



NOAA FISHERIES

Protected Resources

RECOVERY OUTLINE

Pillar Coral, Rough Cactus Coral, Lobed Star Coral, Mountainous Star Coral, Boulder Star Coral

This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, for pillar coral, rough cactus coral, lobed star coral, mountainous star coral, and boulder star coral listed as threatened under the Endangered Species Act (79 FR 53852; September 10, 2014) until a full recovery plan is developed and approved. A preliminary strategy for recovery of the species is presented here, as are recommended high priority actions to stabilize and recover the species. While recovery of listed corals is a requirement of the ESA, NOAA has a long-standing commitment to conservation of corals and coral reef ecosystems. All efforts to recover listed corals will be done in coordination with the NOAA Coral Reef Conservation Program (CRCP).

This Recovery Outline commences our recovery planning process. The Recovery Outline is intended primarily for internal use by the National Marine Fisheries Service as a preplanning document. Formal public participation in recovery planning for these species will be invited upon the release of the draft Recovery Plan for these species. However, any new information or comments that members of the public may wish to offer as a result of this Recovery Outline will be taken into consideration during the recovery planning process. Interested parties may contact Alison Moulding 727-824-5312, Alison.Moulding@noaa.gov.

INTRODUCTION

This document presents the broad, preliminary outline for the recovery of five Caribbean coral species: pillar coral, rough cactus coral, lobed star coral, mountainous star coral, and boulder star coral. A recovery team will be assembled for these species to inform the Recovery Plan, which will provide a complete roadmap for activities necessary to recover the species so they no longer need the protections of the ESA. Meanwhile, this outline will serve to guide recovery-planning efforts and provide information for ESA Section 7 consultations, permitting activities, and conservation efforts until the formal Recovery Plan has been finalized and approved.

Listing and contact information for all species:

Common Name	Scientific Name	Listing Status
Pillar Coral	<i>Dendrogyra cylindrus</i>	Threatened
Rough Cactus Coral	<i>Mycetophyllia ferox</i>	Threatened
Lobed Star Coral	<i>Orbicella annularis</i>	Threatened
Mountainous Star Coral	<i>Orbicella faveolata</i>	Threatened
Boulder Star Coral	<i>Orbicella franksi</i>	Threatened

Listing Date: September 10, 2014 (79 FR 53852)
Lead Agency: National Marine Fisheries Service (NOAA Fisheries Service)
Lead Office: Southeast Regional Office, St. Petersburg, Florida

Available information on the life history, range, and habitat requirements of the five coral species is described in the listing rule (79 FR 53852). The most significant uncertainties with respect to setting recovery objectives and prioritizing recovery actions include the availability of specific information on the current and historical distribution and abundance; reproduction, settlement, and recruitment processes and success; variability in bleaching response and potential acclimation to warming temperatures; the sub-lethal effects of pollution; and the causal factors of disease in each species. These uncertainties are acknowledged as playing a limiting role in the early recovery efforts for these species and should be resolved to the extent possible through coordination with the coral research community and the recovery planning process.

RECOVERY NEEDS ASSESSMENT

BIOLOGICAL ASSESSMENT

Recovery implications of the species' demographic and genetic status

Pillar coral, *Dendrogyra cylindrus*, occurs throughout the Caribbean and off the southeast coast of Florida. It is uncommon and appears as scattered, isolated colonies, though it is rarely found in aggregations. The low abundance and infrequent encounter rate make it difficult to determine population trends. *Dendrogyra cylindrus* is a gonochoric (separate sexes) broadcast spawning species with relatively low annual egg production relative to its large size. Sexual recruitment of this species is low, but *D. cylindrus* can propagate by fragmentation following storms or other physical disturbance. The combination of gonochoric spawning with persistently low population density is expected to hinder successful sexual reproduction, therefore limiting genetic mixing and recovery from threat-induced mortality events.

Rough cactus coral, *Mycetophyllia ferox*, occurs in southeast Florida and throughout the greater Caribbean. It is one of the least common coral species observed in monitoring studies. Low encounter rate and percent cover coupled with the tendency to survey *Mycetophyllia* spp. at the genus level make it difficult to discern population trends from monitoring data. Available data indicate *M. ferox* has experienced significant declines in Florida. *Mycetophyllia ferox* is a hermaphroditic brooding species with colony size greater than 100 cm² at first reproduction. Recruitment of *M. ferox* appears to be very low, even in studies from the 1970s. *Mycetophyllia ferox*'s low recruitment and size at reproductive maturity limits the capacity for recovery from threat-induced mortality events.

