**ATTACHMENT 1-15: Biological Information on Listed Species of Coral and Model Parameterization for Pesticide Effects Determinations**

1. **Introduction**

The purpose of this document is to summarize available information for currently listed corals. The focus of this effort is to capture information that may be used in ecological risk assessments of pesticides to make species-specific effects determinations. This report focuses on defining parameters which may be used to estimate pesticide exposures to listed corals. This report also focuses on defining species characteristics that may be used to assess potential indirect effects to the species (*e.g.,* diet and habitat).

Because of the similarity in the diets and habitat across the currently listed corals, a species profile for each specific species was not developed. Instead, the information needed to assess potential risks from direct and indirect effects to corals, along with the source(s) of the information[[1]](#footnote-1), are provided for each species in this report.

At this time, there are a total of 14 endangered and threatened (listed) species of coral that are listed under the Endangered Species Act (ESA) and occur within the United States, its territories and its waters (all of them are currently listed as threatened) (**Table A 1-15.1**). These species will be considered in the national level risk assessments for chlorpyrifos, diazinon, and malathion. This assessment does not consider foreign species listed under the ESA, as they occur outside of the action area for pesticide registrations in the US. There are no proposed or candidate coral species at this time.

**Table A 1-15.1. Number of Listed Corals by Status.**

|  |  |
| --- | --- |
| **Status** | **Number of listings** |
| Endangered | 0 |
| Threatened | 14 |
| Total | 14 |

1. **Species considered in National Level Effects Determinations**

Coral are marine invertebrates in the phylum Cnidaria. The 14 listed coral species include 7 genera, all of which fall within the Scleractinia order of reef-building, true stony corals. **Table A 1-15.2** lists the species that will be considered in these biological evaluations. Two of the species have designated critical habitats.

**Table A 1-15.2. Listed Corals.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **Listing Status\*** | **Critical Habitat?** | **FWS/NMFS Species ID (ENTITY\_ID)** |
| *Acropora cervicornis* | Staghorn coral | T | Yes | 9382 |
| *Acropora globiceps* | No common name | T | No | 10332 |
| *Acropora jacquelinae* | No common name | T | No | 10319 |
| *Acropora palmata* | Elkhorn coral | T | Yes | 9384 |
| *Acropora retusa* | No common name | T | No | 10340 |
| *Acropora speciosa* | No common name | T | No | 10341 |
| *Dendrogyra cylindricus* | Pillar Coral | T | No | 10310 |
| *Euphyllia paradivisa* | No common name | T | No | 10323 |
| *Isopora crateriformis* | No common name | T | No | 10903 |
| *Mycetophyllia ferox* | Rough Cactus Coral | T | No | 10314 |
| *Orbicella annularis* | Lobed Star Coral | T | No | 10311 |
| *Orbicella faveolata* | Mountainous Star Coral | T | No | 10312 |
| *Orbicella franksi* | Boulder star coral | T | No | 10908 |
| *Seriatopora aculeata* | No common name | T | No | 10326 |

\* T = threatened

1. **Diets**

The listed coral are made up of a tissue layer of polyps that grow on top of a calcium carbonate skeleton (produced via calcification by the polyps). The tissue layer of polyps forms a column with an opening on one end (*i.e*., the mouth) that contains tentacles for the capture of prey (primarily zooplankton); the polyps and carbonate skeleton combine to make complex colonies. All of the listed coral species discussed here have a symbiotic relationship with zooxanthellae (a type of photosynthetic, dinoflagellate algae). The zooxanthellae are found in the tissues of the coral and provide the coral with nutrients. The zooxanthellae are autotrophic (*i.e*., they rely on photosynthesis), and during the day they provide the corals with nutrients. At night, the corals extend their tentacles and feed on zooplankton they catch floating by. Two of the listed coral species are also known to sometimes eat small fish (see **Table A 1-15.3**). For the other listed coral species, specific information on whether or not they eat small fish is not available. However, because two of the listed coral are known to eat small fish, and general information is available suggesting that many coral species may occasionally catch and ingest small fish, we assume that all of the listed coral species may eat fish (see **Table A 1-15.3**).

