

7. Individual Species Accounts—Indo-Pacific Species

7.1 Genus *Millepora* (Class Hydrozoa; Order Milleporina; Family Milleporidae)

7.1.1 *Millepora foveolata* Crossland, 1952

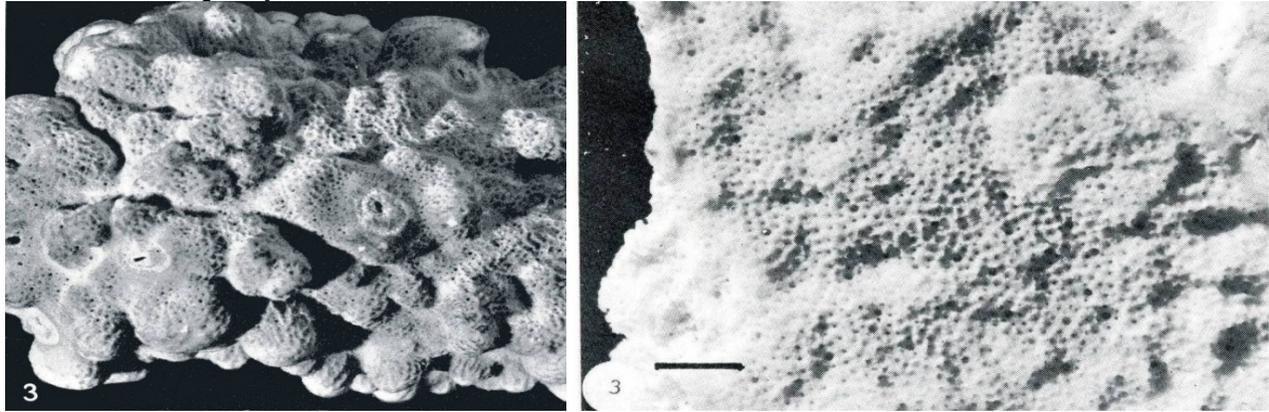


Figure 7.1.1. *Millepora foveolata* images from (top; type specimen) Crossland (1952) and (bottom) Randall and Cheng (1984).

Characteristics

Colonies of *Millepora foveolata* form thin encrusting laminae that adhere closely to the underlying substrata. The coenosteum between the pores on colony surfaces exposed to insolation (light) swell upward into low ridges (foveolations) around individual pores or groups of pores (Randall and Cheng, 1984). Living colonies are yellowish, ranging from pale pinkish-yellow to yellowish-beige in shaded or cryptic areas, grading towards a brighter yellow as the area becomes more exposed to light (Randall and Cheng, 1984).

Taxonomy

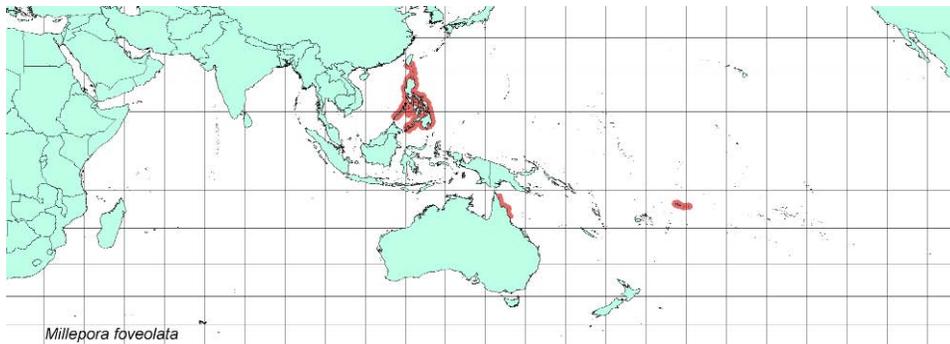
Taxonomic issues: None. The foveolations of *Millepora foveolata* clearly distinguish this encrusting yellow species. *Millepora foveolata* is sometimes confused with the similarly encrusting *Millepora exaesa*, which lacks ridges and has more prominent nodules.

Family: Milleporidae.

Evolutionary and geologic history: The genus *Millepora* has been found in the fossil record for the Cretaceous (about 70 Ma; Rehfeld and Ernst, 1998), so the genus is known to have survived the warm seawater and high concentrations of atmospheric CO₂ in the Cretaceous (Quan et al., 2009; Zeebe, 2001) and the Paleocene-Eocene Thermal Maximum (55.8 Ma; Zachos et al., 2003). Rapid ocean acidification occurred during the Paleocene-Eocene Thermal Maximum (Zachos et al., 2005). Although some species of *Millepora* survived the extraordinarily warm seawater during the Cretaceous and the Paleocene-Eocene Thermal Maximum, it is not evidence that species of *Millepora* could survive those conditions again. However, it does provoke interest in investigating the biology of *Millepora* for how it may have persisted. In the harsh physical environments of shallow reef flat pools in American Samoa, *Millepora* spp. are the first to bleach and die but seem to have a special aptitude for recovering by successful recruitment of new colonies (C. Birkeland, USGS, Honolulu, HI, pers. observ., 5 March 2002).

Global Distribution

Millepora foveolata has been reported on the southern coast of Taiwan, the Philippines, the Northern Marianas but not the Southern Marianas which includes Guam, Rota, Tinian, Saipan, etc. (Randall, 1995), Palau, and the Great Barrier Reef in Australia. The type specimen is from the Great Barrier Reef (Crossland, 1952). It is not known from Indonesia (Razak and Hoeksema, 2003).



Millepora foveolata

Figure 7.1.2. *Millepora foveolata* distribution from IUCN copied from <http://www.iucnredlist.org>.

U.S. Distribution

Millepora foveolata is found in the Northern Mariana Islands (Randall, 1995). According to the IUCN Species Account, *Millepora foveolata* occurs in American Samoa, but no reference in support of its occurrence is provided. However, moderately extensive surveys since 1979 have not found it in American Samoa. *Millepora foveolata* has not been recorded in federally protected waters (Kenyon et al., 2010b).

Habitat

Habitat: Specimens of *Millepora foveolata* have been collected from the forefront reef slope on the upper surface of buttress ridges (Randall and Cheng, 1984).

Depth range: *Millepora foveolata* has been reported in water depths ranging from at least 1 m to 8 m.

Abundance

Abundance of *Millepora foveolata* has been reported mostly as occasional (Randall and Cheng, 1984).

Life History

Hydrozoan corals of the genus *Millepora* are the only reef-building corals with medusae as part of their life history. *Millepora* spp. are gonochoric and reproduction is seasonal (Lewis, 2006). Medusae are in separate sexes and sexual reproduction takes place in the medusa stage. The milleporid medusae of some species live for only a few hours. The gametes of some milleporids can become mature in 20 to 30 days, more rapidly than for many scleractinians.

Branching and columnar forms of *Millepora* are subject to fragmentation and may use this mechanism to reproduce asexually; unlike scleractinian corals, the survival of *Millepora* fragments may not be size-dependent (Lewis, 1991).

Threats

Thermal Stress: Although there is not much species-specific information about the response of *Millepora foveolata* to thermal stress, the genus *Millepora* has been called a bleaching “loser” (Loya et al., 2001). *Millepora* species are ranked as the most susceptible to bleaching in response to high seawater temperatures of any of the 40 genera or other categories of hermatypic corals in the Great Barrier Reef (Marshall and Baird, 2000). The genus has been reported to be highly susceptible to bleaching in the western Indian Ocean (McClanahan et al., 2007) and appears to have experienced local extirpations in the tropical eastern Pacific (Glynn and de Weerd, 1991). Low bleaching occurred in *Millepora* in Moorea during the 1991 event (Gleason, 1993), but elevated temperatures can also kill *Millepora* even in the absence of bleaching (McClanahan, 2004). At elevated temperatures, congener *Millepora dichotoma* showed decreased zooxanthellae density, changes in chlorophyll concentrations, and decreased calcification (Abramovitch-Gottlieb et al., 2003).

Millepora spp. are among the first to bleach and die, but they also seem to have a special aptitude for recovering by recruiting new colonies. *Millepora* survived the extraordinarily warm seawater during the Cretaceous and the Paleocene-Eocene Thermal Maximum (see Evolutionary and Geologic History, above).

Acidification: No specific research has addressed the effects of acidification on the genus *Millepora*. However, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: The ecological and population effects of disease on the genus *Millepora* are unknown. *Millepora* have been observed with a > 20% prevalence of skeleton-eroding-band disease in the Red Sea (Winkler et al., 2004). There are reports of black-band disease on *Millepora* on the Great Barrier Reef (Willis et al., 2004) and white plague in Florida (Richardson et al., 1998). Few other reports exist for the Pacific, and Caribbean congeners have been observed with a small number of diseases (Sutherland et al., 2004).

Predation: *Millepora* species are known to be preyed on by the crown-of-thorns seastar *Acanthaster planci*, although they are less preferred prey than acroporids and perhaps most scleractinians (Colgan, 1987). *Millepora* spp. are also preyed on by the polychaete *Hermodice carunculata* (Witman, 1988), the nudibranch mollusk *Phyllidia*, and filefish of the genera *Alutera* and *Cantherhines* (Lewis, 1989).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are poorly known for *Millepora foveolata*. Although *Millepora* species tend to favor relatively clear water with low rates of sedimentation, they were reported to be among the last 17 out of 42 genera to drop out along a gradient of increasing rate of sedimentation (Randall and Birkeland, 1978). *Millepora* also showed increased relative abundance and colony size on sediment-impacted reefs in Kenya (McClanahan and Obura, 1997). Though little is known about effects of nutrients on Pacific *Millepora*, Caribbean congeners were found to decrease in percent cover on eutrophic reefs in Barbados (Tomascik and Sander, 1987a).

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: The genus *Millepora* has been involved in international trade from Indonesia, Solomon Islands, and Fiji with reported exports between 200 and 3000 pieces per year in the years 2000–2008 (CITES, 2010). Reported exports from Vietnam, Malaysia, and Tonga were < 1000 pieces per year in the same time period.

Risk Assessment

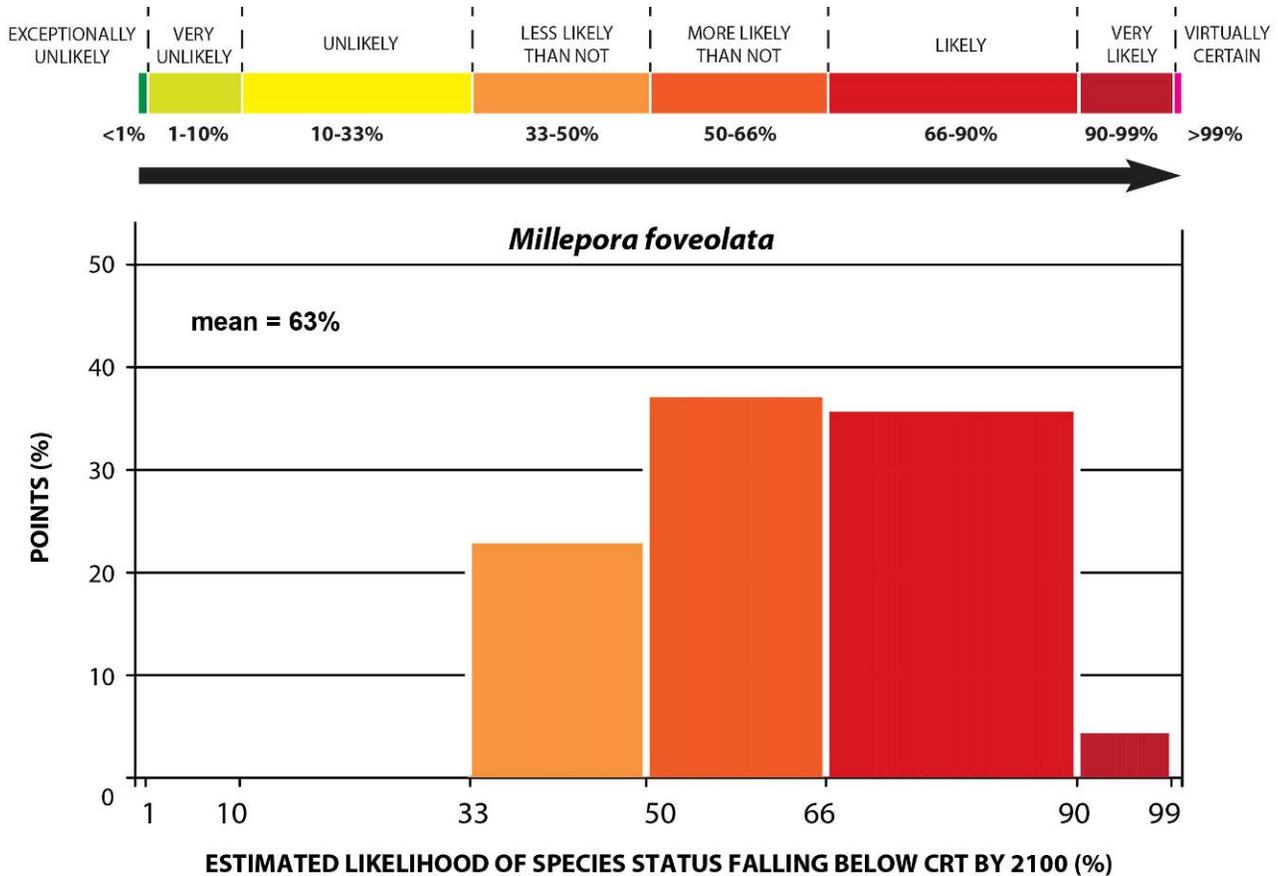


Figure 7.1.3. Distribution of points to estimate the likelihood that the status of *Millepora foveolata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Millepora foveolata* include a relatively narrow geographic range and a generic susceptibility to bleaching in response to unusually warm seawater. The high bleaching rate is the primary threat of extinction for *Millepora foveolata*. *Millepora* species are especially susceptible to seawater warming and among the first to bleach, with by far the greatest rate of mortality. Factors that potentially reduce the extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are that *Millepora foveolata* is inconspicuous and therefore could potentially be more common than previously observed, and this species probably shares the generic trait of having an exceptional aptitude for larval recruitment and population replenishment.

The overall likelihood that *Millepora foveolata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 63% and a standard error (SE) of 9.8% (Fig. 7.1.3). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.1.3) and the average range of likelihood estimates of the seven BRT voters (50.3%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Millepora foveolata*.

7.1.2 *Millepora tuberosa* Boschma, 1966

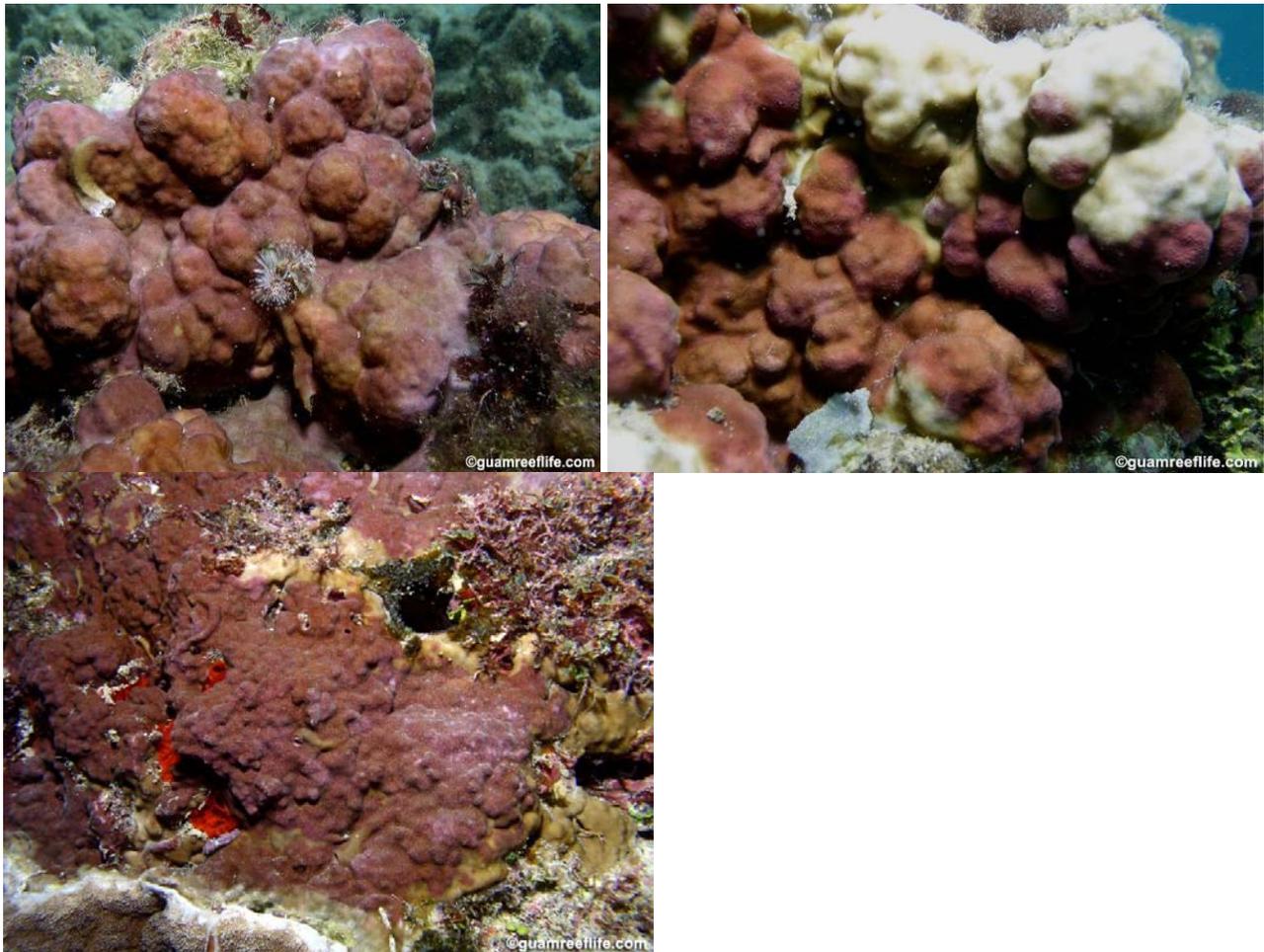


Figure 7.1.4. *Millepora tuberosa* photos from David Burdick copied from GuamReefLife.com.

Characteristics

Colonies of *Millepora tuberosa* form thin (about 1 mm at encrusting peripheral margins) to moderately thick (3 cm or more in the central regions of larger colonies) encrusting laminae that closely adhere to the underlying substrata (Randall and Cheng, 1984). They are always encrusting and so do not make vertical plates or branches, although they can be nodular or lumpy, especially when they encrust rubble. *Millepora tuberosa* is often found as small colonies (5–30 cm diameter) but can be found having diameters greater than a meter (Randall and Cheng, 1984). Living colonies are distinctive purplish-red or wine-colored and so a person surveying corals could inadvertently misidentify *Millepora tuberosa* colonies as crustose coralline algae.

Taxonomy

Taxonomic issues: *Millepora tuberosa* is sometimes synonymized with *Millepora exaesa* (Razak and Hoeksema, 2003). However, R. Randall (Univ. Guam, Mangilao, pers. comm., June 2010) and D. Fenner (Dept. Marine and Wildlife Resources, Tutuila, pers. comm., June 2010) have suggested that museum specimens might be causing confusion because the living specimens look very different. The living wine-colored *Millepora tuberosa* tend to be found on open coasts and tend to be more encrusting and with more rounded or lumpy nodules. The bright yellow *Millepora exaesa* are usually found on the backreef slopes and tend to have short knobby branches growing vertically upward. When the two species are found intermixed in lagoonal habitats in Micronesia (Yap and Chuuk), they can be readily distinguished by form and color (Randall and Cheng, 1984).

Family: Milleporidae.

Evolutionary and geologic history: The genus *Millepora* has been found in the fossil record for the Cretaceous (about 70 Ma; Rehfeld and Ernst, 1998), so the genus is known to have survived the warm seawater and concentrations of atmospheric CO₂ in the Cretaceous (Quan et al., 2009; Zeebe, 2001) and the Paleocene-Eocene Thermal Maximum (55.8 Ma; Zachos et al., 2003). Rapid acidification of the oceans occurred during the Paleocene-Eocene Thermal Maximum (Zachos et al., 2005). Although the species of *Millepora* survived the extraordinarily warm seawater during the Cretaceous and the Paleocene-Eocene Thermal Maximum, it is not evidence that species of *Millepora* could survive those conditions again; however, it provokes interest in investigating the biology of *Millepora* for how it may have persisted. In the harsh physical environments of shallow reef flat pools in American Samoa, *Millepora* spp. are the first to bleach and die, but seem to have a special aptitude for recovering by successful recruitment of new colonies (C. Birkeland, USGS, Honolulu, HI, pers. observ., 5 March 2002).

Global Distribution

Millepora tuberosa is occasionally common in portions of the western Pacific (Taiwan, Mariana Islands, Caroline Islands) and is found in American Samoa (D. Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010; Birkeland, 1987). The range appears quite disjunct, but this could be an identification artifact. Randall and Cheng (1984) suggest that it might be more widespread, but that it gets confused with *Millepora exaesa*. The type specimens were described from Mauritius (Boschma, 1966), but the color of the species while living was not included in the original description. It might be found at a number of archipelagoes between the Marianas and American Samoa but not noticed because it resembles crustose coralline algae to persons surveying corals who have not been familiarized with *Millepora tuberosa*.

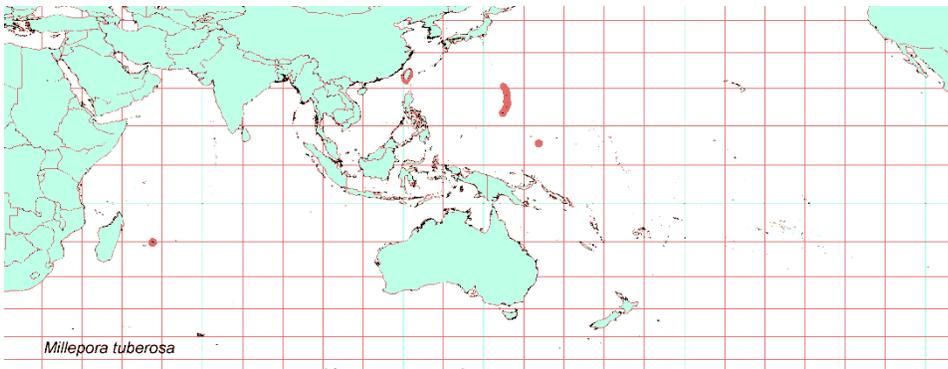


Figure 7.1.5. *Millepora tuberosa* distribution from IUCN copied from <http://www.iucnredlist.org>.

U.S. Distribution

Millepora tuberosa is found in American Samoa (Birkeland, 1987; D. Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010) and the Mariana Islands (including Guam). A search of published and unpublished records of occurrence in U.S. waters indicates *Millepora tuberosa* and *Millepora exaesa* have been reported from Tutuila, Ofu-Olosega, and Ta'u in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; CRED, unpubl. data), Guam, and the Commonwealth of the Northern Mariana Islands (Burdick, unpubl. data; CRED, unpubl. data; Randall, 2003). No substantiated published or unpublished reference supporting its occurrence in the U.S. minor outlying islands could be identified.

Within federally protected waters, *Millepora tuberosa* has been recorded from the following areas (Kenyon et al., 2010b):

- National Park of American Samoa, Tutuila and Ofu Island units
- Fagatele Bay National Marine Sanctuary, Tutuila

Habitat

Habitat: *Millepora tuberosa* has been reported to occupy a variety of habitats, including the forereef and lagoonal areas.

Depth range: *Millepora tuberosa* has been reported in water depths ranging from at least 1 m to 12 m.

Abundance

Abundance of *Millepora tuberosa* has most often been reported as occasional, but R. Randall (Univ. Guam, Mangilao, pers. comm., June 2010) has observed it as predominant in an area of lagoonal reef in southwest Guam near the Agat Boat Harbor.

Life History

Hydrozoan corals of the genus *Millepora* are the only reef-building corals with medusae as part of their life history. *Millepora* are gonochoric and reproduction is seasonal (Lewis, 2006). Medusae are in separate sexes and sexual reproduction takes place in the medusa stage. The milleporid medusae of some species live for only a few hours. The gametes of some milleporids can become mature in 20 to 30 days, more rapidly than for many scleractinians.

Branching and columnar forms of *Millepora* are subject to fragmentation, and may utilize this mechanism to reproduce asexually; unlike scleractinian corals, the survival of *Millepora* fragments may not be size-dependent (Lewis, 1991). However, this strategy is not likely to be significant for *Millepora tuberosa*, which is encrusting and less prone to fragmentation.

Threats

Thermal Stress: Although there is not much species-specific information about the response of *Millepora tuberosa* to thermal stress, the genus *Millepora* has been called a bleaching “loser” (Loya et al., 2001). *Millepora* species are ranked as the most susceptible to bleaching in response to high seawater temperatures of any of the 40 genera or other categories of hermatypic corals in the Great Barrier Reef (Marshall and Baird, 2000). The genus is also highly susceptible to bleaching in the western Indian Ocean (McClanahan et al., 2007) and has caused local extirpations in the tropical eastern Pacific (Glynn and de Weerd, 1991). Low bleaching occurred in *Millepora* in Moorea during the 1991 event (Gleason, 1993), but elevated temperatures can also kill *Millepora* even in the absence of bleaching (McClanahan, 2004). At elevated temperatures, congener *Millepora dichotoma* showed decreased zooxanthellae density, changes in chlorophyll concentrations, and decreased calcification (Abramovitch-Gottlieb et al., 2003).

Although *Millepora* spp. are the first to bleach and die, they also seem to have a special aptitude for recovering by recruiting new colonies. *Millepora* survived the extraordinarily warm seawater during the Cretaceous and the Paleocene-Eocene Thermal Maximum.

Acidification: No specific research has addressed the effects of acidification on the genus *Millepora*. However, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: The ecological and population effects of disease on the genus *Millepora* are unknown. *Millepora* have been observed with a > 20% prevalence of skeleton-eroding band disease in the Red Sea (Winkler et al., 2004). There are reports of black-band disease on *Millepora* on the Great Barrier Reef (Willis et al., 2004) and white plague in Florida (Richardson et al., 1998). Few other reports exist for the Pacific, and Caribbean congeners have been observed with a small number of diseases (Sutherland et al., 2004).

Predation: *Millepora* species are known to be preyed on by the crown-of-thorns seastar, *Acanthaster planci*, although they are less preferred prey than acroporids and perhaps most scleractinians (Colgan, 1987). *Millepora* spp. are also preyed upon by the polychaete *Hermidice carunculata* (Witman, 1988), the nudibranch mollusk *Phyllidia*, and filefish of the genera *Alutera* and *Cantherhines* (Lewis, 1989).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are poorly known for *Millepora tuberosa*. Although *Millepora* species tend to favor relatively clear water with low rates of sedimentation, they are among the last 17 out of 42 genera to drop out along a gradient of increasing rate of sedimentation (Randall and Birkeland, 1978). *Millepora* also showed increased relative abundance and colony size on sediment-impacted reefs in Kenya (McClanahan and Obura, 1997). Although little is known about effects of nutrients on Pacific *Millepora*, Caribbean congeners were found to decrease in percent cover on eutrophic reefs (Tomascik and Sander, 1987a).

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: The genus *Millepora* has been involved in international trade from Indonesia, Solomon Islands, and Fiji with reported exports between 200 and 3000 pieces per year in the years 2000–2008 (CITES, 2010). Reported exports from Vietnam, Malaysia, and Tonga were < 1000 pieces per year in the same time period.

Risk Assessment

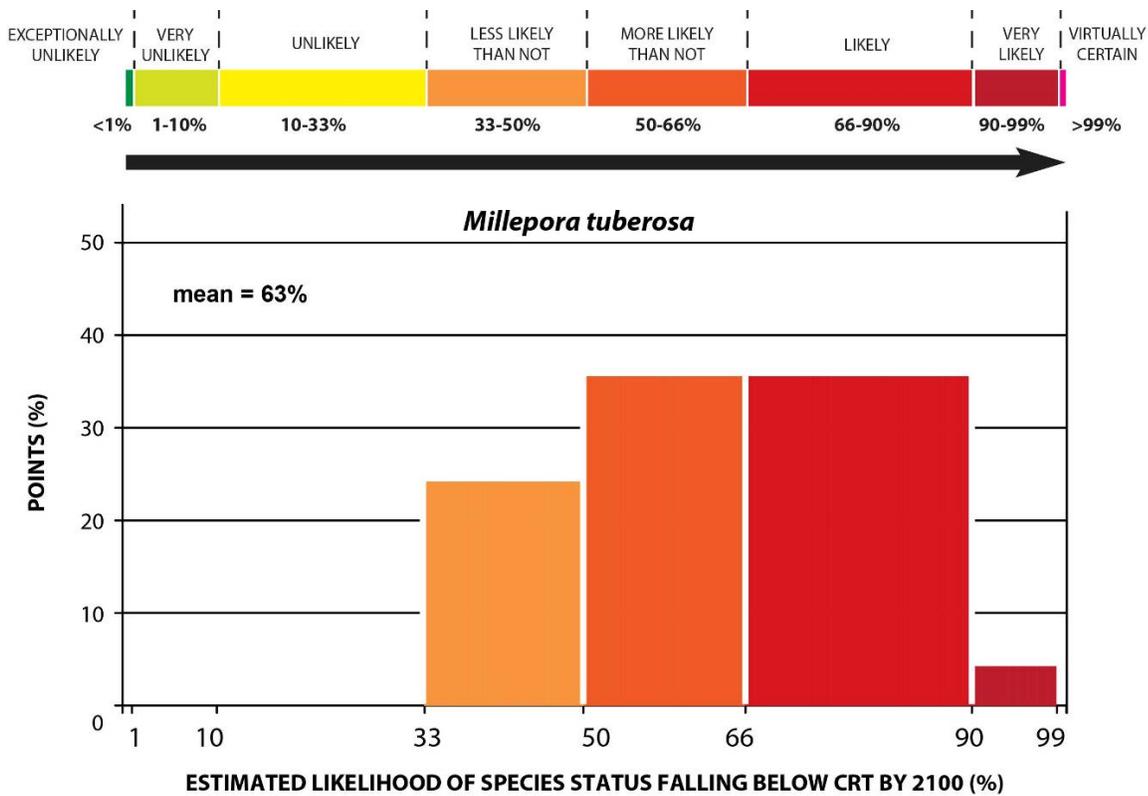


Figure 7.1.6. Distribution of points to estimate the likelihood that the status of *Millepora tuberosa* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Millepora tuberosa* include a relatively narrow geographic range and a generic susceptibility to bleaching in response to unusually warm seawater. The high bleaching rate is the primary generic threat of extinction for *Millepora tuberosa*. *Millepora* species are especially susceptible to seawater warming and among the first to bleach, with by far the greatest rate of mortality. Factors that potentially reduce the extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are that *Millepora tuberosa* can be mistaken for crustose coralline algae and might be more common than previously observed, and this species probably shares the generic trait of having an exceptional aptitude for larval recruitment and population replenishment.

The overall likelihood that *Millepora tuberosa* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 63% and a standard error (SE) of 10.1% (Fig. 7.1.6). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.1.6) and the average range of likelihood estimates of the seven BRT voters (50.3%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Millepora tuberosa* and the particular concern about potential misidentification in this species.

7.2 Genus *Heliopora* (Class Anthozoa; Order Helioporacea; Family Helioporidae)

7.2.1 *Heliopora coerulea* Pallas, 1766

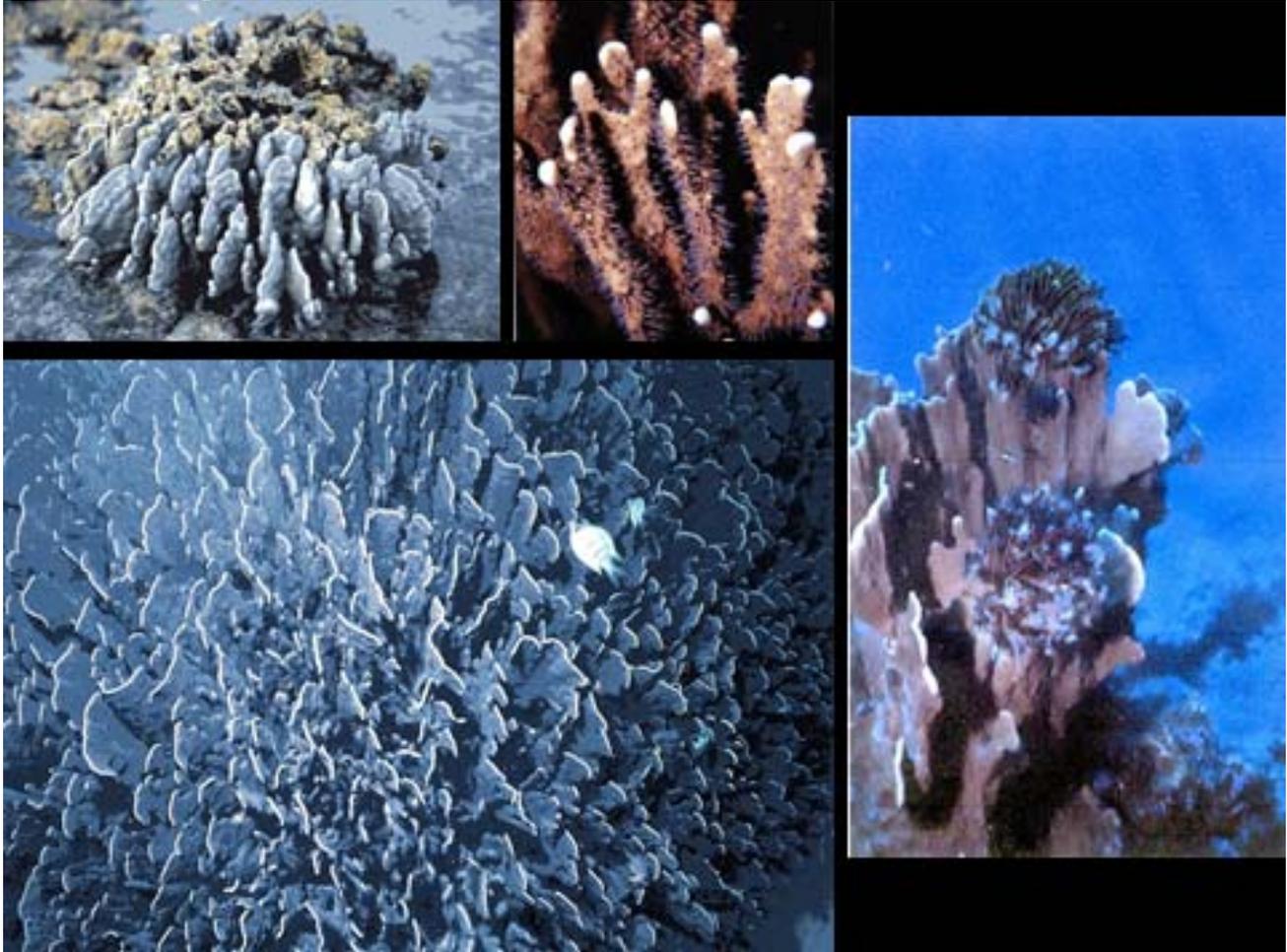


Figure 7.2.1. Colonies of *Heliopora coerulea* copied (three on the left) from Veron (2000) and (one to the right) provided by the BRT.

Characteristics

Colonies of *Heliopora coerulea* most often have rather massive castellate blades. This is the only species of the subclass Octocorallia known to produce a large aragonite skeleton. They can form or contribute to microatoll structures when near the ocean surface. *Heliopora* can dominate large areas, but the colonies are very patchily distributed. The polyps each have eight pinnate tentacles. Polyps live in tubes within the skeleton and are connected by a thin superficial coenenchyme. When a blade is broken to see the inner skeleton, it is always a striking blue. The skeleton can remain blue even in fossils of *Heliopora* millions of years old. The external appearance of living colonies can also be lighter blue or greenish, but perhaps most often brownish because of the color of the living coenenchyme. The polyps and planulae are white.

Taxonomy

Taxonomic issues: None. *Heliopora coerulea* is the only representative of the order Helioporacea (= Coenothecalea) on coral reefs. There are three known species of the genus *Epiphaxum* (family Lithotelestidae, Helioporacea) in the deep sea (two in the Caribbean Sea and one in the Indo-West Pacific), but they are not large or dominant. Like *Heliopora coerulea*, *Epiphaxum* spp. were found back in the Cretaceous Era and have apparently changed little since (Lozouet and Molodtsova, 2008).

Family: Helioporidae.

Evolutionary and geologic history: *Heliopora coerulea* is surely the oldest species of coral, with its fossil record extending 130 million years unchanged, back to the early Cretaceous (about 70 Ma; Colgan, 1984) when it originated in the Tethys Sea in southern Europe. Numerous other species names are associated with *Heliopora* in the paleontological literature, but there are no statistically significant differences in the skeletal structures; therefore, they are all considered synonymous. It is generally agreed that *Heliopora coerulea* probably has changed biochemically and genetically over 130 million years and it, therefore, is considered a chronospecies.

Global Distribution

Heliopora coerulea has been extinct in the Atlantic but in the Pacific has become very broadly distributed both longitudinally, from east Africa and the Red Sea to American Samoa, and latitudinally, from South Africa and the Great Barrier Reef to the Ryukyu Islands near Japan. The extent of distributions into the higher latitudes on the east and west coasts of Australia are indicated substantially differently in maps from the IUCN Red List and from Veron 2000. *Heliopora coerulea* does not occur in the Arabian Gulf and the North Arabian Sea (B. Riegl, National Coral Reef Institute, Dania, FL. pers. comm. 26 November, 2010).

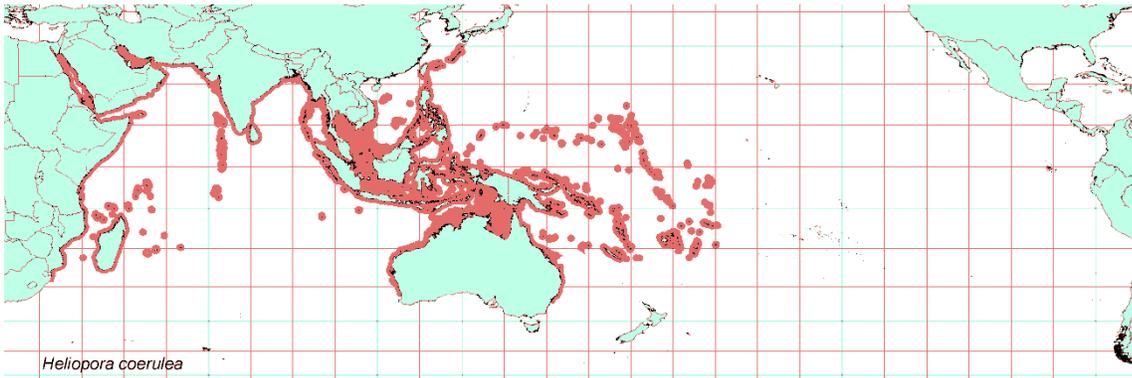


Figure 7.2.2. *Heliopora coerulea* distribution from IUCN copied from <http://www.iucnredlist.org>.

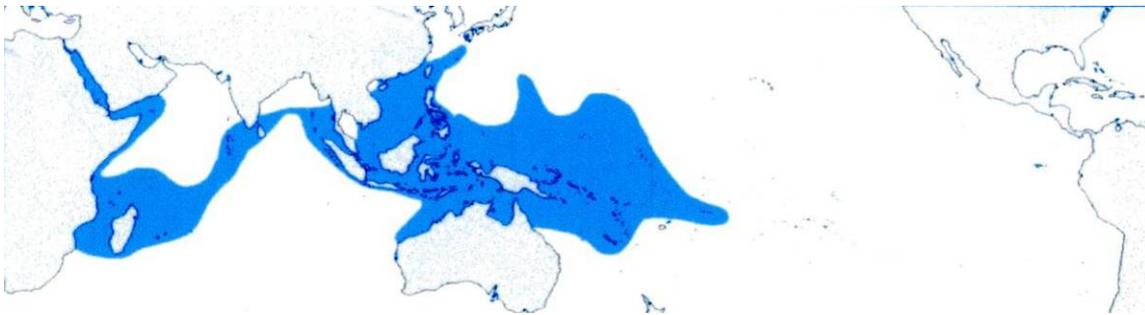


Figure 7.2.3. *Heliopora coerulea* distribution from Veron (2000).

U.S. Distribution

Heliopora coerulea is found in the American Samoa Archipelago but not on the main island of Tutuila. It is found in the Manu'a Islands (about 65 miles east of Tutuila) and on South Bank (37 miles south of Tutuila). It is also found in the Mariana Islands and throughout the Caroline and Marshall Islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Heliopora coerulea* has been reported from Ofu-Olosega, Ta'u, Swains, and South Bank in American Samoa (Coles et al., 2003; Fisk and Birkeland, 2002; Lamberts, 1983; Lovell and McLardy, 2008; Maragos et al., 1994; National Park Service, 2009), Guam (Amesbury et al., 1999; Burdick, unpubl. data) and the Commonwealth of the Northern Mariana Islands (CRED, unpubl. data).

Within federally protected waters, *Heliopora coerulea* has been recorded from the following areas (Kenyon et al., 2010b):

- National Park of American Samoa, Ofu Island unit
- War in the Pacific National Historical Park, Guam
- Marianas Trench Marine National Monument (Asuncion, Maug)

Habitat

Habitat: *Heliopora coerulea* has been reported to occur in areas of very high abundance on shallow reef crests (0–1.2 m) where it has sometimes been referred to as the “*Heliopora* zone” (Wells, 1954), but populations have also been reported as common on the forereef slopes (Zann and Bolton, 1985). *Heliopora* can also live in marginal backwater turbid environments (C. Birkeland, University of Hawai`i, HI, pers. comm. November 2010).

Depth range: *Heliopora coerulea* have been reported in water depths ranging from near 0 to 60 m, most abundant at 0–1.2 m and between 6 m and 10 m, but still common at 20 m (Zann and Bolton, 1985). Specimens have been dredged from 60 m in Funafuti (Gardiner, 1898).

Abundance

Heliopora coerulea have been reported to be dominant in shallow water and to form extensive 10 km long stands in a “*Heliopora* zone” (0–1.2 m at low tide) on Ishigaki (Japan), Banda Aceh (Indonesia) and on a number of atolls in Micronesia. *Heliopora* can also be abundant and dominant to at least 20 m (Zann and Bolton, 1985). *Heliopora* averaged 15%–20% of all corals down to 20 m in southern Tarawa and up to 40% of all corals in the southwestern sector (Zann and Bolton, 1985).

Life History

Heliopora coerulea colonies have separate sexes. The mature eggs are large (> 800 µm diameter). There appears to be a lunar or semi-lunar periodicity in reproductive behavior with brooding of larvae beginning around either full or new moon (Babcock, 1990). Fertilization and development begin internally, but the planula larvae are brooded externally on the surface of the colony under the tentacles of the polyps for 6 to 14 days before leaving (Babcock, 1990). The planulae average 3.7 mm in length and are mostly benthic. The larvae lack zooxanthellae and have a relatively low lipid content (54% dry weight), both factors providing more energy for most scleractinian larvae (Harii et al., 2002). Furthermore, the relatively low lipid content reduces the potential buoyancy of the larvae. Both reduced energy and reduced buoyancy tend to make the larvae of *Heliopora coerulea* benthic “crawl-away” larvae, although they could potentially be kept in the water column by turbulence. Although the competency period of *Heliopora coerulea* is reported to be 30 days, 40% of the larvae crawl onto the substrata within the first hour of leaving the adult colony (Harii et al., 2002). Even when dispersed in the water column, settlement occurs within a few hundred meters of the parent colony (Harii and Kayanne, 2003). This is a likely explanation for the tendency of *Heliopora* to have a strongly clumped distribution and apparently low dispersal tendencies.

The relatively large eggs and larvae in combination with small polyps restrict the fecundity of *Heliopora* to one or two planulae per polyp per reproductive cycle (Babcock, 1990).

Heliopora coerulea apparently does not grow rapidly. Two weeks after settlement, one polyp divided into two and the skeleton turned blue (Harii and Kayanne, 2003).

Although scleractinian corals deposit aragonitic calcium carbonate skeletons, the skeleton of *Heliopora coerulea* also contains magnesium carbonate. The concentration of MgCO₃ in *Heliopora* skeletons increases as temperatures decrease (Velimirov, 1980).

Field observations of coral interactions showed *Heliopora coerulea* to be the weakest competitor of all corals in Taiwan, as it was killed by all corals that physically touched it (Dai, 1990). However, it is still observed to be able to dominate large areas across a broad depth range (Zann and Bolton, 1985).

Threats

Temperature increase: *Heliopora coerulea* is one of the most resistant of corals to temperature stress and bleaching. The species did not bleach in Majuro in 1992 or in Guam in 1994 (Paulay and Benayahu, 1999). During the severe seawater warming of 1997–1998, Kayanne et al (2002) noted that while 100% of the *Pavona*, 77% of the *Acropora*, 66% of the *Montipora*, 53% of the branching *Porites*, and 23% of the massive *Porites* died, “*Heliopora coerulea* was the least susceptible to bleaching and maintained almost constant coverage before and after the bleaching.” No *Heliopora coerulea* were damaged. “In 1999, *Heliopora coerulea* reproduced normally, suggesting that this species can tolerate high water temperatures without detriment to its reproduction in the following year” (Harii and Kayanne, 2003). Likewise in June 2010, there was a major bleaching of corals in the Indian Ocean. Coauthor Mark Eakin observed nearly complete bleaching of all coral species except *Heliopora coerulea* south of Phuket, Thailand in June 2010 (Fig. 7.2.4).

