

			FINAL RULE]	
(7)	Acropora horrida	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(8)	Acropora listeri	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(9)	Acropora microclados	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(10)	Acropora palmerae	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(11)	Acropora paniculata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(12)	Acropora pharaonis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(13)	Acropora polystoma	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(14)	Acropora	Wherever found.	[INSERT FR	NA

	retusa	Indo-Pacific.	CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	
(15)	Acropora speciosa	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(16)	Acropora striata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(17)	Acropora tenella	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(18)	Acropora vaughani	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(19)	Acropora verweyi	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(20)	Acanthastrea brevis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(21)	Acanthastrea hemprichii	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A	NA

			FINAL RULE]	
(22)	Acanthastrea ishigakiensis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(23)	Acanthastrea regularis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(24) Lamarck's sheet coral	Agaricia lamarcki	Wherever found. Caribbean, Western Atlantic, Gulf of Mexico.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(25)	Alveopora allingi	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(26)	Alveopora fenestrata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(27)	Alveopora verrilliana	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(28)	Anacropora puertogalerae	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA

(29)	Astreopora cucullata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(30)	Barabattoia laddi	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(31)	Caulastrea echinulata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(32) Elliptical Star Coral	Dichocoenia stokesii	Wherever found. Caribbean, Western Atlantic, Gulf of Mexico.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(33)	Euphyllia cristata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(34)	Euphyllia paraancora	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(35)	Isopora crateriformis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(36)	Isopora cuneata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN	NA

			PUBLISHED AS A FINAL RULE]	
(37)	Millepora tuberosa	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(38)	Montipora angulata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(39)	Montipora australiensis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(40)	Montipora calcarea	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(41)	Montipora caliculata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(42)	Montipora dilatata/flabellata/turgescens	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(43)	Montipora lobulata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA

(44)	Montipora patula(/verrilli)	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(45)	Pachyseris rugosa	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(46)	Pavona diffluens	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(47)	Pectinia alcicornis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(48)	Physogyra lichtensteini	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(49)	Pocillopora danae	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(50)	Pocillopora elegans (Indo-Pacific)	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(51)	Porites horizontalata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN	NA

			PUBLISHED AS A FINAL RULE]	
(52)	Porites napopora	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(53)	Porites nigrescens	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(54)	Seriatopora aculeata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
* * * * * * *				

[1]Species includes taxonomic species, subspecies, distinct population segments of vertebrates (DPSs) (for a policy statement; see 61 FR 4722, February 7, 1996), and evolutionarily significant units (ESUs) (for a policy statement; see 56 FR 58612, November 20, 1991).

* * * * *

For the reasons set out in the preamble, 50 CFR part 224 is proposed to be amended as follows:

PART 224—ENDANGERED MARINE AND ANADROMOUS SPECIES

1. The authority citation of part 224 continues to read as follows:

Authority: 16 U.S.C. 1531–1543 and 16 U.S.C. 1361 et seq.

2. In § 224.101, paragraph (d) is revised to read as follows:

§ 224.101 Enumeration of endangered marine and anadromous species.

* * * * *

(d) Marine invertebrates. The following table lists the common and scientific names of endangered species, the locations where they are listed, and the citations for the listings and critical habitat designations.

* * *

Species[1]		Where Listed	Citation (s) for Listing Determinations	Citations (s) for Critical Habitat Designations
Common name	Scientific name			
(1) Black abalone	Haliotis cracherodii	USA, CA. From Crescent City, California, USA to Cape San Lucas, Baja California, Mexico, including all offshore islands.	NOAA 2009; 74 FR 1937, January 14, 2009.	NOAA 2011; 76 FR 66806, October 27, 2011.
(2) White abalone	Haliotis sorenseni	USA, CA. From Point Conception, California to Punta Abreojos, Baja California, Mexico including all offshore islands and banks.	NOAA 2001; 66 FR 29054, May, 29, 2001.	Deemed not prudent NOAA 2001; 66 FR 29054, May, 29, 2001.
(3) Staghorn coral	Acropora cervicornis	Wherever found. Caribbean, Western Atlantic.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA

(4)	Acropora jacquelineae	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(5)	Acropora lokani	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(6) Elkhorn coral	Acropora palmata	Wherever found. Caribbean, Western Atlantic.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(7)	Acropora rudis	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(8)	Anacropora spinosa	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(9) Pillar coral	Dendrogyra cylindrus	Wherever found. Caribbean, Western Atlantic.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA

(10)	<u>Euphyllia paradivisa</u>	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(11)	<u>Millepora foveolata</u>	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(12) Boulder star coral	<u>Montastraea annularis</u>	Wherever found. Caribbean, Western Atlantic, Gulf of Mexico.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(13) Boulder star coral	<u>Montastraea faveolata</u>	Wherever found. Caribbean, Western Atlantic, Gulf of Mexico.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(14) Mountainous star coral	<u>Montastraea franksi</u>	Wherever found. Caribbean, Western Atlantic, Gulf of Mexico.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(15) Rough cactus coral	<u>Mycetophyllia ferox</u>	Wherever found. Caribbean, Western Atlantic, Gulf of Mexico.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA

(16)	Millepora foveolata	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
(17)	Pocillopora elegans (East Pacific)	Wherever found. Indo-Pacific.	[INSERT FR CITATION & DATE WHEN PUBLISHED AS A FINAL RULE]	NA
* * * * *				

[1]Species includes taxonomic species, subspecies, distinct population segments of vertebrates (DPSs) (for a policy statement; see 61 FR 4722, February 7, 1996), and evolutionarily significant units (ESUs) (for a policy statement; see 56 FR 58612, November 20, 1991).

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