**Table A 1-15.3. Diets of listed coral species.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **Aquatic Invertebrate (zooplankton)** | **Fish** | **Source** |
| *Acropora cervicornis* | Staghorn coral | Yes | Yes | NOAA (2015)1 (http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/staghorn-coral.html) |
| *Acropora globiceps* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Acropora jacquelinae* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Acropora palmata* | Elkhorn coral | Yes | Yes | NOAA (2015)3 (http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/elkhorn-coral.html) |
| *Acropora retusa* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Acropora speciosa* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Dendrogyra cylindricus* | Pillar Coral | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Euphyllia paradivisa* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Isopora crateriformis* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Mycetophyllia ferox* | Rough Cactus Coral | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Orbicella annularis* | Lobed Star Coral | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Orbicella faveolata* | Mountainous Star Coral | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Orbicella franksi* | Boulder star coral | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |
| *Seriatopora aculeata* | No common name | Yes | Yes\* | NOAA (2015)2(http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html) |

\* This is based on general reef-building coral information and is not specific to this species. Specific information regarding whether or not the specific coral species eats fish could not be located.

1. **Exposure models**

Since all of the listed corals rely upon the oceans for their prey and habitat, the estimated environmental concentrations (EECs) from the Pesticide Root Zone Model (PRZM5) and the Variable Volume Water Model (VVWM) will be used to estimate exposures to assess the potential for direct and indirect effects for all life stages of the listed coral and their associated zooxanthellae. The effects thresholds for aquatic non-vascular plants (to represent effects to zooxanthellae) and aquatic invertebrates (to represent the corals) will be used to assess the potential for direct effects to the listed corals. The effects thresholds for aquatic invertebrates (to represent zooplankton) and fish will be used to assess the potential for indirect effects to corals from loss of prey.

1. **Habitat**

Because the zooxanthellae that the listed coral rely on for nutrients are autotrophic during the day, the listed corals rely on habitats with enough light to allow for photosynthesis. Therefore, depth and water quality parameters (*e.g*., sedimentation) are important habitat parameters for the listed coral. All of the corals are assigned to aquatic bin 9 (subtidal habitats). **Table A 1-15.4** lists the HUCs relevant to each of the listed coral species. **Table A 1-15.5** lists the depths where each species has been found.

**Table A 1-15.4. HUCs Associated with the Listed Corals**

|  |  |  |
| --- | --- | --- |
| **Scientific Name** | **Common Name** | **HUC(s)** |
| *Acropora cervicornis* | Staghorn coral | 03, 21 |
| *Acropora globiceps* | No common name | 201 |
| *Acropora jacquelinae* | No common name | 201 |
| *Acropora palmata* | Elkhorn coral | 03, 21 |
| *Acropora retusa* | No common name | 201 |
| *Acropora speciosa* | No common name | 201 |
| *Dendrogyra cylindricus* | Pillar Coral | 03, 21 |
| *Euphyllia paradivisa* | No common name | 201 |
| *Isopora crateriformis* | No common name | 201 |
| *Mycetophyllia ferox* | Rough Cactus Coral | 03, 21 |
| *Orbicella annularis* | Lobed Star Coral | 03, 21 |
| *Orbicella faveolata* | Mountainous Star Coral | 03, 21 |
| *Orbicella franksi* | Boulder star coral | 03, 21 |
| *Seriatopora aculeata* | No common name | 201 |

1 HUC 20 (Hawaii) is being used as a surrogate for the Indio-Pacific corals.

**Table A 1-15.5. Depths Where Listed Corals Have Been Found.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **Depth (m)** | **Source** |
| *Acropora cervicornis* | Staghorn coral | 0 - 30 | NOAA (2015)1 (http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/staghorn-coral.html) |
| *Acropora globiceps* | No common name | 0 - 8 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Acropora jacquelinae* | No common name | 10 - 35 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Acropora palmata* | Elkhorn coral | 1 – 20 m | NOAA (2015)3 (http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/elkhorn-coral.html) |
| *Acropora retusa* | No common name | 1 - 5 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Acropora speciosa* | No common name | 12 - 40 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Dendrogyra cylindricus* | Pillar Coral | 2 - 25 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/009\_corals\_status\_review\_western\_atlantic.pdf) |
| *Euphyllia paradivisa* | No common name | 5 - 20 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/014\_corals\_status\_review\_indo\_pac5.pdf) |
| *Isopora crateriformis* | No common name | <50 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/011\_corals\_status\_review\_indo\_pac2.pdf) |
| *Mycetophyllia ferox* | Rough Cactus Coral | 5 - 30 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/009\_corals\_status\_review\_western\_atlantic.pdf) |
| *Orbicella annularis* | Lobed Star Coral | ≤90 | 79 FR 53851 (https://federalregister.gov/a/2014-20814) |
| *Orbicella faveolata* | Mountainous Star Coral | ≤90 | 79 FR 53851 (https://federalregister.gov/a/2014-20814) |
| *Orbicella franksi* | Boulder star coral | ≤90 | 79 FR 53851 (https://federalregister.gov/a/2014-20814) |
| *Seriatopora aculeata* | No common name | 3 - 40 | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |

1. **Obligate Relationships**

Coral polyps cannot survive for a long period of time without zooxanthellae (a lack of zooxanthellae causes bleaching in corals). Therefore, for the purposes of these biological evaluations, the relationship between all 14 of the listed corals and zooxanthellae is considered an obligate relationship.

1. **Geographic Ranges of Listed Species**

Listed corals occur in several different water bodies that include waters of the US. The currently listed species are found in the Caribbean or Indo-Pacific regions. The waterbodies and relevant states and/or territories where listed corals occur are provided in **Tables A 1-15.6 - A 1-15.7** and **A 1-15.8 - A 1-15.9**,respectively.

 **Table A 1-15.6. Waters of the US where the listed coral species are found.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **Water Bodies** | **Source** |
| *Acropora cervicornis* | Staghorn coral | Caribbean Sea  | NOAA (2015)1 (http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/staghorn-coral.html) |
| Atlantic Ocean |
| *Acropora globiceps* | No common name | Pacific Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Acropora jacquelinae* | No common name | Pacific Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Acropora palmata* | Elkhorn coral | Caribbean Sea | NOAA (2015)3 (http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/elkhorn-coral.html) |
| *Acropora retusa* | No common name | Indian Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| Pacific Ocean |
| *Acropora speciosa* | No common name | Pacific Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| *Dendrogyra cylindricus* | Pillar Coral | Caribbean Sea | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/009\_corals\_status\_review\_western\_atlantic.pdf) |
| Atlantic Ocean |
| *Euphyllia paradivisa* | No common name | Pacific Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/014\_corals\_status\_review\_indo\_pac5.pdf) |
| *Isopora crateriformis* | No common name | Indian Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/011\_corals\_status\_review\_indo\_pac2.pdf) |
| Pacific Ocean |
| *Mycetophyllia ferox* | Rough Cactus Coral | Caribbean Sea | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/009\_corals\_status\_review\_western\_atlantic.pdf) |
| *Orbicella annularis* | Lobed Star Coral | Caribbean Sea | 79 FR 67356(http://www.gpo.gov/fdsys/pkg/FR-2014-11-13/pdf/2014-26893.pdf) |
| Atlantic Ocean |
| Gulf of Mexico |
| *Orbicella faveolata* | Mountainous Star Coral | Caribbean Sea | 79 FR 67356(http://www.gpo.gov/fdsys/pkg/FR-2014-11-13/pdf/2014-26893.pdf) |
| Atlantic Ocean |
| Gulf of Mexico |
| *Orbicella franksi* | Boulder star coral | Caribbean Sea | 79 FR 67356(http://www.gpo.gov/fdsys/pkg/FR-2014-11-13/pdf/2014-26893.pdf) |
| Atlantic Ocean |
| Gulf of Mexico |
| *Seriatopora aculeata* | No common name | Indian Ocean | NOAA (2011)(http://www.nmfs.noaa.gov/stories/2012/05/docs/010\_corals\_status\_review\_indo\_pac1.pdf) |
| Pacific Ocean |

**Table A 1-15.7. Number of listed coral species with ranges that overlap with Waters of the US.**

|  |  |
| --- | --- |
| **US Water Body** | **Number of species** |
| Caribbean Sea | 7 |
| Atlantic Ocean | 5 |
| Gulf of Mexico | 3 |
| Indian Ocean | 3 |
| Pacific Ocean | 7 |