The star corals in the *Orbicella* species complex historically dominated coral reefs throughout the Caribbean both by abundance and cover. They formed dense assemblages of large, hundreds-of-years old colonies interspersed with few small colonies (Bruckner, 2012). Over the last twenty years, major declines between 50 to 95 percent have been reported in many locations; a few locations report stable or increasing coverage. Since the 1980's decline of *Acropora* spp., total coral cover decline in the Caribbean has been associated with the decline of the star corals.

Star corals (*Orbicella* spp.) have slow growth rates, late reproductive maturity, and low recruitment rates. Colonies can grow very large and live for centuries. Partial mortality of large colonies is common on modern reefs and can result in the production of genetically identical ramets with accompanying shifts to smaller size class distributions. These large colonies of star corals have been able to maintain populations over time, but recent population declines and partial colony mortality is resulting in smaller colonies with less reproductive output and even lower replenishment potential. The historical presence of few small colonies coupled with observation of few recruits in the presence of large gamete production from the large colonies suggests recruitment events are rare, and were less important for the survival of the *Orbicella* species complex in the past than today (Bruckner, 2012).

THREATS ASSESSMENT

What are the recovery implications of the threats facing the species?

The threats to these five coral species are generally the same threats affecting coral reefs throughout the world (climate change impacts, fishing impacts, and land-based sources of pollution impacts) and have been fully described through the listing process. Specifically, disease and ocean warming are the two biggest threats that will impact the potential for recovery of all five coral species. These threats are severe, ongoing, synergistic, and have displayed an increasing trend in the recent past. Disease is widespread, episodic, and often unpredictable in its occurrence and results in high amounts of mortality that have not been replenished by natural recruitment and growth. Sea-surface temperature is expected to continue to rise over time and may exacerbate disease impacts. In order to ensure the species do not decline further, actions are needed to determine the causal and mechanistic aspects of disease and to reduce temperature stress. Ocean acidification is another global threat that will hinder recovery of these five coral species if atmospheric carbon dioxide concentration continues to rise unchecked.

Global threats to the five coral species are exacerbated further by local threats such as nutrients, sedimentation, and the trophic effects of fishing, which degrade coral condition and habitat and increase synergistic stress effects (e.g., bleaching, disease). Actions also need to be taken to reduce local threats posed by human activity (e.g., construction, dredging, run-off, water pollution). Curtailment of these local threats may increase the ability of these corals to withstand the more severe global threats.

Additional threats that were not described through the listing process that have a negative impact on the species and may hinder their recovery include toxicants and physical damage from storms and anthropogenic sources. The extent to which each of these threats impacts the species' status and recovery will be scrutinized during the development of the Recovery Plan.

CONSERVATION ASSESSMENT

What steps have been taken to address the species' recovery needs?

All five coral species occur both inside and outside of U.S. jurisdiction and foreign countries have varying levels of protective legislation for corals and coral reefs. Some laws, regulations, and policies governing U.S. waters provide various protections for coral reefs in general but are not specifically directed toward the conservation of these five coral species. The NOAA CRCP has been working to reduce the impacts of threats for conservation of coral reefs since 2000. Research has been conducted primarily for the *Orbicella* species concerning restoration, reproduction, genetics, and diseases.

Current conservation measures specifically for the listed corals consist of restoration efforts following physical damage from ship groundings and relocations for minimization of impacts from permitted coastal construction activities. For restoration efforts, dislodged and broken colonies are either re-attached to the substrate at the damage site or transplanted to suitable substrate (natural and artificial) elsewhere. For permitted construction activities, colonies usually above a certain size are to be relocated to areas outside the area of impact. Additionally, based on success with acroporid corals, efforts have begun to propagate *D. cylindrus*, *O. faveolata*, and *O. annularis* through fragmentation in coral nurseries to evaluate the potential of active propagation to supplement natural populations.

Additional measures intended to protect the coral reef ecosystem, such as mooring buoys and navigational markers, will also afford protection to these five species. All five coral species are found within the boundaries of several different marine protected areas (MPAs) in Florida, Puerto Rico, and the U.S. Virgin Islands.

The State of Florida has an action plan for conservation of *D. cylindrus*. The plan has several objectives including stabilizing or increasing the existing population, the current area of occupancy, and the number of sexually mature individuals and evaluating the reproductive potential of the population over the next decade (Florida Fish and Wildlife Conservation Commission, 2013). However, the management plan recognizes that there are threats to *D. cylindrus* that need to be addressed outside the scope of the plan in order to improve the status of this species.

Numerous governmental and non-governmental agencies, institutions, and organizations are involved in conservation awareness for coral reef resources. These entities provide an active conservation constituency and are integral to the recovery of these five species.