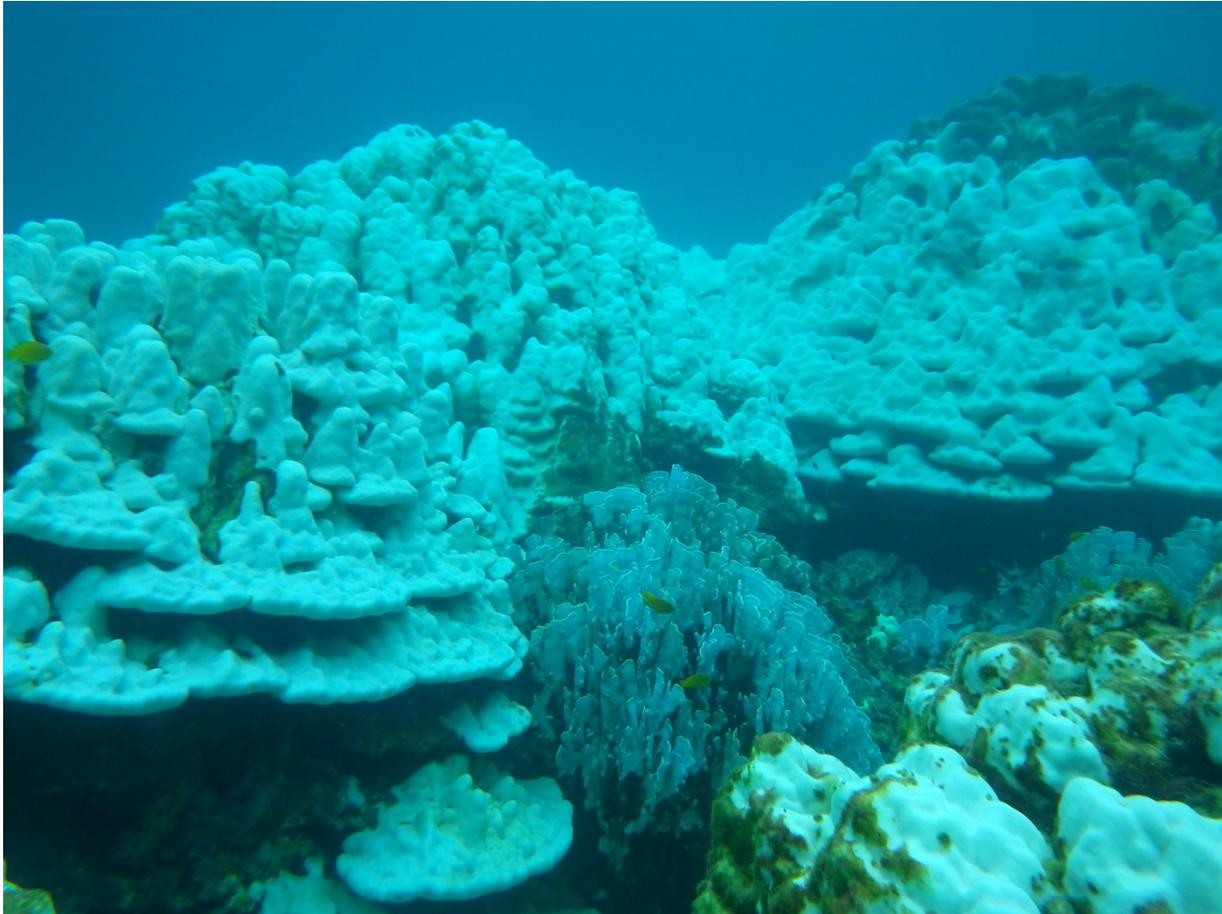


Figure 7.2.4. Nearly complete bleaching of all coral species except *Heliopora coerulea* at Koh Racha Yai about 1-hour boat ride south of Phuket, Thailand. Photo by Mark Eakin (NOAA Coral Reef Watch, Silver Spring, MD, 24 June 2010).

Heliopora coerulea may have suffered significantly from bleaching in Java during the 1982-1983 El Niño event, although some of the observed declines were also attributed to anthropogenic impacts (Brown et al., 1990). *Heliopora coerulea* has been found to predominantly contain stress-resistant clade D zooxanthellae (LaJeunesse et al., 2010).

Heliopora coerulea or its ancestors survived during the extraordinarily warm temperatures of the Cretaceous (Zeebe, 2001) and the Paleocene-Eocene Thermal Maximum (Quan et al., 2009).

Acidification: No specific research has addressed the effects of acidification on the genus *Heliopora*. However, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100. *Heliopora coerulea* seemed to have survived the rapid acidification of the oceans at the Paleocene-Eocene Thermal Maximum (Zachos et al., 2005).

Disease: *Heliopora coerulea* has been identified as a potential host for *Porites* ulcerative white-spot disease (Kaczmarek, 2006), but disease does not appear to pose a substantial threat to this species.

Predation: Adult colonies of *Heliopora coerulea* appear to be avoided by crown-of-thorns seastar (*Acanthaster planci*), fireworms, and corallivorous molluscs and fishes. However, the larvae being brooded on the outer surface of colonies are intensely preyed on by several species of butterflyfishes (chaetodontids; Villanueva and Edwards, 2010).

Land-based sources of pollution (LBSP): Sediment does not seem to be a significant threat to *Heliopora coerulea*. Although it has been reported to be able to live in marginal backwater turbid environments, field studies of the distribution of 159 species of corals in relation to rates of sedimentation along gradients from river mouths to the open forereefs in two bays in Guam (Randall and Birkeland, 1978) indicated that *Heliopora coerulea* tends to favor relatively clear water with low rates of sedimentation. Although it bleached during short-term (< 20 h) sediment burial, *Heliopora coerulea* recovers within a month (Wesseling et al., 1999). *Heliopora coerulea* has been successfully maintained in high-nutrient, low-pH water in aquarium settings (Atkinson et al., 1995), suggesting it can tolerate at least some nutrient enrichment.

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: The aquarium trade has been reported to be removing 1.5 million live stony corals per year from the wild. *Heliopora coerulea* has been reported as one of the top 10 species traded between 1985 and 1997 (Bruckner, 2001). A small specimen can sell for \$75 (e.g., www.freshmarine.com. Accessed November 2010).

Risk Assessment

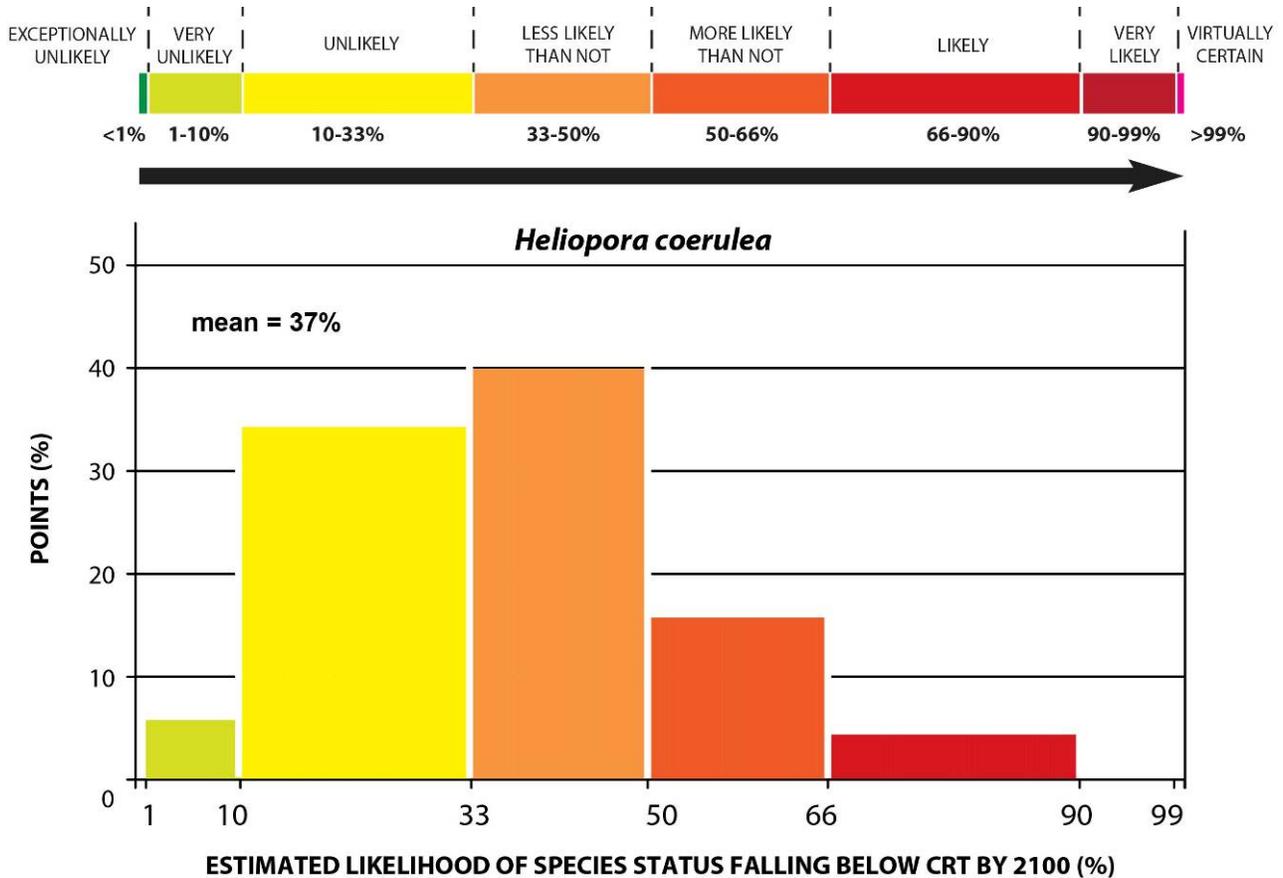


Figure 7.2.5. Distribution of points to estimate the likelihood that the status of *Heliopora coerulea* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Heliopora coerulea* include predation on the externally brooded larvae and harvesting. Heavy use in the aquarium trade implies potential for local extirpation for *Heliopora coerulea* with benthic larvae and very limited tendencies for population replenishment by larvae from populations more than a kilometer away. If collectors reduce a local population to levels below the Critical Risk Threshold, extirpation is possible as the population is unlikely to be replenished with larvae from another population. The following factors reduce potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold): *Heliopora coerulea* is one of the species most resistant to thermal stress; adult colonies of *Heliopora coerulea* are not favored by predators such as *Acanthaster planci*, corallivorous gastropods or fishes; and *Heliopora coerulea* occupies a broad depth range, a variety of habitat types, and is broadly distributed latitudinally and longitudinally. It is obviously able to dominate some coral communities from the low-tide level down to at least 20 m. Broad distribution is considered to reduce extinction risk, as it is more likely that stresses or catastrophes can be avoided in at least some locations.

The overall likelihood that *Heliopora coerulea* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “less likely than not” risk category with a mean likelihood of 37% and a standard error (SE) of 11% (Fig. 7.2.5). This SE was calculated by taking the standard deviation of the seven mean scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 1%–90% (Fig. 7.2.5) and the average range of likelihood estimates of the seven BRT voters (54%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Heliopora coerulea*.

7.3 Genus *Pocillopora* (Class Anthozoa; Order Scleractinia; Family Pocilloporidae)

Characteristics

Corals of genus *Pocillopora* are submassive-to-branching readily identified by prominent verrucae. While fossils of *Pocillopora* show that it was previously in the Caribbean until the Pilo-Pleistocene Era (Budd et al., 1994), it is found today in the entire Indo-Pacific region from Africa to the Americas. Many species of the genus are broadly distributed while numerous regional endemics have been described. Morphological plasticity has made identification problematic in some cases (Veron, 2000).

Taxonomic Issues

Pocillopora is known to be morphologically plastic, and multiple sympatric species frequently exhibit seemingly continuous intergradation of skeletal characteristics. *Pocillopora*, especially those found in the eastern Pacific, have been among the earliest coral taxa to be analyzed using modern genetic analysis tools. Chavez-Romo et al. (2008) and Combosch et al. (2008) both interpreted the variability and intergradation of eastern Pacific pocilloporids as cases of introgressive hybridization. The Chavez-Romo et al. (2008) study was limited to the Mexican Pacific only, finding exclusive genotypes in the northern and southern parts of the study and evidence of hybridization in the region between these zones. Combosch et al. (2008) provide data that support the hypothesis that the eastern Pacific pocilloporids are indeed genetically isolated from those elsewhere in the Indo-Pacific and that there appears to be one-way gene flow into *Pocillopora damicornis* from one or both of congeners in the eastern Pacific, *Pocillopora eydouxi* and *Pocillopora elegans*. However, these studies both assume that the species descriptions of pocilloporids in the eastern Pacific, based on morphological and ecological characteristics, are valid. A more recent paper by Pinzón and LaJeunesse (2011) completely questions the validity of classical species descriptions of pocilloporids in the eastern Pacific, finding distinct genetic clades that do not correspond with the classical species. Their work shows that clade 1 and 3 species exist among colonies identified morphologically as *Pocillopora damicornis*, *Pocillopora elegans*, and *Pocillopora capitata* in Panama. Only *Pocillopora eydouxi* is found to exist entirely within clade 3 in Panama, although individuals identified as *Pocillopora eydouxi* exist entirely within clade 1 in Mexico. Similar work in the western Indian Ocean (Souter, 2010; Souter et al., 2009) demonstrates similar issues in *Pocillopora* there. However, one distinct issue has long been identified as a concern over the identification of eastern Pacific pocilloporids as conspecifics of corals found elsewhere in the Pacific and in the Indian Ocean: the eastern Pacific corals are broadcast spawners while elsewhere they are brooders (Chavez-Romo and Reyes-Bonilla, 2007; Glynn et al., 1991).

In summary, three features were considered the most important by the BRT in resolving taxonomic issues among the candidate pocilloporid species: (1) taxonomic uncertainties among morphologically identified species in the eastern Pacific; (2) the distinctly different reproductive pattern of eastern Pacific pocilloporids (broadcast spawning) when compared to the pattern in the central Pacific (brooding); and (3) the evidence of low gene flow between the eastern Pacific and the Indo-Pacific pocilloporids. Most importantly, distinct reproductive modes (brooding vs. broadcasting) seems to preclude interbreeding as required in the U.S. Endangered Species Act species definition. Also, the restricted habitats in the eastern Pacific and high threat of thermally induced bleaching (Glynn, 1990) suggested that pocilloporids in the eastern Pacific are at greater risk than elsewhere in their ranges. Based on these factors, it was determined by the BRT that the corals classically identified as *Pocillopora elegans* in the eastern Pacific are most likely members of at least two different genetic clades that include corals identified as other pocilloporids. However, the eastern Pacific *Pocillopora elegans* (and congeners) are genetically separate from those found in the Indo-Pacific. Therefore, the BRT determined that corals identified as *Pocillopora elegans* in the eastern Pacific were a distinct species from corals identified as *Pocillopora elegans* in the central and western Pacific. The BRT evaluated and reported the extinction risk of these two as separate species. *Pocillopora danae* is not found in the eastern Pacific and was considered a valid species for the purpose of this review. While recent genetic work places all pocilloporid taxonomy based solely on morphology and ecology into question, there was no particular information available that would allow the BRT to synonymize *Pocillopora elegans* from the Indo-western Pacific or *Pocillopora danae* with other pocilloporids.

Life History

The genus *Pocillopora* has one of the most diverse sets of life history strategies among corals. According to Baird et al. (2009), all studies of reproduction found *Pocillopora* were hermaphrodites, but some are brooders and others broadcast spawners. In fact, the presence of spawning and brooding in corals identified morphologically as *Pocillopora damicornis* and *Pocillopora elegans*, but from different parts of the geographic range has been considered by the BRT as sufficient to suspect that *Pocillopora elegans*, is most likely two separate species. As with most branching corals, asexual reproduction by fragmentation is common (Glynn and Colley, 2008).

In the eastern Pacific, *Pocillopora damicornis* and *Pocillopora elegans* are both inferred to be hermaphroditic broadcast spawners, based on the disappearance of mature gametes after the full moon (Glynn et al., 1991). In that study, conducted between 1984 and 1990, corals were most reproductively active in the more thermally stable (less-upwelling) environments of Costa Rica and the Gulf of Chiriqui (Panama) where 32% to 90% of colonies contained gametes. In the moderately varying thermal conditions of the Galapagos Islands, 16% to 40% of colonies contained gametes, and in the pronounced seasonal upwelling environment of the Pearl Islands (Panama) only 6% to 18% contained gametes. Year-round reproduction occurred in Costa Rica and the Gulf of Chiriqui, whereas reproduction was confined to warm periods in the seasonally varying environments of the Galapagos Islands and the Gulf of Panama. Larvae contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Glynn and Colley, 2008). While frequent gamete maturation was observed during the study period 1984 to 1990, the relatively low rates of larval recruitment occurring on eastern Pacific coral reefs disturbed by the 1982-83 El Niño suggested that the recovery of important frame-building corals could be prolonged (Glynn and Colley, 2008).

In the western end of the distribution of *Pocillopora*, broadcast spawning is also common. *Pocillopora verrucosa* has been identified as a hermaphroditic spawner in South Africa (Kruger and Schleyer, 1998) and the Maldives (Sier and Olive, 1994). Sexuality and reproductive mode have been determined for 5 other species of *Pocillopora*, all of which are hermaphroditic broadcast spawners in the western Pacific (Baird et al., 2009). *Pocillopora damicornis* in the western Pacific is also known to brood larvae that may be sexually or asexually produced (Harii et al., 2002; Stoddart, 1983; Ward, 1992). In three *Pocillopora* species studied, the minimum size ranges from 6 to 16 cm, and the estimated age ranges from 1 to 5 years (Harrison and Wallace, 1990).

However, in the central Pacific, i.e., Micronesia, Hawai'i, and Australia, *Pocillopora damicornis* has been reported to be a brooder, planulating throughout the year (Richmond, 1987). Numerous studies have considered various aspects of the larval biology of these planulae as they are easy to study. The candidate species *Pocillopora elegans* has also been identified as a brooder in Micronesia (Stimson, 1978). Larval longevity has not been determined for broadcast-spawning species in this genus, but brooded larvae of Hawaiian *Pocillopora damicornis* have an observed competency period of more than 100 days (Harii et al., 2002; Richmond, 1988). The larvae of all *Pocillopora* species studied (six, including one spawner) contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are autotrophic. This is one of only four coral genera known to have maternally provided zooxanthellae in the eggs. The larvae of all *Pocillopora* species studied (six, including one spawner) contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009).

Threats

Temperature stress: *Pocillopora* are widely recognized as being prone to expelling their zooxanthellae when the water becomes anomalously warm. In a series of field assessments, Marshall and Baird (2000) identified *Pocillopora damicornis* as having a "severe" response to increased water temperature, only matched by acroporids. McClanahan et al. (2007) surveyed thousands of corals of 39 genera and found *Pocillopora* to be among the most sensitive, with only 7 genera ranking higher and just below *Acropora* and branching *Porites*. Warming events, including the 1982-1983 El Niño, demonstrated the susceptibility of the pocilloporid corals that dominate reefs and coral communities of the eastern tropical Pacific Ocean (Glynn, 1984; 1990). Susceptibility of *Pocillopora* to thermal stress has not only been seen in the field, but demonstrated in controlled, laboratory experiments (Berkelmans and Willis, 1999; Glynn, 1990; Hueerkamp et al., 2001; Jokiel and Coles, 1977). Even if bleaching is only temporary, physiological stress and decrease in nutrition are likely to have the synergistic effects of lowered fecundity and increased susceptibility to disease (Bruno et al., 2007; Muller et al., 2008; Whelan et al., 2007).

Acidification: One recent study (Manzello, 2010) compared growth rates of *Pocillopora elegans* and *Pocillopora damicornis* in the eastern Pacific and attributed the 25%–30% decline in growth over the past 30 years to acidification. Additionally, the extension rate of pocilloporids within the eastern Pacific declined nonlinearly along a saturation state gradient (Manzello, 2010). This major decrease in growth is despite the already-existing low aragonite saturation state seen naturally in reef waters of the eastern Pacific Ocean (Abramovitch-Gottlieb et al., 2003). While the dominance of pocilloporids in the eastern Pacific might have been thought to imply a degree of tolerance to acidification, they may have been living close to a threshold for skeletal deposition. Brooding *Pocillopora damicornis* in Hawai'i were found to settle successfully in aquaria with reduced saturation state (Jokiel et al., 2008). Work with other corals has shown that impacts are not limited to extension as acidification impairs fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and contributes to reef destruction (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). The BRT considers it to be a significant threat to corals by 2100.

Disease: Like most corals, infectious diseases have been found in corals of the genus *Pocillopora*. However, pocilloporids are not particularly vulnerable to most of the diseases known to affect scleractinian corals. Aeby (Aeby, 2006) identified *Pocillopora* as the genus least affected by disease in the Northwestern Hawaiian Islands. Pocilloporids on the Great Barrier Reef have been identified occasionally with the more common diseases (Willis et al., 2004), while in Zanzibar they were found to be susceptible to an especially destructive bacterium (Ben-Haim and Rosenberg, 2002). However, the limited number of reports of disease in pocilloporids suggests that infectious disease may not be a major threat to members of this genus.

Predation: *Pocillopora* species are among the most commonly consumed coral genera by crown-of-thorns seastar, *Acanthaster planci* (Glynn, 1976). However, *Pocillopora* are defended from *Acanthaster* predation by two mutualistic crustacean symbionts: a crab and a snapping shrimp, often forming protective barriers around unprotected species (Glynn, 1976). Because smaller colonies lack these symbionts, *Acanthaster* often target young colonies, potentially reducing recruit success. Additionally, *Pocillopora* has been identified as preferred prey for corallivorous invertebrates such as the asteroid *Calcita novaeguineae* (Glynn and Krupp, 1986), the gastropod *Jenneria pustulata* (Glynn, 1976), and corallivorous fishes (Cole et al., 2008).

Land-based sources of pollution (LBSP): Like most corals, *Pocillopora* are generally found in clear waters. McClanahan and Obura (1997) identified *Pocillopora* as sediment-intolerant in the western Indian Ocean. In contrast, *Pocillopora* has often been found in relatively turbid waters in the eastern Pacific and were considered potentially sediment-tolerant from an examination of data from Guam (Randall and Birkeland, 1978; Rogers, 1990). However, excess sedimentation has been identified as the cause of reef collapse in Costa Rica (Cortés, 1990; Randall and Birkeland, 1978; Rogers, 1990). Clearly, while some *Pocillopora* may show a degree of sediment tolerance, the distribution of corals of this genus is often sediment-limited.

Pocillopora have been reported to be particularly susceptible to mortality from freshwater runoff (Van Woesik et al., 1995), as well as physiological and reproductive impacts from elevated nutrients (Cox and Ward, 2002; Koop et al., 2001; Villanueva et al., 2006).

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: No trade information on *Pocillopora* was listed on the CITES Trade Database, UNEP World Conservation Monitoring Centre (CITES, 2010). However, *Pocillopora* is frequently seen for sale as curios (M. Eakin, NOAA Coral Reef Watch, Silver Spring, MD, pers. comm., February 2011).

7.3.1 *Pocillopora danae* Verrill, 1864

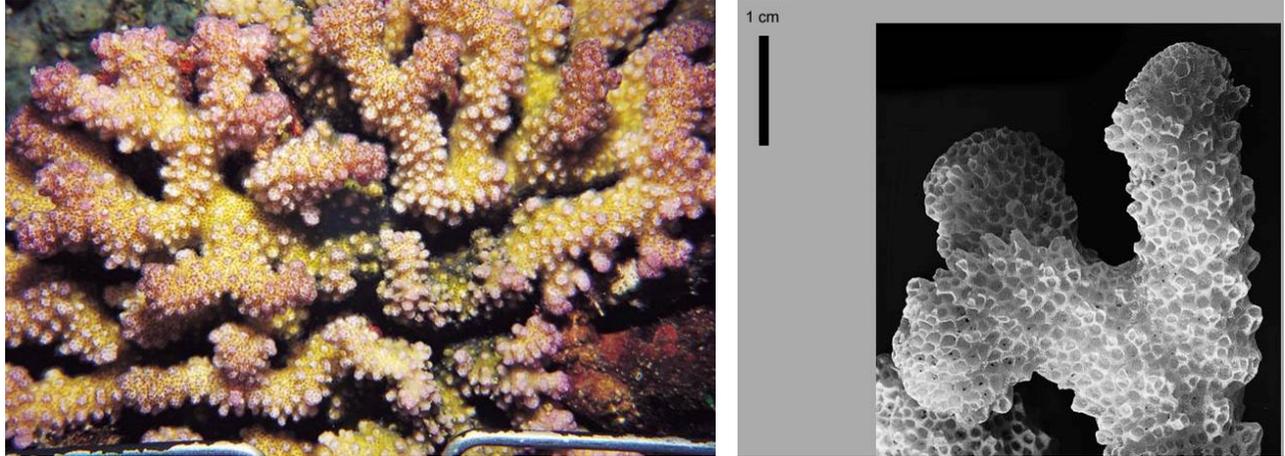


Figure 7.3.1. *Pocillopora danae* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Pocillopora danae* may be greater than 1 m across and are composed of irregular, mostly prostrate branches that tend to form a three-dimensional tangle. Verrucae are widely spaced and irregular in size, although they remain distinct from branches. Colonies are usually cream, brown or pink in color (Veron, 2000).

Taxonomy

Taxonomic issues: The genus *Pocillopora* is known to be morphologically plastic, and multiple sympatric species frequently exhibit seemingly continuous intergradation of skeletal characteristics. *Pocillopora* in the eastern Pacific and western Indian Ocean have been analyzed using modern genetic analysis tools (Chávez-Romo et al., 2008; Combosch et al., 2008; Pinzón and LaJeunesse, 2011; Souter et al., 2009), showing a complex story of variability, intergradation, introgressive hybridization, and distinct clades that do not correspond to classical morphological species. However, such work has yet to be performed on *Pocillopora danae*. *Pocillopora danae* is similar to *Pocillopora verrucosa*, which has more compact branches and less irregular verrucae. See also *Pocillopora damicornis* (Vaughan 1918, cited in Veron 2000). No synonyms and no known interbreeding. While recent genetic work places all pocilloporid taxonomy based solely on morphology and ecology into question, there was no particular information available to identify taxonomic problems with *Pocillopora danae*.

Family: Pocilloporidae.

Evolutionary and geologic history: The genus *Pocillopora* was found in the Caribbean Sea as recently as the late Pleistocene (0.13–0.01 Ma; Geister, 1977b) and are widespread from the western Indian Ocean to the eastern Pacific Ocean.

Global Distribution

Pocillopora danae has a somewhat broad longitudinal and latitudinal range. It has been reported throughout the western Pacific and a small part of the central Pacific, the Great Barrier Reef, and around Sri Lanka (Veron, 2000). However, *Pocillopora danae* has also been identified as part of the fauna at Easter Island (Egana and Disalvo, 1982) and the Red Sea (Schuhmacher, 1977) in ecological papers.

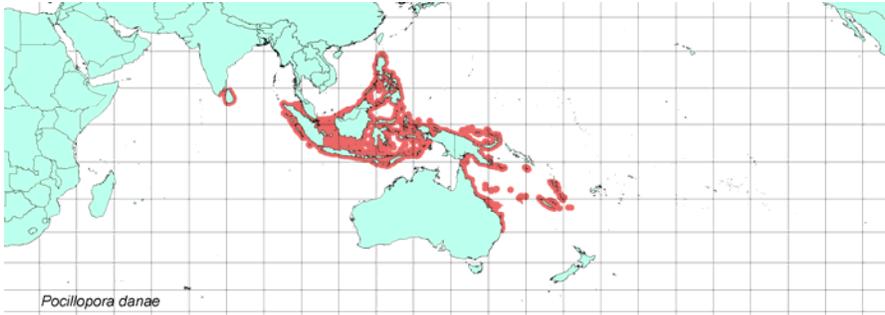


Figure 7.3.2. *Pocillopora danae* distribution from IUCN copied from <http://www.iucnredlist.org>.

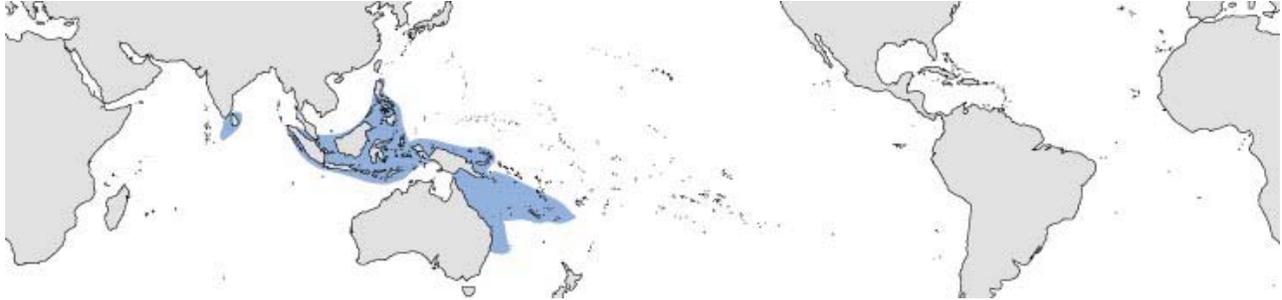


Figure 7.3.3. *Pocillopora danae* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Pocillopora danae* has been recorded in the Northern Mariana Islands. The CITES species database lists its occurrence in American Samoa.

A search of published and unpublished records of occurrence in U.S. waters indicates *Pocillopora danae* has been recorded at Tutuila and Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; Lamberts, 1983; Lovell and McLardy, 2008; National Park Service, 2009), Guam (Amesbury et al., 1999; Burdick, unpubl. data; Randall, 2003), the Commonwealth of the Northern Mariana Islands (CRED, unpubl. data), Howland and Baker Islands, Jarvis Island, and Kingman Reef (CRED, unpubl. data), and Palmyra Atoll (Williams et al., 2008b).

Within federally protected waters, *Pocillopora danae* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Howland, Baker, Jarvis, Palmyra, Kingman)
- National Park of American Samoa, Ofu Island unit
- War in the Pacific National Historical Park, Guam
- Marianas Trench Marine National Monument (Asuncion, Maug, Farallon de Pajaros)

Habitat

Habitat: *Pocillopora danae* has been reported on partly protected reef slopes (Veron, 2000).

Depth range: *Pocillopora danae* has been reported in water depths ranging from 1 m to 15 m (Carpenter et al., 2008).

Abundance

Abundance of *Pocillopora danae* has usually been reported to be uncommon (Carpenter et al., 2008; Veron, 2000).

Life History

The reproductive characteristics of *Pocillopora danae* have not been determined (Baird et al., 2009). However, sexuality and reproductive mode have been determined for five other species of *Pocillopora*, all of which are hermaphroditic broadcast spawners in the western Pacific (Baird et al., 2009). *Pocillopora damicornis* in the western Pacific is also known to brood larvae that may be sexually or asexually produced (Harii et al., 2002; Stoddart, 1983; Ward, 1992). The minimum size and estimated age at first reproduction have not been determined for this species. However, for three other *Pocillopora* species, the minimum size ranges from 6 to 16 cm, and the estimated age ranges from 1 to 5 years (Harrison and Wallace, 1990). Although specific observations have not been published for this species, the larvae of all other *Pocillopora* species studied (six) contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are autotrophic. Larval longevity has not been determined for broadcast-spawning species in this genus, but larvae of the congener *Pocillopora damicornis*, which brood larvae, have an observed competency period of more than 100 days (Richmond, 1988).

Threats

For each of these possible threats, see also Section 7.3: *Pocillopora* for additional genus level information.

Temperature stress: Studies have shown that *Pocillopora* are widely recognized as being prone to expelling their zooxanthellae when the water becomes anomalously warm. In a series of field assessments, Marshall and Baird (2000) identified *Pocillopora damicornis* as showing a “severe” response to increased water temperature, only matched by acroporids. McClanahan et al. (2007) surveyed thousands of corals of 39 genera and found *Pocillopora* to be among the most sensitive to bleaching, with only 7 genera ranking higher and just below *Acropora* and branching *Porites*. Warming events, including the 1982-83 El Niño, demonstrated the susceptibility of the pocilloporid corals that dominate reefs and coral communities of the eastern tropical Pacific Ocean (Glynn, 1984; 1990). Susceptibility of *Pocillopora* to thermal stress has not only been seen in the field, but demonstrated in controlled, laboratory experiments (Berkelmans and Willis, 1999; Glynn and D’Croz, 1990; Hueerkamp et al., 2001; Jokiel and Coles, 1977). Even if bleaching is only temporary, physiological stress and decrease in nutrition are likely to have the synergistic effects of lowered fecundity and increased susceptibility to disease (Bruno et al., 2007; Muller et al., 2008; Whelan et al., 2007).

Acidification: No specific research has addressed the effects of acidification on *Pocillopora danae*. However, studies on other pocilloporids have indicated impacts of acidification. One recent study (Manzello, 2010) compared growth rates of *Pocillopora elegans* and *Pocillopora damicornis* in the eastern Pacific and attributed the 25%–30% decline in growth over the past 30 years to acidification. Additionally, the extension rate of pocilloporids within the eastern Pacific declined nonlinearly along a saturation state gradient (Manzello, 2010). This major decrease in growth is despite the already-existing low aragonite saturation state seen naturally in reef waters of the eastern Pacific Ocean (Manzello et al., 2008). While the dominance of pocilloporids in the eastern Pacific might have been thought to imply a degree of tolerance to acidification, they may have been living close to a threshold for skeletal deposition. Brooding *Pocillopora damicornis* in Hawai‘i were found to settle successfully in aquaria with reduced saturation state (Jokiel et al., 2008). Work with other corals has shown that impacts are not limited to extension as acidification impairs fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and contributes to reef destruction (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). The BRT considers it to be a significant threat to corals by 2100.

Disease: There have been a medium number of disease reports for the genus *Pocillopora* (UNEP, 2010): chronic skeletal growth anomalies, including hyperplasia and neoplasia, subacute black-band disease, yellow-band disease, tissue loss, and pigmentation response including pink-line syndrome, and acute tissue necrosis including white-band disease (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010; CRED, unpubl. data). Effects on reproduction are unknown. Synergy with other threats is largely unknown except with bleaching in east Pacific (1982-83, 1997-98 ENSO east Pacific). Aeby (2006) identified *Pocillopora* as the genus least affected by disease in the Northwestern Hawaiian Islands. Pocilloporids on the Great Barrier Reef have been identified occasionally with the more common diseases (Willis et al., 2004), while in Zanzibar this genus was found to be susceptible to an especially destructive bacterium (Ben-Haim and Rosenberg, 2002). However, the limited number of reports of disease in pocilloporids indicates that infectious disease is not a major threat to members of this genus.

Predation: *Pocillopora* species are among the most commonly consumed coral genera by crown-of-thorns seastar, *Acanthaster planci* (Glynn, 1976). However, *Pocillopora* are defended from *Acanthaster* predation by two mutualistic crustacean symbionts: a crab and a snapping shrimp, often forming protective barriers around unprotected species (Glynn, 1976). Because smaller colonies lack these symbionts, *Acanthaster* often target young colonies, potentially reducing recruit success. Additionally, *Pocillopora* also has been identified as preferred prey for corallivorous invertebrates such as the asteroid *Culcita novaeguineae* (Glynn and Krupp, 1986) and the gastropod *Jenneria pustulata* (Glynn, 1976) and corallivorous fishes (Cole et al., 2008).

Land-based sources of pollution (LBSP): McClanahan and Obura (1997) identified *Pocillopora* as sediment-intolerant in the western Indian Ocean. In contrast, *Pocillopora* has often been found in relatively turbid waters in the eastern Pacific and were considered potentially sediment-tolerant by Rogers (1990) and from an examination of data from Guam (Randall and Birkeland, 1978). However, excess sedimentation has been identified as the cause of reef collapse in Costa Rica (Cortés, 1990). Clearly, while some *Pocillopora* may have shown a degree of sediment tolerance, the distribution of corals of *Pocillopora* has often been found to be sediment-limited.

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: No trade information on *Pocillopora* was listed on the CITES Trade Database, UNEP World Conservation Monitoring Centre (CITES, 2010). However, *Pocillopora* is frequently seen for sale as curios (Mark Eakin NOAA Coral Reef Watch, Silver Spring, MD, pers. comm., February 2011).

Risk Assessment

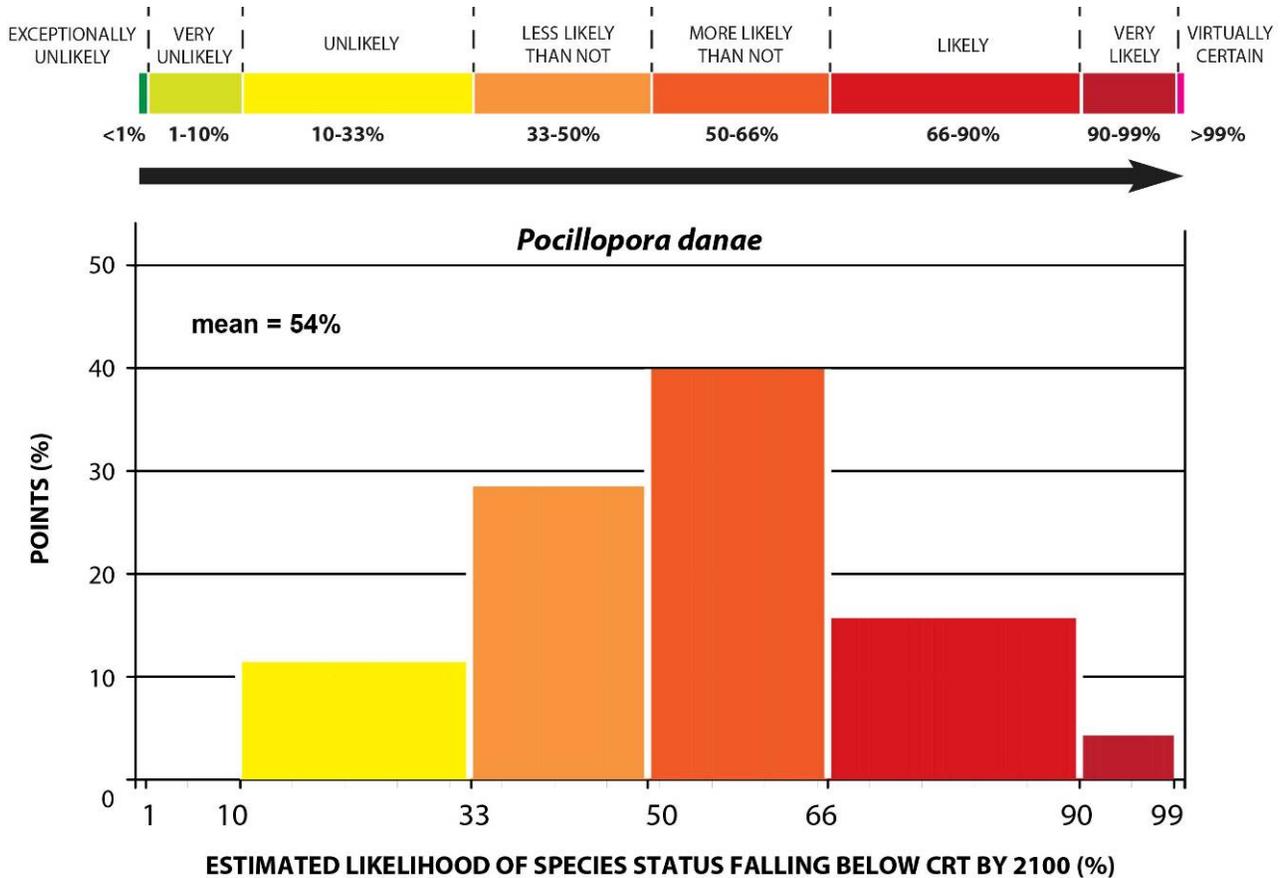


Figure 7.3.4. Distribution of points to estimate the likelihood that the status of *Pocillopora danae* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Pocillopora danae* include its relatively high bleaching susceptibility and that its small colonies are common prey of crown-of-thorns seastars. The high bleaching rate of pocilloporid corals is the primary known threat of extinction for *Pocillopora danae*. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are the somewhat wide geographic distribution range, including the Coral Triangle, quite common abundance where found, and potentially high disease resistance.

The overall likelihood that *Pocillopora danae* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 54% and a standard error (SE) of 14% (Fig. 7.3.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.3.4) and the mean range of votes of 52%—the latter calculated by averaging the range of likelihood estimates from each of the seven BRT voters. The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Pocillopora danae*.

7.3.2 *Pocillopora elegans* Dana, 1864

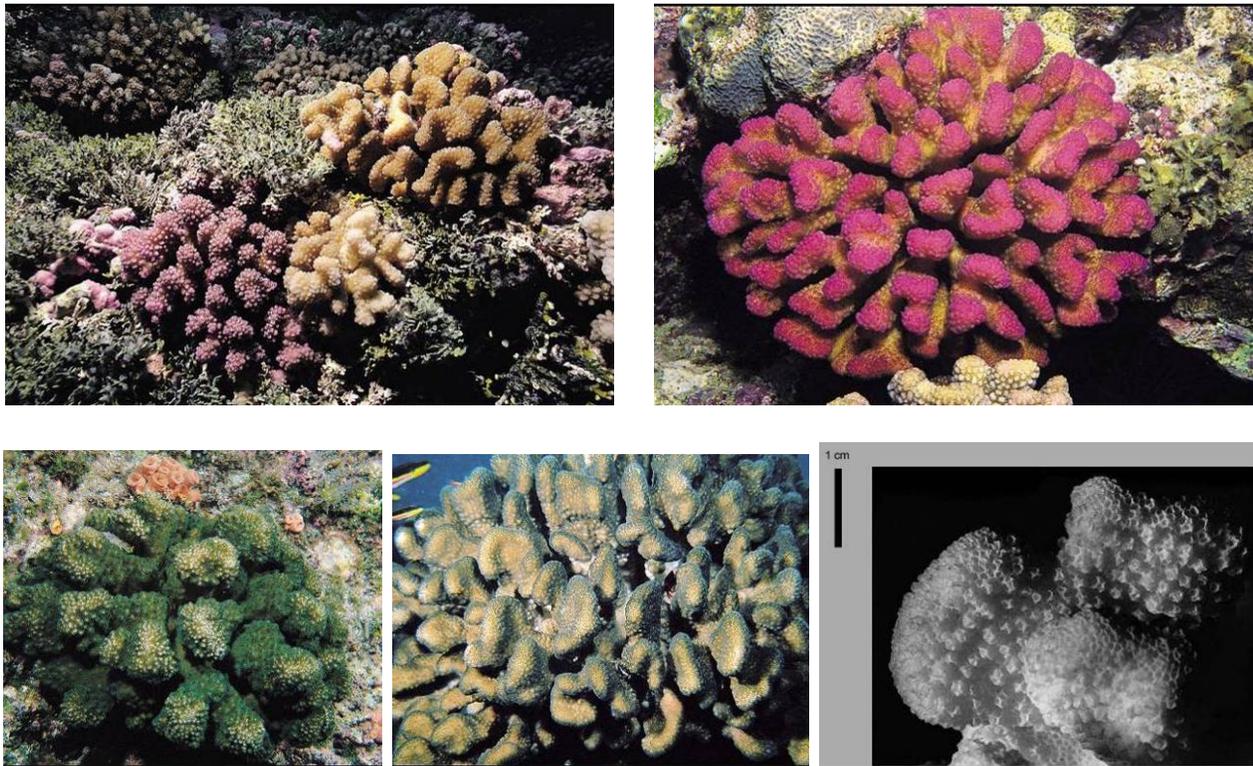


Figure 7.3.5. *Pocillopora elegans* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Pocillopora elegans* are usually compact clumps composed of uniform, thick, primarily upright branches with flattened ends. Verrucae are uniform, rounded and smooth. Colonies are cream, brown-green or pink in color (Veron, 2000).

Taxonomy

Taxonomic issues: See Section 7.3 Genus *Pocillopora* for additional information. *Pocillopora* has been reported to be morphologically plastic, and multiple sympatric species frequently exhibit seemingly continuous intergradation of skeletal characteristics. A variety of taxonomic and systematic issues plague the clear discrimination of some species within the genus. In particular, there continue to be questions about the separation of *Pocillopora elegans* and *Pocillopora verrucosa*. Reyes-Bonilla (2002) determined that the two species were likely inseparable, and this determination was followed in Glynn et al. (2007) where the name *Pocillopora verrucosa* was used.