**Table A 1-15.8. Listed coral species with ranges that overlap with waters of specific states or territories.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **State/Territory** | **Source** |
| *Acropora cervicornis* | Staghorn coral | Florida | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico |
| US Virgin Islands |
| *Acropora globiceps* | No common name | Guam | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Northern Mariana Islands  |
| Pacific Remote Island Areas  |
| America Samoa |
| *Acropora jacquelinae* | No common name | America Samoa | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| *Acropora palmata* | Elkhorn coral | Florida | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico |
| US Virgin Islands |
| *Acropora retusa* | No common name | Guam | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Pacific Remote Island Areas |
| America Samoa |
| *Acropora speciosa* | No common name | Pacific Remote Island Areas  | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| America Samoa |
| *Dendrogyra cylindricus* | Pillar Coral | Florida  | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico |
| US Virgin Islands |
| *Euphyllia paradivisa* | No common name | America Samoa | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| *Isopora crateriformis* | No common name | America Samoa | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| *Mycetophyllia ferox* | Rough Cactus Coral | Florida | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico  |
| US Virgin Islands |
| *Orbicella annularis* | Lobed Star Coral | Florida  | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico  |
| US Virgin Islands |
| *Orbicella faveolata* | Mountainous Star Coral | Florida  | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico |
| US Virgin Islands |
| *Orbicella franksi* | Boulder star coral | Florida  | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |
| Puerto Rico  |
| US Virgin Islands |
| *Seriatopora aculeata* | No common name | Guam | NOAA (2014)(http://www.fisheries.noaa.gov/stories/2014/08/docs/corals\_fact\_sheet.pdf) |

**Table A 1-15.9. Number of listed coral species with ranges that overlap with waters of specific states or territories.**

|  |  |
| --- | --- |
| **State/Territory** | **Number of species** |
| United States Virgin Islands | 7 |
| Puerto Rico | 7 |
| Florida | 7 |
| Guam | 4 |
| Northern Mariana Islands | 2 |
| Pacific Remote Island Areas | 3 |
| American Samoa | 6 |

1. **Strategy for grouping species**

There are two major factors that impact the risk of a pesticide to a species: exposure and effects. Because all of the listed corals are found in similar habitats (*i.e*., the same aquatic bins) and have similar diets, the strategy for assessing the species will be the same across all currently listed corals. Species specific timing of life history parameters (*e.g*., spawning, polyp stage, *etc*.) will be considered when making the effects determinations for each listed coral.

1. **References**

Federal Register (2014) (79 FR 53851). *Endangered and Threatened Wildlife and Plants: Final Listing Determinations on Proposal to List 66 Reef-Building Species and the Reclassify Elkhorn and Staghorn Corals*. National Oceanic and Atmospheric Administration. Final Rule, 50 CFR 223, Document Number – 2014-20814. October 10, 2014. Pp. 53851 – 54123 (273 pages). <https://federalregister.gov/a/2014-20814> (accessed Oct. 16, 2015).

Federal Register (2014) (79 FR 67356). Endangered and Threatened Wildlife and Plants: Adding 20 Coral Species to the List of Endangered and Threatened Wildlife. Fish and Wildlife Service. Final Rule, 50 CFR Part 17. November 13, 2014. Pp. 67356 – 67359. <http://www.gpo.gov/fdsys/pkg/FR-2014-11-13/pdf/2014-26893.pdf> (accessed Oct. 16, 2015).

NOAA (2011). *Status Review Report of 82 Candidate Coral Species Petitioned Under the U.S. Endangered Species Act*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Pacific Islands Fisheries Science Center. NOAA Technical Memorandum NMFS-PIFSC-27. September 2011. Pp. 581. <http://www.nmfs.noaa.gov/stories/2012/05/docs/full_doc_corals_status_review_report.pdf> (accessed on Oct. 16, 2015).

NOAA (2014). *NOAA Lists 20 New Corals as Threatened Under the Endangered Species Act*. Factsheet. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. August 2014. <http://www.fisheries.noaa.gov/stories/2014/08/docs/corals_fact_sheet.pdf> (accessed Oct. 16, 2015).

NOAA (2015)1. *Species Profile: Staghorn Coral* (*Acropora cervicornis*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service. March 5, 2015. <http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/staghorn-coral.html> (accessed on Oct. 16, 2015).

NOAA (2015)2. *Coral Feeding Habits*. National Oceanic and Atmospheric Administration, Coral Reef Conservation Program. October 16, 2015. <http://coralreef.noaa.gov/aboutcorals/coral101/feedinghabits/welcome.html> (accessed on Oct. 16, 2015).

NOAA (2015)3. *Species Profile: Elkhorn Coral* (*Acropora palmata*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service. March 5, 2015. <http://www.fisheries.noaa.gov/pr/species/invertebrates/coral/elkhorn-coral.html> (accessed on Oct. 16, 2015).

1. For species information, we relied on sources of information from the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service (FWS). [↑](#footnote-ref-1)