SUMMARY ASSESSMENT

Overall, available data indicate *Orbicella* coral populations are on the decline; population trends of *M. ferox* and *D. cylindrus* are unknown, but abundance is very low. Recovery will depend on successful sexual reproduction and reducing mortality of extant populations. The key challenges will be moderating the impacts of ocean warming associated with climate change and decreasing susceptibility to disease which may be furthered through reduction of local stressors. The recovery of these five species will require an ecosystem approach including habitat protection measures, a reduction in threats caused by human activity, additional research, and time.

PRELIMINARY RECOVERY STRATEGY

RECOVERY PRIORITY NUMBER WITH RATIONALE

The recovery priority number for each of the five coral species is 7 based on moderate threat due to continuing habitat degradation, moderate recovery potential due to complexity of threat and the high cost of required management actions, and the potential for economic conflict due to the threat of climate change and increasing coastal development. The recovery potential is also based on low rates of sexual recruitment of all five species that will slow the capacity for recovery.

RECOVERY VISION STATEMENT

Populations of *O. annularis*, *O. faveolata*, *O. franksi*, *D. cylindrus*, and *M. ferox* should be present across the historical range, with populations large enough and genetically diverse enough to support successful reproduction and recovery from mortality events and dense enough to maintain ecosystem function. Recovery of these species will require conservation of the coral reef ecosystem through threats abatement to ensure a high probability of survival into the future.

INITIAL ACTION PLAN

Given that many of the important threats to the recovery of *O. annularis*, *O. faveolata*, *O. franksi*, *M. ferox*, and *D. cylindrus* are not directly manageable, the recovery strategy must pursue actions both in the short and long term to address both global and local threats. The initial focus will be to protect extant populations and the species' habitat through reduction of threats. Further, we must gather information through research and monitoring on current distribution and abundance; variability in bleaching response and potential acclimation to warming temperatures; the sub-lethal effects of pollution; the causal factors of disease; and reproduction, settlement, and recruitment success. Public awareness through various outreach efforts may play a role in generating voluntary protection actions. Additionally, we will continue to support and facilitate existing coral ecosystem conservation programs. All of these actions must be undertaken both domestically and internationally, throughout the species' range of the wider-Caribbean.

Specific actions that will be undertaken early in the process may include the following:

- Improve understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, improve understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility

- Reduce locally-manageable stress and mortality sources (e.g., acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *D. cylindrus*, *M. ferox*, and *Orbicella* spp.

Recovery actions needed in the longer term include:

- Develop and implement U.S. and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

PREPLANNING DECISIONS

PLANNING APPROACH

A Recovery Plan will be prepared for *O. annularis*, *O. faveolata*, *O. franksi*, *M. ferox*, and *D. cylindrus* pursuant to section 4(f) of the ESA. The scope of the plan will be five species, though we may address these through a recovery plan that restores coral-reef habitat as a functioning ecosystem.

A recovery team consisting of key stakeholders and coral experts will be assembled to develop the Recovery Plan. Recovery planning efforts will be coordinated with the Pacific Islands Regional Office, NOAA Fisheries, NOAA Sanctuaries, and the NOAA CRCP. In the interim, a recovery implementation team for elkhorn and staghorn corals will guide planning of recovery actions that will benefit coral reef ecosystems including *D. cylindrus*, *M. ferox*, and *Orbicella* spp.

INFORMATION MANAGEMENT

All information relevant to recovery management of *O. annularis*, *O. faveolata*, *O. franksi*, *M. ferox*, and *D. cylindrus* will be housed in NOAA Fisheries Southeast Regional Office administrative files.

STAKEHOLDER INVOLVEMENT

Key stakeholders:

Federal, state, territorial, local, and international agencies
 Domestic and foreign universities and research organizations
 Domestic and foreign conservation organizations

Stakeholder involvement strategy:

Representatives of key stakeholder groups will be invited to participate in the recovery planning process. As needed, meetings and/or conference calls will be held to discuss particular issues, and stakeholders will be invited to participate as warranted. All stakeholders will be afforded an opportunity to review and comment on a draft of the Recovery Plan in conformance with the ESA. Stakeholders may also be asked to contribute directly in the development of implementation strategies for planned actions.

LITERATURE CITED

Bruckner, A. 2012. Factors contributing to the regional decline of *Montastraea annularis* (complex). Yellowlees, D. and Hughes, T. P. (Ed). Proceedings of the 12th International Coral Reef Symposium. James Cook University, Cairns, Australia.

Florida Fish and Wildlife Conservation Commission. 2013. A Species Action Plan for the Pillar Coral *Dendrogyra cylindrus*, Final Draft. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.