Pocillopora, especially those found in the eastern Pacific, have been analyzed using modern genetic analysis tools. Chavez-Romo et al. (2008) and Combosch et al. (2008) both interpreted the variability and intergradation of eastern Pacific pocilloporids as cases of introgressive hybridization. Combosch et al. (2008) provided data supportive of genetic isolation between eastern Pacific pocilloporids and those elsewhere in the Pacific and Indian Oceans and an apparent one-way gene flow into *Pocillopora damicornis* from one or both of congeners in the eastern Pacific, *Pocillopora eydouxi* and *Pocillopora elegans*. However, these studies both assume that the species descriptions of pocilloporids in the eastern Pacific, based on morphological and ecological characteristics, are valid. A more recent paper by Pinzón and LaJeunesse (2011) completely questions the validity of classical species descriptions of pocilloporids in the eastern Pacific, finding distinct genetic clades that do not correspond with the classical species. Their work shows that clade 1 and 3 species exist among colonies identified morphologically as *Pocillopora damicornis*, *Pocillopora elegans*, and *Pocillopora capitata* in Panama. Only *Pocillopora eydouxi* is found to exist entirely within clade 3 in Panama, although individuals identified as *Pocillopora eydouxi* exist entirely within clade 1 in Mexico. Similar work in the western Indian

Ocean (Souter, 2010; Souter et al., 2009) demonstrated similar issues in *Pocillopora* there. However, one distinct issue has long been identified as a concern over the identification of eastern Pacific pocilloporids as conspecifics of corals found elsewhere in the Pacific and in the Indian Ocean: the eastern Pacific corals are broadcast spawners, while elsewhere they are brooders (Glynn et al., 1991). Thus, *Pocillopora elegans* in these two regions are not only geographically isolated but unlikely to interbreed because of completely different reproductive modes.

Family: Pocilloporidae.

Evolutionary and geologic history: The genus *Pocillopora* was found in the Caribbean Sea as recently as the late Pleistocene (1.8–0.01 Ma; Geister, 1977b) and are widespread from the western Indian Ocean to the eastern Pacific Ocean. DeWeerd and Glynn (1991) discussed the strong affinity of the eastern Pacific coral fauna with the Indo-Pacific as being either due to massive Eocene and Pleistocene extinctions in the eastern Pacific followed by reintroduction of Indo-West Pacific species by long-distance dispersal, or survival of some coral populations in eastern Pacific refugia after the closure of the Isthmus of Panama, providing the source for recolonization of places close enough to these refugia (see (Rosen, 1988) for a review of the different theories). The past extinctions of eastern Pacific corals are of particular relevance to eastern Pacific pocilloporids.

Global Distribution

The global distribution of *Pocillopora elegans* is rather fragmented; it is found in the central Indo-Pacific, the Marianas and central Pacific and along the coastline of the eastern tropical Pacific and the Galapagos Islands (Veron, 2000; Wells, 1954).

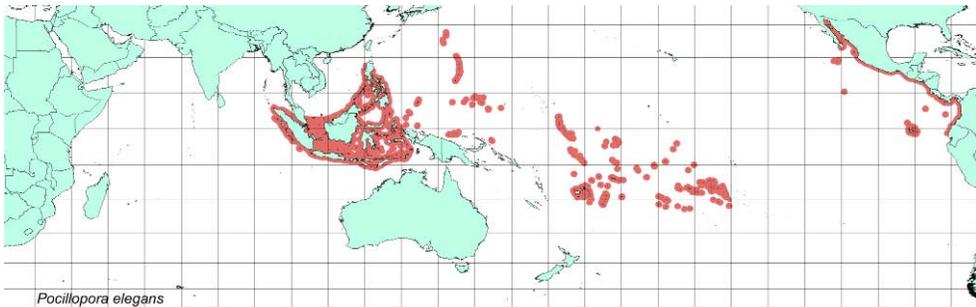


Figure 7.3.6. *Pocillopora elegans* distribution from IUCN copied from <http://www.iucnredlist.org>.

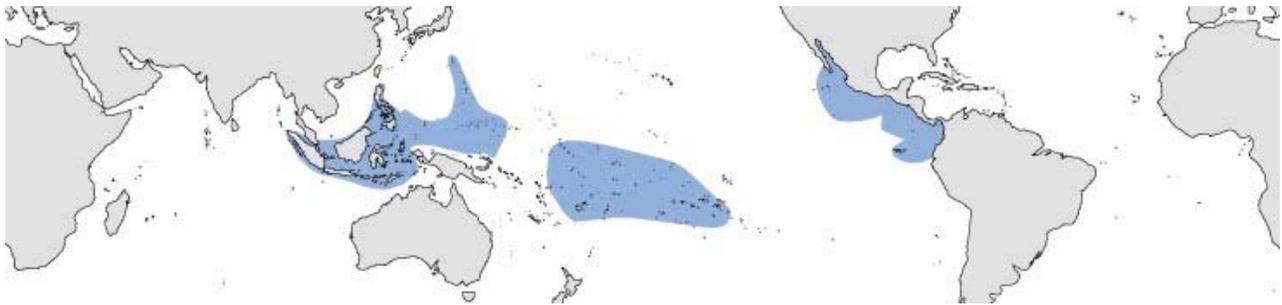


Figure 7.3.7. *Pocillopora elegans* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Pocillopora elegans* has been recorded in American Samoa and the Northern Mariana Islands. The IUCN Species Account also lists its occurrence in the U.S. minor outlying islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Pocillopora elegans* has been recorded at Tutuila and Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; Lovell and McLardy, 2008; National Park Service, 2009), Guam (Amesbury et al., 1999; Burdick, unpubl. data; Randall, 2003), Commonwealth of the Northern Mariana Islands, Johnston Atoll, Howland and Baker Islands, Jarvis Island and Kingman Reef (CRED, unpubl. data), and Palmyra Atoll (Williams et al., 2008b).

Within federally protected waters, *Pocillopora elegans* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Johnston, Howland, Baker, Jarvis, Palmyra, Kingman, Wake)
- National Park of American Samoa, Tutuila Island unit
- Fagatele Bay National Marine Sanctuary, Tutuila
- Rose Atoll Marine National Monument
- Marianas Trench Marine National Monument (Asuncion, Maug, Farallon de Pajaros)

Habitat

Habitat: *Pocillopora elegans* has been reported from shallow reef environments (Veron, 2000).

Depth range: *Pocillopora elegans* has been reported in water depths ranging from 1 m to 20 m (Carpenter et al., 2008); however, it has been found at a depth of 60 m, suggesting the potential for deep refugia.

Abundance

Abundance of *Pocillopora elegans* has been reported to be locally common in some regions of the central Indo-Pacific and the far eastern Pacific (Carpenter et al., 2008; Veron, 2000).

Life History

In the eastern Pacific, *Pocillopora elegans* was inferred to be a hermaphroditic broadcast spawner, based on the disappearance of mature gametes after the full moon (Glynn et al., 1991). However, that study did not directly observe spawning and little evidence shows successful recruitment through sexual propagation (Glynn and Ault, 2000; Glynn et al., 1991). Year-round reproduction occurred in Costa Rica and the Gulf of Chiriqui, whereas reproduction was confined to warm periods in the seasonally varying environments of the Galapagos Islands and the Gulf of Panama. Larvae contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Glynn and Colley, 2008). While frequent gamete maturation was observed during the study period 1984 to 1990, the relatively low rates of larval recruitment occurring on eastern Pacific coral reefs disturbed by the 1982-83 El Niño suggested that the recovery of important frame-building corals could be prolonged (Glynn and Colley, 2008).

During the strong El Niño conditions in the eastern Pacific experienced during the 1997-1998 ENSO colonies of *Pocillopora elegans* continued reproductive activity throughout severe bleaching episodes in the eastern Pacific (Colley et al., 2006). In the Galapagos Islands, this species displayed an enhanced effect on gametogenesis during moderate warming episodes but diminished activity with prolonged +2°C to +4°C temperature anomalies (Colley et al., 2006).

The minimum size and estimated age at first reproduction have not been determined for this species. However, for three other *Pocillopora* species, the minimum size ranges from 6 to 16 cm, and the estimated age ranges from 1 to 5 years (Harrison and Wallace, 1990). Larval longevity has not been determined for broadcast-spawning species in this genus, but larvae of the congener *Pocillopora damicornis*, which brood larvae, have an observed competency period of more than 100 days (Harri et al., 2002; Richmond, 1988).

Asexual reproduction by fragmentation is common in eastern Pacific populations of *Pocillopora elegans* (Glynn and Colley, 2008).

Threats

For each of these possible threats, see also Section 7.3: *Pocillopora* for additional genus level information.

Temperature stress: *Pocillopora* are widely recognized as being prone to expelling their zooxanthellae when the water becomes anomalously warm. In a series of field assessments, Marshall and Baird (2000) identified *Pocillopora damicornis* as having a “severe” response to increased water temperature, only matched by acroporids. McClanahan et al. (2007) surveyed thousands of corals of 39 genera and found *Pocillopora* to be among the most sensitive, with only 7 genera ranking higher and just below *Acropora* and branching *Porites*. Warming events, including the 1982-1983 El Niño, demonstrated the susceptibility of the pocilloporid corals that dominate reefs and coral communities of the eastern tropical Pacific Ocean (Glynn, 1984; 1990). Susceptibility of *Pocillopora* to thermal stress has not only been seen in the

field, but demonstrated in controlled, laboratory experiments (Berkelmans and Willis, 1999; Glynn and D'Croz, 1990; Hueerkamp et al., 2001; Jokiel and Coles, 1977). Even if bleaching is only temporary, physiological stress and decrease in nutrition are likely to have the synergistic effects of lowered fecundity and increased susceptibility to disease (Bruno et al. 2007, Whelan et al. 2007, Muller et al. 2008).

Acidification: One recent study (Manzello, 2010) compared growth rates of *Pocillopora elegans* and *Pocillopora damicornis* in the eastern Pacific and attributed the 25%-30% decline in growth over the past 30 years to acidification. Additionally, the extension rate of pocilloporids within the eastern Pacific declined nonlinearly along a saturation state gradient (Manzello, 2010). This major decrease in growth is despite the already-existing, low aragonite saturation state seen naturally in reef waters of the eastern Pacific Ocean (Manzello et al., 2008). While the dominance of pocilloporids in the eastern Pacific might have been thought to imply a degree of tolerance to acidification, they may have been living close to a threshold for skeletal deposition. Brooding *Pocillopora damicornis* in Hawai'i were found to settle successfully in aquaria with reduced saturation state (Jokiel et al., 2008). Work in other corals has shown that impacts are not limited to extension as acidification impairs fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and contributes to reef destruction (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). The BRT considers it to be a significant threat to corals by 2100.

Disease: There have been a medium number of disease reports for the genus *Pocillopora* (UNEP, 2010). Disease reports included chronic skeletal growth anomalies, including hyperplasia and neoplasia, subacute black-band disease, yellow-band disease, tissue loss, and pigmentation response including pink-line syndrome, and acute tissue necrosis white-band disease (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010; CRED, unpubl. data). Effects on reproduction are unknown. Synergy with other threats is largely unknown except with bleaching in the eastern Pacific (1982-83, 1997-98 ENSO East Pacific). Aeby (2006) identified *Pocillopora* as the genus least affected by disease in the Northwestern Hawaiian Islands. Pocilloporids on the Great Barrier Reef have been identified occasionally with the more common diseases (Willis et al., 2004), while in Zanzibar they were found to be susceptible to an especially destructive bacterium (Ben-Haim and Rosenberg, 2002). However, the limited number of reports of disease in pocilloporids indicates that infectious disease is not a major threat to members of this genus.

Predation: *Pocillopora* species are among the most commonly consumed coral genera by crown-of-thorns seastar, *Acanthaster planci* (Glynn, 1976). However, *Pocillopora* are defended from *Acanthaster* predation by two mutualistic crustacean symbionts: a crab and a snapping shrimp, often forming protective barriers around unprotected species (Glynn, 1976). Because smaller colonies lack these symbionts, *Acanthaster* often target young colonies, potentially reducing recruit success. Additionally, *Pocillopora* also has been identified as preferred prey for corallivorous invertebrates such as the asteroid *Culcita novaeguineae* (Glynn and Krupp, 1986) and the gastropod *Jenneria pustulata* (Glynn, 1976), and corallivorous fishes (Cole et al., 2008).

Land-based sources of pollution (LBSP): McClanahan and Obura (1997) identified *Pocillopora* as sediment-intolerant in the western Indian Ocean. In contrast, *Pocillopora* has often been found in relatively turbid waters in the eastern Pacific and were considered potentially sediment-tolerant by Rogers (1990) and from an examination of data from Guam (Randall and Birkeland, 1978). However, excess sedimentation has been identified as the cause of the collapse of a predominately *Pocillopora* spp. reef in Costa Rica (Cortés, 1990). Clearly, while some *Pocillopora* may have shown a degree of sediment tolerance, the distribution of corals of the genus *Pocillopora* has often been found to be sediment-limited.

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: No trade information on *Pocillopora* was listed on the CITES Trade Database, UNEP World Conservation Monitoring Centre (CITES 2010). However, *Pocillopora* is frequently seen for sale as curios (Mark Eakin NOAA Coral Reef Watch, Silver Spring, MD, pers. comm., February 2011).

Risk Assessment

The nominal candidate species, *Pocillopora elegans*, was split into two probable species based on three features considered the most important by the BRT in resolving taxonomic issues among the candidate pocilloporid species: (1) taxonomic uncertainties among morphologically identified species in the eastern Pacific; (2) the distinctly different reproductive pattern of eastern Pacific pocilloporids; and, (3) the evidence of low gene flow between the eastern Pacific and other Pacific and Indian Ocean pocilloporids. These latter two factors appear to preclude interbreeding as required in the U.S. Endangered Species Act definition of a species. Also, the restricted habitats in the eastern Pacific and high threat of thermally induced bleaching (Glynn, 1990) suggested that pocilloporids in the eastern Pacific are at greater risk than elsewhere in their ranges. Based on these factors, it was determined by the BRT that the corals classically identified as *Pocillopora elegans* in the eastern Pacific are most likely members of at least two different genetic clades that include corals identified as other pocilloporids. However, the eastern Pacific *Pocillopora elegans* (and congeners) are genetically separate from those found elsewhere in the Pacific and Indian Oceans. Therefore, the BRT determined that corals identified as *Pocillopora elegans* in the eastern Pacific were a distinct species from corals identified as *Pocillopora elegans* in the central and Indo-Pacific. For the purposes of this Status Review Report, the BRT evaluated and reported the extinction risk of these two as separate species. Further molecular genetic analysis will be required to determine if further subdivisions are warranted within the two allopatric species. If this BRT determination is in error (i.e., all corals currently identified as *Pocillopora elegans* are actually members of the same species), the risk would be similar to or less than the likelihood of falling below the Critical Risk Threshold for the central and Indo-Pacific species.

Eastern Pacific *Pocillopora elegans*

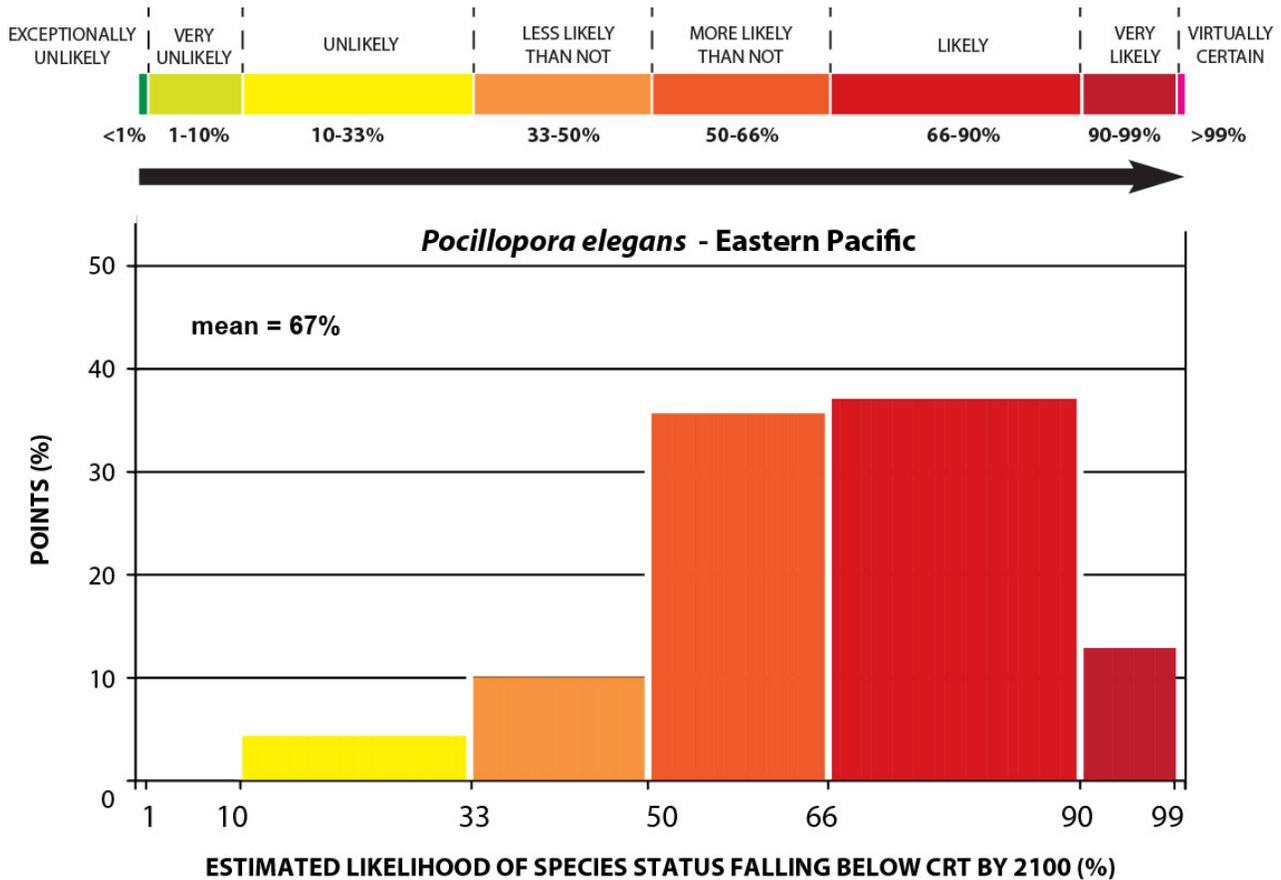


Figure 7.3.8. Distribution of points to estimate the likelihood that the status of *Pocillopora elegans* from the eastern Pacific falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Pocillopora elegans* (eastern Pacific) include its relatively high bleaching susceptibility, its susceptibility to crown-of-thorns seastar predation, and its susceptibility to acidification impacts. The high bleaching rate of pocilloporid corals is the primary known threat of extinction for *Pocillopora elegans* (eastern Pacific). While it is one of the dominant species in the eastern Pacific, the eastern Pacific taxon has a very restricted range in an environment where impacts of both bleaching and acidification have been shown to be high. In particular, severe losses after bleaching, slow recovery, and little evidence of successful recruitment through sexual propagation particularly threaten these corals. The impacts of bleaching and acidification are expected to increase with anthropogenic climate change. Because of repeated thermal stress and limited coral reef habitats, corals endemic to the eastern tropical Pacific are especially at risk. In a discussion of *Millepora boschmai*, a hydrocoral presumed to have gone extinct in recent decades, de Weerd and Glynn (1991) discussed the risk posed to any coral endemic to the eastern Pacific:

“Elements of the eastern Pacific reef coral fauna, consisting of several small, geographically isolated populations in a highly varying environment, would seem to be especially vulnerable to extinction (Carlton et al., 1991; Diamond, 1984; Leigh, 1981; MacArthur, 1972; MacArthur and Wilson, 1967; Morain, 1984; Simberloff, 1976; Vermeij, 1978). ENSO events, which started about 2.8 million years ago after the rise of the Panama Isthmus (Colgan, 1990), and have since then occurred continuously but unpredictably (Colgan, 1990; Glynn, 1990), probably contribute to the poor development of eastern Pacific coral reefs (Glynn, 1990). Range reductions, which affected the hydrocoral *Millepora platyphylla* and possibly three scleractinian species (Colgan, 1990; Glynn, 1990), may therefore have occurred regularly in the eastern Pacific since the onset of said events. If *Millepora boschmai* was endemic to the Gulf of Chiriqui prior to its disappearance, recovery of the species seems highly unlikely, but this can only be ascertained in due time.”

Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are the species' quite common abundance where found, and potentially high disease resistance.

The overall likelihood that eastern Pacific *Pocillopora elegans* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “likely” risk category with a mean likelihood of 67% and a standard error (SE) of 13% (Fig. 7.3.8). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.3.8) and the mean range of votes of 53%—the latter calculated by averaging the range of likelihood estimates from each of the seven BRT voters. The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for this species. However, the number of votes cast at the high end of the likelihood range demonstrates that the BRT considered eastern Pacific *Pocillopora elegans* to be much more at risk than its congeners across the remainder of the Indo-Pacific to the west.

Central and Indo-Pacific *Pocillopora elegans*

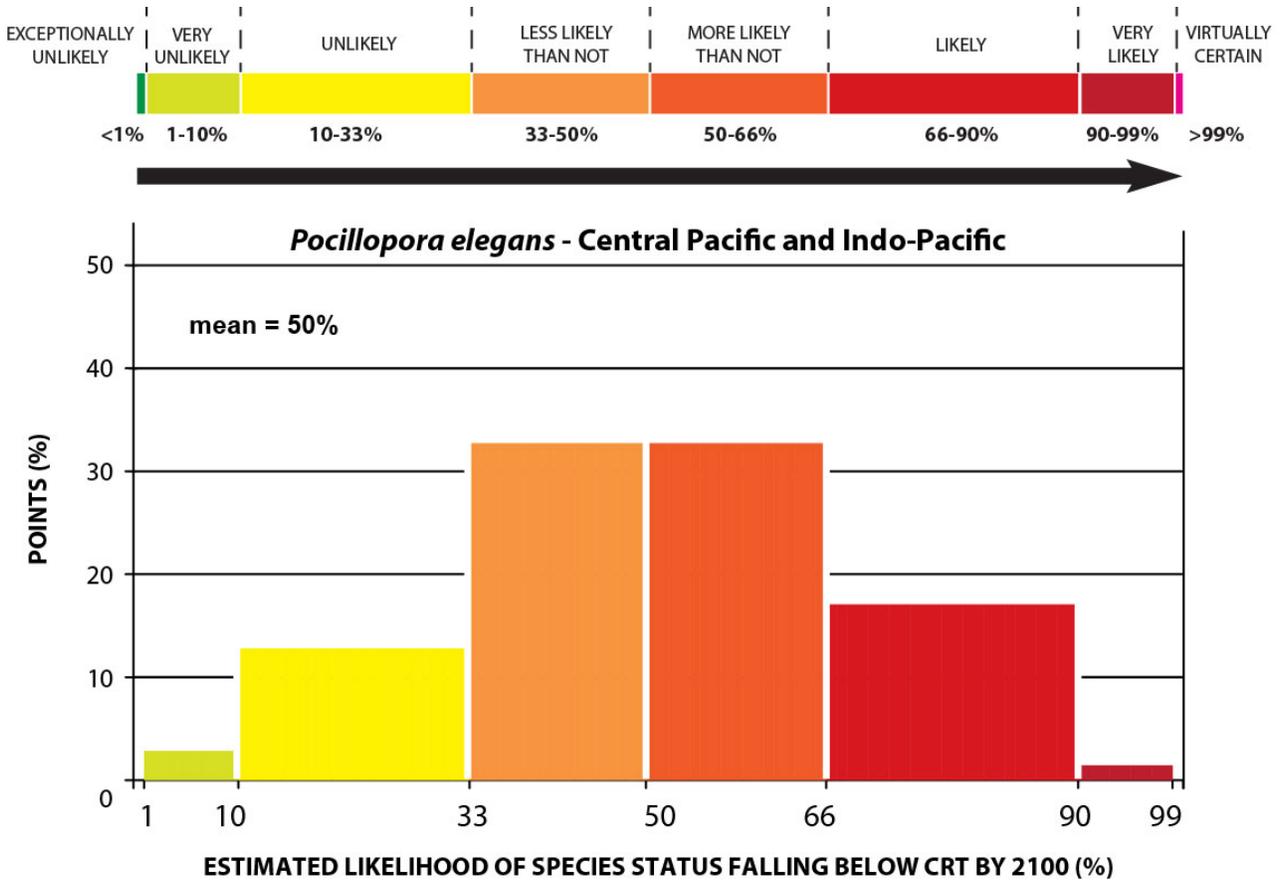


Figure 7.3.9. Distribution of points to estimate the likelihood that the status of *Pocillopora elegans* from the central and Indo-Pacific falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Pocillopora elegans* (central and Indo-Pacific) include its relatively high bleaching susceptibility, its susceptibility to crown-of-thorns seastar predation, and its susceptibility to acidification impacts. The high bleaching rate of pocilloporid corals is the primary known threat of extinction for *Pocillopora elegans*. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are the species’ somewhat wide geographic distribution range including the Coral Triangle, quite common abundance where found, and potentially high disease resistance.

The overall likelihood that *Pocillopora elegans* from the central Pacific and Indo-Pacific will fall below the Critical Risk Threshold by 2100 was estimated to be “as likely as not” with a mean likelihood of 50% and a standard error (SE) of 15% (Fig. 7.3.9). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 1%–99% (Fig. 7.3.9) and the mean range of votes of 57%—the latter calculated by averaging the average range of likelihood estimates from each of the seven BRT voters. The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Pocillopora elegans* (central and Indo-Pacific).

7.4 Genus *Seriatopora*

7.4.1 *Seriatopora aculeata* Quelch, 1886



Figure 7.4.1. *Seriatopora aculeata* photos from Veron (2000).

Characteristics

Colonies of *Seriatopora aculeata* have thick, short, tapered branches, usually in fused clumps. Their corallites are irregularly distributed, and tentacles are commonly extended during the day. Colonies are pink or cream in color (Veron, 2000).

Taxonomy

Taxonomic issues: The taxonomic status of the genus *Seriatopora* is somewhat uncertain; mitochondrial DNA shows four sequence clusters that do not correspond well to morphological species identifications (Flot et al., 2008). The few *Seriatopora aculeata* samples that were included clustered together and overlapped with *Seriatopora hystrix*. Similar species *Seriatopora stellata* and *Seriatopora hystrix* can have similar branching structures in shallow, exposed reef flats (Veron, 2000). This phenotypic plasticity could account for some of the taxonomic uncertainty in the genus. Additional genetic research is required to resolve the status of the genus *Seriatopora*; for the purposes of this status review the BRT considered this to be a valid species.

Family: Pocilloporidae.

Evolutionary and geologic history: The genus *Seriatopora* first appeared in the Indo-Pacific in the Miocene (23–5.3 Ma) (Veron, 1986).

Global Distribution

Seriatopora aculeata has a relatively confined distribution. It has been reported primarily from the Indo-Pacific, including Australia, Fiji, Indonesia, Japan, and Papua New Guinea. However, it is also reported from Madagascar. It was recently found in Bikini (Richards et al., 2008a), despite not being recorded in previous surveys there (Wells, 1954).

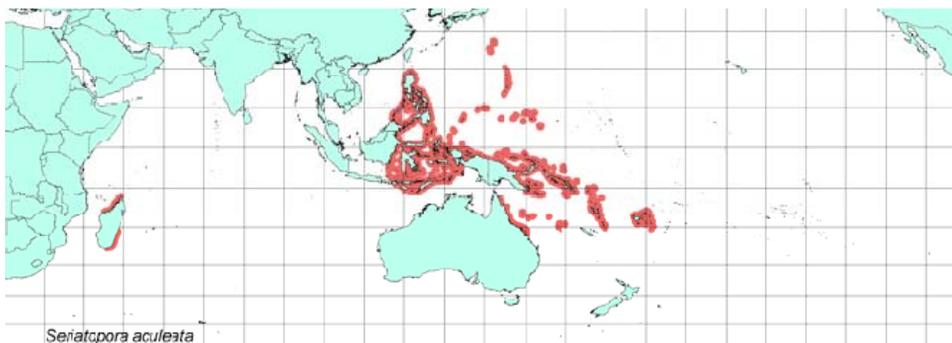


Figure 7.4.2. *Seriatopora aculeata* distribution from IUCN copied from <http://www.iucnredlist.org>.

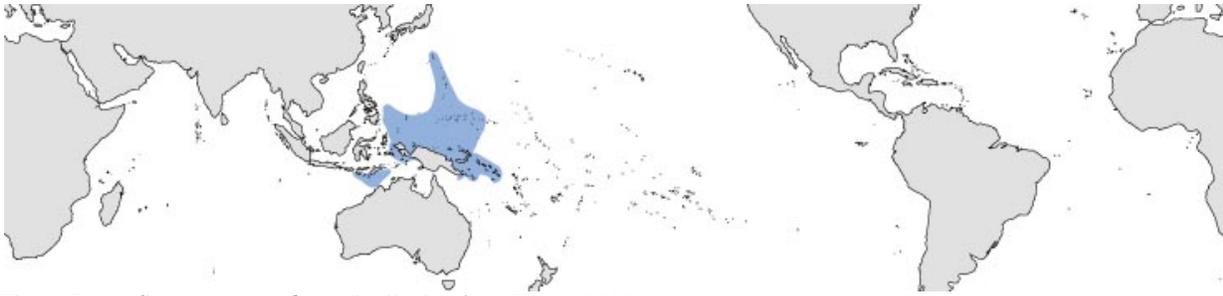


Figure 7.4.3. *Seriatopora aculeata* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Seriatopora aculeata* has been recorded in the Northern Mariana Islands. The CITES species database does not list its occurrence in U.S. waters.

A search of published and unpublished records of occurrence in U.S. waters indicates *Seriatopora aculeata* has been reported from Guam (Burdick, unpubl. data; Randall, 2003). Veron (2000) lists the species in the Marianas; however, the Marianas reference is likely an error based on geographic location of photographic evidence (Kenyon et al., 2010b). G. Paulay (University of Florida, Gainesville, FL, pers. comm., 28 February 2010) indicates a number of photos submitted by him to Veron from Palau, the Cook Islands, and other locations in the Pacific were mistakenly attributed to Guam (similar to the *errata* later acknowledged by Veron (2002) for *Acanthastrea regularis* and *Porites napopora*).

Seriatopora aculeata has not been recorded from federally protected U.S. waters (Kenyon et al., 2010b).

Habitat

Habitat: *Seriatopora aculeata* has been reported to occupy shallow reef environments (Veron, 2000).

Depth range: *Seriatopora aculeata* has been reported in water depths ranging from 3 m to 40 m (Carpenter et al., 2008).

Abundance

Abundance of *Seriatopora aculeata* has been reported as uncommon (Veron, 2000).

Life History

The reproductive characteristics of *Seriatopora aculeata* have not been determined, but its congeners are hermaphroditic brooders (Rinkevich and Loya, 1979a; Shlesinger and Loya, 1985; Yamazato et al., 1991). The larvae of the other *Seriatopora* species studied contain zooxanthellae, leading to the development of autotrophic larvae that can supplement maternal provisioning with energy sources provided by their photosynthetic symbionts (Baird et al., 2009). The minimum size and estimated age at first reproduction have not been determined for *Seriatopora aculeata*. However, for the congener *Seriatopora hystrix*, the minimum diameter is 8 cm and the estimated age at first reproduction is 1–2 years (Stimson, 1978). Larval longevity has not been determined in this genus. *Seriatopora hystrix* can undergo polyp bailout during environmentally stressful conditions and successfully reattach (though at low rates) to the substrate (Sammarco, 1982); however, this potential mode of asexual reproduction has not been documented for *Seriatopora aculeata*.

Threats

Thermal stress: Although there is not much species-specific information about the response of *Seriatopora aculeata* to thermal stress, the genus *Seriatopora* are highly susceptible to bleaching across regions, including Micronesia (Paulay and Benayahu, 1999), the Great Barrier Reef (Marshall and Baird, 2000), and the western Indian Ocean (McClanahan et al., 2007).

Acidification: No specific research has addressed the effects of acidification on the genus *Seriatopora*. However, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Seriatopora aculeata* are not known. However, there is ample evidence that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004).

Predation: The specific effects of predation are poorly known for *Seriatopora aculeata*. The genus *Seriatopora* is known to be susceptible to predation by snails (Cumming, 1999) and the crown-of-thorns seastar, *Acanthaster planci* (Weber and Woodhead, 1970).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Seriatopora aculeata*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: The genus *Seriatopora* has been heavily traded (CITES, 2010), primarily from Fiji and Indonesia (and occasionally the Philippines and Taiwan). Many records are at the genus level; trade was heavy in the mid-1980s (exceeding 134,000 pieces in 1987). Congeneric species *Seriatopora hystrix* is the most heavily exploited species, although *Seriatopora caliendrum* is also exported. The only record for *Seriatopora aculeata* is for four pieces from Indonesia in 2008.

Risk Assessment

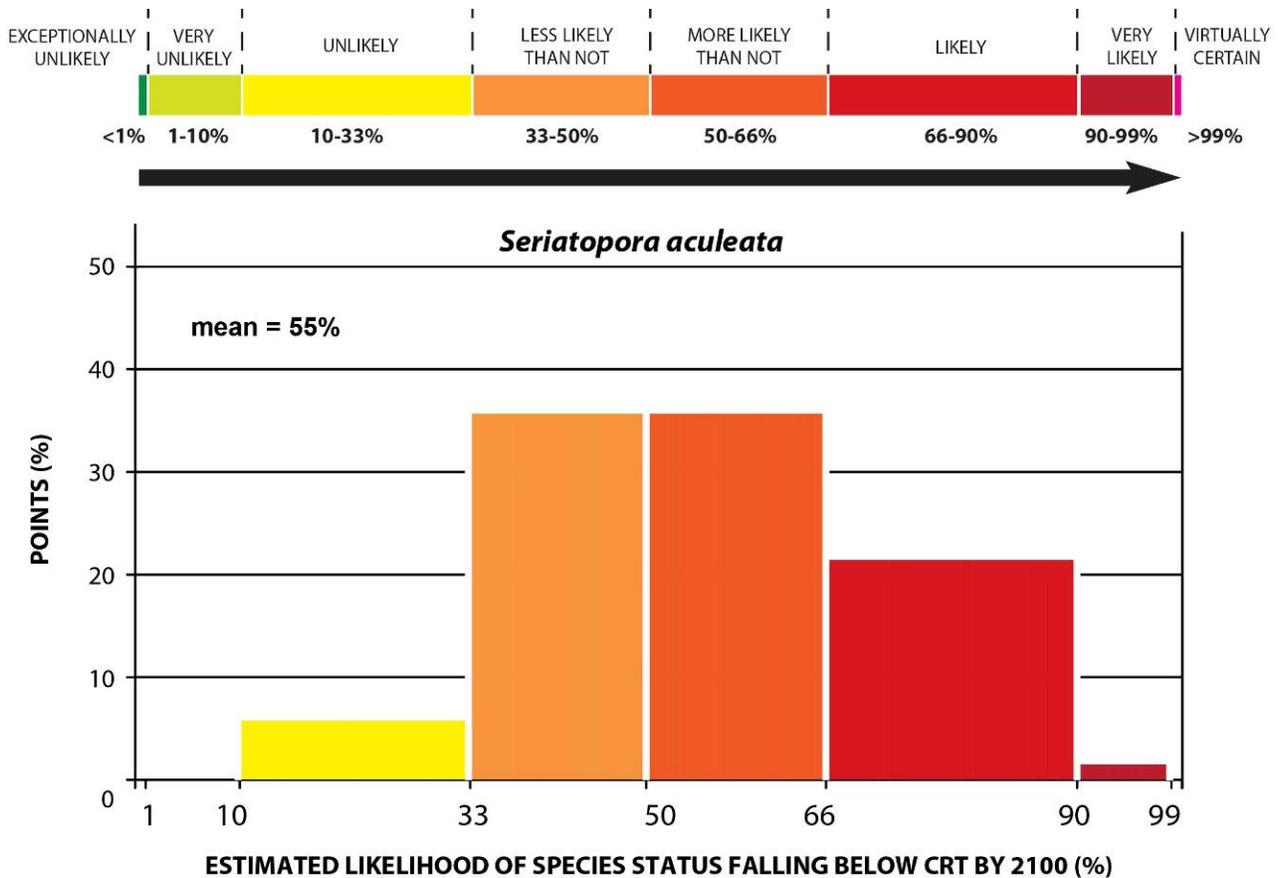


Figure 7.4.4. Distribution of points to estimate the likelihood that the status of *Seriatopora aculeata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

The primary factor that increases the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Seriatopora aculeata* is its high bleaching susceptibility. The genus *Seriatopora* is heavily traded, but not often identified to species. Heavy use in the aquarium trade implies the potential for local extirpation for this usually uncommon species. The primary factor that reduces potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) is that *Seriatopora aculeata* has a moderate range latitudinally (if additional genetic work determines *Seriatopora aculeata* and *Seriatopora hystrix* to be the same species, the range and abundance would increase and further reduce risk).

The overall likelihood that *Seriatopora aculeata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 55% and a standard error (SE) of 10% (Fig. 7.4.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.4.4) and the average range of likelihood estimates of the seven BRT voters (59%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Seriatopora aculeata*. The BRT considered this a valid species for evaluation purposes, but uncertainty over the taxonomic status of species within this genus and may also have contributed to the spread of votes.

7.5 Genus *Acropora* (Family Acroporidae)

Acroporidae

Worldwide, *Acropora* are usually among the first corals to show substantial losses in times of stress (Riegl, 2002). Species of *Acropora* tend to have particularly high vulnerability to predation, disease, sedimentation, and high temperatures (discussed separately below). Although the earliest fossils of *Acropora* that have been found were from the late Paleocene (54 Ma) and ancestors of 9 of the 20 *Acropora* species groups existed in the Eocene (49–34 Ma), the impressive diversification of the genus *Acropora* is thought to have occurred in the southwestern Pacific very recently, within the past 2 million years (Wallace and Rosen, 2006; Wood, 1999). *Acropora palmata* became a dominant component of western Atlantic reefs about 0.5 Ma. The Ice Ages have been especially good for the formation of coral reefs, and apparently the diversification of *Acropora*, because of low levels of atmospheric CO₂ and because it was a time in which the Mg/Ca ratio of seawater supported the aragonitic mineralogy of coral skeletons (Ries et al., 2006; Stanley, 2006).

During times when environmental conditions are favorable to coral growth, winning in competition for space might have a greater selective advantage than ability to withstand a stressful physical environment. By the Principle of Allocation (Cody, 1966), phenotypes have to allocate limited resources between competing physiological processes. This involves trade-offs. If *Acropora* is selected to grow very rapidly to overtop other corals, then it might be cutting costs in complex biochemical defenses against predation, chemicals or infection, such as heat-shock proteins, antioxidants, and innate immunity (Palmer et al., 2010), thereby reducing its ability to resist environmental stresses. *Acropora* species became a dominant component of reefs in the later Neogene (23 Ma to present) by their rapid growth, outcompeting for space by growing upward and overtopping. This rapid growth was achieved by maintaining lower tissue and energetic reserves than slower-growing corals do. The tissue layer of *Acropora* species is 1.0–1.9 mm thick, while massive corals generally have tissues 2.8–4.0 mm thick (Loya et al., 2001). The percent nitrogen in the tissues of *Acropora* was found to be 1.55–1.81 while the percent nitrogen in six genera of massive corals was 2.66–4.65 (Rotjan, 2007). The percent carbon in *Acropora* was 11.74–11.83 while the percent carbon in six genera of massive corals was 19.01–27.59 (Rotjan, 2007). High energetic reserves help corals withstand or recover from bleaching (Grottoli et al., 2004; Rodrigues and Grottoli, 2007; Rodrigues et al., 2008), so the thin, nutrient-poor tissues of *Acropora* may be a handicap in that regard. The rates of growth of branching corals, especially *Acropora*, are more directly affected by the physical environment (Gladfelter et al., 1978) while the growth of massive corals is controlled to a greater degree by their own physiology (Smith et al., 2008). Similarly, while skeletons of massive corals are usually deposited as dense layers (dissepiments) beneath each polyp, *Acropora* can grow an order of magnitude faster by having an axial polyp deposit a highly porous skeleton. Acroporids are apparently focused on rapid growth, overtopping, and competition for space, with a cost in resources for withstanding harsh physical environmental factors.

The Pacific Acroporids are a particularly speciose and ecologically important group of corals and, as such, have been the subject of extensive taxonomic, as well as ecological research. This extensive taxonomic attention has included several authoritative taxonomic revisions, the work of Wallace (1999) providing the best example. In the course of such revisions, old species names are often subsumed (or renamed), a process known as synonymizing. Hence, in the future treatment of such species, it will be noted that it is ‘synonymous’ with additional (generally obsolete) species names. In these cases, the term synonymy does not indicate current taxonomic uncertainty, rather, it indicates that authoritative taxonomic revision has occurred in the past.

Another manifestation of the special attention given to this speciose group is the recent work of Richards (2009) which has undertaken ecological and genetic comparison of naturally rare and very common species within the *Acropora* genus. Several useful constructs of Richards’ analysis were considered extensively by the BRT in assessing extinction risk among the candidate *Acropora*. These useful constructions included a ranking of 114 species by geographic range size and a nuanced description of rarity for each species that incorporated global distribution, local distribution (frequency of occurrence at sites within individual localities), and local abundance. Richards articulates the latter characterization of rarity for each as one of eight Occupancy Types, with Types 1 and 2 representing high risk of global and local extinction, respectively, because of low abundance *combined with* restricted range. The other six Occupancy Types (3–8) are characterized by some combination of higher abundance and/or greater distribution which yields lower expected extinction risk (Richards, 2009). These Richards Occupancy Types are listed in the appropriate species’ assessments below.

Life History

Acropora are sessile colonies that spawn their gametes into the water column, and the azooxanthellate larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many *Acropora* species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). Vollmer and Palumbi (2007), using DNA sequence data, determined that *Acropora cervicornis* in the Caribbean have limited realized gene flow despite long-distance dispersal potential. Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for *Acropora*, the year-by-year replenishment of populations requires local source populations. All species of the genus *Acropora* studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in *Acropora* colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of *Acropora* are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five *Acropora* species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 10^6 ml^{-1} have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization. *Acropora* spp. can show a high degree of hybridization (Kenyon, 1994; Richards et al., 2008b; Van Oppen et al., 2002; Van Oppen et al., 2000), which can complicate taxonomic classification but allow persistence of the genus if the hybrids are reproductively viable.

As sessile spawners with planktonic larvae, the Critical Risk Threshold assessments for *Acropora* species must weigh the broad distributions that provide replicated opportunities for potential escape from local disturbances against the necessity to have colonies in close enough proximity to have successful fertilization of enough eggs to replenish the attrition of the spawning stock. If the effective population size (i.e., the number of genotypes [might be substantially less than the number of colonies in highly clonal species] close enough for successful fertilization) becomes too low to replenish the population, then the positive-feedback compensatory processes begin. It is worth noting that Edinger and Risk (1995) concluded that brooding corals survived the harsh environmental conditions better than did the spawners in the western Atlantic during the major extinctions of the Oligocene-Miocene transition period. Many *Acropora* have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Threats

Thermal Stress: The genus *Acropora* is widely recognized as being particularly prone to expelling their zooxanthellae when the water becomes anomalously warm. In a series of field assessments, Marshall and Baird (2000) noted that 14 of the 22 species of *Acropora* showed a “severe” response to increased water temperature. The others were “mixed” and possibly “severe” with them also. McClanahan et al. (2007) surveyed thousands of corals of 39 genera and found *Acropora* to be among the most sensitive to anomalously warm waters, with only 5 genera ranking higher. Branching *Acropora* tended to be more severely affected than tabular *Acropora* (Floros et al., 2004; Loya et al., 2001), although this was not always the case (Marshall and Baird, 2000). In addition, bleaching-induced mortality can be severe; *Acropora* in the southeastern Arabian Gulf suffered > 90% mortality during the 1996 bleaching event (Riegl, 1999). However, remnants of *Acropora vaughani* deep inside the reef framework survived after the 1998 mass bleaching event (Riegl and Piller, 2001), providing for potentially accelerated recovery. A modeling study by Riegl and Purkis (2009) emphasized the importance of larval connectivity in promoting recovery of coral populations following repeated bleaching events and predicted that mass bleaching mortality events must remain infrequent (< 15 years) to avoid *Acropora* spp. collapse in Arabian Gulf reef communities.

Even if bleaching is only temporary, physiological stress and the decrease in nutrition are likely to have the synergistic effects of lowered fecundity and increased susceptibility to disease (Bruno et al., 2007; Muller et al., 2008; Whelan et al., 2007). Fertilization and larval stages of *Acropora* spp. have also been shown to be particularly vulnerable to

anomalously warm temperatures, displaying reduced fertilization, developmental abnormalities and reduced larval survivorship (Negri et al., 2007; Randall and Szmant, 2009a).

Acidification: Acidification can have a variety of effects on *Acropora*. While increased CO₂ (increased acidity) does not appear to affect the survival of *Acropora* larvae, fertilization, settlement, rate of zooxanthellae acquisition, and post-settlement growth are all significantly impaired (Albright et al., 2010; Suwa et al., 2010). Elevated CO₂ also induces bleaching in *Acropora*, even more so than temperature increases (Anthony et al., 2008). CO₂ enrichment to 600–790 ppm enhanced maximum photosynthetic rates in *Acropora formosa* (Crawley et al., 2010), but elevated CO₂ levels had no effect on photosynthesis or respiration in *Acropora eurystoma* (Schneider and Erez, 2006). Moderate increases in CO₂ may enhance *Acropora* productivity, which falls back to zero at high CO₂ (Anthony et al., 2008). More consistently, elevated CO₂ tends to decrease *Acropora* growth and calcification rates (Anthony et al., 2008; Gattuso et al., 1998; Renegar and Riegl, 2005; Schneider and Erez, 2006), primarily as a result of carbonate ion concentration rather than pH or total inorganic carbon levels (Schneider and Erez, 2006). Although other coral taxa may experience a similar overall reduction in calcification based on CO₂, *Acropora* show a greater reduction in the mineral density of its skeletal crystals (Marubini et al., 2003).

Decadal-scale reductions in growth rates of the Caribbean congener, *Acropora palmata*, in Curaçao have been attributed to acidification (Bak et al., 2009).

Disease: *Acropora* are vulnerable to most of the diseases known to affect scleractinian corals and are more commonly affected by acute and lethal conditions (e.g., “white diseases”) than some other taxa. The greatest losses of corals to diseases throughout the western Atlantic have been *Acropora palmata* and *Acropora cervicornis* (Aronson and Precht, 2001). By drastically reducing the population fecundity, the depensatory effects of disease mortality can act synergistically with the depensatory effects of low colony density impairing successful fertilization, with both factors operating by positive feedback. As an example from Eastern Dry Rocks Reef in the Florida Keys: “During the 7 years of the photostation survey, living cover of *Acropora palmata* decreased by 98% [from white pox]. Coral recruitment was not observed within the photostation during the 7-year survey (Patterson et al., 2002). Other examples of diseases impacting *Acropora* include: black-band disease in Australia (Miller, 1996), skeleton-eroding band disease in Jordan (Winkler et al., 2004), a fungal disease in Kenya (McClanahan et al., 2004b), a yellow-band disease in the Arabian Gulf (Korrubel and Riegl, 1998; Riegl, 2002), and white-band disease in Saudi Arabia (Antonius, 1985).

Predation: *Acropora* species are preferred prey of most corallivorous invertebrate predators, e.g., *Acanthaster planci*, *Drupella* spp., *Quoyula monodonta*, *Coralliophila abbreviata*, and *Hermodice carunculata*. Of 14 species of corallivorous butterflyfishes on the Great Barrier Reef, 11 preferred *Acropora* and at least one chaetodontid fed exclusively on *Acropora* (Motta, 1989). Of 14 species of corallivorous butterflyfishes on the Great Barrier Reef, 11 preferred *Acropora* and at least one chaetodontid fed exclusively on *Acropora* (Motta, 1989). Chaetodontids with territories consume between 400 and 700 bites per hour from tabular *Acropora* (Gochfeld, 2004; Tricas, 1985) and corallivorous chaetodontids can occur at average densities of 50–70 fish per 1000 m². This intense predation appears to have been sustainable under the environmental conditions of the Pleistocene (2.6 M to 12,000 years ago) that were favorable to the growth of *Acropora* colonies. In view of the relatively low nitrogen and carbon in the tissue of *Acropora* in combination with its preference as prey by such a disparate group of corallivores, it is reasonable to assume that *Acropora* species do not invest a major portion of metabolic energy in biochemical or structural defenses against predation. Their defense against both competitors and predators appears to be rapid growth.

However, it has been shown that when a living coral population is substantially reduced by natural or anthropogenic disturbances to below a threshold (< 5% cover), the risk of overpredation produces a positive-feedback depensatory effect (Jayewardene et al., 2009). Even with the rates of predation staying the same as in the stable reef community, once a severe disturbance lowers the living coral cover below a threshold, predation by corallivorous invertebrates (Glynn, 1985a; 1990; Knowlton et al., 1990) or fishes (Guzmán and Robertson, 1989; McClanahan et al., 2005b; Rotjan et al., 2006) can seriously impede or even prevent the recovery of the coral populations. The depensatory effects of predation can act synergistically with the depensatory effects of colonies being too spread out for successful fertilization.

Land-based sources of pollution (LBSP): In clear water, *Acropora* colonies of a number of species have been reported to be living apparently well at 60-m depth and deeper (Bare et al., 2010). But *Acropora* colonies can be restricted by turbid waters. Experiments by Rogers (1979) showed *Acropora* to be the most sensitive to shading (a proxy for turbidity) of the genera she tested. In two communities composed of a total of 159 species of stony corals that extended from forereef slopes into turbid bays up to the mouths of rivers in Guam, colonies of *Acropora* were among the first to

drop out (Randall and Birkeland, 1978). Certain *Acropora* growth forms are effective at passive sediment rejection (Stafford-Smith and Ormond, 1992)—for example, cylindrical branching or perforated tabular forms. However, the cylindrical form of branching *Acropora* and the perforated form of tabular *Acropora* possibly reduce the vulnerability of adult colonies to sediment per se, but *Acropora* are not particularly adept at actively removing sediment (Hubbard and Pocock, 1972), and Rogers (1983) found *Acropora* to be most vulnerable of the genera she studied.

As with most corals, adult colonies of *Acropora* have been reported to be especially affected by sedimentation during reproduction. Turbidity and coating by sediment decrease the metabolic energy available to corals by reducing the light available for photosynthesis by the zooxanthellae and increasing energy needed for the removal of sediment by the coral animal through mucus production and ciliary action. These decreases in metabolic energy reduce the fecundity of the coral (Tomascik and Sander, 1987b). Lateritic soils are typical of tropical islands. The iron in lateritic (“red”) soils and other chemicals in runoff interfere with synchronization among colonies, egg-sperm recognition and interactions, fertilization, and embryological development (Richmond et al., 2006). Sediment, toxins, and elevated nutrients all reduce fertilization success, survival, and settlement of *Acropora* larvae (Gilmour, 1999; Humphrey et al., 2008; Reichelt-Brushett and Harrison, 2000; Ward and Harrison, 2000). The recruitment of larvae is inhibited by sediment covering signals for substratum recognition, covering the appropriate hard surface, and burying the newly settled corals if they are temporarily given the chance to settle. Sediment particles, specifically lateritic red clay and mud particles, serve as nuclei for bacterial and microfaunal aggregations in organically rich materials that settle on the reef substrata and contribute to the biological oxygen demand on reef surfaces at night (Richmond et al., 2006). By reducing success in fecundity, fertilization, larval settlement, and survival of juveniles, sedimentation and associated turbidity have compensatory effects (Birrell et al., 2005).

Collection/Trade

As a whole, *Acropora* are heavily traded (Table 7.5.1). However, trade quotas or reported exports are generally listed only at the genus level, making assessment of species-level threat difficult. Export records are available for *Acropora striata*, *Acropora tenella*, and *Acropora vaughani*.

Table 7.5.1. Summary tables for quotas and exports of *Acropora* spp. as reported to CITES (CITES, 2010).

Quotas by Country									
(pieces of corals)	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fiji				48180		96930		96360	72270
Indonesia	6300	7000	5500	24500	24500	18000	48000	40000	18000
Exports by Country									
(pieces of corals)	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fiji	61664	67554	82411	51070	102400	52340	43187	42232	31428
Indonesia	56124	45903	51550	62151	132246	173870	238872	268305	157649
Malaysia	0	0	0	722	2491	1668	1833	6946	5053
Solomon Islands	1849	3146	2128	12388	17868	14733	28840	17450	16940
Tonga	16884	16318	16461	406595	13649	20444	26461	14838	12074
Vietnam	45861	22047	2818	4642	3237	13	4	21	10

7.5.1 *Acropora aculeus* Dana, 1846

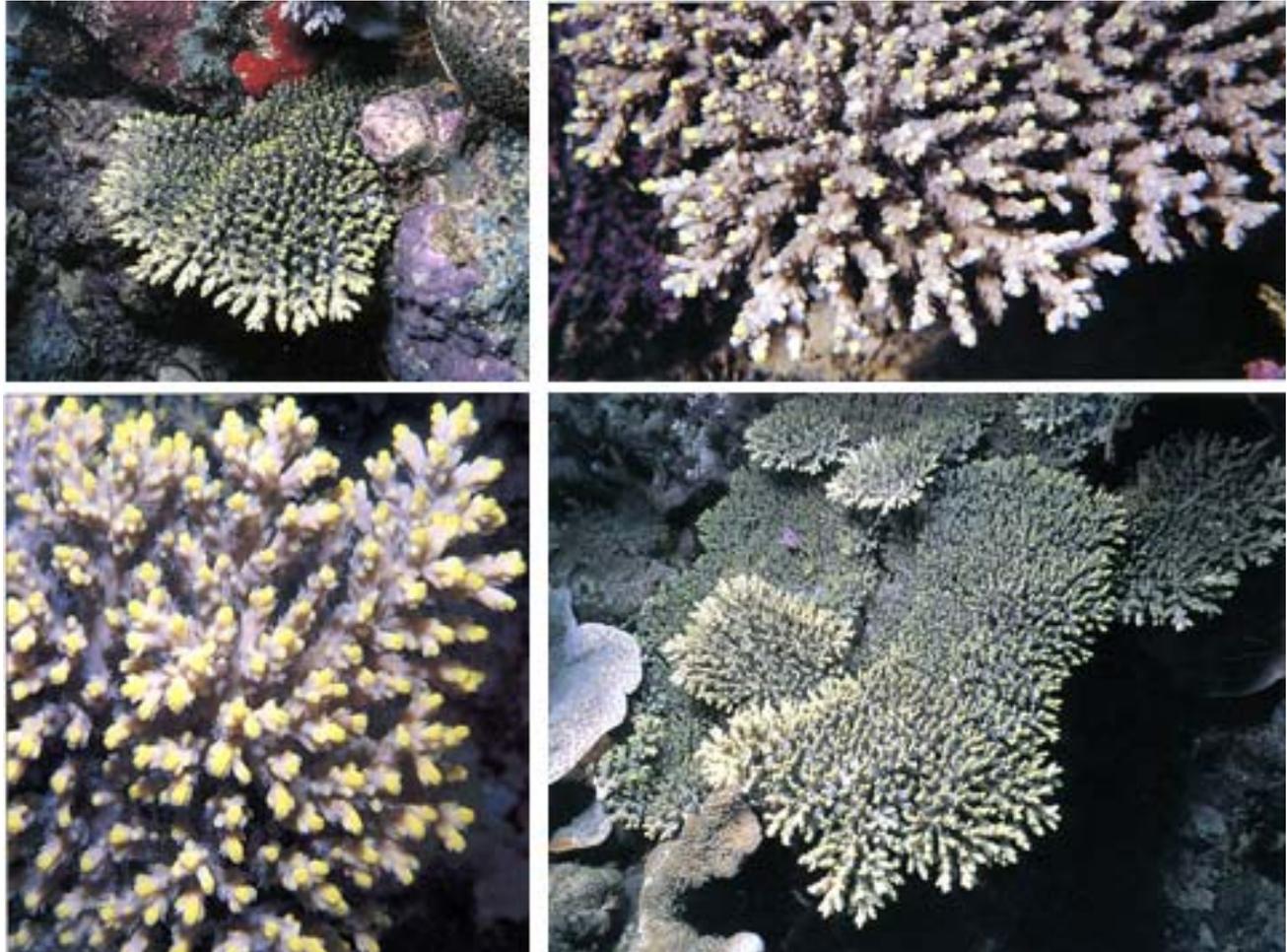


Figure 7.5.1. *Acropora aculeus* photos from Veron (2000).

Characteristics

Acropora aculeus forms flattened corymbose colonies to about 40 cm in diameter (Wallace, 1999). It is typically flat-topped, clumping, or tabular, with colonies formed by horizontal branches that protrude short slender vertical branches. Colonies are usually a pale grey-green in color but can be bright blue-green or yellow. The tips of the branches can be yellow, lime-green, pale blue or brown (Veron, 2000).

Taxonomy

Taxonomic issues: None, but *Acropora aculeus* can be confused with *Acropora latistella*, which also has a broad depth and geographic range.

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora aculeus* have been reported (Wallace, 1999).

Global Distribution

Acropora aculeus has a relatively broad range, having the 15th largest range of 114 *Acropora* species examined (Richards, 2009), extending from east Africa, the Comoros, and Seychelles in the Indian Ocean all the way to Pitcairn

Island in the southeastern Pacific Ocean. Latitudinally, it has been reported from Japanese waters in the northern hemisphere across the southern Great Barrier Reef and Mozambique in the southern hemisphere.

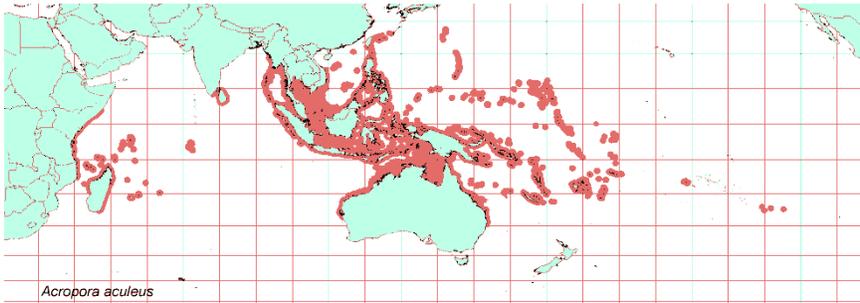


Figure 7.5.2. *Acropora aculeus* distribution from IUCN copied from <http://www.iucnredlist.org>.

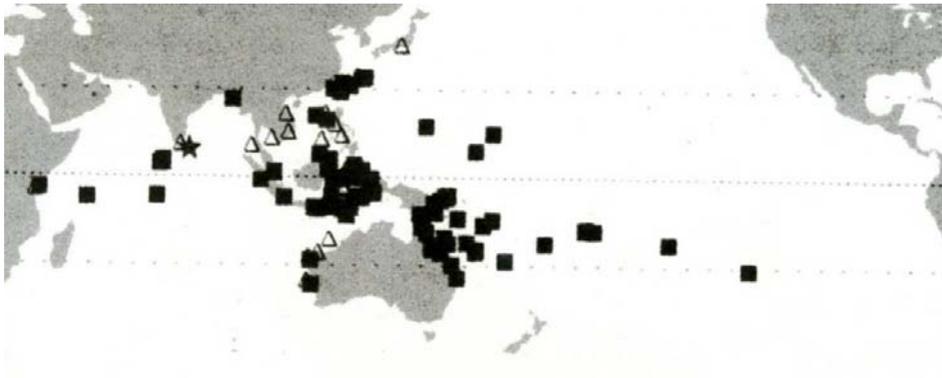


Figure 7.5.3. *Acropora aculeus* distribution from Wallace (1999). The black squares are specimen-based records in *Acropora* database at the Museum of Tropical Queensland, the stars are type localities of senior and junior synonyms, and the black triangles are taken from records in the literature. When the triangles are open (not black), the records from the literature are possibly misidentifications.

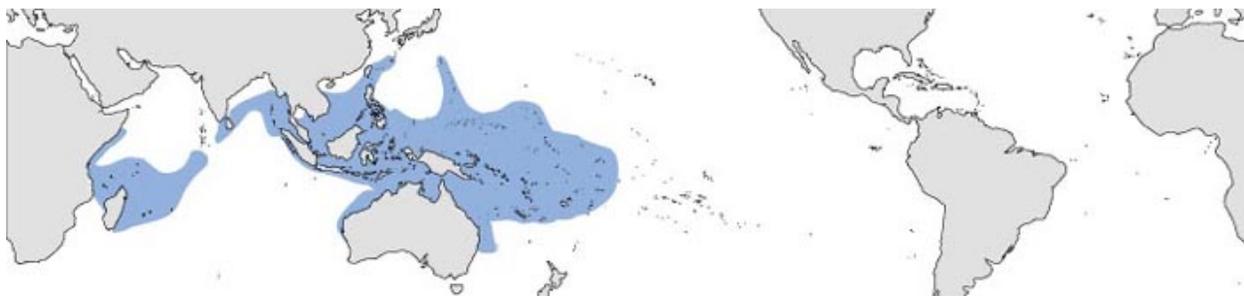


Figure 7.5.4. *Acropora aculeus* distribution from Veron (2002).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora aculeus* occurs in American Samoa, the Northern Mariana Islands, and the U.S. minor outlying islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora aculeus* has been reported from Tutuila and Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Lamberts, 1983; Lovell and McLardy, 2008; Mundy, 1996; National Park Service, 2009), Guam (Burdick, unpubl. data; Randall, 2003; Wallace, 1999), Palmyra Atoll (Williams et al., 2008b), Kingman Reef, and Wake Atoll (CRED, unpubl. data).

Within federally protected waters, *Acropora aculeus* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Palmyra, Kingman, Wake)
- National Park of American Samoa, Ofu Island unit

Habitat

Acropora aculeus has a broad depth range. It is particularly abundant in shallow lagoons and is common in most habitats where it is protected from direct wave action.

Depth range: *Acropora aculeus* has been reported in water depths ranging from low tide to at least 20 m (Wallace, 1999).

Abundance

Abundance of *Acropora aculeus* has been reported as generally common and locally abundant, especially in the central Indo-Pacific (Veron, 2000).

Life History

Acropora aculeus is a hermaphroditic spawner that is a participant in mass broadcast spawning in some localities (Babcock et al., 1986; Babcock et al., 1994). Growth is determinate or sometimes semideterminate (Wallace, 1985). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: The genus *Acropora* is consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a), although the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). *Acropora aculeus* tolerates high temperatures in back-reef pools in Ofu, American Samoa (Craig et al., 2001), although it is not abundant and acroporids still bleach in these pools (Fenner and Heron, 2008). Most acroporids in the Great Barrier Reef host clade C zooxanthellae, but *Acropora aculeus* hosts clade D (LaJeunesse et al., 2004a) as well as clade C (Van Oppen et al., 2001). As *Acropora aculeus* bleaches via loss of zooxanthellae (Hoegh-Guldberg, 1994) and corals preferentially expel clade C during bleaching (Rowan et al., 1997), the presence of clade D could either confer bleaching resistance or simply indicate stressful conditions. In any case, *Acropora aculeus* has moderately high bleaching susceptibility relative to other acroporids on the Great Barrier Reef (Done et al., 2003) and, as a whole, bleaching presents a high risk to this species.

Acidification: No specific research has addressed the effects of acidification on *Acropora aculeus*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). In general, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al. 2007, Silverman et al. 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora aculeus* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. Additionally, ample evidence show that diseases can have devastating regional impacts on individual coral species (Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner 2000).

Predation (COTS, snails, other): Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci* (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010.). When predation occurs, it can have significant effects—corymbose corals (including *Acropora aculeus*) with lesions from *Drupella* predation suffer 33%–54% mortality within 3 months (Cumming, 2002). Predation may, therefore, present a moderate risk at local scales but would be unlikely to lead to extinction.

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora aculeus*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora aculeus* could be affected.

Risk Assessment

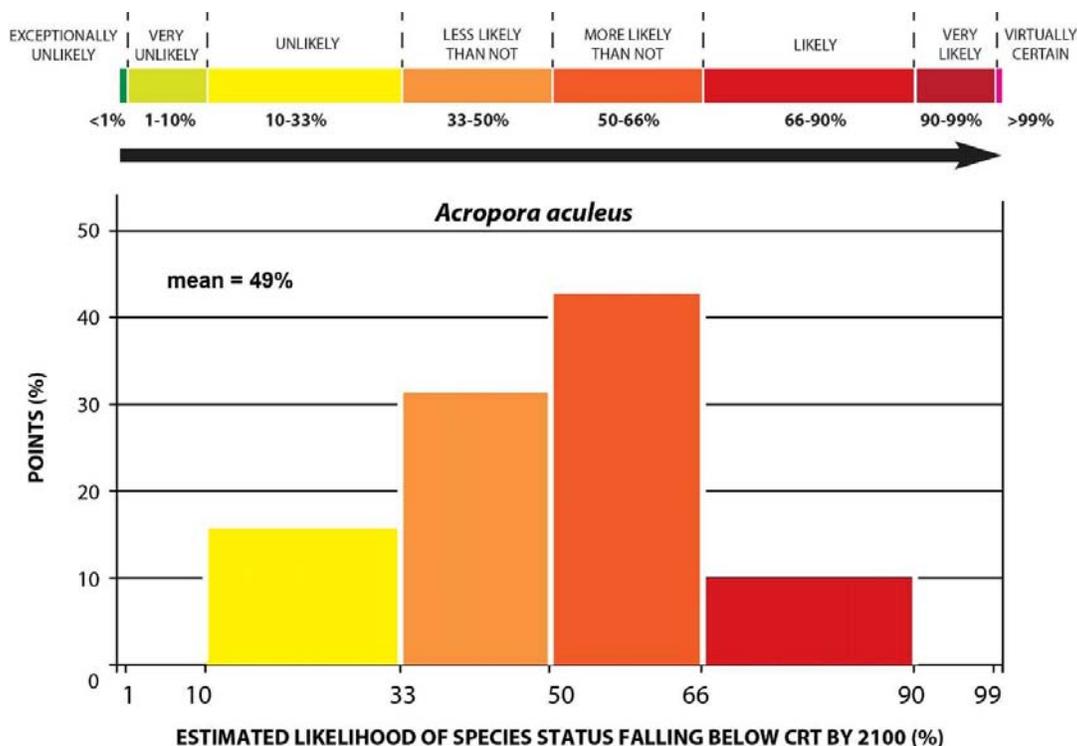


Figure 7.5.5. Distribution of points to estimate the likelihood that the status of *Acropora aculeus* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora aculeus* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora aculeus*. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) include the very wide geographic range, the broad depth range, the fact that it is often common and sometimes abundant, and the somewhat broad range of suitable habitats for *Acropora aculeus*. Vulnerability of *Acropora aculeus* may be somewhat ameliorated by the fact that it is known to occur in deeper water than many other acroporids and perhaps experiences disturbances (e.g. bleaching, storms, etc.) less frequently. These characteristics tend toward species persistence (Richards, 2009).

The overall likelihood that *Acropora aculeus* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “less likely than not” risk category with a mean likelihood of 49% and a standard error (SE) of 12% (Fig. 7.5.5). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–90% (Fig. 7.5.5) and the average range of likelihood estimates of the seven BRT voters (51%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora aculeus*.

7.5.2 *Acropora acuminata* Verrill, 1864

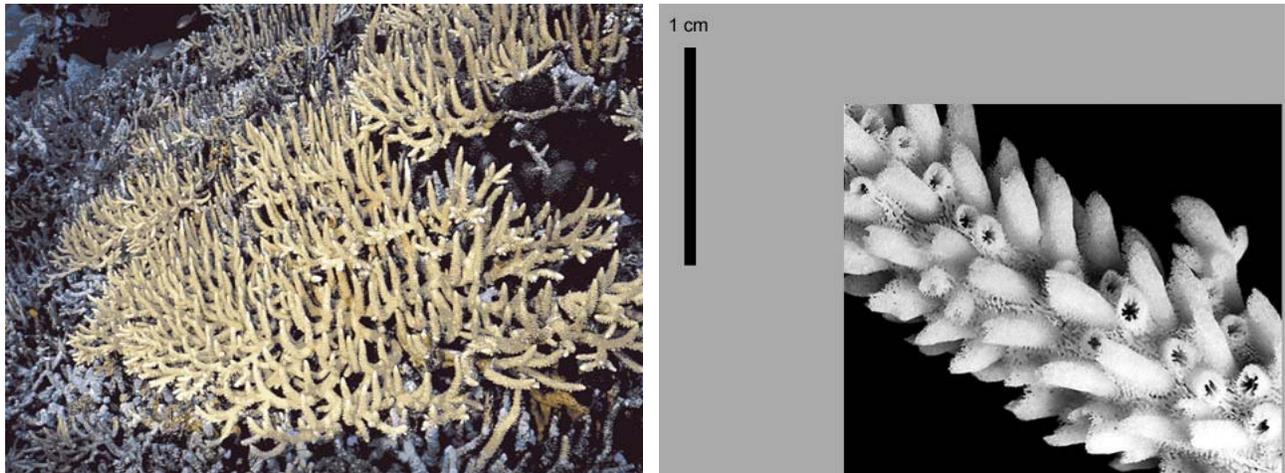


Figure 7.5.6. *Acropora acuminata* photo and coralite plan from Veron (2000).

Characteristics

Colonies of *Acropora acuminata* typically form a tabular base of fused horizontal branches that turn upward and taper to points. Colonies are most often pale or bright brown or blue.

Taxonomy

Taxonomic issues: None. *Acropora acuminata* was originally called *Madrepora nigra*, probably because drying specimens turn black (Wallace, 1999; Wells, 1954).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora acuminata* have been reported (Wallace, 1999).

Global Distribution

Acropora acuminata has a very broad range, having the fifth most extensive range of 114 *Acropora* species examined (Richards, 2009), extending longitudinally from the Red Sea all the way to Pitcairn Island in the southeastern Pacific. Its total range covers 110 million km². It extends latitudinally from Taiwan in the northern hemisphere across the Great Barrier Reef in the southern hemisphere. It can be very common in the center of its range (e.g., Indonesia), but it can be uncommon in the outer parts of its range (Wallace, 1999).

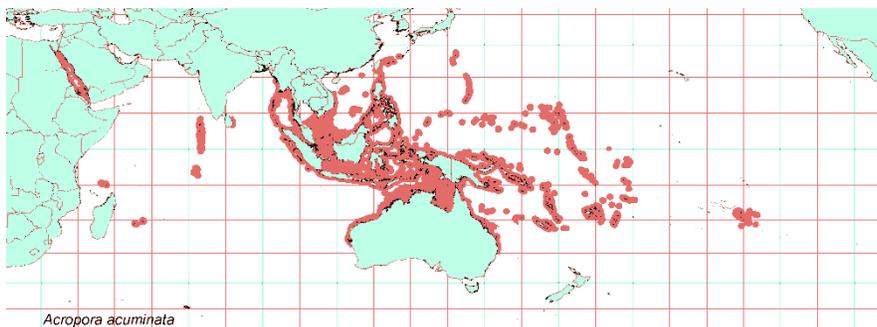


Figure 7.5.7. *Acropora acuminata* distribution from IUCN copied from <http://www.iucnredlist.org>.

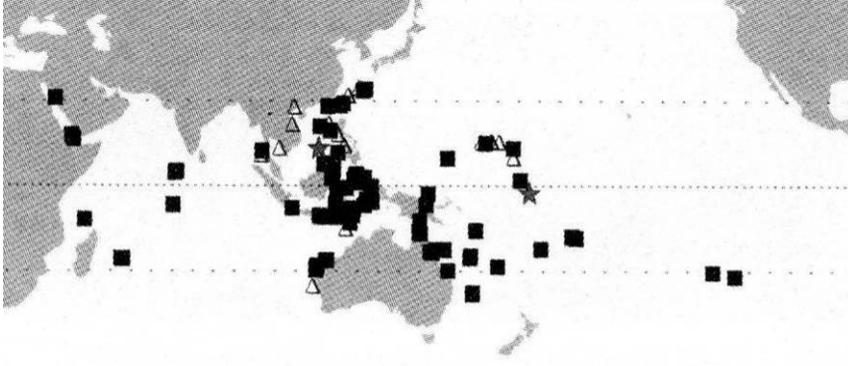


Figure 7.5.8. *Acropora acuminata* distribution copied from Wallace (1999). The black squares are specimen-based records in Worldwide Acropora database at the Museum of Tropical Queensland, the stars are type localities of senior and junior synonyms, and the black triangles are taken from records in the literature. When the triangles are open (not black), the records from the literature are possibly misidentifications.

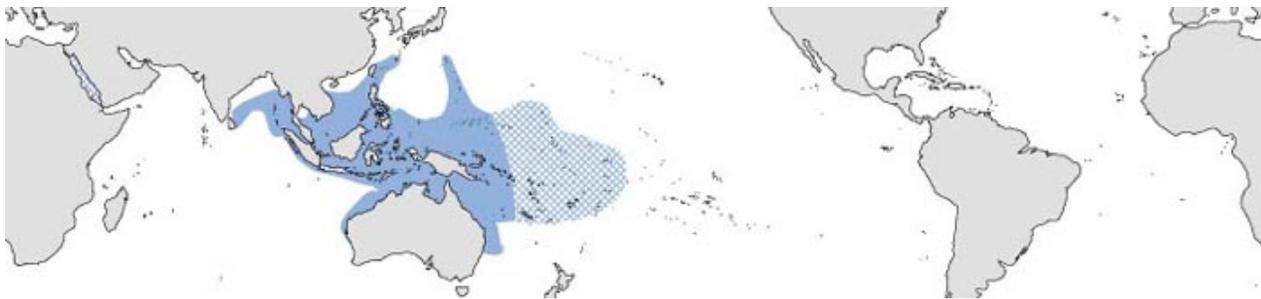


Figure 7.5.9. *Acropora acuminata* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora acuminata* occurs in American Samoa, the Northern Mariana Islands, and the U.S. minor outlying islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora acuminata* has been reported from Tutuila and Ofu-Olosega in American Samoa (Coles et al., 2003; Fisk and Birkeland, 2002; Lovell and McLardy, 2008; Maragos et al., 1994; National Park Service, 2009), Guam (Burdick, unpubl. data; Randall, 2003), Howland and Baker Islands, Kingman Reef, Wake Atoll (CRED, unpubl. data), and Palmyra Atoll (Williams et al., 2008b).

Within federally protected waters *Acropora acuminata* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Howland, Baker, Palmyra, Kingman, Wake)
- National Park of American Samoa, Ofu Island unit
- Fagatele Bay National Marine Sanctuary, Tutuila

Depth range: *Acropora acuminata* is not well known, although it has been reported in waters ranging from 15 to 20 m (IUCN, 2010).

Abundance

Abundance of *Acropora acuminata* has been reported to occasionally live in extensive clumps with dimensions of several meters (Wallace, 1999).

Life History

Like most of its congeners, *Acropora acuminata* is a broadcast spawner (Baird et al., 2002). However, it may achieve some degree of reproductive isolation in some locations by not spawning synchronously with the majority of its congeners (Baird et al., 2010; Carroll et al., 2006). Growth is determinate (Wallace, 1999). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora acuminata* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a), although the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). Bleaching-induced mortality can be severe—*Acropora* in the southeastern Arabian Gulf suffered > 90% mortality during the 1996 bleaching event (Riegl, 1999). Bleaching poses a substantial risk to this species.

Acidification: No specific research has addressed the effects of acidification on *Acropora acuminata*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006), productivity (Anthony et al., 2008; Crawley et al., 2010), fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010), and reduced growth in *Acropora palmata* from Curaçao (Bak et al., 2009). In general, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora acuminata* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. Additionally, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner 2000).

Predation: *Acropora acuminata* is the only acroporid known to not be preferred as prey by the crown-of-thorns seastar, *Acanthaster planci*. Large clumps of colonies of *Acropora acuminata* were bypassed when *Acanthaster planci* devastated the coral communities on Guam in the late 1960s (R. Randall, Univ. Guam, Mangilao, pers. comm., June 2010). *Acanthaster planci* will eat *Acropora acuminata* if there are no other corals to prey on, but *Acropora acuminata* are among the last to be preyed upon. Predation therefore seems a minor risk, even at local levels.

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora acuminata*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora acuminata* could be affected.

Risk Assessment

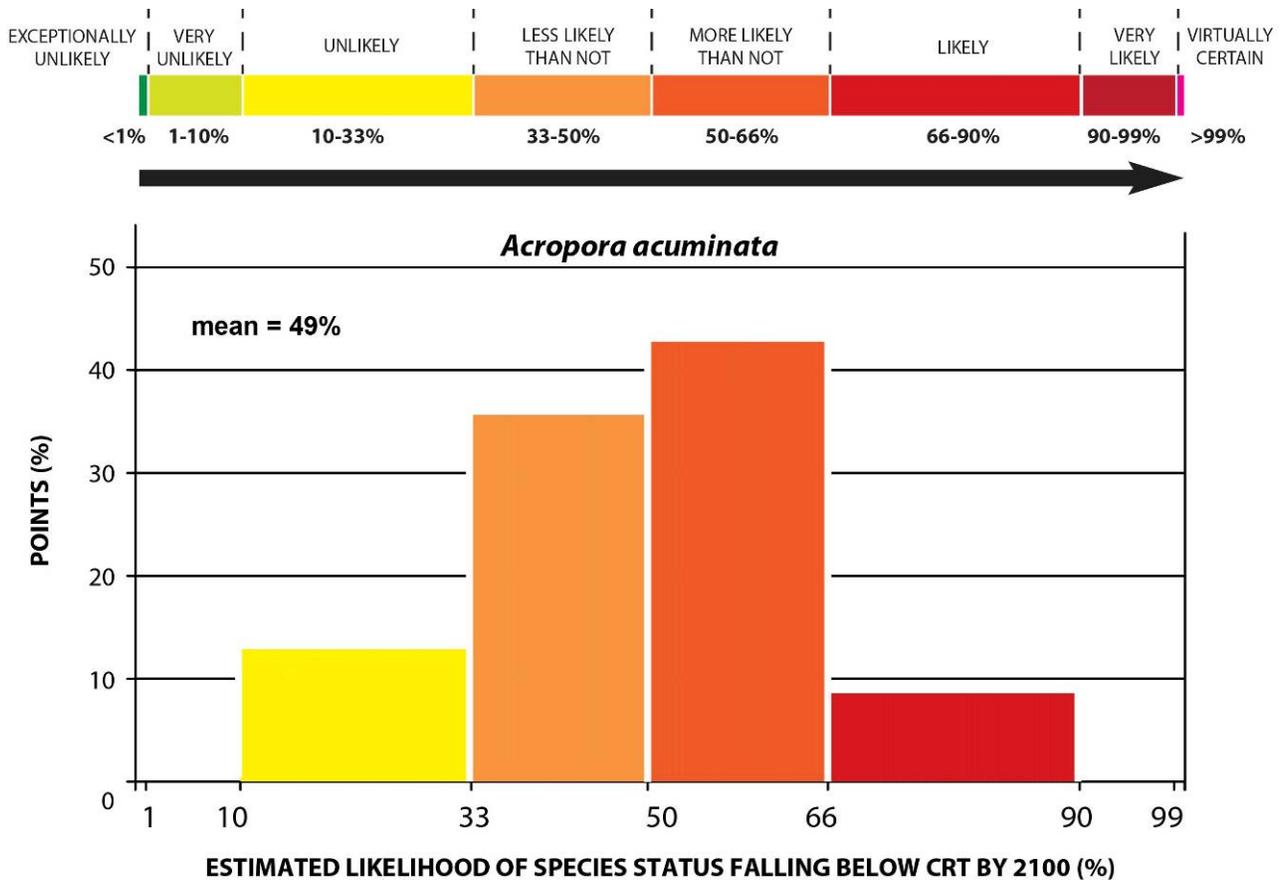


Figure 7.5.10. Distribution of points to estimate the likelihood that the status of *Acropora acuminata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora acuminata* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora acuminata*. Factors that reduce the potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) for *Acropora acuminata* include the very wide geographic range, the fact that it is often common and sometimes abundant, and the somewhat broad range of habitats that *Acropora acuminata* finds acceptable, including habitats with turbid waters and habitats with clear waters. Additionally, it is less preferred as prey by *Acanthaster planci* than are other members of the genus *Acropora*.

The overall likelihood that *Acropora acuminata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “less likely than not” risk category with a mean likelihood of 49% and a standard error (SE) of 8.5% (Fig. 7.5.10). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–90% (Fig. 7.5.10) and the average range of likelihood estimates of the seven BRT voters (57%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for this species. The uncertainty shown in the range of votes also stems from the tension between the relatively high extinction risk of *Acropora* as a genus vs. the potential for *Acropora acuminata* to be among the less vulnerable species of that genus.

7.5.3 *Acropora aspera* Dana, 1846

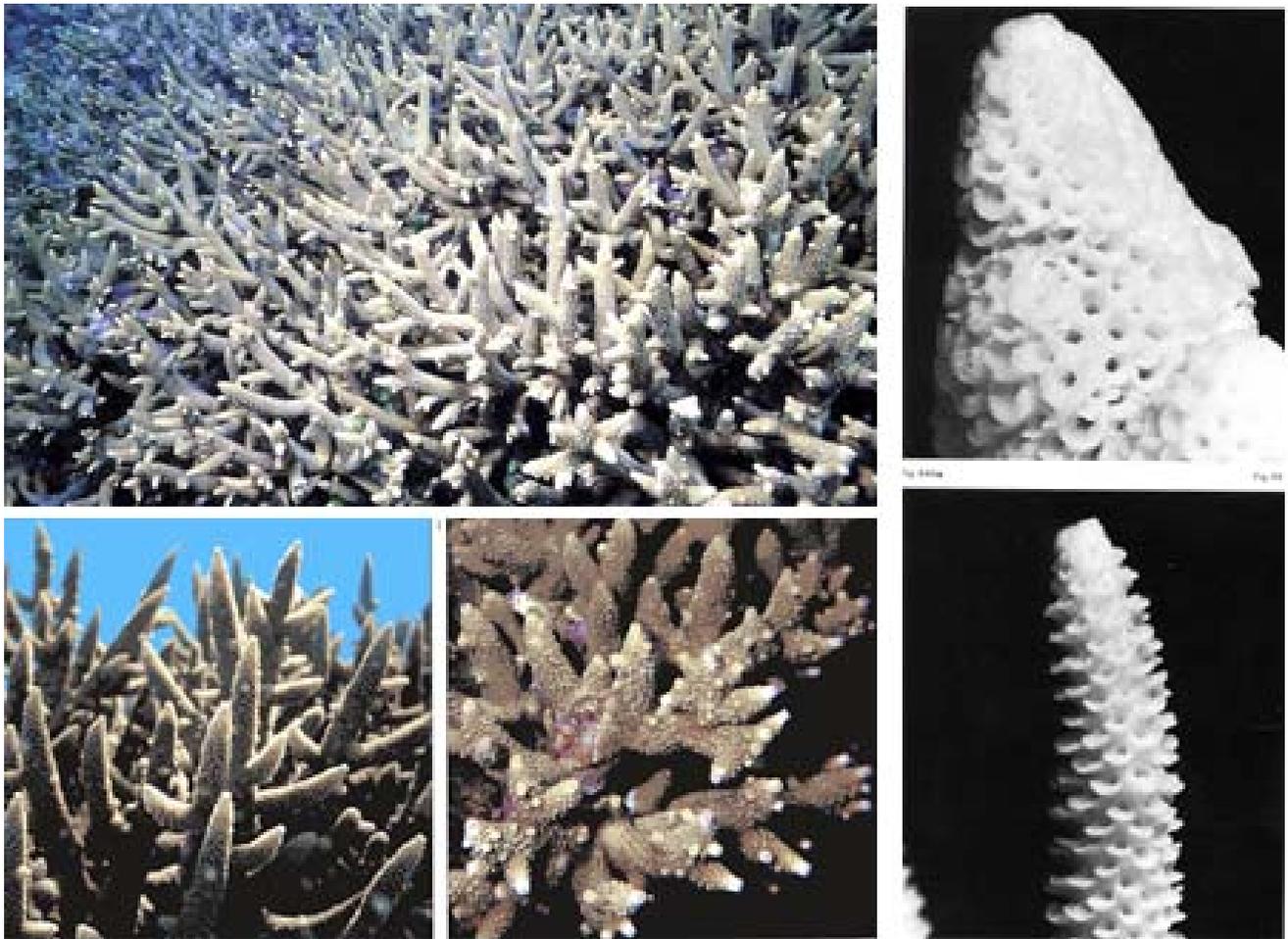


Figure 7.5.11. *Acropora aspera* photos copied from (color) Veron (2000) and (black and white) corallite plan from Wallace (1999).

Characteristics

Acropora aspera typically forms arborescent to caespitose-corymbose clumps of thick, relatively stout branches. The thickness and stoutness of the branches can vary considerably, depending on their exposure to wave energy. Taller colonies can be found in shallow protected habitats. Branches tend to be of relatively even length. The low, sprawling colonies can appear corymbose because of the even length of the branches or height of the colonies (Wallace, 1999). The clumps can sometimes be extensive, forming large uninterrupted stands.

On exposed forereefs, *Acropora aspera* colonies can be caespitose-corymbose with stout, tapering, highly anastomosed branches and short, thick secondary branches with crowded radial corallites of relatively uniform size (see upper black and white photograph above; Wallace 1999). In shallow protected waters, *Acropora aspera* can form micro-atolls. In deeper protected waters, *Acropora aspera* can form arborescent colonies with sturdy branches that seldom anastomose. In protected waters, the radial corallites are less crowded than in exposed habitats. In areas of reduced light (e.g., shallow, turbid lagoons or deeper reef slopes), the branches are relatively thin and the corallites are relatively small and widely spaced (see lower black and white photograph above; Wallace 1999).

Acropora aspera colonies are pale brown, beige, or pale blue-grey, green or cream (Randall and Myers, 1983).

Taxonomy

Taxonomic issues: None.

Family: Acroporidae

Evolutionary and geologic history: Fossil records of *Acropora aspera* have been reportedly found from the Pleistocene (1.8–0.01 Ma; Wallace, 1999).

Global Distribution

Acropora aspera has a relatively broad range, having the 46th largest range of 114 *Acropora* species examined (Richards, 2009), extending longitudinally from the Red Sea (Antonius et al., 1990) and Oman (Wallace, 1999) to Samoa (east-central Pacific Ocean). It extends latitudinally from Japanese waters in the northern hemisphere across the Great Barrier Reef in the southern hemisphere.

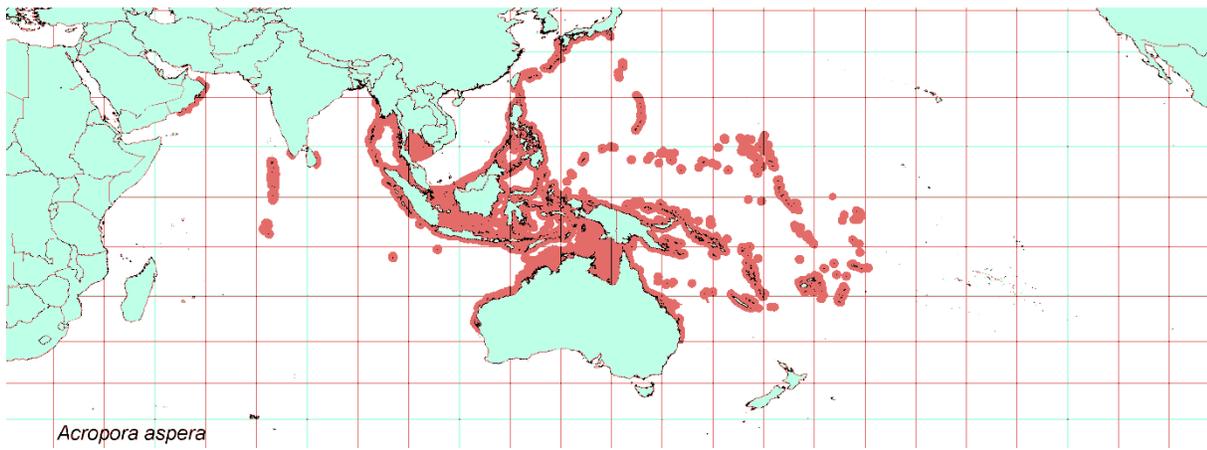


Figure 7.5.12. *Acropora aspera* distribution from IUCN copied from <http://www.iucnredlist.org>.

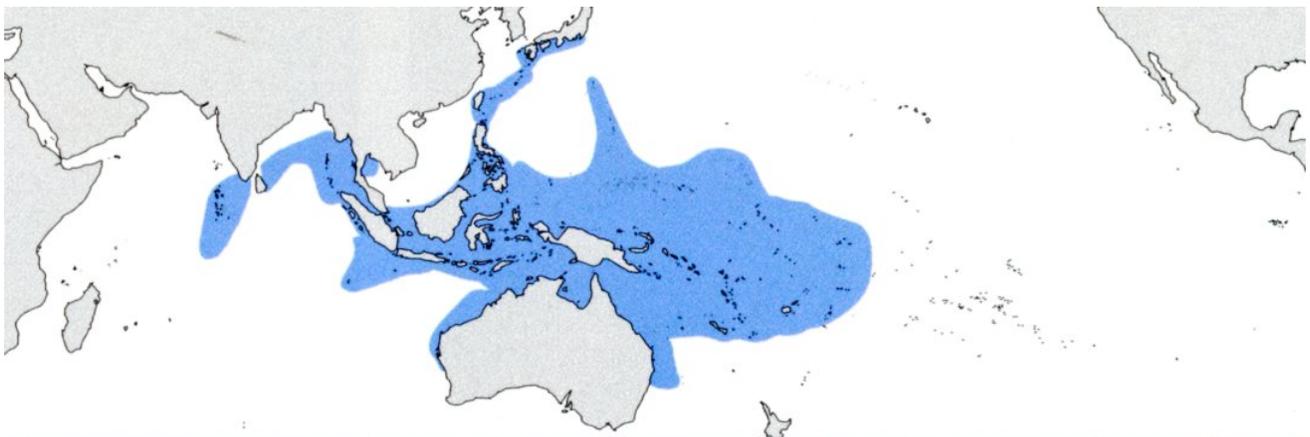


Figure 7.5.13. *Acropora aspera* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora aspera* occurs in American Samoa, the Northern Mariana Islands, and the U.S. minor outlying islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora aspera* has been reported from Tutuila and Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Lamberts, 1983; Mundy, 1996),

Guam (Amesbury et al., 1999; Burdick, unpubl. data; Randall, 2003; Wallace, 1999), Palmyra Atoll (Williams et al., 2008b), and Kingman Reef (CRED, unpubl. data).

- Within federally protected waters, *Acropora aspera* has been recorded from the following areas (Kenyon et al., 2010b):
- Pacific Remote Islands Marine National Monument (Palmyra, Kingman)
- National Park of American Samoa, Ofu Island unit
- Rose Atoll Marine National Monument
- War in the Pacific National Historical Park, Guam

Habitat

Habitat: *Acropora aspera* has been reported to occupy a broad range of habitats and its colony structure varies substantially with habitat (Wallace, 1999), as described above in “Characteristics.”

Depth range: *Acropora aspera* has been reported in water depths ranging from low tide to at least 10 m (Veron, 2000).

Abundance

Abundance of *Acropora aspera* has been reported as sometimes locally common (Veron, 2000). *Acropora aspera* can occasionally live in extensive clumps with dimensions of several meters.

Life History

Acropora aspera is a hermaphroditic spawner (Babcock et al., 1994; Simpson, 1985). While it is a participant in mass broadcast spawning in some localities, asynchrony of gamete development on the Great Barrier Reef (Baird and Marshall, 2002) and New Caledonia (Baird et al., 2010) may provide a degree of reproductive isolation, although *Acropora aspera* has been shown to hybridize with other acroporids (Van Oppen et al., 2002). Gamete development in *Acropora aspera* may be aborted in years with storm impacts (Bothwell, 1981). Asexual reproduction can account for the majority of *Acropora aspera* population structure in certain areas and can lead to local dominance (Birkeland et al., 1979; Bothwell, 1981; Highsmith, 1982).

As noted above, *Acropora aspera* has multiple growth forms. Growth varies with the influence of monsoon season, and skeletal extension, accretion, and density are all influenced by wave energy (Brown et al., 1985). Growth is indeterminate. *Acropora aspera* has been utilized for a range of laboratory studies, including nitrogen metabolism (Crossland and Barnes, 1974; 1977; Streamer, 1980), calcification (Barnes, 1982; Barnes and Crossland, 1982; Crossland and Barnes, 1974), and lipid metabolism (Crossland et al., 1980). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a), although the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). *Acropora aspera* is among the most bleaching-susceptible of the acroporids on the Great Barrier Reef (Done et al., 2003), where it harbors primarily clade C2 zooxanthellae (Van Oppen et al., 2001). It suffered 65% mortality in Fiji during the 2000 event (Cumming et al., 2002), but was one of the few species in good condition in Okinawa 5–10 months after the 1998 event (Stimson et al., 2002). The species can also suffer substantial mortality during cold-water bleaching events (Hoegh-Guldberg et al., 2005).

Acropora aspera contains green fluorescent proteins, but elevated temperatures reduce their effectiveness in this species, making it hypersensitive to bleaching (Dove, 2004). Other researchers have found that thermal history enhances photoprotection and reduces bleaching in *Acropora aspera* (Middlebrook et al., 2008). However, when it bleaches, *Acropora aspera* can experience reduced fecundity (Ward et al., 2000).

Although range expansion was not directly considered in this analysis, corals in the *Acropora aspera* group had a broader range in Australia during the Pleistocene than today and are predicted to potentially expand southward as temperatures increase (Greenstein and Pandolfi, 2008).

Acidification: No specific research has addressed the effects of acidification on *Acropora aspera*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). In general, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al. 2007, Silverman et al. 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora aspera* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. *Acropora aspera* experiences subacute black-band disease (UNEP, 2010), as well as ciliate infections (Antonius and Lipscomb, 2000). The ecological and population impacts of disease have not been established for this species. Bacterial communities on the surface of *Acropora aspera* also change as a result of bleaching, which potentially makes it more susceptible to disease (Ainsworth and Hoegh-Guldberg, 2009).

Predation: Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci* (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010). *Acropora aspera* is a preferred prey of *Acanthaster planci* (Sonoda and Paul, 1993) and, when killed, is rapidly overgrown by algae (Belk and Belk, 1975).

Land-based sources of pollution (LBSP): Toxins and nutrients have been reported to have deleterious effects on *Acropora aspera*. Cyanide (used for fish collection in some areas) significantly reduced the photosynthetic performance and induced bleaching in *Acropora aspera* (Jones and Hoegh-Guldberg, 1999). Although there was temporal variability, *Acropora aspera* produced smaller, fewer eggs and had reduced testes development when exposed to nitrogen, while phosphorus produced fewer but larger eggs (Ward and Harrison, 2000). *Acropora aspera* appears to have mixed susceptibility to runoff. The species was found to be relatively tolerant of silty/turbid water in the South China Sea (Latypov and Dautova, 2005), but suffered complete mortality when exposed to hyposaline waters during a 1991 flood in the Keppel Islands, Australia (Van Woesik, 1991).

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora aspera* could be affected.

Risk Assessment

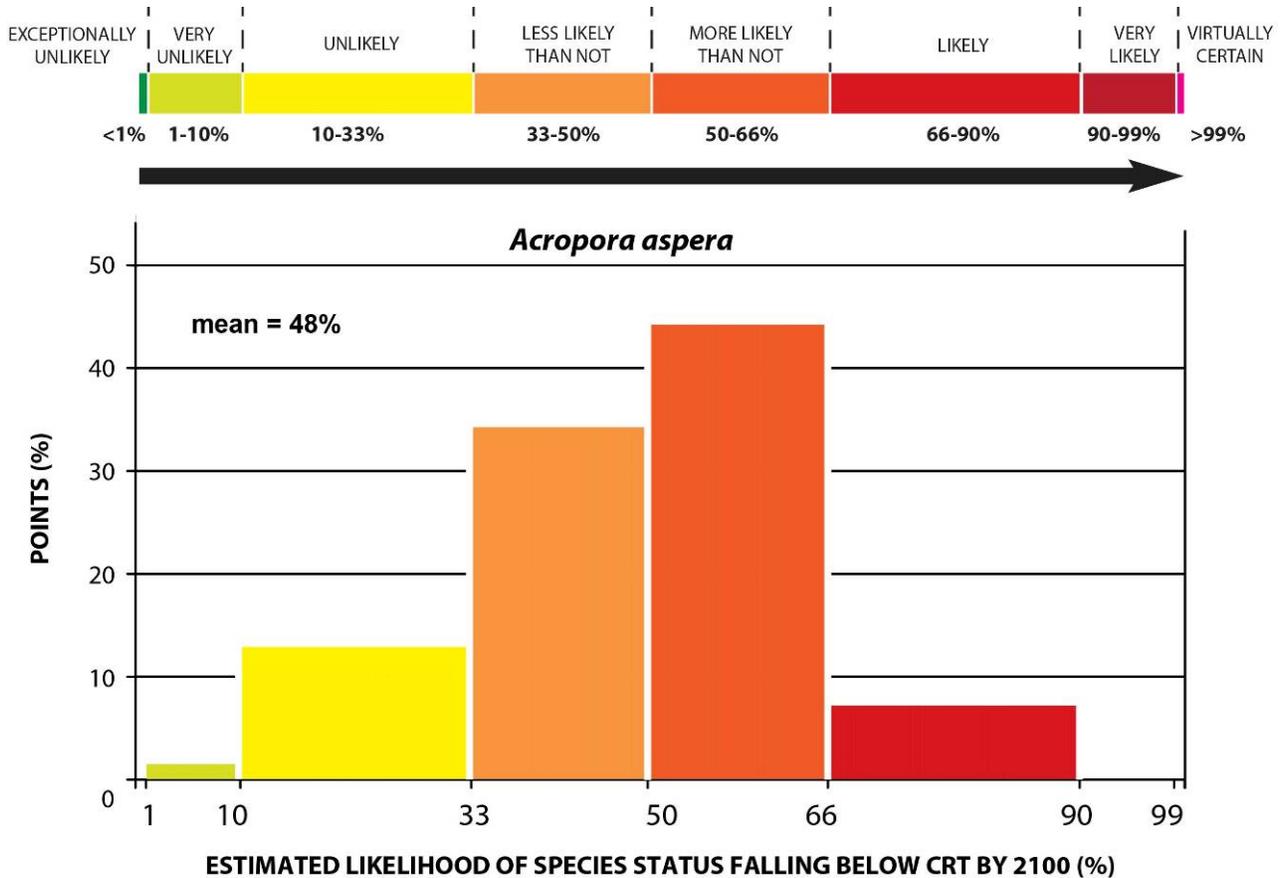


Figure 7.5.14. Distribution of points to estimate the likelihood that the status of *Acropora aspera* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora aspera* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora aspera*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora aspera* are the wide geographic range, it is often common and sometimes abundant, and the somewhat broad range of habitats that *Acropora aspera* finds acceptable, including its ability to grow in a variety of morphologies that are conditioned to the habitat characteristics. These characteristics tend toward species persistence.

The overall likelihood that *Acropora aspera* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “less likely than not” risk category with a mean likelihood of 48% and a standard error (SE) of 9% (Fig. 7.5.14). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 1%–90% (Fig. 7.5.14) and the average range of likelihood estimates of the seven BRT voters (58%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora aspera*.

7.5.4 *Acropora dendrum* Bassett-Smith, 1890

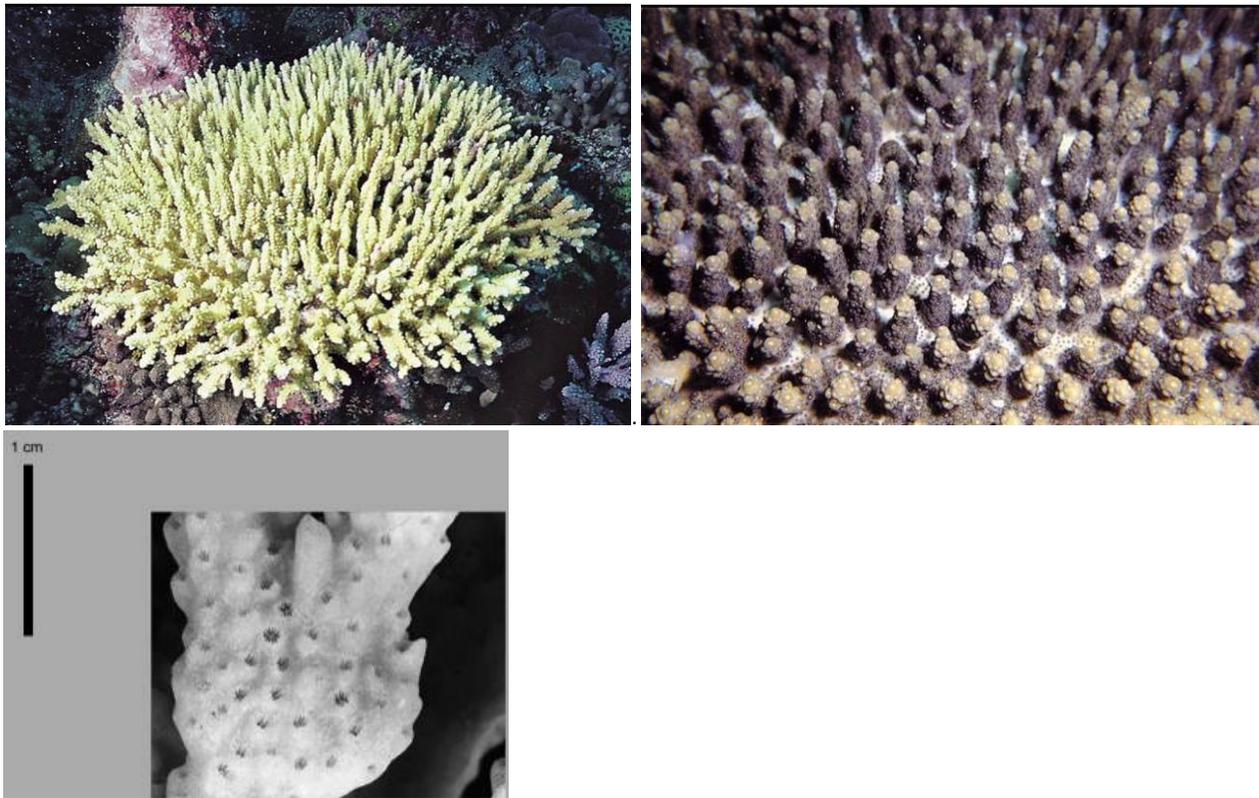


Figure 7.5.15. *Acropora dendrum* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora dendrum* are usually 0.5–1 m across and are corymbose plates with widely-spaced, tapering branchlets. Their axial corallites are small. Radial corallites are immersed or nearly so, giving branchlets a smooth appearance. Colonies are pale brown or cream in color (Veron, 2000). Maximum colony size is 100 cm. Determinate growth.

Taxonomy

Taxonomic issues: None. *Acropora dendrum* is most similar to *Heteropora appressa* and *Acropora microclados*. Wallace (1999) reported that *Acropora dendrum* is “poorly characterized and may indeed be a ‘phantom’ species, being made up from specimens that cannot be allocated to other species.” However, the BRT treats it as a nominal species (for taxonomic discussion see Section 2.1.2). There is no location recorded where it is common or even more abundant than a rare species Wallace (1999).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora dendrum* have been reported (Wallace, 1999).

Global Distribution

The IUCN Red List reports *Acropora dendrum* from the northern Indian Ocean, the central Indo-Pacific, east and west coasts of Australia, Southeast Asia, Japan and the East China Sea. Other reports are from the oceanic west Pacific and Palau (Randall, 1995) and Vanuatu, Tonga, and Samoa (IUCN, 2010).

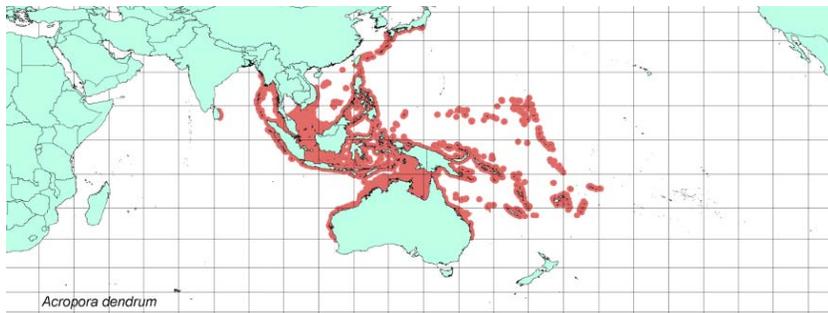


Figure 7.5.16. *Acropora dendrum* distribution from IUCN copied from <http://www.iucnredlist.org>.

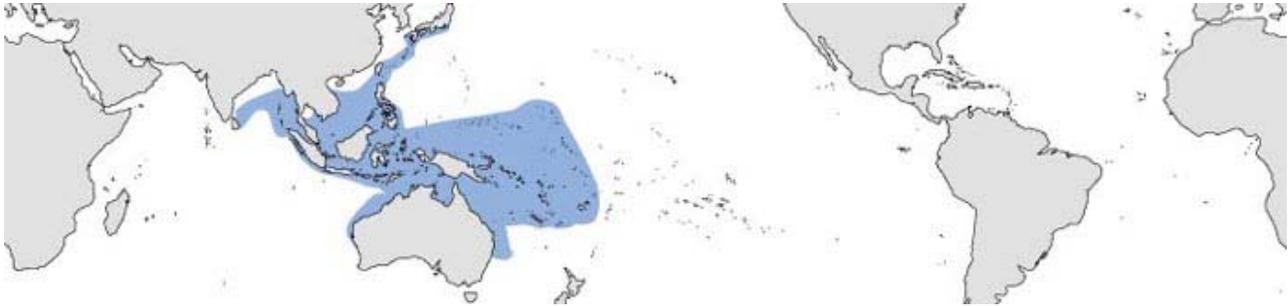


Figure 7.5.17. *Acropora dendrum* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora dendrum* occurs in American Samoa, but no supporting reference is given. The CITES species database includes Samoa as a country of occurrence but distinguishes American Samoa from Samoa in other species accounts. *Acropora dendrum* is not listed as occurring in American Samoa in Lovell and McLardy (2008).

Fenner reported tentative identification of *Acropora dendrum* at Tutuila, American Samoa, with three photographs of two colonies, but no voucher sample. Branches tapered slightly. One colony had sub-immersed radial corallites at the bases of branches with reduced cochlearform or labellate radial corallites on the upper parts of branches. The axial corallites looked fairly large, perhaps 3 mm diameter. Branches appeared to be about 4–7 mm diameter. In the other colony, branches appeared to be a bit thinner, and more of the radial corallites appeared to be lying flat against each other. The axial corallites in the first colony appeared about 1 mm larger than the description of the species by Wallace (1999), but otherwise the photos appear to be a fairly good match.

Acropora dendrum was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta'u, Rose Atoll, Swains, and South Bank in March 2010 (CRED, unpubl. data). The occurrence of *Acropora dendrum* in American Samoa remains uncertain.

No other published or unpublished data sources indicate the occurrence of *Acropora dendrum* elsewhere in U.S. waters.

Habitat

Habitat: *Acropora dendrum* has been reported to occupy upper reef slopes (Veron, 2000).

Depth range: *Acropora dendrum* has been reported in water depths ranging from 5 m to 20 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora dendrum* has been reported as uncommon or rare (Veron, 2000; Veron and Wallace, 1984).

Life History

Acropora dendrum is a hermaphroditic spawner (Mezaki et al., 2007; Wallace, 1985) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora for additional genus level information*.

Thermal stress: Although there is not much species-specific information about the response of *Acropora dendrum* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000) though the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora dendrum*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). In general, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al. 2007, Silverman et al. 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora dendrum* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. Additionally, ample evidence show that diseases can have devastating regional impacts on individual coral species (Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner 2000).

Predation: The specific effects of predation are poorly known for *Acropora dendrum*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci* (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora dendrum*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

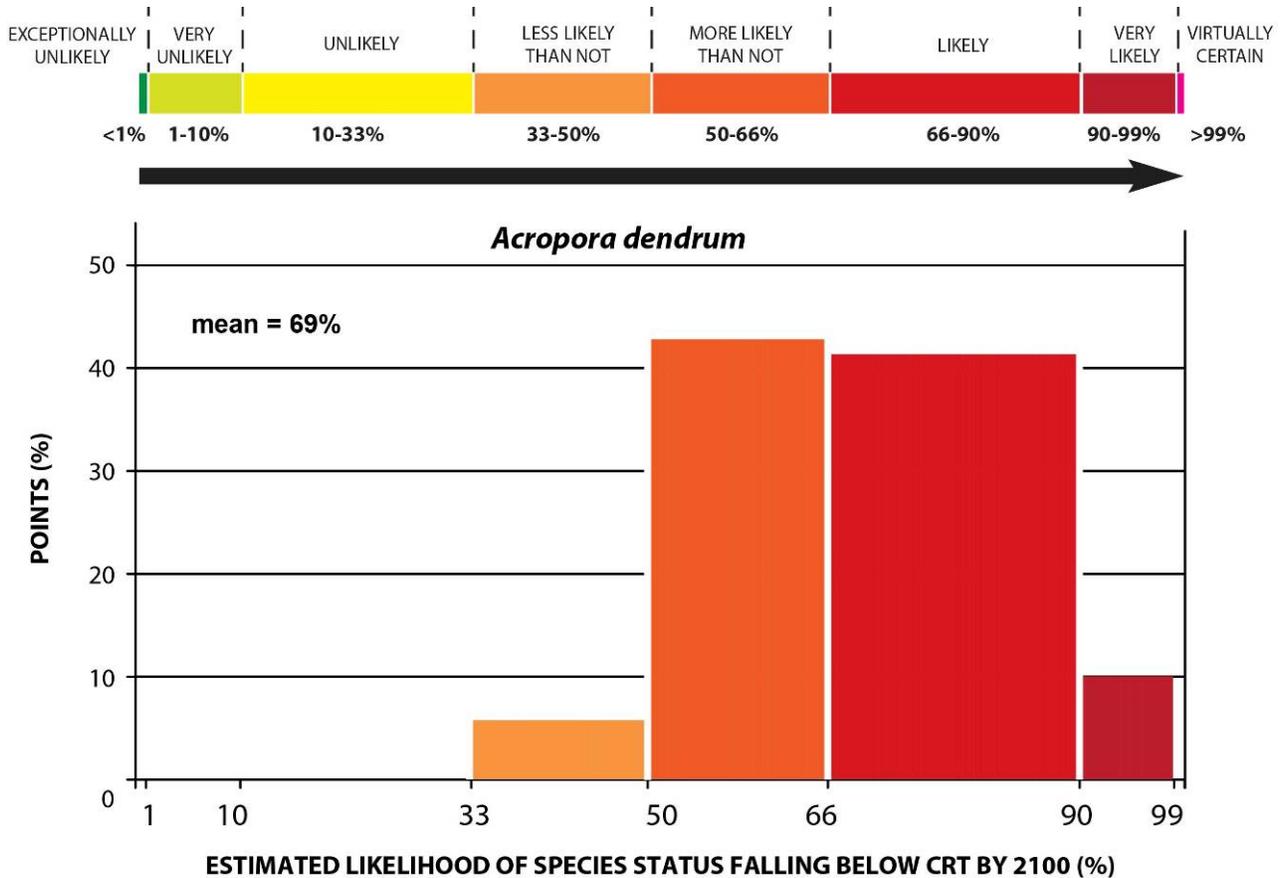


Figure 7.5.18. Distribution of points to estimate the likelihood that the status of *Acropora dendrum* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora dendrum* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution) and the Richards' Occupancy Type 2 (see Section 7.5: Genus *Acropora*), with broad north–south distribution from Japan to southern Great Barrier Reef and east–west distribution from the South Pacific to the northern Indian Ocean, small local distribution, and small local and abundance, characteristics tending toward making this species potentially vulnerable to local extinction (Richards, 2009). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora dendrum*. (Richards, 2009). Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora dendrum* were the wide geographic range, its moderate depth range (5–20 m), it is often common and sometimes abundant, and the somewhat broad range of habitats that *Acropora aspera* finds acceptable, including its ability to grow in a variety of morphologies that are conditioned to the habitat characteristics.

The overall likelihood that *Acropora dendrum* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “likely” risk category with a mean likelihood of 69% and a standard error (SE) of 6% (Fig. 7.5.18). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.5.18) and the average range of likelihood estimates of the seven BRT voters (55%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora dendrum*.

7.5.5 *Acropora donei* Veron and Wallace, 1984

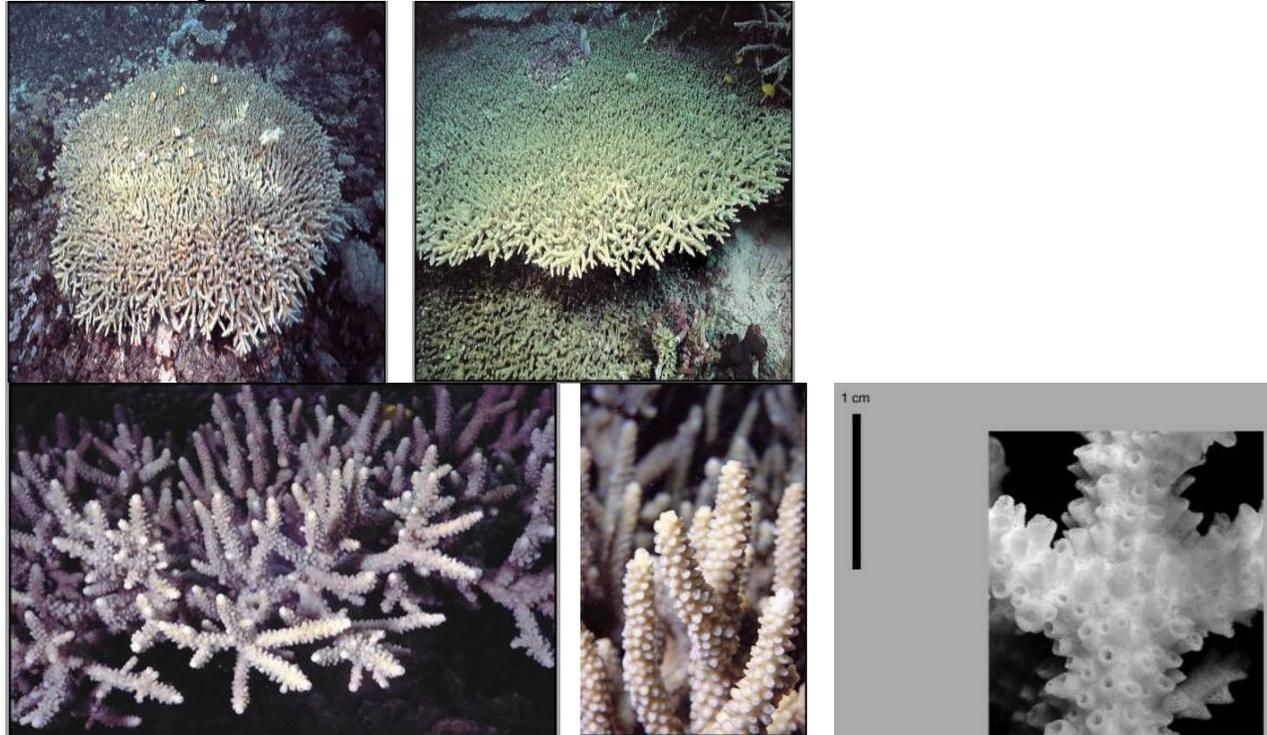


Figure 7.5.19. *Acropora donei* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora donei* are table-like, up to 2 m in diameter, and consist of masses of fused horizontal branches. Their peripheral branches are all horizontal; those towards the colony center have upturned ends. All branches have blunt ends and are neatly arranged. Radial corallites are usually in two sizes, the larger of which have flaring lips. The coenosteum is coarse, giving a rough appearance to branches. Colonies are green, white, cream, rarely pale brown in color (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora donei* is similar to *Acropora yongei*, which has similar corallites but does not have upturned branches. (Veron, 2000).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora donei* have been reported (Wallace, 1999).

Global Distribution

The global distribution of *Acropora donei* (IUCN) has been reported from the northern Indian Ocean, the central Indo-Pacific, Australia, Southeast Asia, the oceanic west Pacific, Yemen, and Japan. *Acropora donei* has a relatively broad range overall, having the 44th largest range of 114 *Acropora* species examined (Richards, 2009).

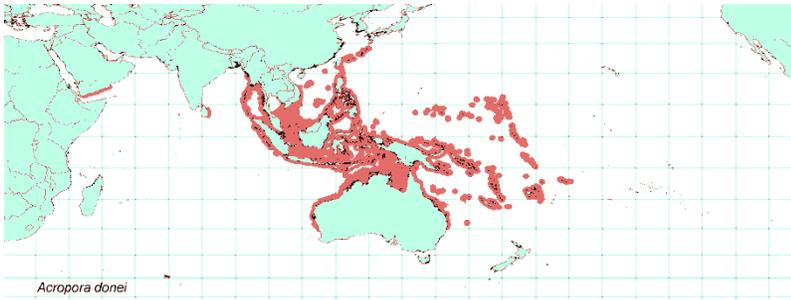


Figure 7.5.20. *Acropora donei* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.21. *Acropora donei* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora donei* occurs in American Samoa. A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora donei* has been reported from Tutuila and Ofu-Olosega in American Samoa (Coles et al., 2003; Lovell and McLardy, 2008; National Park Service, 2009).

Within federally protected waters, *Acropora donei* has been recorded from the following areas (Kenyon et al., 2010b):

- National Park of American Samoa, Ofu Island unit

Habitat

Habitat: *Acropora donei* has been reported to occupy in subtidal areas on upper reef slopes or submerged reefs, apparently restricted to shallow fringing reefs and upper reef slopes where *Acropora* diversity is high (Veron, 2000).

Depth range: *Acropora donei* has been reported in water depths ranging from 5 m to 20 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora donei* has been reported as uncommon but distinctive (Veron, 2000).

Life History

Acropora donei is a hermaphroditic spawner (Baird et al., 2002; Hayashibara et al., 1993) with lecithotrophic larvae (Baird et al., 2009) and may develop asynchronously in some areas (Guest et al., 2005b). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora donei* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a), although the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora donei*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: *Acropora* species are moderately to highly susceptible to disease (UNEP, 2010). Susceptibility and impacts of disease on *Acropora donei* are not known. However, ample evidence show that diseases can have devastating regional impacts on individual coral species, particularly acroporids (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004; Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora donei*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects stresses are largely unknown for *Acropora donei*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

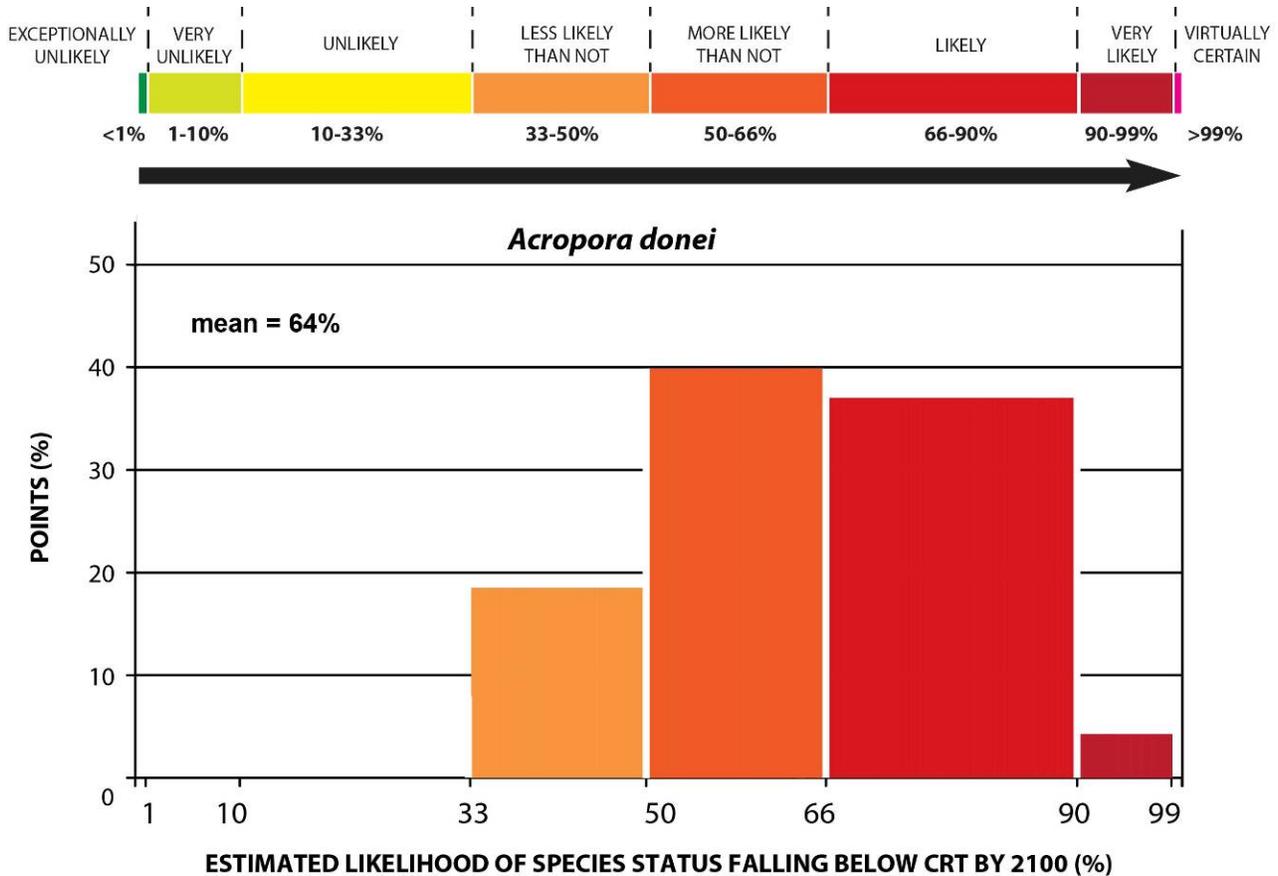


Figure 7.5.22. Distribution of points to estimate the likelihood that the status of *Acropora donei* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora donei* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution) and the Richards occupancy estimate of 2 (see Section 7.5: “Genus *Acropora*”), small local distributions and small local abundances—these characteristics tend toward species local extinction (Richards, 2009), and the fact that it is also a distinctive species and therefore unlikely to be overlooked during surveys. The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora donei*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora donei* were the moderate geographic and depth ranges.

The overall likelihood that *Acropora donei* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 64% and a standard error (SE) of 8% (Fig. 7.5.22). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.5.22) and the average range of likelihood estimates of the seven BRT voters (53%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora donei*.

7.5.6 *Acropora globiceps* Dana, 1846

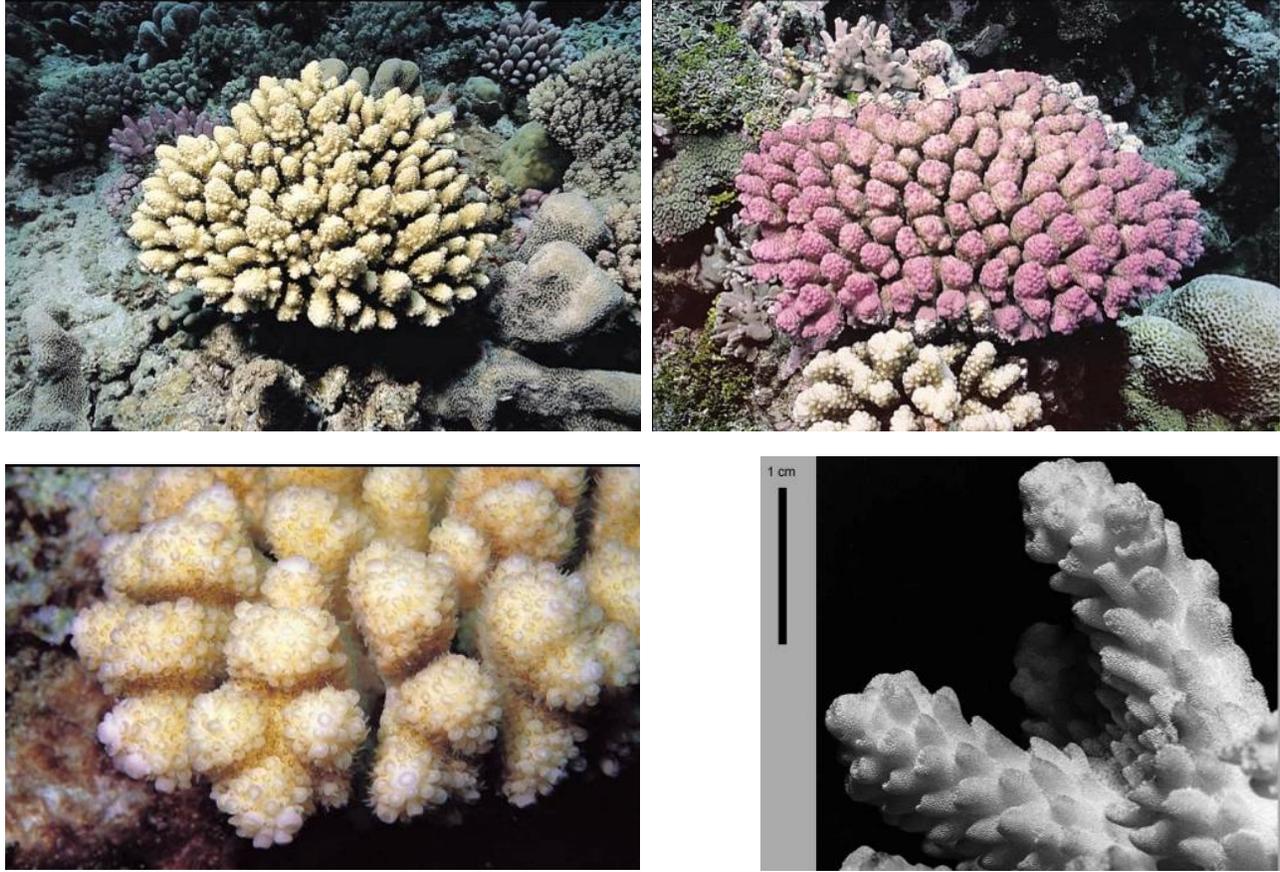


Figure 7.5.23. *Acropora globiceps* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora globiceps* are digitate and usually small. The size and appearance of branches depend on degree of exposure to wave action but are always short and closely compacted. Colonies exposed to strong wave action have pyramid-shaped branchlets. Corallites are irregular in size, those on colonies on reef slopes are tubular, and those on reef flat colonies are more immersed. Axial corallites are small and sometimes indistinguishable. Radial corallites are irregular in size and are sometimes arranged in rows down the sides of branches. Colonies are uniform blue (which may photograph purple) or cream in color (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora globiceps* is similar to *Acropora gemmifera*, which has radial corallites increasing in size down the sides of branches. Colonies exposed to strong wave action have a growth-form similar to that of *Acropora monticulosa*. Corallites are similar to those of *Acropora secale* and *Acropora retusa* (Veron, 2000).

Family: Acroporidae.

Evolutionary and geologic history: Fossil records of *Acropora globiceps* have been reported from the Pleistocene (0.01–1.8 Ma) from Niue (Wallace, 1999).

Global Distribution

Acropora globiceps has been reported from the central Indo-Pacific, the oceanic west Pacific, and the central Pacific (IUCN, 2010). There are reports from the Great Barrier Reef (D. Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010, not shown on maps), the Philippines, Andaman Islands, Polynesia, and Micronesia (IUCN,

2010) and Pitcairn (Wallace, 1999). It has been reported as common and relatively widespread longitudinally but restricted latitudinally and has a narrow depth range. *Acropora globiceps* has the 88th largest (26th smallest) range of 114 *Acropora* species examined (Richards, 2009).

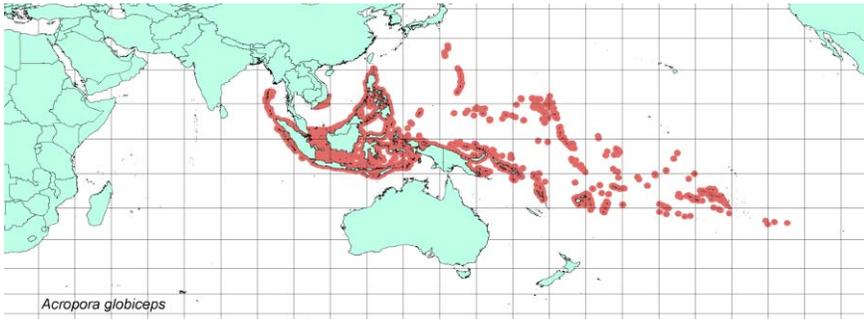


Figure 7.5.24. *Acropora globiceps* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.25. *Acropora globiceps* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora globiceps* occurs in American Samoa, the Northern Mariana Islands, and the U.S. minor outlying islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora globiceps* has been reported from Tutuila, Ofu-Olosega, Ta'u, Rose Atoll, and South Bank in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; CRED, unpubl. data; Kenyon et al., 2010a; Lovell and McLardy, 2008), Guam (Burdick, unpubl. data; Wallace, 1999), Palmyra Atoll (Williams et al., 2008b), and Kingman Reef (CRED, unpubl. data).

Within federally protected waters, *Acropora globiceps* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Palmyra, Kingman)
- National Park of American Samoa, Ofu Island unit
- Rose Atoll Marine National Monument

Habitat

Habitat: *Acropora globiceps* has been reported from intertidal, upper reef slopes and reef flats (Veron, 2000).

Depth range: *Acropora globiceps* has been reported in water depths ranging from 0 m to 8 m (Veron, 2000).

Abundance

Abundance of *Acropora globiceps* has been reported as common (Veron, 2000).

Life History

Acropora globiceps is a hermaphroditic spawner with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora globiceps* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a), although the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora globiceps*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al. 2007, Silverman et al. 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: There is little species-specific information, although in general *Acropora* species are moderately to highly susceptible to disease. Susceptibility and impacts of disease on *Acropora globiceps* are not known. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., (Aronson and Precht, 2001; Bruckner and Hill, 2009)), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

Predation: The specific effects of predation are poorly known for *Acropora globiceps*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora globiceps*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

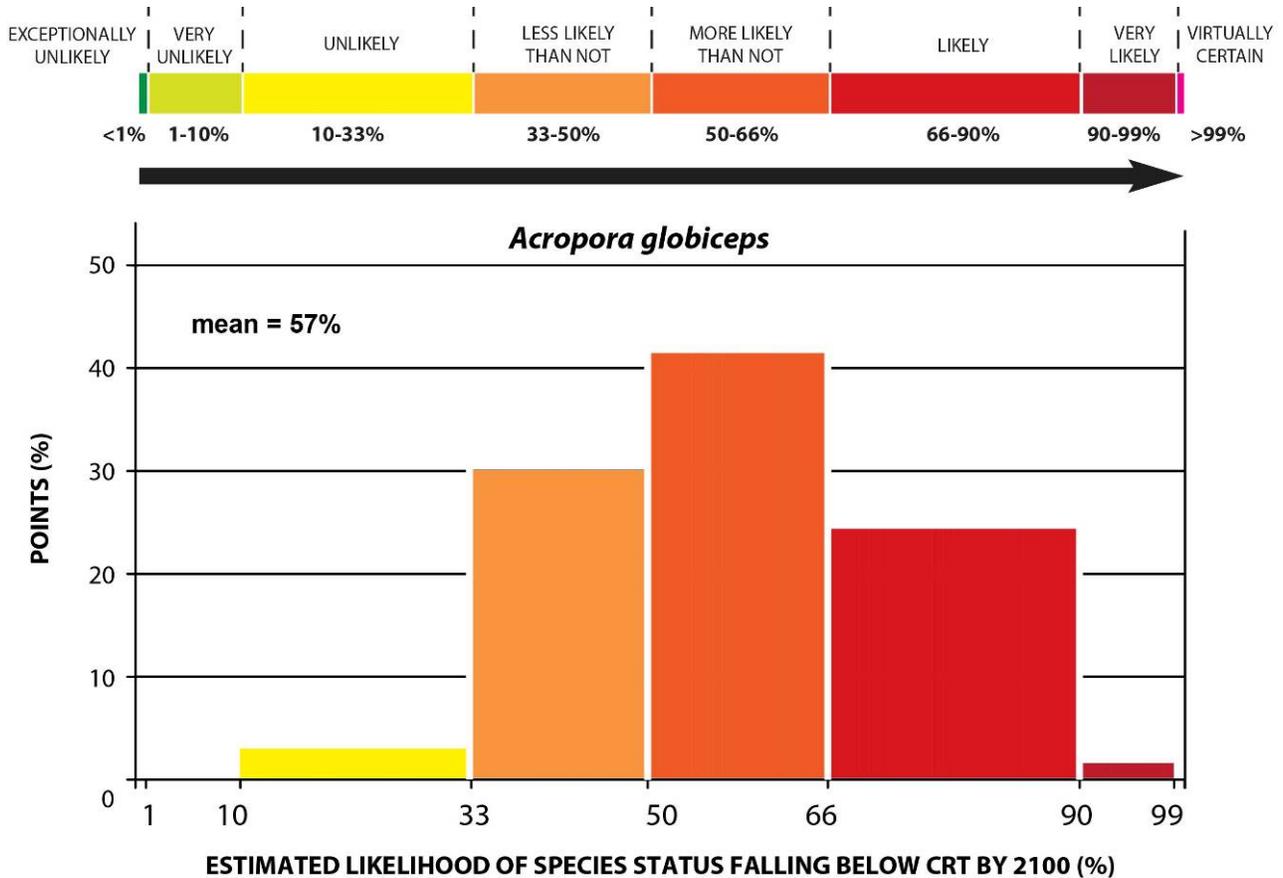


Figure 7.5.26. Distribution of points to estimate the likelihood that the status of *Acropora globiceps* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora globiceps* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), its restricted depth range (0-8 m), and narrow geographic and latitudinal distribution. The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora globiceps*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora globiceps* were the reports of common abundance and persistence in intertidal habitats, suggesting potentially increased physiological tolerance. Wide geographic range was considered to decrease extinction risk, since it makes the species more likely to escape stresses or catastrophes in at least some locations.

The overall likelihood that *Acropora globiceps* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 57% and a standard error (SE) of 8% (Fig. 7.5.26). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.5.26) and the average range of likelihood estimates of the seven BRT voters (58%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora globiceps*.

7.5.7 *Acropora horrida* Dana 1846

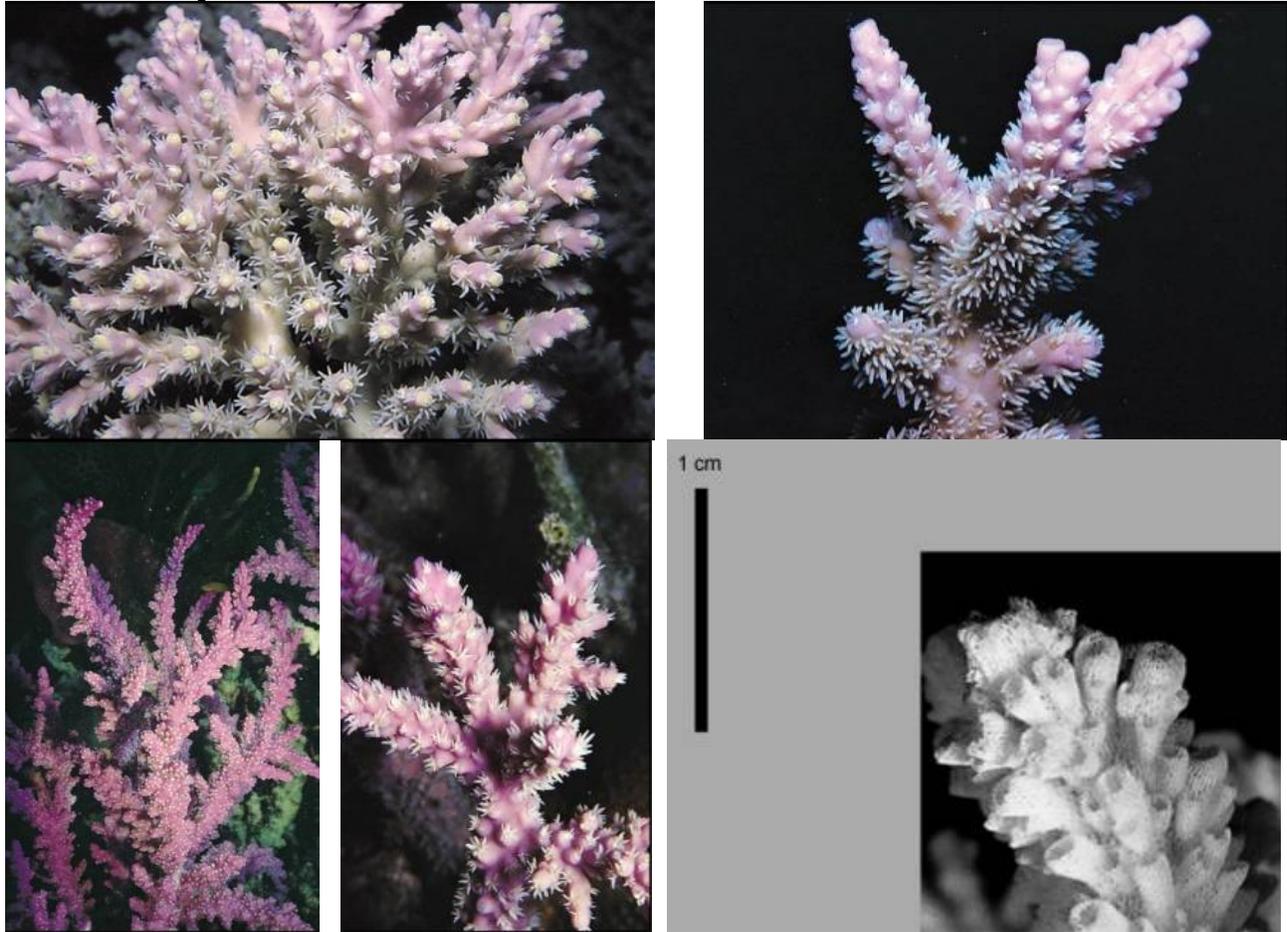


Figure 7.5.27. *Acropora horrida* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora horrida* are usually open branched, becoming bushy on upper reef slopes and in shallow lagoons. Main branches of colonies in turbid water have irregular branchlets; those in shallow clear water have compact branchlets, giving colonies a bushy appearance. Corallites are irregular and the surface of branches is rough. Tentacles are usually extended during the day. Colonies are usually pale blue (which may photograph pink or purple), sometimes dark blue or pale yellow or brown. Polyps are pale blue or white (Veron, 2000).

Taxonomy

Taxonomic issues: *Acropora horrida* is similar to *Acropora tortuosa*, and also to *Acropora vaughani*, which has widely-spaced corallites and a smooth coenosteum (Veron, 2000).

Family: Acroporidae.

Evolutionary and geologic history: Fossil records of *Acropora horrida* dating back to the Pliocene (1.8–5.3 Ma) were reported from Papua New Guinea (Wallace, 1999).

Global Distribution

Acropora horrida has been reported to have large longitudinal and latitudinal ranges. Reported ranges include the Red Sea and the Gulf of Aden, the southwest and northwest Indian Ocean, the Arabian/Iranian Gulf, the northern Indian Ocean, the central Indo-Pacific, east and west coasts of Australia, Southeast Asia, Japan and the East China Sea, the oceanic west Pacific, and the central Pacific (IUCN, 2010). It is found in Palau (Randall, 1995) and the Line Islands

(Wallace, 1999). *Acropora horrida* has a very broad range overall, having the 14th largest range of 114 *Acropora* species examined (Richards, 2009).

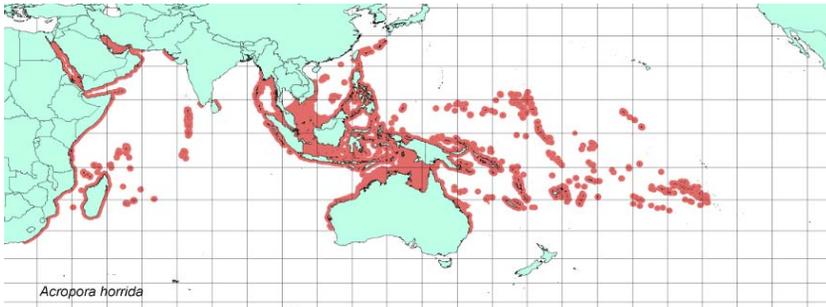


Figure 7.5.28. *Acropora horrida* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.29. *Acropora horrida* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora horrida* occurs in American Samoa. The IUCN Species Account also notes its occurrence in the U.S. minor outlying islands but the CITES database does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora horrida* has been reported from Tutuila and Ofu-Olosega in American Samoa (Lovell and McLardy, 2008; National Park Service, 2009). No reference supporting its occurrence in the U.S. minor outlying islands, as reported in the IUCN Species Account, has been identified.

Within federally protected waters, *Acropora horrida* has been recorded from the following areas (Kenyon et al., 2010b):

- National Park of American Samoa, Ofu Island unit

Habitat

Habitat: *Acropora horrida* has been reported to occupy fringing reefs with turbid water (Veron 2000), subtidal, sheltered habitats, protected deepwater flats, lagoons, and sandy slopes (Wallace, 1999).

Depth range: *Acropora horrida* has been reported in water depths ranging from 5 m to -20 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora horrida* has been reported as usually uncommon (Veron, 2000).

Life History

Acropora horrida is a hermaphroditic spawner (Babcock et al., 1994; Baird et al., 2002; Kenyon, 1995) with lecithotrophic larvae (Baird et al., 2009), although spawning may be asynchronous in some areas (Baird et al., 2002). Mean egg size for *Acropora horrida* has been recorded as 0.64 mm and mean polyp fecundity has been recorded as 9.0 eggs per polyp (Wallace, 1999). This species did not spawn on the central Great Barrier Reef during the major multispecies spawning events in early summer 1981-1983. Colonies of this species in which gametogenesis did not proceed to completion differed from those in which it did in two ways: they were in deeper water and they underwent chronic fragmentation and partial burial. It is possible that their resources were at all times allocated to extension in preference to sexual reproduction (Wallace, 1985). For more genus level information, see Section 7.5 “Genus *Acropora*.”

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora horrida* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a), although the genus may have differential responses across regions during mass bleaching mortalities. *Acropora horrida* is thought to have been locally extirpated in the Arabian Gulf after the 1996 and 1998 bleaching events (Riegl 2002). That said, *Acropora horrida* is considered less susceptible to bleaching than other *Acropora* spp (Done et al., 2003).

Acidification: No specific research has addressed the effects of acidification on *Acropora horrida*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora horrida* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. Ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., (Aronson and Precht, 2001; Bruckner and Hill, 2009)), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner 2000).

Predation: The specific effects of predation are poorly known for *Acropora horrida*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP-related stresses are largely unknown for *Acropora horrida*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia and 30,000–100,000 pieces from Fiji (CITES, 2010).

Risk Assessment

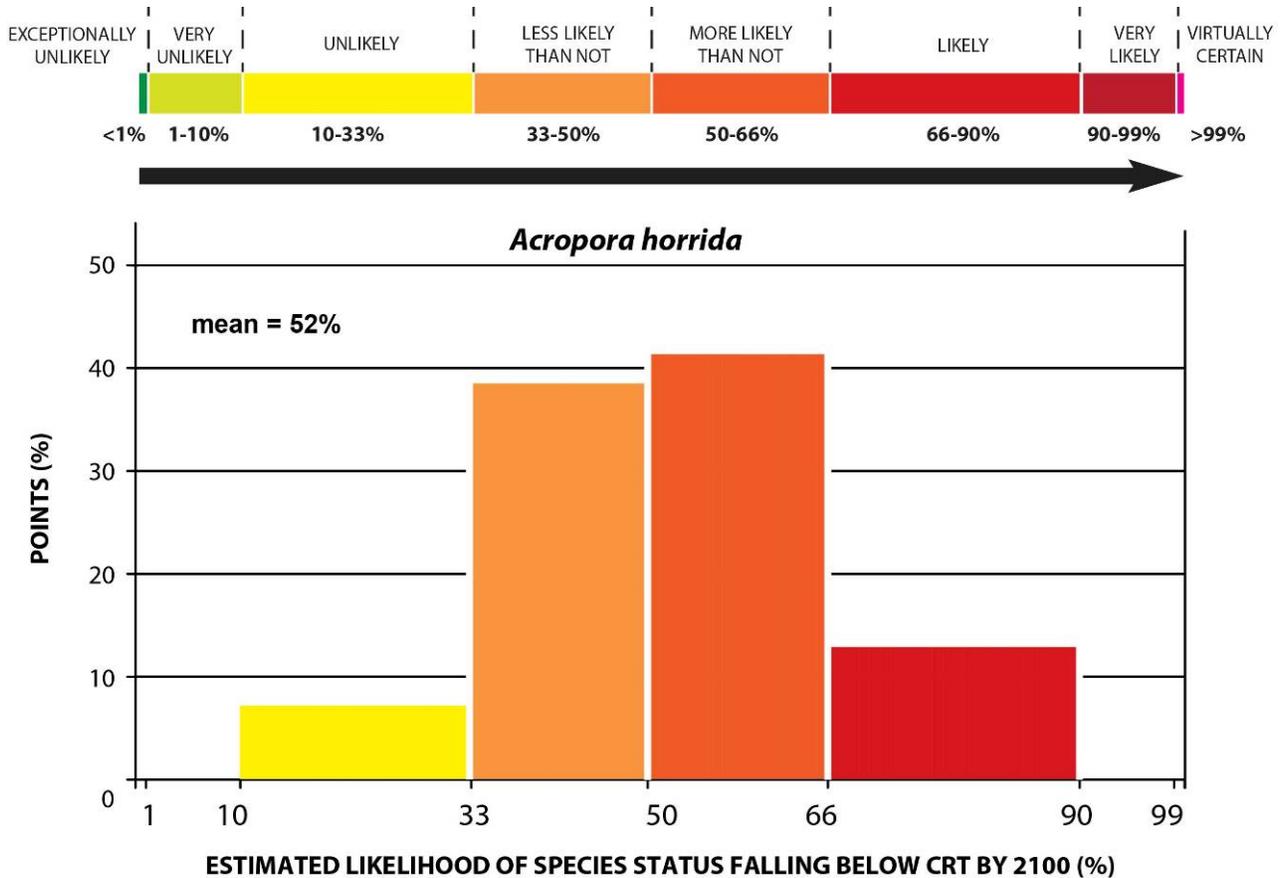


Figure 7.5.30. Distribution of points to estimate the likelihood that the status of *Acropora horrida* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora horrida* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora horrida*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora horrida* were the very broad longitudinal and latitudinal distributions, Richards' occupancy estimate of 6 (see Section 7.5: Genus *Acropora*), with large local distributions and small local abundance—these characteristics tend toward species persistence (Richards, 2009), tolerance for turbid water, and it is considered less susceptible to bleaching than other *Acropora* species.

The overall likelihood that *Acropora horrida* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 52% and a standard error (SE) of 7% (Fig. 7.5.30). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–90% (Fig. 7.5.30) and the average range of likelihood estimates of the seven BRT voters (57%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of ecological and demographic information. The uncertainty shown in the range of votes stems also from the tension between the relatively high risk of *Acropora* as a genus versus the potential for *Acropora horrida* to be among the less vulnerable species of that genus.

7.5.8 *Acropora jacquelineae* Wallace, 1994

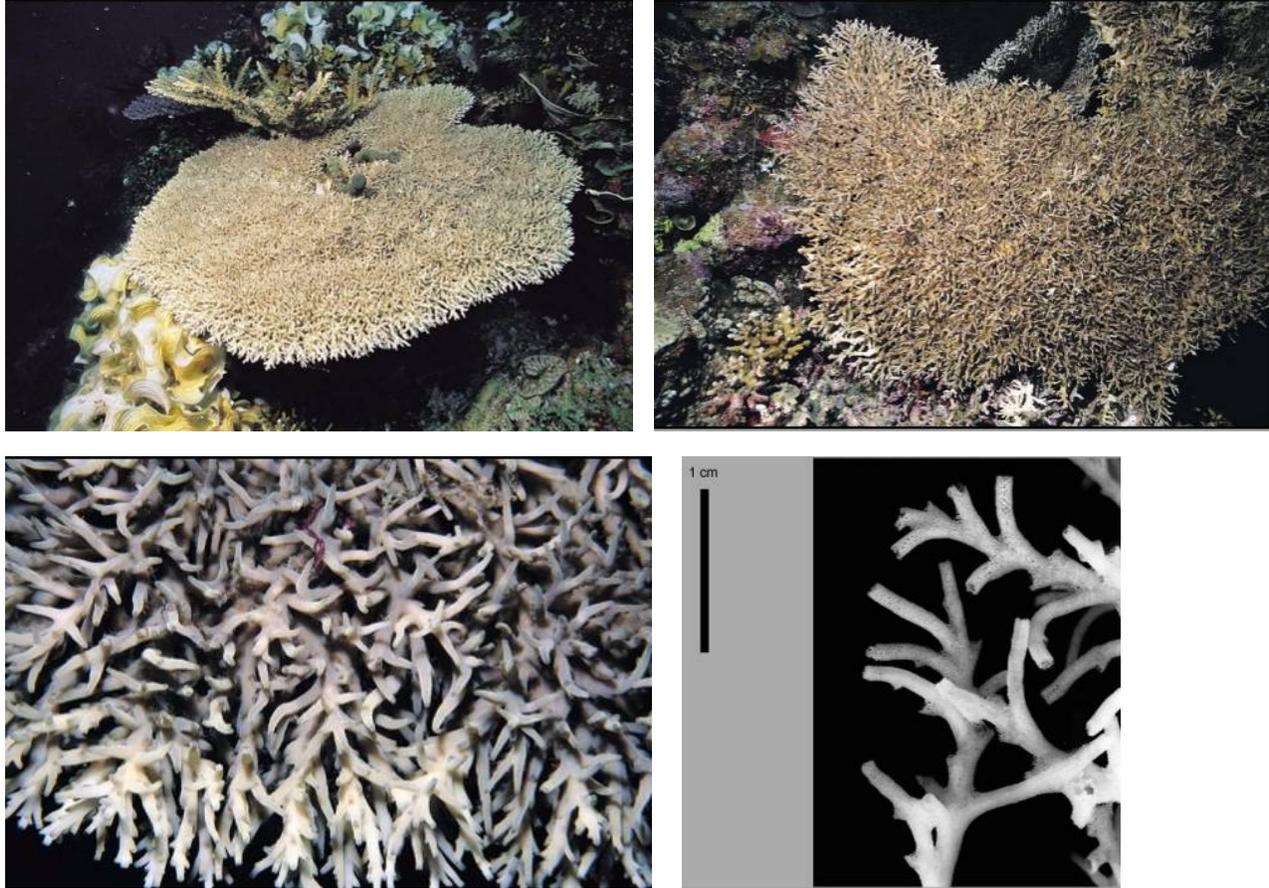


Figure 7.5.31. *Acropora jacquelineae* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora jacquelineae* are flat plates up to 1 m in diameter. Viewed from above, plates are covered with a mass of fine delicately-curved axial corallites giving an almost moss-like appearance. There is almost no development of radial corallites. Colonies are uniform grey-brown or pinkish in color (Veron, 2000).

Taxonomy

Taxonomic issues: Genetic analyses among 35 *Acropora* spp. examining variation in both mitochondrial (mt control region) and nuclear (PaxC) markers indicates that *Acropora jacquelineae* is polyphyletic for the mitochondrial marker, but monophyletic for the nuclear marker (Richards et al., 2008b). This pattern, along with evidence of some allele sharing with other species, is consistent with *Acropora jacquelineae* having a complex, reticulate evolutionary history including introgression, but does not provide strong evidence that it constitutes a ‘hybrid species’ as is shown for other *Acropora* spp. in Richards’ analysis (Richards et al., 2008b), none of which are candidate coral species considered in this Status Review Report. Hence, the BRT considered *Acropora jacquelineae* as a valid species. *Acropora jacquelineae* is similar to *Acropora paniculata* which has larger corallites (Veron, 2000).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora jacquelineae* have been reported (Wallace, 1999).

Global Distribution

Acropora jacquelineae has been reported from the central Indo-Pacific (IUCN, 2010). It has been found in Indonesia and Papua New Guinea (Richards et al., 2008b). It has also been recorded in the Philippines, American Samoa,

Suluwesi, and Papua New Guinea (D. Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010). *Acropora jacquelineae* has a fairly limited range overall, having the 22nd smallest range of 114 *Acropora* species examined (Richards, 2009).

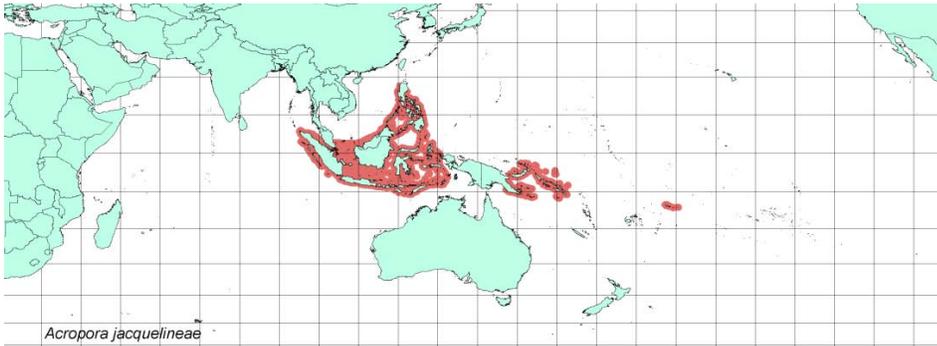


Figure 7.5.32. *Acropora jacquelineae* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.33. *Acropora jacquelineae* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora jacquelineae* occurs in American Samoa, with the supporting reference given as Fenner (pers. comm.). The CITES species database does not include any record of occurrence in U.S. waters. *Acropora jacquelineae* is not listed as occurring in American Samoa in Lovell and McLardy (2008).

D. Fenner (Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010) reports *Acropora jacquelineae* in American Samoa at Tutuila. Visual identifications are supported by photographs (2) and a sample. This species is similar to *Acropora granulosa* and *Acropora speciosa* but has thinner corallites than either. A sample was collected and fits the description of *Acropora jacquelineae* in all aspects including corallite diameter. So far it has only been found at Faga'alu, Tutuila, where it was found in water around depths of 20–25 m and was relatively rare. The tsunami of 29 September 2009 caused extensive damage at this site at these depths. No search for this species has been conducted since the tsunami.

This species was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta'u, Rose Atoll, Swains, and South Bank in March 2010 (CRED, unpubl. data). No other published or unpublished data sources indicate the occurrence of *Acropora jacquelineae* elsewhere in U.S. waters.

Acropora jacquelineae has not been recorded from federally protected waters.

Habitat

Habitat: *Acropora jacquelineae* has been reported to occupy subtidal, walls, ledges on walls, and shallow reef slopes protected from wave action (Veron, 2000; Wallace, 1999).

Depth range: *Acropora horrida* has been reported in water depths ranging from 10 m to 35 m (Carpenter et al., 2008; Wallace, 1999).

Abundance

Abundance of *Acropora horrida* has been reported as uncommon (Veron, 2000).

Life History

Acropora jacquelineae is a hermaphroditic spawner (Baird et al., 2002) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora jacquelineae* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). For more genus level information, see Section 7.5: Genus *Acropora*.

Acidification: No specific research has addressed the effects of acidification on *Acropora jacquelineae*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora jacquelineae* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. Additionally, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and evidence also show that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004; Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora jacquelineae*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora jacquelineae*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported pieces being exported per year from Indonesia (CITES, 2010).

Risk Assessment

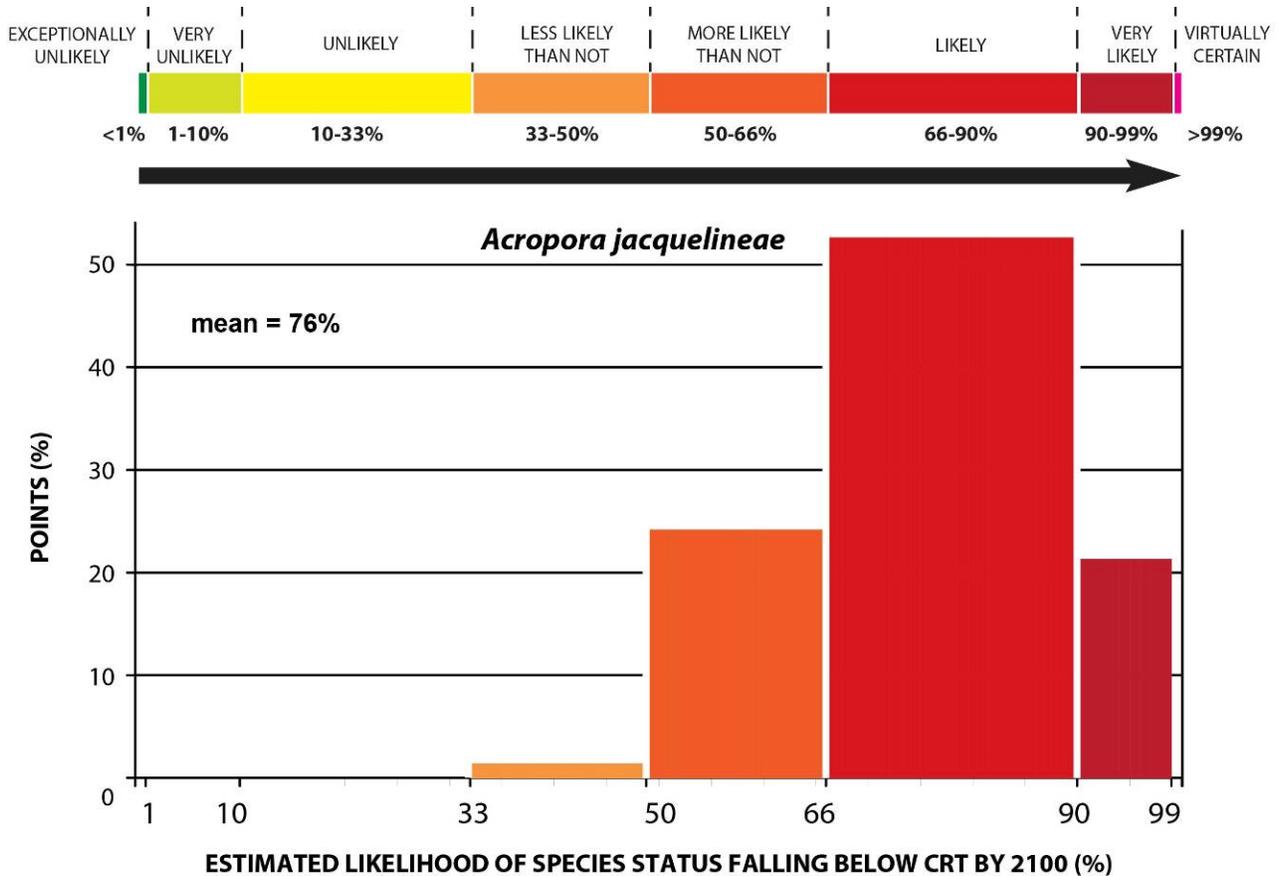


Figure 7.5.34. Distribution of points to estimate the likelihood that the status of *Acropora jacquelineae* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora jacquelineae* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), a small effective population size (of the few species with actual data), limited range, restricted latitudinal range, Richards occupancy estimate of 1 (see Section 7.5: Genus *Acropora*) with a small global distribution, small local distributions, and small local abundances—these characteristics tend toward species extinction (Richards, 2009) and its genetic uncertainty with potential introgression (Richards, 2009). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora jacquelineae*.

The overall likelihood that *Acropora jacquelineae* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “likely” risk category with a mean likelihood of 76% and a standard error (SE) of 7% (Fig. 7.5.34). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.5.34) and the average range of likelihood estimates of the seven BRT voters (50%). The overall range of votes reflects the uncertainty among BRT members inherent in the lack of ecological and demographic information. Although the range of votes is somewhat broad, more than half of the votes were for “likely.”

7.5.9 *Acropora listeri* Brook, 1893

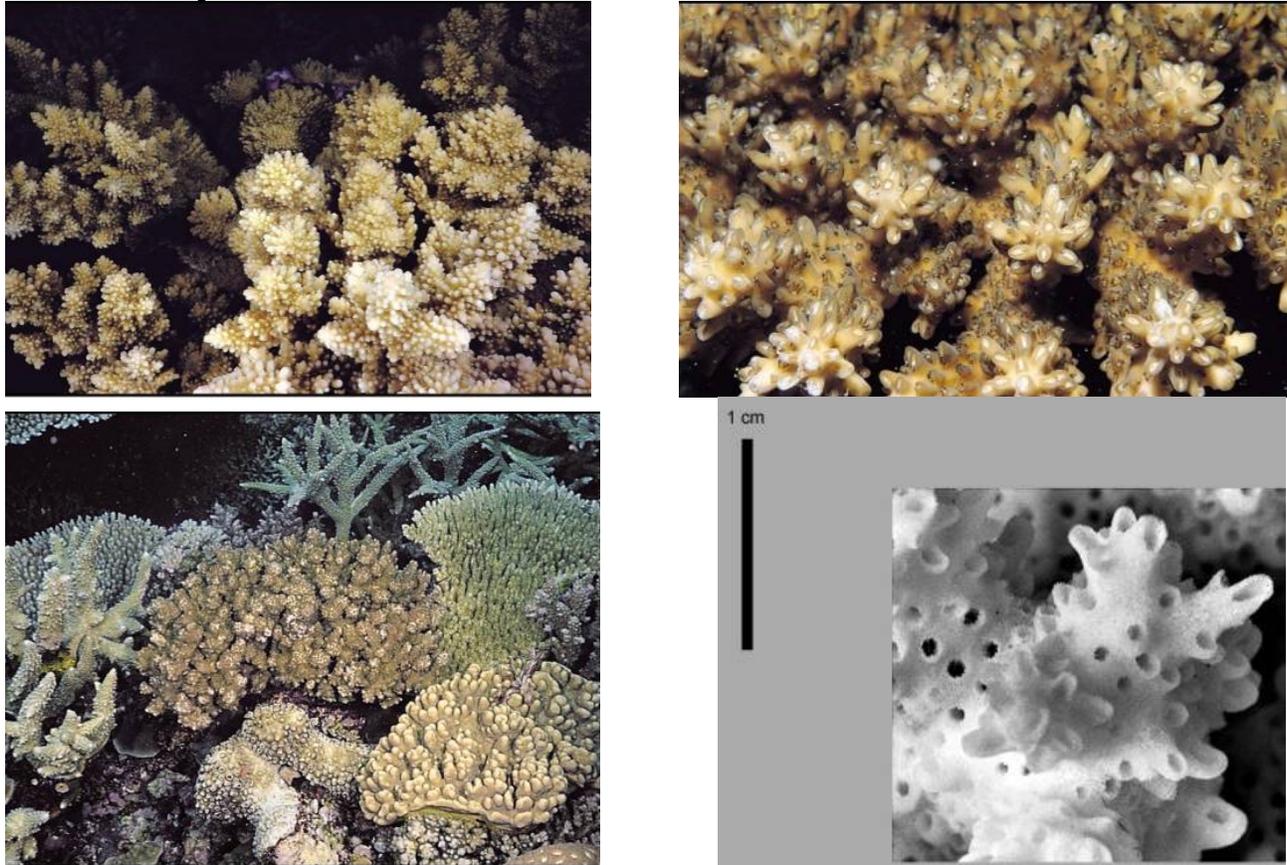


Figure 7.5.35. *Acropora listeri* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora listeri* are irregular clumps or corymbose plates with thick branches of highly irregular length and shape. Branches may be tapered (in wave-washed habitats), conical, dome-shaped or globular (in less-exposed habitats), depending upon the degree of formation of axial corallites. One or more axial corallites may occur on branch ends or, commonly, there are no axial corallites. Radial corallites are irregularly immersed to tubular and often have slit-like openings and pointed rims, giving colonies a spiny appearance. Colonies are cream or brown in color (Veron, 2000).

Taxonomy

Taxonomic issues: None. “Like *Acropora polystoma*, this species is not easily identified in the field and it appears to be restricted to reef edge situations” (Wallace, 1999). *Acropora listeri* is similar to *Acropora polystoma*, which has well-defined axial corallites; it does not form dome-shaped or globular branches and has less irregular radial corallites. It is also similar to *Acropora lutkeni* (Veron, 2000).

Family: Acroporidae.

Evolutionary and geologic history: Fossil records of *Acropora listeri* have been reported from the Pleistocene (1.8–0.01 Ma) from Niue (Wallace, 1999).

Global Distribution

Acropora listeri has been reported from the Red Sea and the Gulf of Aden (questionable according to Veron 2000), the northern Indian Ocean, the central Indo-Pacific, east and west coasts of Australia, Southeast Asia, Japan and the East China Sea, the oceanic west Pacific, and the central Pacific (IUCN, 2010). It has also been found in Mauritius (Wallace,

1999). *Acropora listeri* has a very broad range overall, having the 13th largest range of 114 *Acropora* species examined (Richards, 2009).

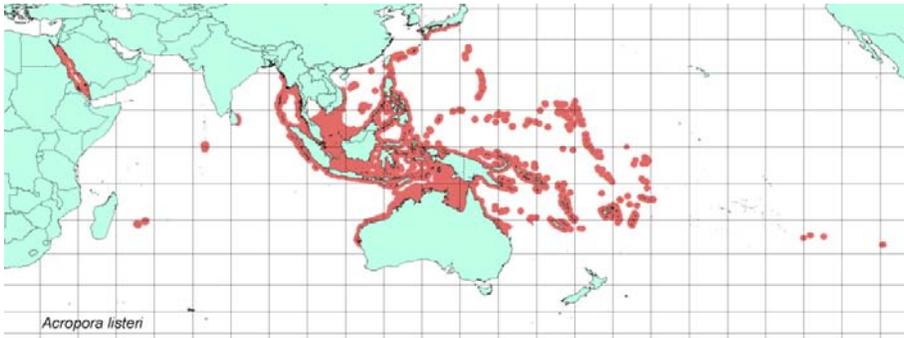


Figure 7.5.36. *Acropora listeri* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.37. *Acropora listeri* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora listeri* occurs in American Samoa and the Northern Mariana Islands. The IUCN Species Account also notes its occurrence in the U.S. minor outlying islands but the CITES database does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora listeri* has been reported from Tutuila in American Samoa (Coles et al., 2003; National Park Service, 2009), and Guam (Wallace, 1999). No reference supporting its occurrence in the U.S. minor outlying islands, as reported in the IUCN Species Account, has been identified.

Within federally protected waters, *Acropora listeri* has been recorded from the following areas (Kenyon et al., 2010b):

- National Park of American Samoa, Tutuila Island unit

Habitat

Habitat: *Acropora listeri* has been reported from subtidal shallow reef edges, upper reef slopes, and in strong wave action (Veron, 2000; Wallace, 1999).

Depth range: *Acropora listeri* has been reported in water depths ranging from near the surface to 15 m (Veron, 2000).

Abundance

Abundance of *Acropora listeri* has been reported as uncommon (Veron, 2000).

Life History

Acropora listeri is a hermaphroditic spawner (Baird et al., 2010; Harrison et al., 1984) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora listeri* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). *Acropora listeri* has moderate to high bleaching susceptibility among *Acropora* (Done et al., 2003).

Acidification: No specific research has addressed the effects of acidification on *Acropora listeri*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: In general, *Acropora* species are moderately to highly susceptible to disease. Specific susceptibility and impacts of disease on this species are not known. However, ample evidence show that diseases can have devastating regional impacts on individual coral species, particularly acroporids (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004; Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora listeri*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora listeri*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

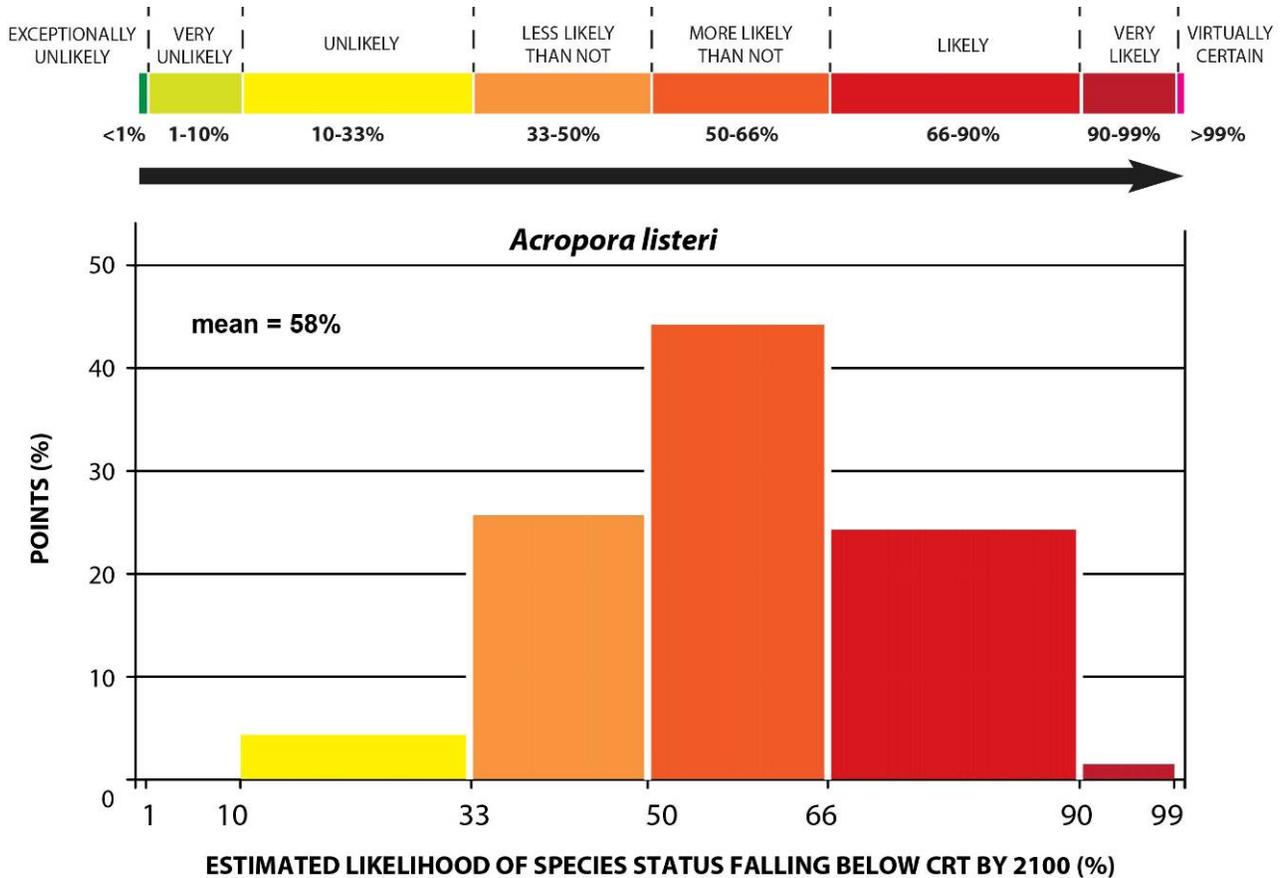


Figure 7.5.38. Distribution of points to estimate the likelihood that the status of *Acropora listeri* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora listeri* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), a Richards' Occupancy Type 2 (see Section 7.5: Genus *Acropora*) with large global distribution, limited local distribution, uncommon local abundance—these characteristics tend toward species local extinction (Richards, 2009). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora listeri*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora listeri* were the broad longitudinal and latitudinal distributions, moderate depth range (0 m-15 m), and tolerance for high-energy environments.

The overall likelihood that *Acropora listeri* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 58% and a standard error (SE) of 7% (Fig. 7.5.38). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the very wide range of votes of 10%–99% (Fig. 7.5.38) and the average range of likelihood estimates of the seven BRT voters (65%). The overall range of votes reflects the uncertainty among BRT members inherent in the lack of ecological and demographic information for *Acropora listeri*.

7.5.10 *Acropora lokani* Wallace, 1994

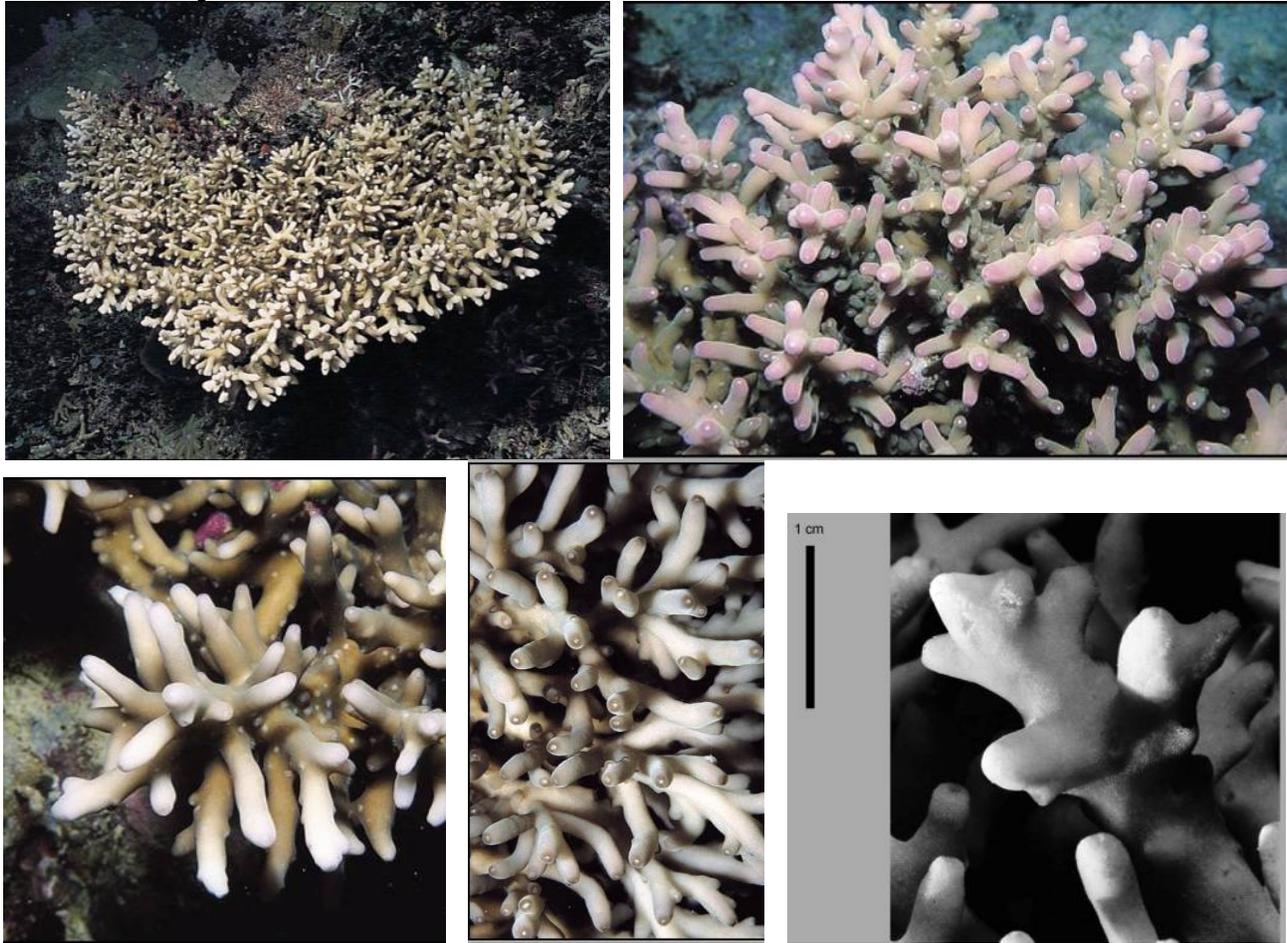


Figure 7.5.39. *Acropora lokani* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora lokani* are composed of robust horizontal main branches that usually diverge. Short upright branchlets diverge from main branches. Axial corallites and incipient axial corallites radiate from branchlets and are tubular in shape and large. Radial corallites are small and pocket shaped. Colonies are cream, brown or blue (which may photograph pink) in color (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora lokani* is similar to *Acropora caroliniana* which has smaller corallites and *Acropora granulosa* (Veron, 2000).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora lokani* have been reported (Wallace, 1999).

Global Distribution

Acropora lokani has been reported from the central Indo-Pacific (IUCN, 2010). It is found in Southeast Asia (Richards et al., 2008b), Fiji, American Samoa (D. Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010 but see below), Pohnpei, Solomons (IUCN, 2010), Raja Ampat, Coral Sea and the Great Barrier Reef (D. Fenner, pers. comm., April 2010). *Acropora lokani* has a relatively small range overall, having the 33rd smallest range of 114 *Acropora* species examined (Richards, 2009).

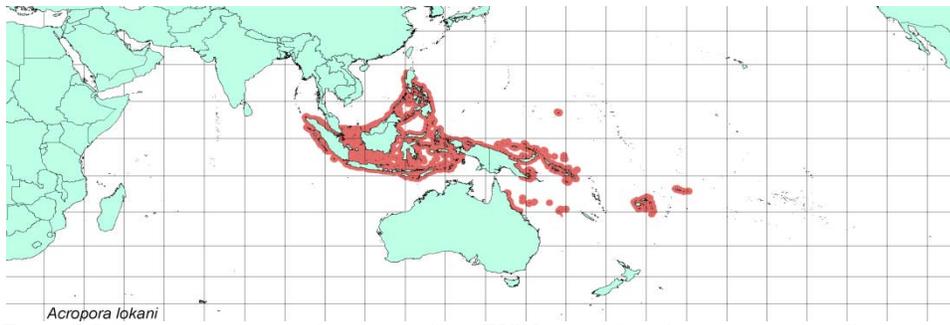


Figure 7.5.40. *Acropora lokani* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.41. *Acropora lokani* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora lokani* occurs in American Samoa, with the supporting reference given as Fenner (pers. comm.). The CITES species database does not include any record of occurrence of *Acropora lokani* in U.S. waters. *Acropora lokani* is not listed as occurring in American Samoa in Lovell and McLardy (2008).

Fenner corrected his personal communication to the IUCN and now reports that he has not found *Acropora lokani* in American Samoa (D. Fenner, Dept. of Marine and Wildlife Resources, Tutuila, pers. comm., April 2010). An observed and photographed colony at Tutuila is *Acropora carolineana*, originally misidentified as *Acropora lokani*. *Acropora lokani* as described in Wallace (1994; 1999) has bifurcating branchlets, while *Acropora carolineana* as described in Wallace (1999) and Veron and Wallace (1984) has branchlets radiating in a Christmas-tree-like pattern on a central branchlet. The photos clearly show radiating branchlets and, thus, the species is *Acropora carolineana*. Veron (2000) shows *Acropora lokani* having the radiating branchlets, and *Acropora carolineana* not having them, in error, leading to the original error in identification.

This species was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta'u, Rose Atoll, Swains, and South Bank in March 2010 (CRED, unpubl. data). No other published or unpublished data sources indicate the occurrence of *Acropora lokani* elsewhere in U.S. waters.

Habitat

Habitat: *Acropora lokani* have been reported to occupy sheltered lagoon patch reefs and, shallow reef environments (Veron, 2000; Wallace, 1999).

Depth range: *Acropora lokani* has been reported in water depths ranging from 8 m to 25 m (Veron, 2000).

Abundance

Abundance of *Acropora lokani* has been reported as uncommon (Carpenter et al., 2008), but sometimes common (Veron, 2000).

Life History

Acropora lokani is assumed to be a hermaphroditic spawner with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the susceptibility of *Acropora lokani* to thermal stress, the genus, *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora lokani*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora lokani* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. However, ample evidence show that diseases can have devastating regional impacts on individual coral species, particularly acroporids (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004; Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora lokani*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora lokani*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

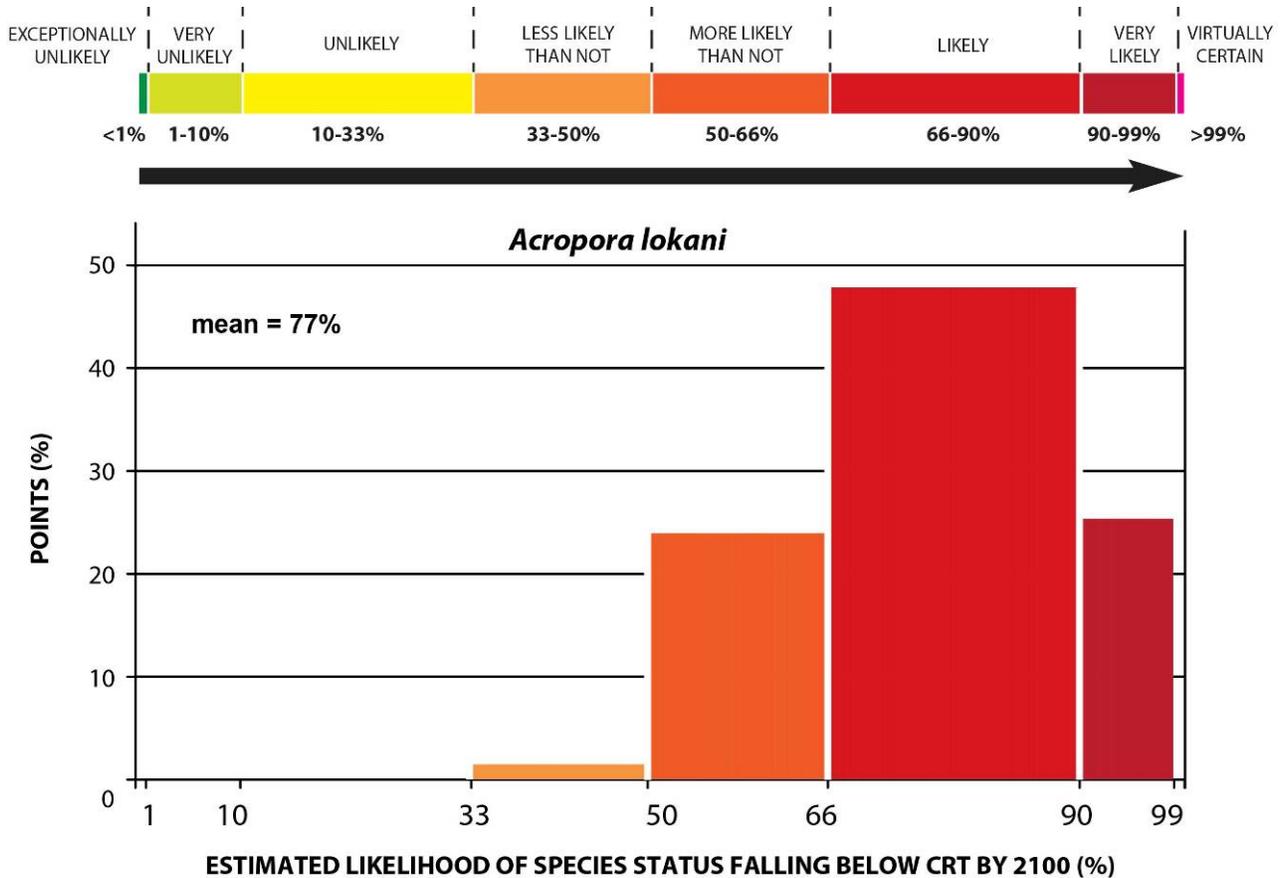


Figure 7.5.42. Distribution of points to estimate the likelihood that the status of *Acropora lokani* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora lokani* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), the smallest effective population size of ones with actual data, limited geographic and restricted latitudinal range, Richards occupancy estimate of 1 (see Section 7.5: *Genus Acropora*) with a small global distribution, small local distributions, and small local abundances—these characteristics tend toward Genus *Acropora* species extinction (Richards, 2009). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora lokani*.

The overall likelihood that *Acropora lokani* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “likely” risk category with a mean likelihood of 77% and a standard error (SE) of 8% (Fig. 7.5.42.). A substantial ~25% portion of the vote was “very likely.” This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.5.42) and the average range of likelihood estimates of the seven BRT voters (50%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora lokani*. Although the range of votes is somewhat broad, few votes were cast on the less likely end of the scale.

7.5.11 *Acropora microclados* Ehrenberg, 1834

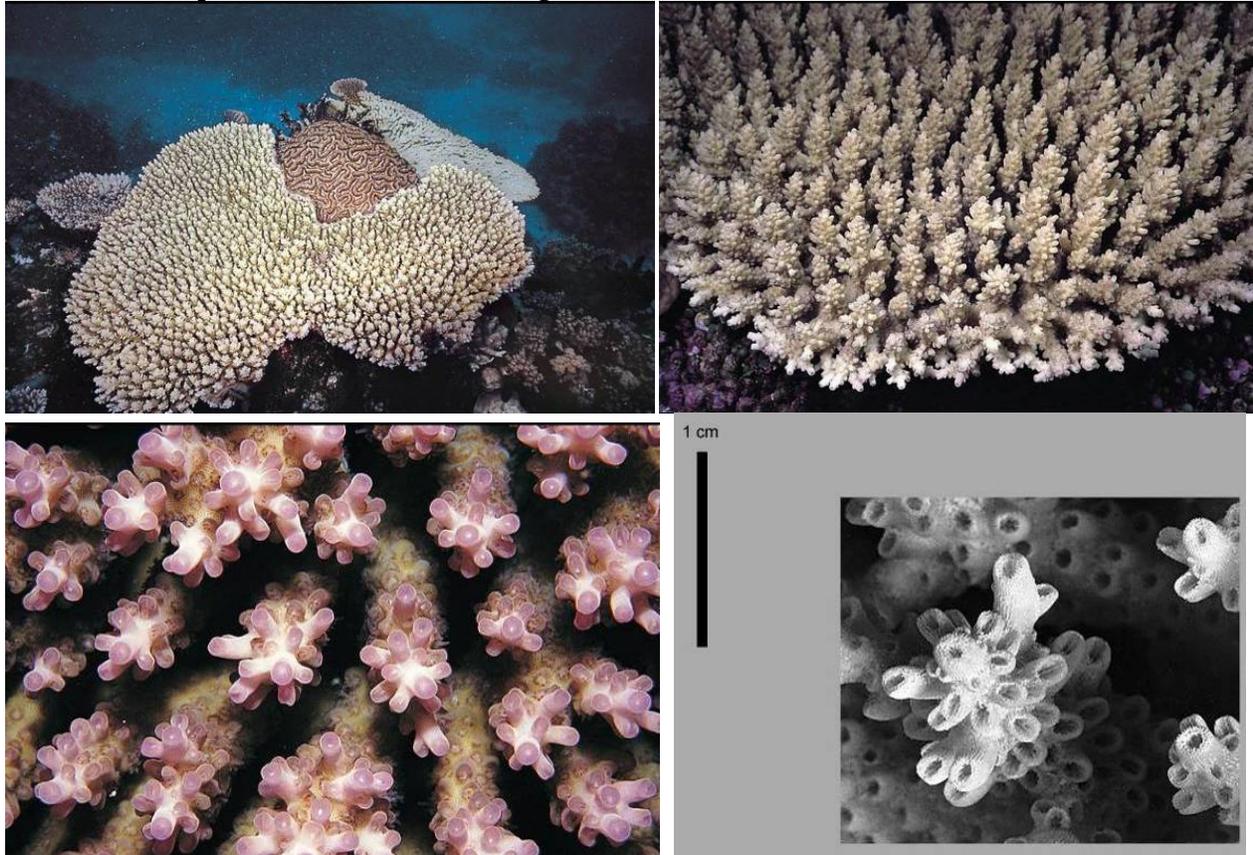


Figure 7.5.43. *Acropora microclados* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora microclados* are corymbose plates up to approximately 1 m across, with short, uniform, evenly-spaced, tapered branchlets up to 10 mm thick at the base. Axial corallites are tubular and conspicuous. Incipient axial corallites are common. Radial corallites are irregular, mostly tubular and appressed, with sharp-edged nariform openings. Colonies are usually a distinctive pale pinkish-brown in color but are occasionally other colors. Pale grey tentacles are often extended during the day (Veron, 2000; Veron and Wallace, 1984). Determinate growth.

Taxonomy

Taxonomic issues: None. *Acropora microclados* is most similar to *Acropora massawensis*, which forms prostrate colonies and has less tubular radial corallites, *Acropora lamarcki*, which has less exsert and less tubular radial corallites, and *Acropora macrostoma*, which does not have nariform corallite openings (Veron and Wallace, 1984).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora microclados* have been reported (Wallace, 1999).

Global Distribution

Acropora microclados has been reported across a wide distribution ranging from the Red Sea, the central and western Indian Ocean, to the central Indo-Pacific, west and east coasts of Australia, Southeast Asia, Japan and the East China Sea (Veron, 2000; Veron and Wallace, 1984). J. Maragos (USFWS, Honolulu, HI, pers. comm., April 2010) has confirmed its presence in the central Pacific. *Acropora microclados* has a broad range overall, having the 20th largest range of 114 *Acropora* species examined (Richards, 2009).

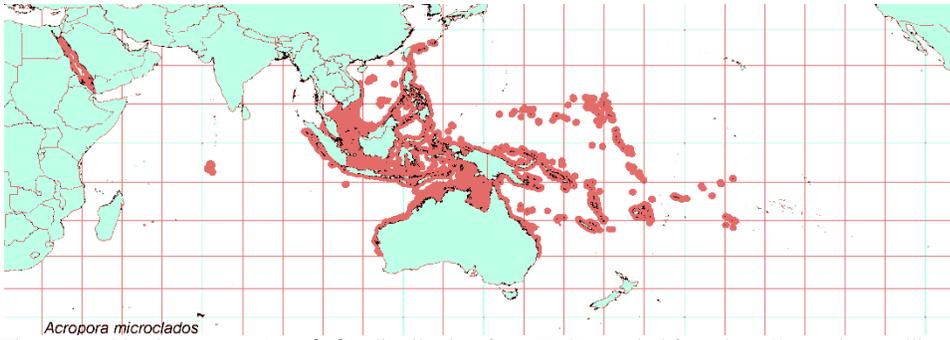


Figure 7.5.44. *Acropora microclados* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.45. *Acropora microclados* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora microclados* occurs in the Northern Mariana Islands. The CITES database also notes its occurrence in American Samoa but the IUCN Species Account does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora microclados* has been reported from Tutuila in American Samoa (Lovell and McLardy, 2008; National Park Service, 2009) and from Guam (Wallace, 1999). It has also been reported from Jarvis Island, Kingman Reef, and Baker Island and may occur at Wake Atoll (CRED, unpubl. data).

Within federally protected waters, *Acropora microclados* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Baker, Jarvis, Kingman)
- National Park of American Samoa, Tutuila Island unit

Habitat

Habitat: *Acropora microclados* have been reported to occur on upper reef slopes (Veron, 2000) and subtidal reef edges (Carpenter et al., 2008).

Depth range: *Acropora microclados* has been reported in water depths ranging from 5 m to 20 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora microclados* has been reported as uncommon (Veron, 2000; Veron and Wallace, 1984).

Life History

Acropora microclados is a hermaphroditic spawner (Baird et al., 2010; Baird et al., 2002; Guest et al., 2005b; Hanafy et al., 2010; Hayashibara et al., 1993) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora microclados* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2005a; McClanahan et al., 2007). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). *Acropora microclados* may be less prone to bleaching than other *Acropora* (Done et al., 2003). For more genus level information, see Section 7.5: Genus *Acropora*.

Acidification: No specific research has addressed the effects of acidification on *Acropora microclados*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora microclados* are not well understood, although in general *Acropora* species are moderately to highly susceptible to disease. Medium to high level of traces of subacute dark spots disease for *Acropora microclados* have been reported (UNEP, 2010). Effects on reproduction include reduced fecundity (Sutherland et al. 2004). Ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004; Green and Bruckner 2000).

Predation: The specific effects of predation are poorly known for *Acropora microclados*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci* (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora microclados*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia and 30,000–100,000 pieces from Fiji (CITES, 2010).

Risk Assessment

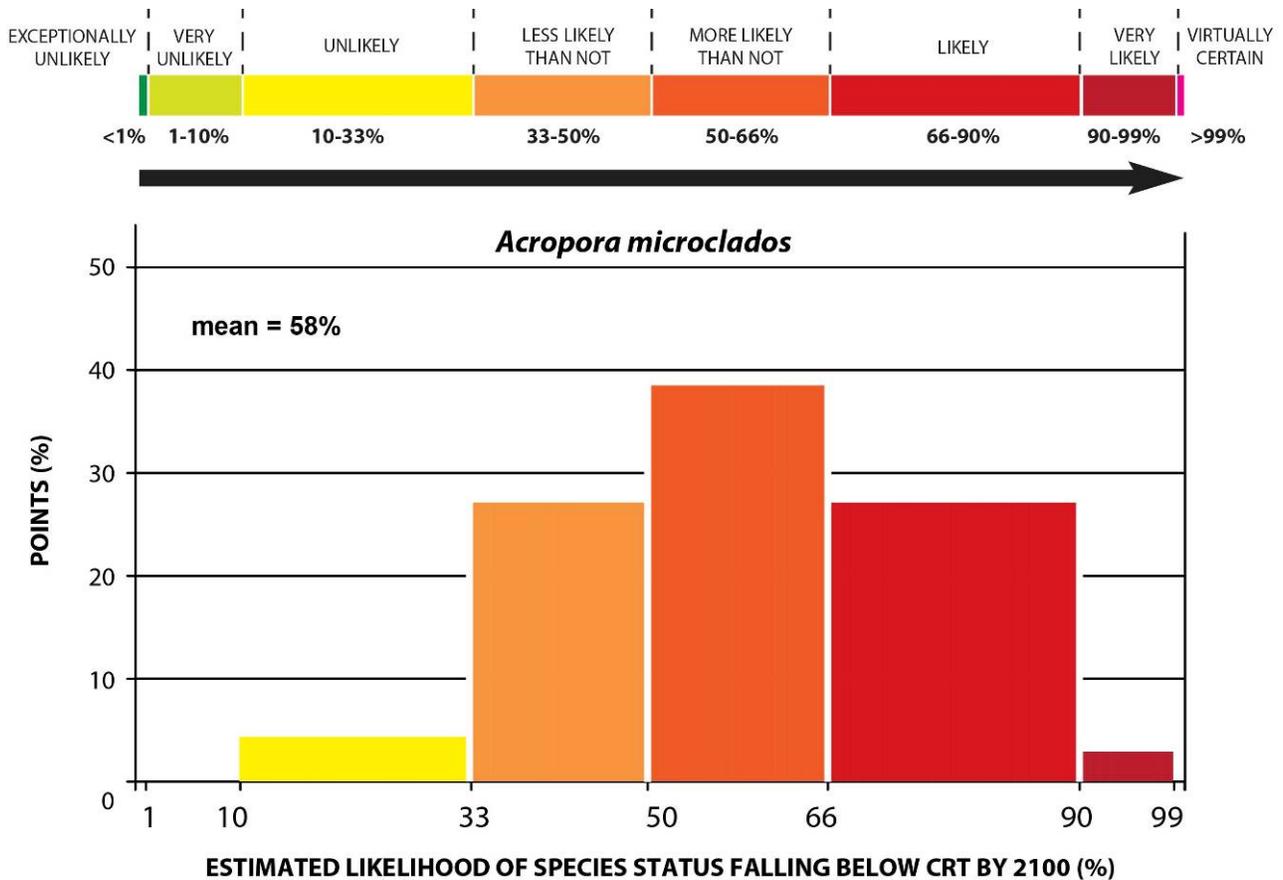


Figure 7.5.46. Distribution of points to estimate the likelihood that the status of *Acropora microclados* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora macroclados* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), a Richards' Occupancy Type 2 (see Section 7.5: Genus *Acropora*), with broad global distribution, limited local distribution, uncommon local and abundance—these characteristics tend toward making this species potentially vulnerable to local extinction (Occupancy Type 2; Richards, 2009). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora macroclados*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora macroclados* were the moderate longitudinal and latitudinal distributions and depth range (5 m-20 m).

The overall likelihood that *Acropora macroclados* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 58% and a standard error (SE) of 11% (Fig. 7.5.46). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the very wide range of votes of 10%–99% (Fig. 7.5.46) and the average range of likelihood estimates of the seven BRT voters (60%). The wide overall range of votes reflects the uncertainty among BRT members inherent in the lack of ecological and demographic information.

7.5.12 *Acropora palmerae* Wells, 1954

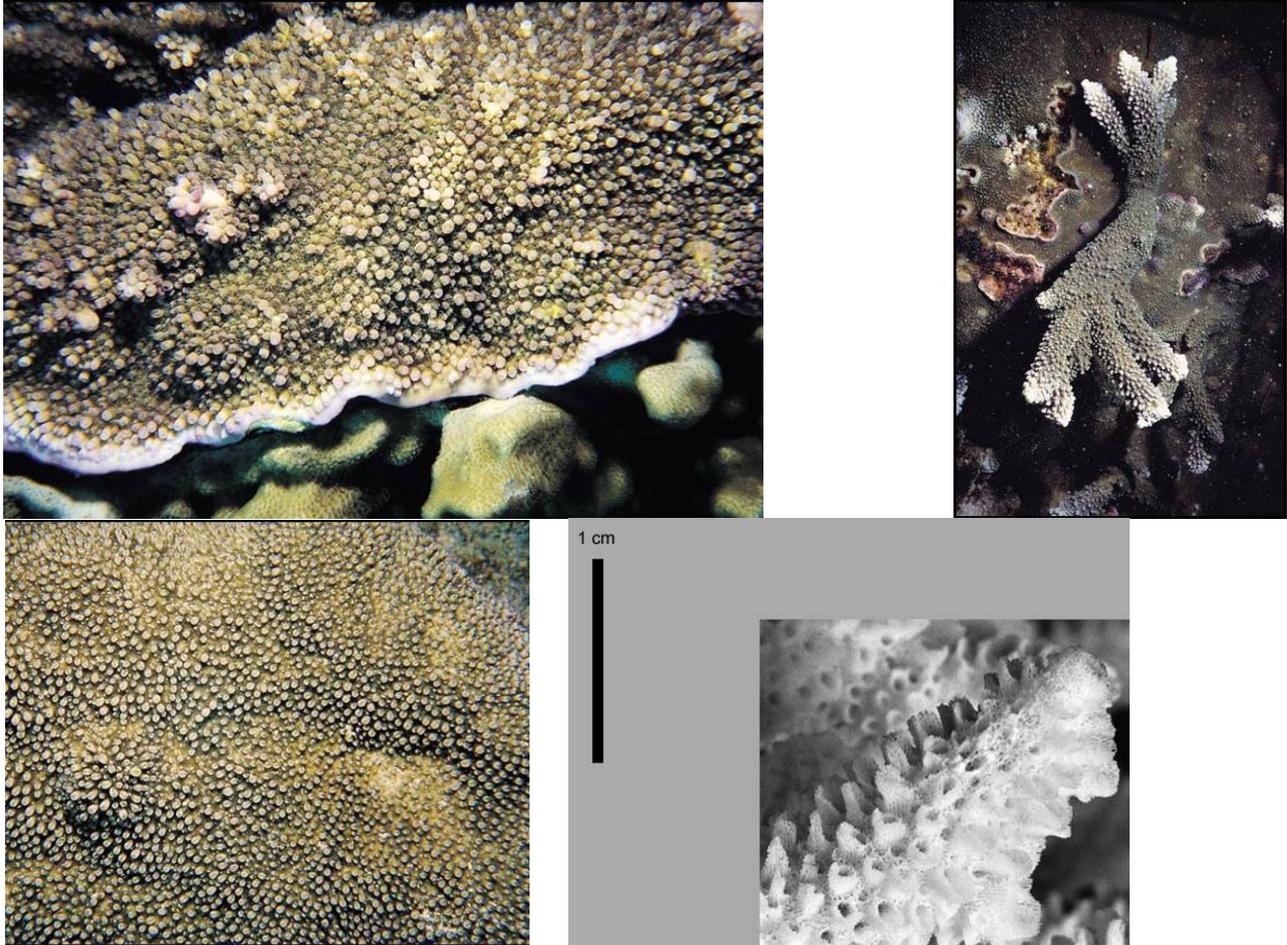


Figure 7.5.47. *Acropora palmerae* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora palmerae* are encrusting with or without short, irregularly shaped branches. Colonies seldom exceed 1 m across. Axial corallites, if formed, are conspicuous. Radial corallites are mostly rasp-like but are of variable size and face different directions. Colonies are greenish- or pinkish-brown in color (Veron, 2000).

Taxonomy

Taxonomic issues: There is doubt as to whether *Acropora palmerae* is a separate species or a strong-water form of *Acropora robusta* (Wallace, 1999); however, in the absence of genetic information, the BRT considered it a valid species for the purposes of this Status Review Report (see discussion in Section 2.1.2 on taxonomic issues). It is like the encrusting base of *Acropora robusta* but does not form large branches. Small colonies of these species may be inseparable. Also similar to *Acropora pinguis*, which may also be encrusting but forms thick tapered branches (Veron and Wallace, 1984).

Family: Acroporidae.

Evolutionary and geologic history: Fossil records of *Acropora palmerae* have been reported from the Holocene (up to 10,000 years ago) from the Ryukyu Islands (Wallace, 1999).

Global Distribution

Acropora palmerae has been reported from the northern Indian Ocean, central Indo-Pacific, west and east coasts of Australia, Southeast Asia, Japan and the East China Sea, and the oceanic west Pacific (Veron, 2000). *Acropora palmerae* has a relatively moderate range overall, having the 52nd largest range of 114 *Acropora* species examined (Richards, 2009).

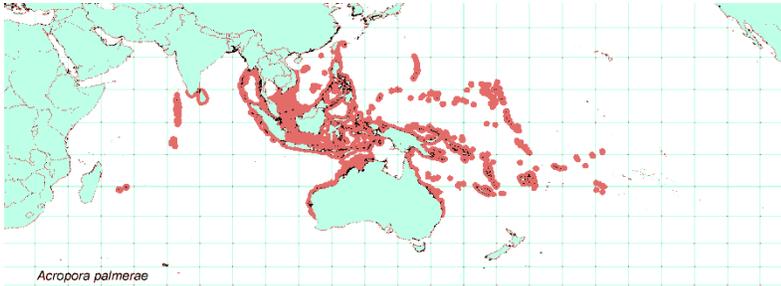


Figure 7.5.48. *Acropora palmerae* distribution from IUCN copied from <http://www.iucnredlist.org>.

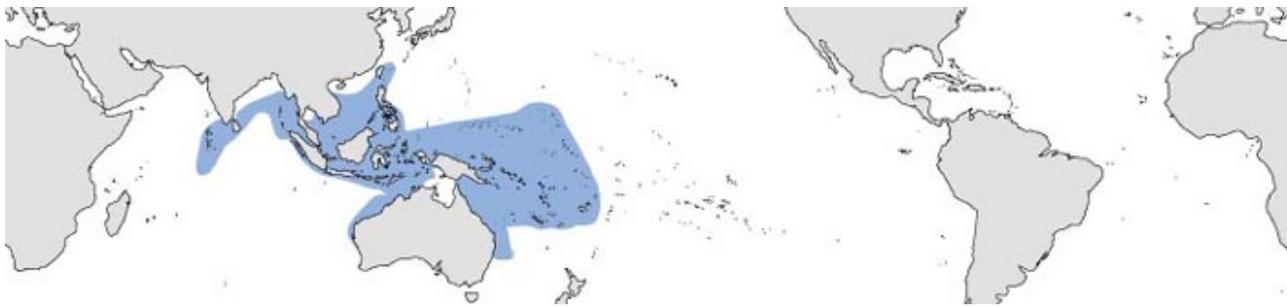


Figure 7.5.49. *Acropora palmerae* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora palmerae* occurs in American Samoa and the Northern Mariana Islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora palmerae* has been reported from Tutuila and Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; Lamberts, 1983; Lovell and McLardy, 2008; Maragos et al., 1994; National Park Service, 2009), Guam and the Commonwealth of the Northern Mariana Islands (Burdick, unpubl. data; CRED, unpubl. data; Randall, 2003; Wallace, 1999), and Wake Atoll (CRED, unpubl. data).

Within federally protected waters, *Acropora palmerae* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Wake)
- National Park of American Samoa, Ofu Island unit
- Fagatele Bay National Marine Sanctuary, Tutuila

Habitat

Habitat: *Acropora palmerae* has been reported to occupy reef flats exposed to strong wave action and lagoons (Veron, 2000) and intertidal, subtidal, shallow, reef tops, reef flats, and reef edges (Carpenter et al., 2008).

Depth range: *Acropora palmerae* has been reported in water depths ranging from 5 m to 20 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora palmerae* has been reported as uncommon (Carpenter et al., 2008; Veron, 2000).

Life History

Acropora palmerae is a hermaphroditic spawner (Baird et al., 2002; Dai et al., 1992) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora palmerae* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora palmerae*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora palmerae* are not known, although in general *Acropora* species are moderately-to-highly susceptible to disease. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004; Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora palmerae*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora palmerae*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

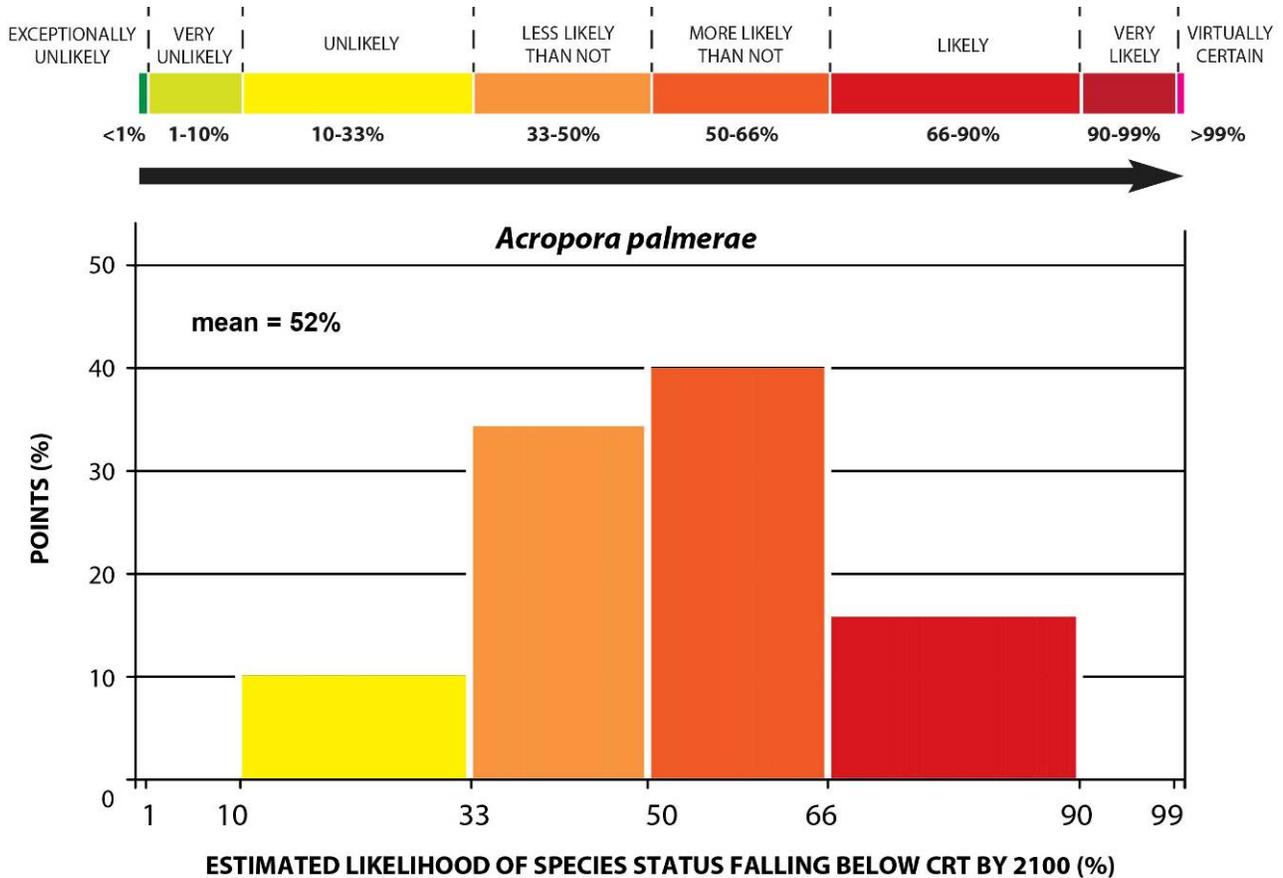


Figure 7.5.50. Distribution of points to estimate the likelihood that the status of *Acropora palmerae* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora palmerae* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution) and uncommon abundance. The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora palmerae*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora palmerae* were the moderate geographic and depth distributions, tolerance for high-energy and intertidal habitats, and the potential for higher than reported abundance based on species uncertainty, i.e., it could be a strong-water form of the more common *Acropora robusta*. Wide geographic distribution was considered to reduce extinction risk by increasing the likelihood that the species would evade stresses and/or catastrophes in at least some locations.

The overall likelihood that *Acropora palmerae* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 52% and a standard error (SE) of 9% (Fig. 7.5.50). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the wide range of votes of 10%–90% (Fig. 7.5.50) and the average range of likelihood estimates of the seven BRT voters (60%). The overall range of votes reflects the uncertainty among BRT members about the species taxonomy and the lack of ecological and demographic information for *Acropora palmerae*.

7.5.13 *Acropora paniculata* Verrill, 1902

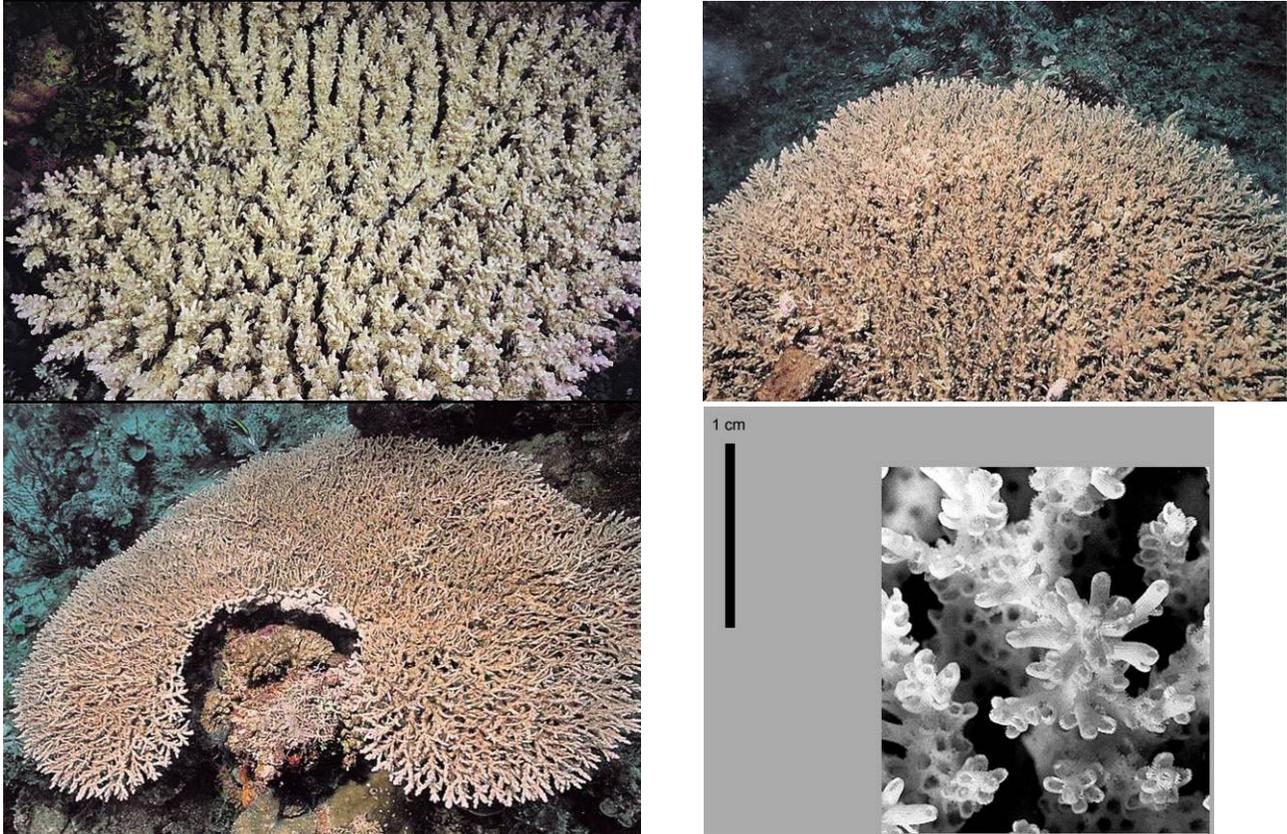


Figure 7.5.51. *Acropora paniculata* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora paniculata* are large plates or tables that are 25 mm thick and frequently greater than 1 m across. Branchlets are short and compact. Axial and incipient axial corallites crowd the upper surface and are long, thin and tubular. Radial corallites are immersed on lower branchlets. Colonies are cream, grey or blue in color (Veron, 2000). Maximum colony size is 200 cm. Determinate growth.

Taxonomy

Taxonomic issues: None. *Acropora paniculata* is similar to *Acropora jacquelineae*, which has finer corallites, and *Acropora cytherea*, which forms thinner plates and has branchlets which do not terminate in masses of tubular corallites (Veron and Wallace, 1984). It is quite similar to *Acropora cytherea*, but more delicate in structure (Wallace, 1999).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora paniculata* have been reported (Wallace, 1999).

Global Distribution

Acropora paniculata has been reported across a wide distribution ranging from the Red Sea and Indian Ocean (Chagos), to the west and central Pacific with some range discrepancies between IUCN and Veron (IUCN, 2010; Veron, 2000). Also observed in Hawai'i (J. Maragos, USFWS, Honolulu, HI, pers. comm., April 2010), Rodrigues (Fenner et al., 2004) and Society Islands (Wallace, 1999). *Acropora paniculata* has a moderately broad range overall, having the 40th largest range of 114 *Acropora* species examined (Richards, 2009).

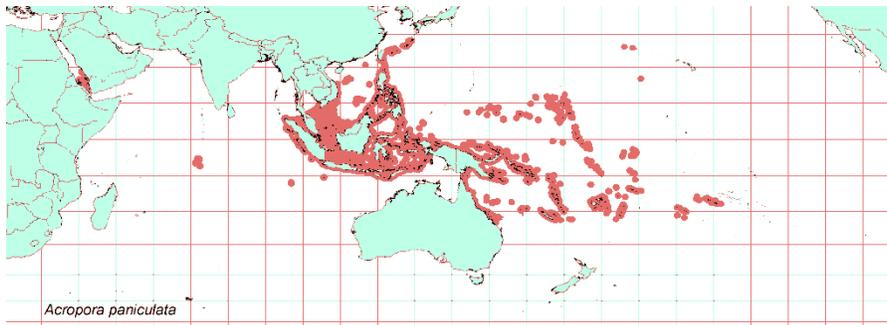


Figure 7.5.52. *Acropora paniculata* distribution from IUCN copied from <http://www.iucnredlist.org>.

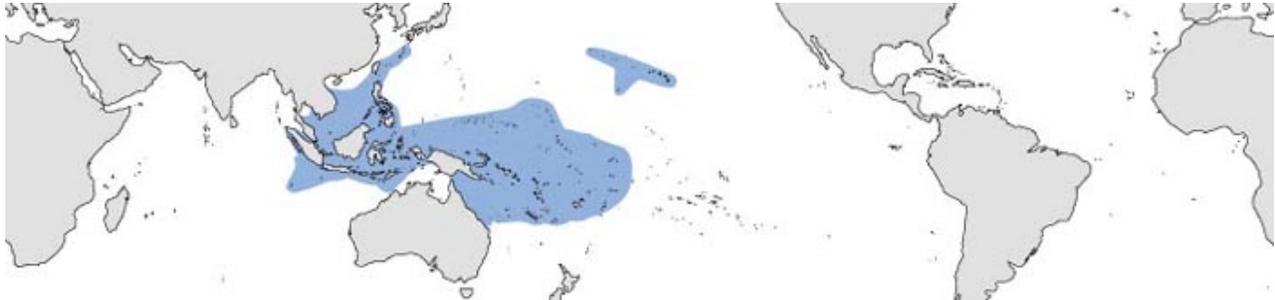


Figure 7.5.53. *Acropora paniculata* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora paniculata* occurs in American Samoa and minor U.S. outlying islands. The CITES species database also notes its occurrence in Hawai'i but the IUCN Species Account does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora paniculata* has been reported from Tutuila, Ofu-Olosega, Ta'u, and Rose Atoll in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; Kenyon et al., 2010a; Lamberts, 1983; Lovell and McLardy, 2008; Maragos et al., 1994; Mundy, 1996; National Park Service, 2009), the Commonwealth of the Northern Mariana Islands (CRED, unpubl. data), the Northwestern Hawaiian Islands (Fenner, 2005; Maragos et al., 2004; Veron, 2000), Johnston Atoll, Kingman Reef (CRED, unpubl. data; Maragos and Jokiel, 1986), and Palmyra Atoll (Williams et al., 2008b).

Within federally protected waters, *Acropora paniculata* has been recorded from the following areas (Kenyon et al., 2010b):

- Papahānaumokuākea Marine National Monument (French Frigate Shoals)
- Pacific Remote Islands Marine National Monument (Johnston, Palmyra, Kingman)
- National Park of American Samoa, Ofu Island unit
- Rose Atoll Marine National Monument
- Marianas Trench Marine National Monument (Maug)

Habitat

Habitat: *Acropora paniculata* has been reported to occupy upper reef slopes, just subtidal, reef edges, and sheltered lagoons (Carpenter et al., 2008).

Depth range: *Acropora paniculata* has been reported in water depths ranging from 10 m to 35 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora paniculata* has been reported as uncommon to rare on most reefs (Veron, 2000); however, common in Papua New Guinea (Wallace, 1999).

Life History

Acropora paniculata is a hermaphroditic spawner (Kenyon, 1995) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora paniculata* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora paniculata*, but experiments on acidification impacts have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora paniculata* are not known, although in general *Acropora* species are moderately to highly susceptible to disease. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora paniculata*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora paniculata*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

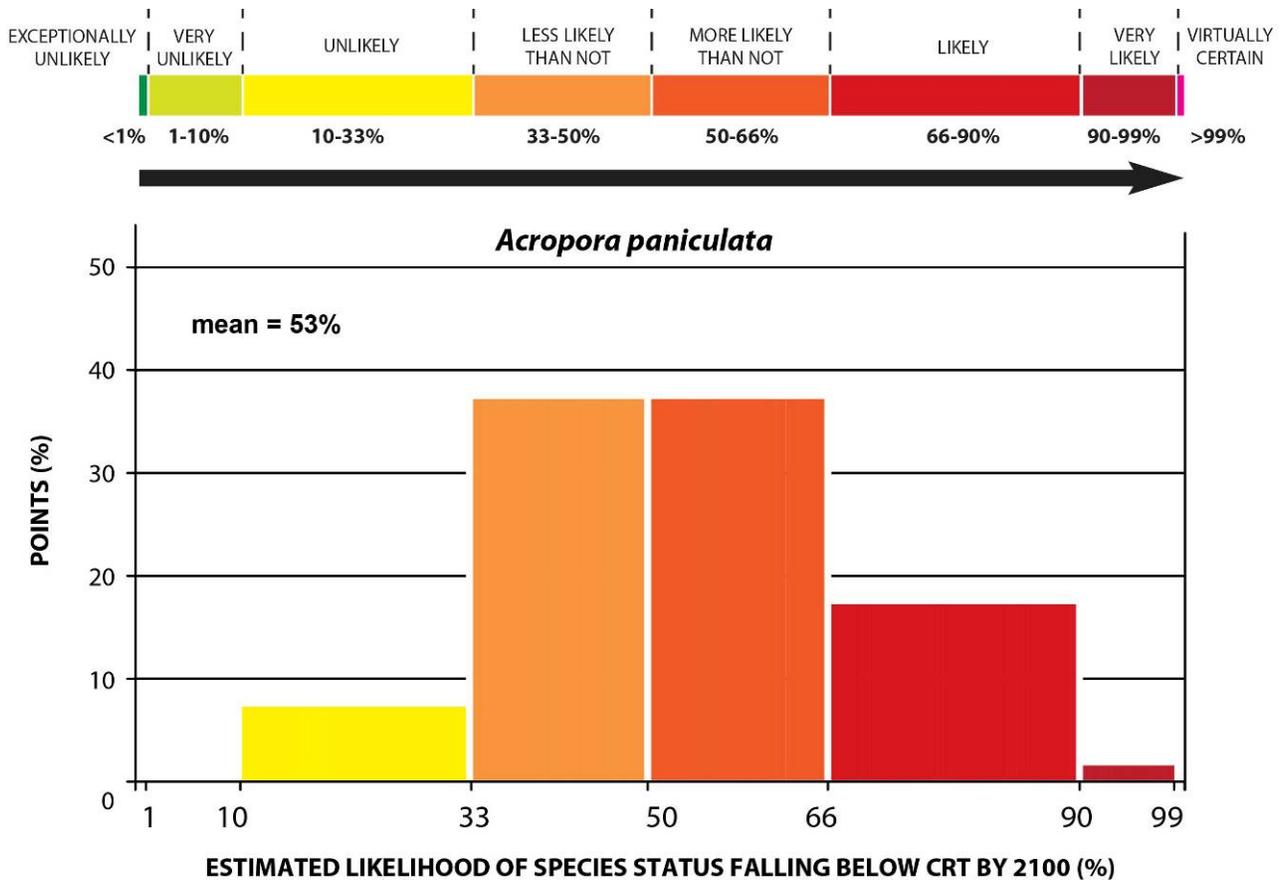


Figure 7.5.54. Distribution of points to estimate the likelihood that the status of *Acropora paniculata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora paniculata* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora paniculata*. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora paniculata* were a moderately wide geographic distribution range, presence in deepwater habitats, and being common in Papua New Guinea although rare elsewhere. *Acropora paniculata* fits Richards' occupancy Type 8 (see Section 7.5: *Genus Acropora*), with broad global distribution, broad local distribution, and low local abundance—these characteristics tend toward species persistence (Richards, 2009)—although it was mostly uncommon throughout its range. Risk was also reduced by this species' extension to mesophotic depths (35m) which suggests it can be buffered somewhat from surface-based threats.

The overall likelihood that *Acropora paniculata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 53% and a standard error (SE) of 9% (Fig. 7.5.54). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the very wide range of votes of 10%–99% (Fig. 7.5.54) and the average range of likelihood estimates of the seven BRT voters (50%). The wide overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for this species. The uncertainty shown in the range of votes stems largely from the tension between the relatively high extinction risk of *Acropora* as a genus vs. the potential for *Acropora paniculata* to be among the less vulnerable species of that genus.

7.5.14 *Acropora pharaonis* Milne Edwards and Haime, 1860

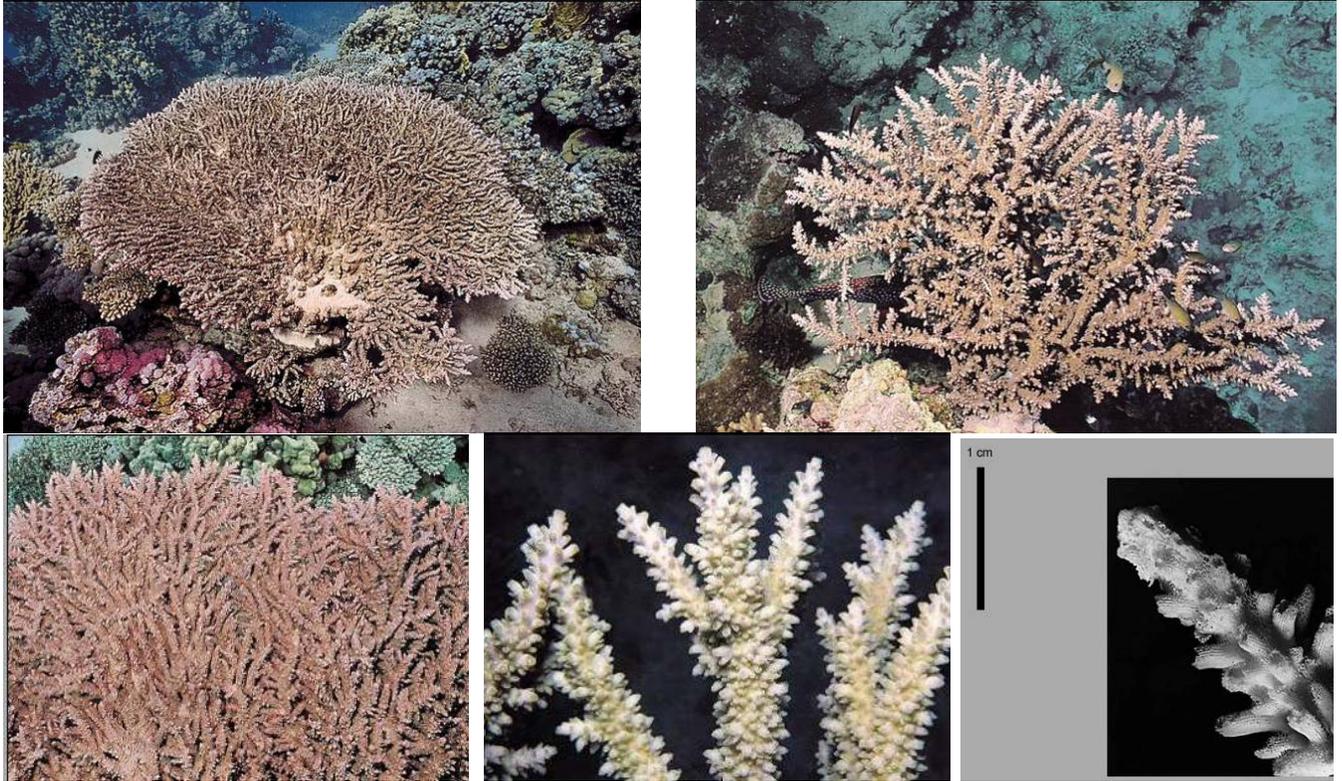


Figure 7.5.55. *Acropora pharaonis* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora pharaonis* are large horizontal tables or irregular clusters of horizontal or upright interlinked contorted branches. Branches are pointed and have short branchlets that link main branches. Axial corallites are small and incipient axial corallites are abundant giving branches a spiky surface. Radial corallites are laying flat against each other, with nariform openings. Colonies are grey-brown in color, usually with pale branch tips (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora pharaonis* is similar to *Acropora clathrata*, which has more highly-fused branches without abundant incipient axial corallites, and *Acropora plumosa*, which has larger and more open branches with less development of branchlets without abundant incipient axial corallites (Wallace, 1999).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora pharaonis* have been reported (Wallace, 1999).

Global Distribution

Acropora pharaonis has a disjoint distribution. It has been reported in some places in the Indo-Pacific, the Red Sea, the Gulf of Aden, the Indian Ocean, the Arabian/Iranian Gulf, and the northern Indian Ocean (Veron, 2000). D. Fenner (Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010) also found *Acropora pharaonis* in New Caledonia, American Samoa, and Fiji. There is some doubt about Pacific records (IUCN, 2010), and Cocos-Keeling (Wallace, 1999). *Acropora pharaonis* has a relatively limited range overall, having the 14th smallest range of 114 *Acropora* species examined (Richards, 2009).

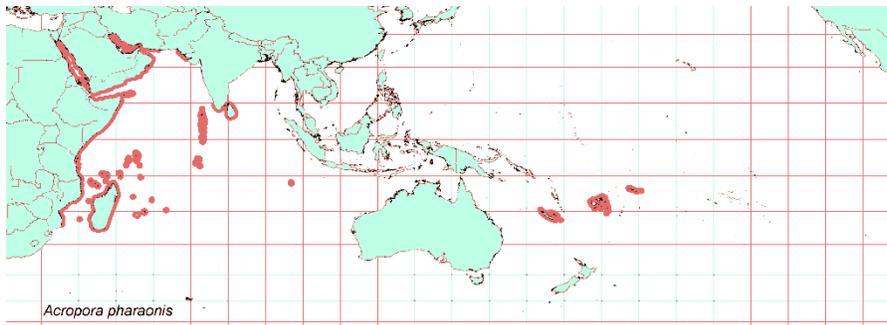


Figure 7.5.56. *Acropora pharaonis* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.57. *Acropora pharaonis* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora pharaonis* occurs in American Samoa, with the supporting reference given as Fenner (pers. comm.). The IUCN Species Account also indicates “there is some doubt about Pacific records (E. Lovell, pers. comm.)” The CITES species database does not include any record of occurrence in U.S. waters. *Acropora pharaonis* is not listed as occurring in American Samoa in Lovell and McLardy (2008).

Fenner reported *Acropora pharaonis* in American Samoa at Tutuila (CRED, unpubl. data). It has only been found so far at Leone, where it was very rare. One sample has been collected from American Samoa, but no photographs were acquired. *Acropora pharaonis* was originally described from the Red Sea, and Wallace (1999) concluded that it is only known from the Red Sea. Although there are about 10 records in the literature from the Indian Ocean, Wallace does not consider them to be *Acropora pharaonis*. Veron (2000) reported *Acropora pharaonis* from the western Indian Ocean as well as the Red Sea. Fenner has reported it from both New Caledonia and Fiji. From all three locations, it resembled Veron’s (2000) pictures from Madagascar in the Indian Ocean (volume 1, page 297, Figures 7 and 8). In those photos and in American Samoa, New Caledonia and Fiji, branches are separated. In Fiji, there has often been a central stock with radiating branches at the top of the stalk, like the outline of some of the Red Sea colonies that are somewhat vase-shaped with branches not tightly fused into a table (Sheppard and Sheppard, 1991). Branches were very rough in appearance as they were covered with radial corallites and incipient axials of a wide variety of lengths. Radial and incipient axial corallites had little or no traces of septa. All aspects of the sample from American Samoa, as well as Fiji and New Caledonia, match the species description in Wallace (1999).

Acropora pharaonis was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta’u, Rose Atoll, Swains, and South Bank in March 2010. No other published or unpublished data sources indicate the occurrence of *Acropora pharaonis* elsewhere in U.S. waters.

Acropora pharaonis has not been recorded from federally protected waters.

Habitat

Habitat: *Acropora pharaonis* has been reported to occupy sheltered reef slopes (Veron, 2000) and lagoons (Carpenter et al., 2008).

Depth range: *Acropora pharaonis* has been reported in water depths ranging from 5 m to 25 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora pharaonis* has been reported as common (Veron, 2000).

Life History

Acropora pharaonis is a hermaphroditic spawner (Hanafy et al., 2010; Shlesinger and Loya, 1985) with lecithotrophic larvae (Baird et al., 2009). Shlesinger et al (1998) indicated polyp fecundity was high, with an estimated 20 eggs per polyp, based on histological sections. For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora pharaonis* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). It was reported that *Acropora pharaonis* was locally extirpated in the SE Arabian Gulf after the combined impacts of the 1996, 1998 bleaching events (Riegl, 2002).

Acidification: No specific research has addressed the effects of acidification on *Acropora pharaonis*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: There are a medium-to-high number of disease reports specifically for *Acropora pharaonis* (UNEP, 2010). This species experiences acute white-band disease/white plague diseases and subacute black-band and yellow-band disease. Effects on reproduction include reduced fecundity (Sutherland et al., 2004). Ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora pharaonis*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora pharaonis*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

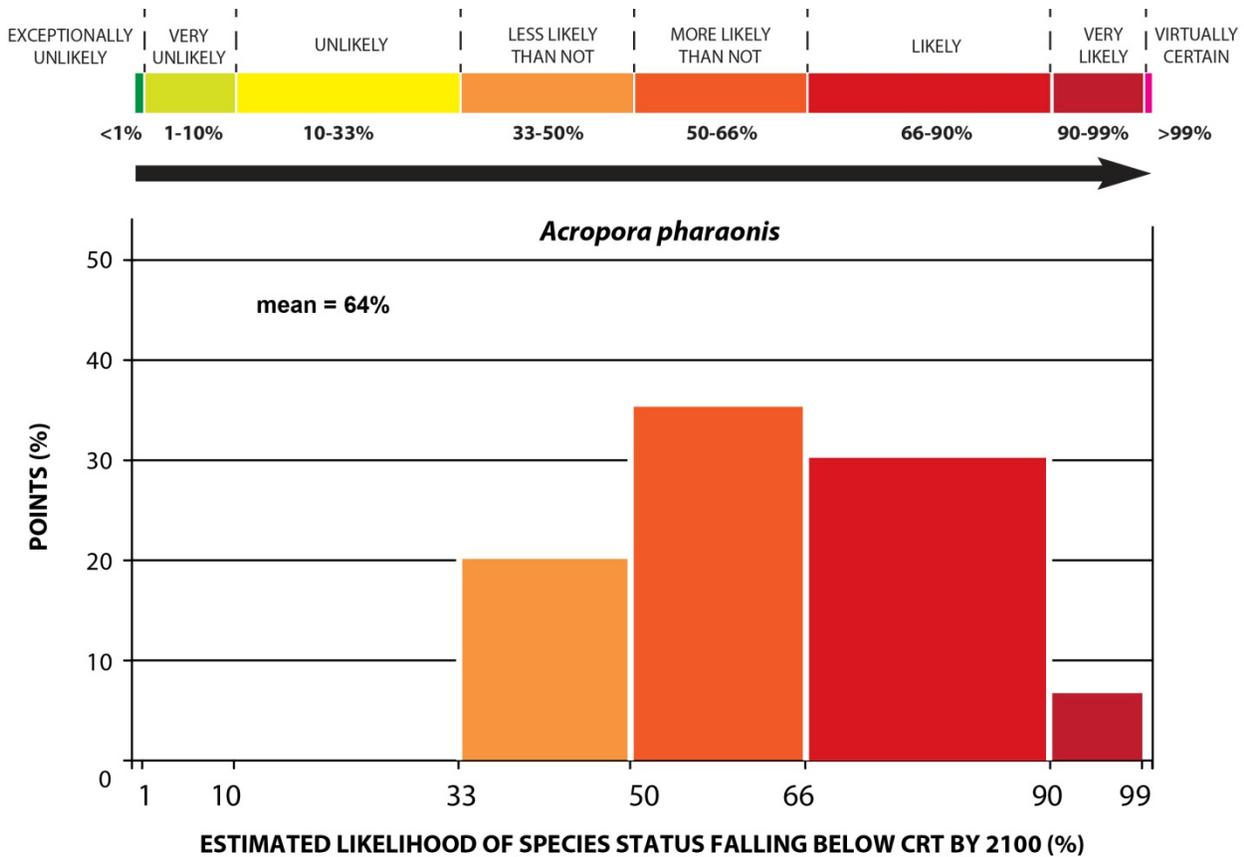


Figure 7.5.58. Distribution of points to estimate the likelihood that the status of *Acropora pharaonis* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora pharaonis* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), the restricted geographic range to potentially only the Red Sea or western Indian Ocean, and the affinity for sheltered habitats. The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora pharaonis*. The disjoint distribution of *Acropora pharaonis* makes this concern greater since it suggests the potential for repopulating local extirpations of either section of the range would be reduced. Factors that reduce the potential extinction risk (decrease likelihood of falling below Critical Risk Threshold) for *Acropora pharaonis* were its moderate depth range (5 m–25 m) and its relatively common abundance levels.

The overall likelihood that *Acropora pharaonis* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 64% and a standard error (SE) of 9% (Fig. 7.5.58). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 7.5.58) and the average range of likelihood estimates of the seven BRT voters (55%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information, particularly uncertainty of reports from American Samoa, Fiji, and New Caledonia.

7.5.15 *Acropora polystoma* Brook, 1891

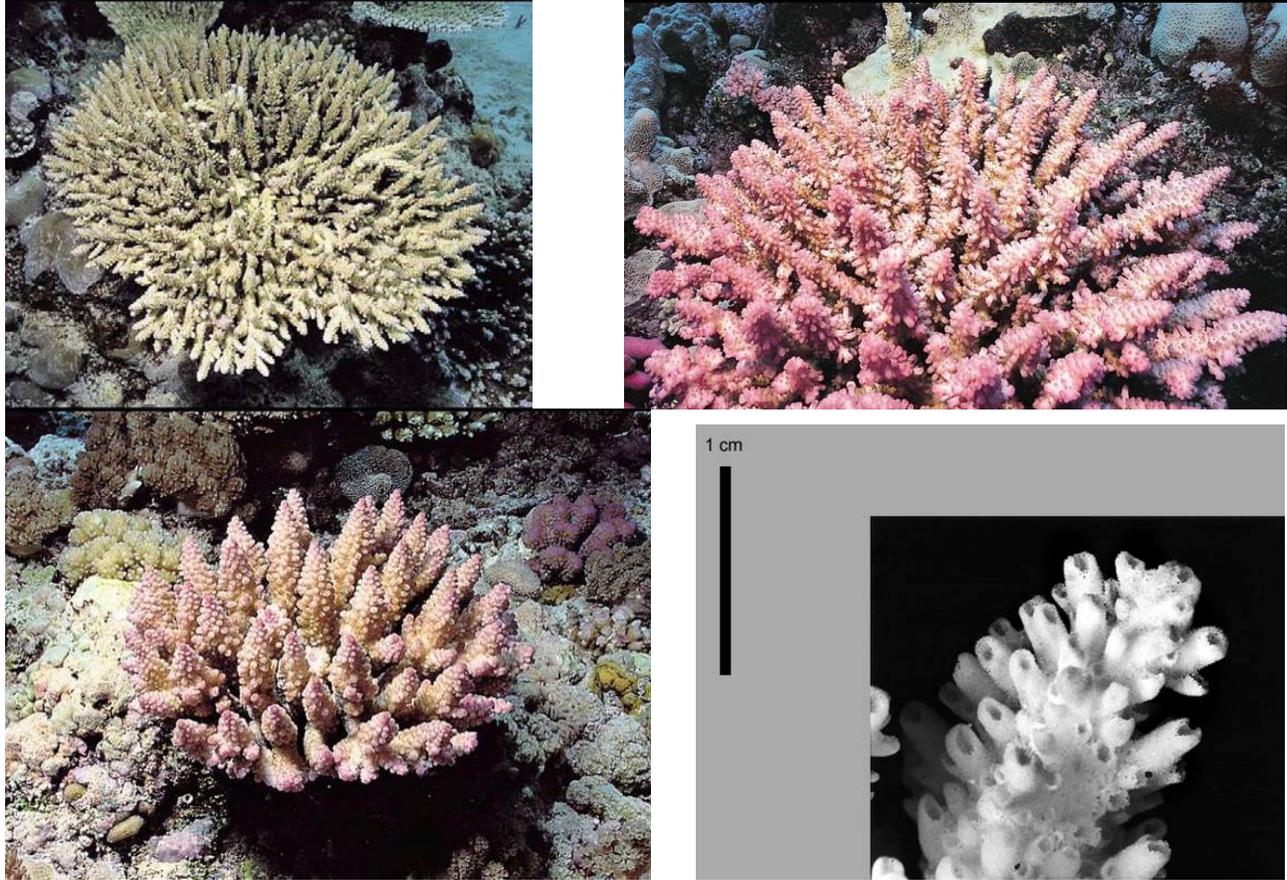


Figure 7.5.59. *Acropora polystoma* photos and corallite plan from Veron (2000).

Characteristics

Colonies of *Acropora polystoma* are irregular clumps or corymbose plates with tapered branches of similar length and shape. Axial corallites are small and exsert. Radial corallites are usually arranged in rows down the sides of the branchlets. They are irregularly immersed to tubular, giving colonies a spiny appearance. The maximum colony size is 80 cm and it has a semi-determinate growth. Colonies are cream, blue (which may photograph pink) or yellow in color (Veron, 2000; Veron and Wallace, 1984).

Taxonomy

Taxonomic issues: None. *Acropora polystoma* is most similar to *Acropora massawensis* and *Acropora listeri* (Veron and Wallace, 1984).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora polystoma* have been reported (Wallace, 1999).

Global Distribution

Acropora polystoma has been reported to have a wide distribution ranging from the Red Sea, and southwest and central Indian Ocean (Mauritius and Chagos) to the central Indo-Pacific, west and east coasts of Australia, Southeast Asia, west Pacific, Japan, Samoa and the Cook Islands (Veron, 2000). It is also found in the central Pacific (J. Maragos, USFWS, Honolulu, HI, pers. comm., April 2010). *Acropora polystoma* has a relatively broad range overall, having the 29th largest range of 114 *Acropora* species examined (Richards, 2009).

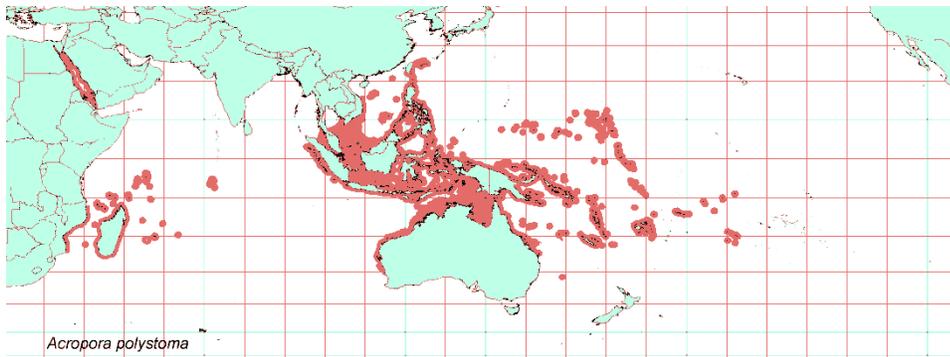


Figure 7.5.60. *Acropora polystoma* distribution from IUCN copied from <http://www.iucnredlist.org>.

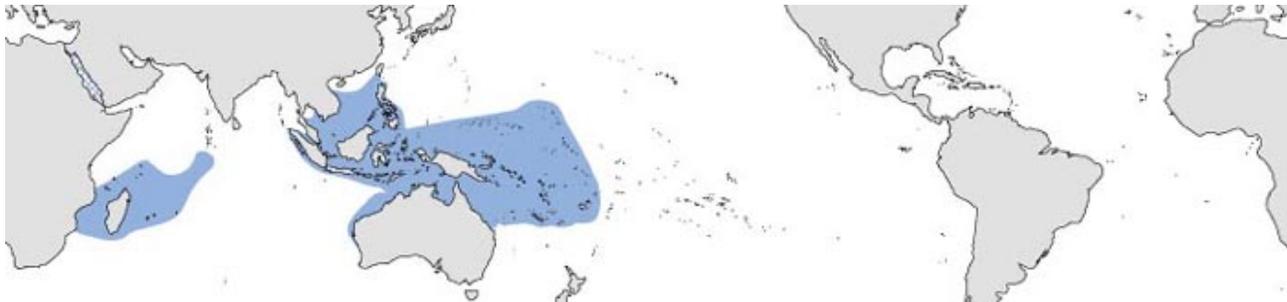


Figure 7.5.61. *Acropora polystoma* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora polystoma* occurs in American Samoa. The CITES species database also notes its occurrence in minor outlying islands but the IUCN Species Account does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora polystoma* has been reported from Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Maragos et al., 1994; National Park Service, 2009), Guam (Burdick, unpubl. data), Johnston Atoll and Howland Island (CRED, unpubl. data), and Palmyra Atoll (Williams et al., 2008b).

Within federally protected waters, *Acropora polystoma* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Howland, Baker, Palmyra)
- National Park of American Samoa, Ofu Island unit

Habitat

Habitat: *Acropora polystoma* has been reported to occupy upper reef slopes exposed to strong wave action (Veron, 2000) and intertidal, just subtidal, shallow, reef tops, reef edges, and high current areas (Carpenter et al., 2008).

Depth range: *Acropora polystoma* has been reported in water depths ranging from 3 m to 10 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora polystoma* has been reported as uncommon (Carpenter et al., 2008; Veron, 2000).

Life History

Acropora polystoma is a hermaphroditic spawner (Baird et al., 2010; Carroll et al., 2006; Kenyon, 2008; Wilson and Harrison, 2003) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora polystoma* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora polystoma*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: A medium-to-high number of species-specific disease reports indicate that *Acropora polystoma* experiences severe white-band/white-plague disease (UNEP, 2010). Effects on reproduction include reduced fecundity (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010). Ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner 2000).

Predation: The specific effects of predation are poorly known for *Acropora polystoma*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci* (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora polystoma*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). The little species-specific information that is available suggests *Acropora polystoma* has experienced some traffic in trade from maricultured specimens in Indonesia. In 2005, export quotas were 2600 pieces (Table 7.5.1).

Risk Assessment

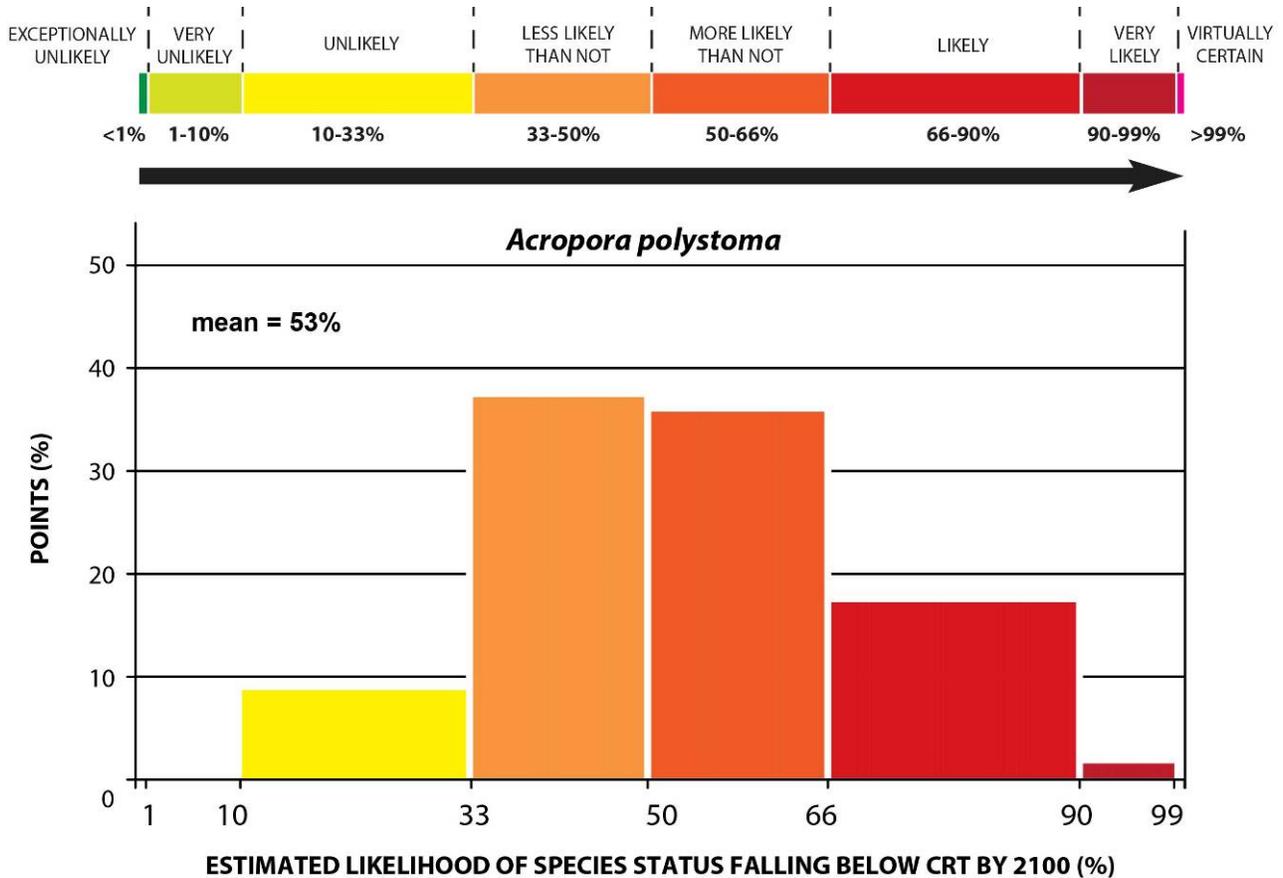


Figure 7.5.62. Distribution of points to estimate the likelihood that the status of *Acropora polystoma* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora polystoma* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), a relatively restricted depth range (< 10 m), and generally uncommon abundance. The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora polystoma*. Factors that reduce the potential extinction risk (decrease likelihood of falling below Critical Risk Threshold) were the wide geographic range and the fact that it is found in intertidal areas (indicating potentially enhanced physiological stress tolerance).

The overall likelihood that *Acropora polystoma* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 53% and a standard error (SE) of 10% (Fig. 7.5.62). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.5.62) and the average range of likelihood estimates of the seven BRT voters (61%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for this species.

7.5.16. *Acropora retusa* Dana, 1846

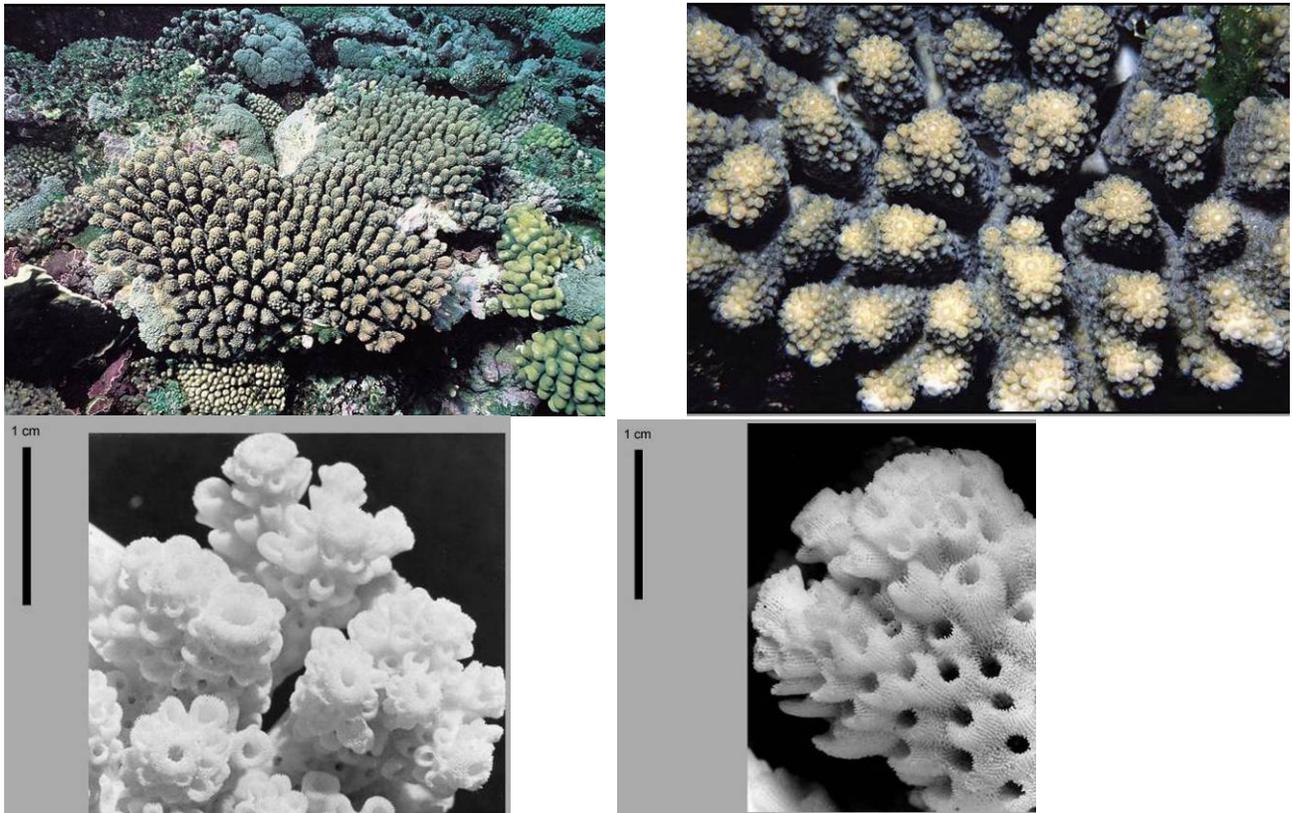


Figure 7.5.63. *Acropora retusa* photos and corallites from Veron (2000).

Characteristics

Colonies of *Acropora retusa* are flat plates with short thick digitate branchlets. Corallites have thick rounded walls and wide openings. Axial corallites are indistinct. Radial corallites are laying flat against each other, becoming nariform near branch ends. Colonies are brown in color. (Veron, 2000; Veron and Wallace, 1984).

Taxonomy

Taxonomic issues: None. *Acropora retusa* is reported to be similar to *Acropora branchi*, which occupies the same habitat, is distinguished by having highly fused basal branches and exsert axial corallites. See also *Acropora gemmifera*, which has longer branchlets and more exsert basal radial corallites and *Acropora monticulosa*, which has corallites in rows. (Veron, 2000; Veron and Wallace, 1984).

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora retusa* have been reported (Wallace, 1999).

Global Distribution

Acropora retusa has a wide distribution longitudinally ranging from the Red Sea, Madagascar, South Africa, and Chagos in the Indian Ocean to the central Indo-Pacific, the Solomons, and in the central Pacific all the way east to Pitcairn (Veron, 2000; Veron and Wallace, 1984). Its range is restricted to shallow water. *Acropora retusa* has a relatively moderate range overall, having the 52nd largest range of 114 *Acropora* species examined (Richards, 2009).

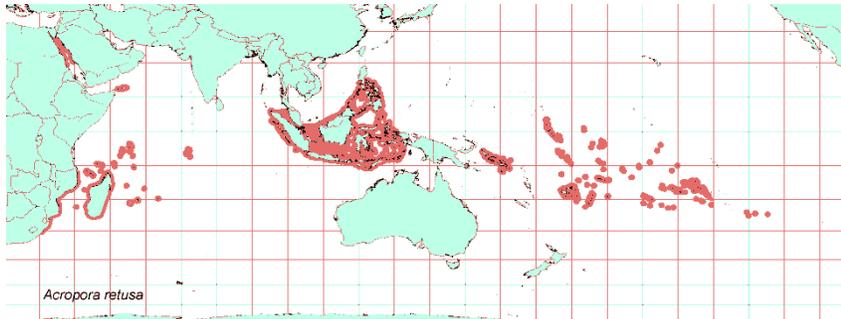


Figure 7.5.64. *Acropora retusa* distribution from IUCN copied from <http://www.iucnredlist.org>.

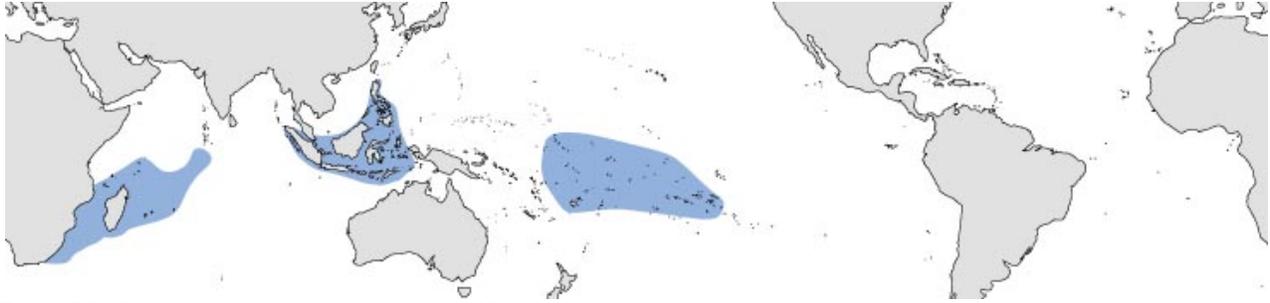


Figure 7.5.65. *Acropora retusa* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Acropora retusa* occurs in American Samoa. The IUCN Species Account also notes its occurrence in minor outlying islands but the CITES species database does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora retusa* has been reported from Tutuila, Ofu-Olosega, Ta'u, and Rose Atoll in American Samoa (Birkeland, unpubl. data; Kenyon et al., 2010a; Lovell and McLardy, 2008; National Park Service, 2009), Johnston Atoll, Howland Island, and Kingman Reef (CRED, unpubl. data).

Within federally protected waters, *Acropora retusa* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Johnston, Howland, Kingman)
- National Park of American Samoa, Ofu Island unit
- Rose Atoll Marine National Monument

Habitat

Habitat: *Acropora retusa* has been reported to occupy upper reef slopes and tidal pools (Veron, 2000; Veron and Wallace, 1984).

Depth range: *Acropora retusa* has been reported in water depths ranging from 1 m to 5 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora retusa* has been reported as common in South Africa and, uncommon elsewhere (Veron, 2000; Veron and Wallace, 1984).

Life History

Acropora retusa is a hermaphroditic spawner (Carroll et al., 2006) with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora retusa* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities.

Acidification: No specific research has addressed the effects of acidification on *Acropora retusa*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Marubini et al., 2003; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008; Crawley et al., 2010), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010), and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on *Acropora retusa* are not known, although *Acropora* species are moderately to highly susceptible to disease. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora retusa*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora retusa*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors.. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection: As a whole, this genus is heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010).

Risk Assessment

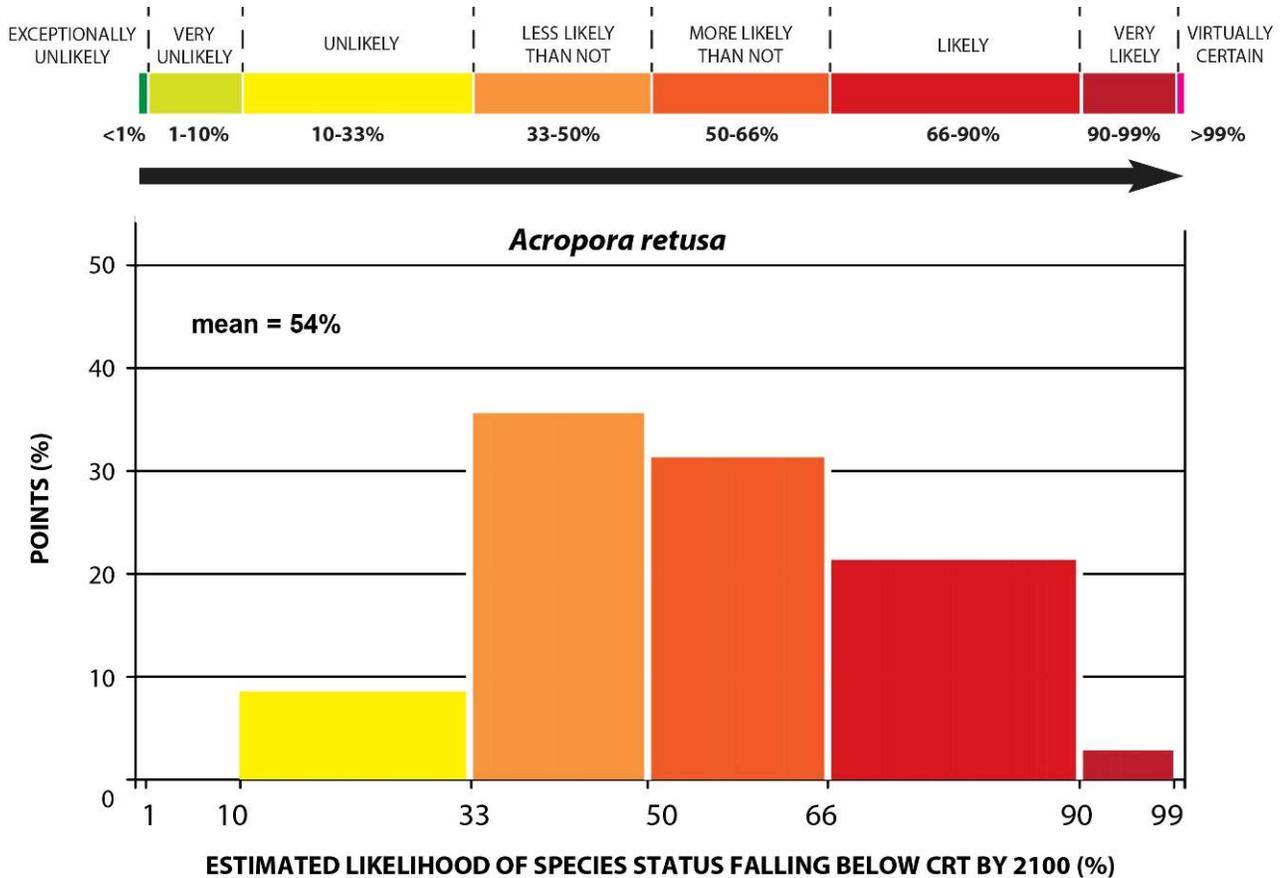


Figure 7.5.66. Distribution of points to estimate the likelihood that the status of *Acropora retusa* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below Critical Risk Threshold) for *Acropora retusa* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution) and its restriction to shallow depths (suggesting potentially greater exposure to surface-based threats). The high bleaching rate of acroporid corals is the primary known threat of extinction for *Acropora retusa*. Factors that reduce the potential extinction risk (decrease likelihood of falling below Critical Risk Threshold) for *Acropora retusa* were the wide geographic range and its occurrence in tidal pools (suggesting high physiological stress tolerance).

The overall likelihood that *Acropora retusa* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 54% and a standard error (SE) of 14% (Fig. 7.5.66). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.5.66) and the average range of likelihood estimates of the seven BRT voters (56%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora retusa*.

7.5.16 *Acropora rudis* Rehberg, 1892



Figure 7.5.67. *Acropora rudis* photos from Veron (2000).

Characteristics

Colonies of *Acropora rudis* are arborescent with large, tapered, prostrate branches, reaching a maximum size of 50 cm (Wallace, 1999). Upper branch surfaces have radial corallites while lower surfaces are smooth. Corallites vary in size, as large as 4 mm, but openings are small. The coenosteum is smooth and dense. Colonies are dark tan in color with pale branch tips (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora rudis* is similar to *Acropora hemprichii* and *Acropora variolosa* (Veron, 2000). Wallace's revision of *Acropora* taxonomy describes an *Acropora rudis* group (Wallace, 1999), which also includes *Acropora austera*, *Acropora variolosa*, and *Acropora hemprichii*.

Family: Acroporidae.

Evolutionary and geologic history: The *Acropora rudis* group is the oldest living *Acropora* lineage (Wallace, 1999).

Global Distribution

Acropora rudis has been reported to have a relatively restricted range overall, having the 90th largest range (24th smallest range) of 114 *Acropora* species examined (Richards, 2009). Reports indicate that it is primarily restricted to the Indian Ocean and Red Sea, as it is found in Bangladesh, Indonesia, the Seychelles, Sri Lanka, Thailand (Wallace, 1999), Mauritius (Fenner et al., 2004), and India (Raghuram and Venkataraman, 2005). However, recent reports place *Acropora rudis* in the Pacific, in New Caledonia (D. Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010) and the Samoas. *Acropora rudis* often has a restricted distribution in the archipelagoes in which it is found (Wallace et al., 2001).

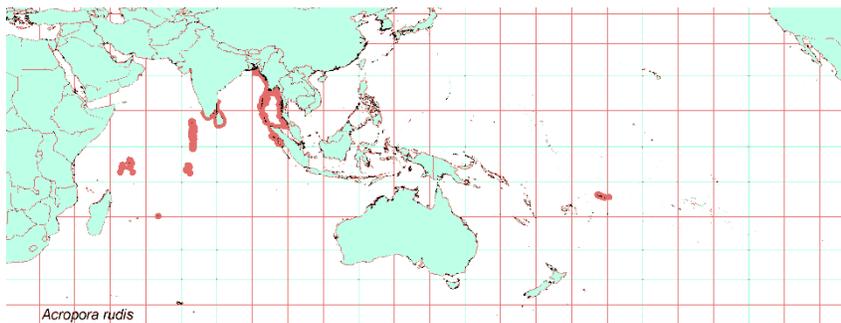


Figure 7.5.68. *Acropora rudis* distribution from IUCN copied from <http://www.iucnredlist.org>.



Figure 7.5.69. *Acropora rudis* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora rudis* occurs in American Samoa, with the supporting reference given as Fenner (pers. comm.). The CITES species database does not include any record of occurrence in U.S. waters.

Fenner reports *Acropora rudis* in American Samoa at Tutuila (CRED, unpubl. data). However, *Acropora rudis* is not listed as occurring in American Samoa in Lovell and McLardy (2008), and this species was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta'u, Rose Atoll, Swains, and South Bank in March 2010 (CRED, unpubl. data).

Within federally protected waters, *Acropora rudis* has been recorded from the following areas (Kenyon et al., 2010b):

- Fagatele Bay National Marine Sanctuary (Kenyon et al., 2010).

Habitat

Habitat: *Acropora rudis* has been reported to occupy shallow to deep rocky foreshores (Veron, 2000) and may be restricted to fringing reefs (Richards, 2009 ; Wallace et al., 2001).

Depth range: *Acropora rudis* has been reported in water depths ranging from 3 m to 15 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora rudis* has been reported as uncommon (Veron, 2000); however, it has been noted to comprise as much as half of the *Acropora* in some areas (Rajasuriya, 2002).

Life History

Life history parameters are not well described for *Acropora rudis*. However, the similar species *Acropora hemprichii* is a hermaphroditic broadcast spawner (Babcock et al., 1986; Baird et al., 2009; Shlesinger et al., 1998), as are all other acroporids studied to date (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora rudis* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora rudis*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in *Acropora* juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman

et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: There is little species-specific information, although in general *Acropora* species are moderately to highly susceptible disease. *Acropora rudis* experiences skeletal growth anomalies, black-band disease, pigmentation response, skeleton-eroding band, tissue necrosis, and white-band/white-plague diseases (UNEP, 2010). The ecological and population impacts of disease have not been established for this species. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and there is some evidence that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

Predation: The specific effects of predation are poorly known for *Acropora rudis*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci* (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora rudis*. Its highly branched growth form would likely enhance passive sediment rejection, making *Acropora rudis* unlikely to be susceptible to the effects of direct sediment deposition. Indirect effects of sedimentation (light reduction, energetic cost of rejection, effects of sediment-associated nutrients and contaminants) are unknown. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in the genus *Acropora* can be difficult to distinguish by nonexperts, it is possible that *Acropora rudis* could be impacted. However, no trade quotas or reported exports are listed for this particular species.

Risk Assessment

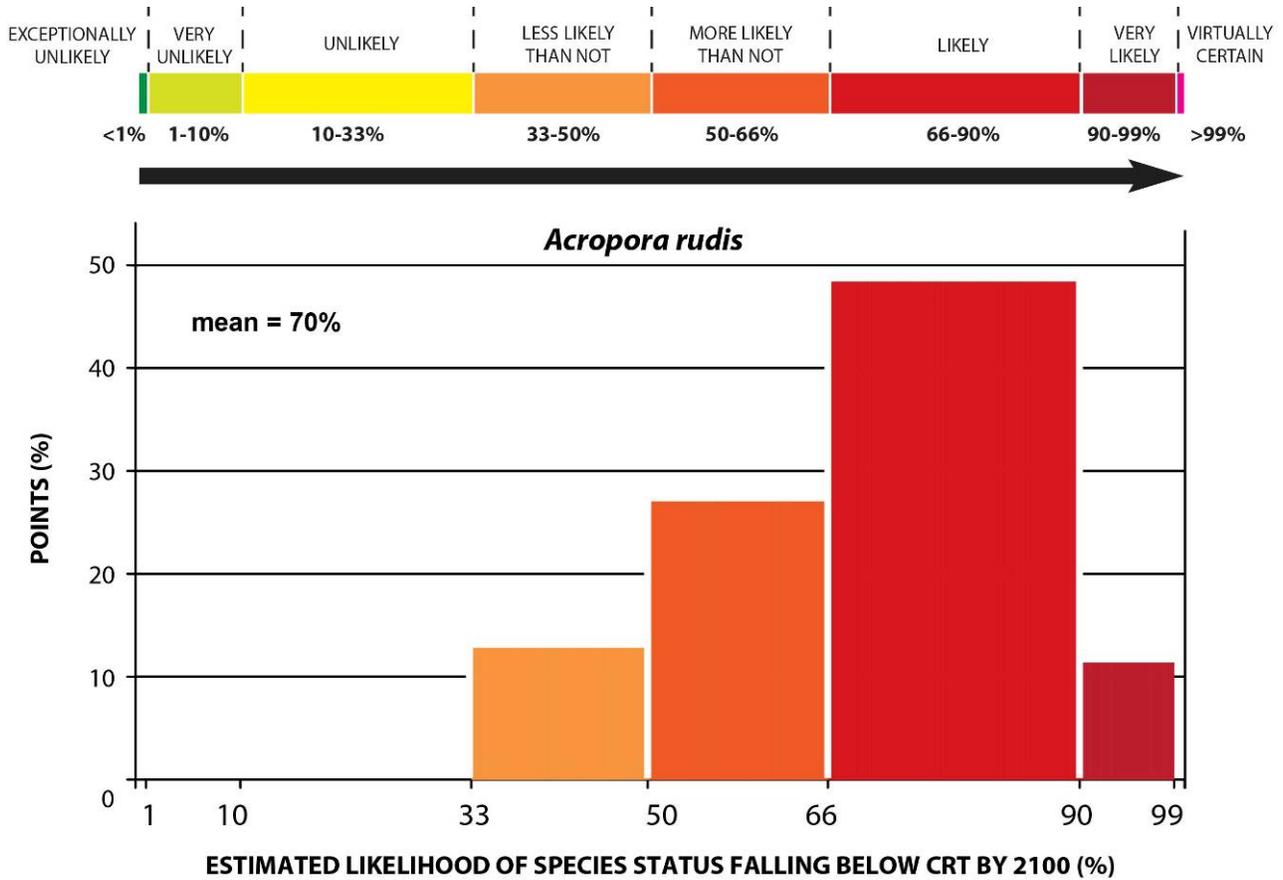


Figure 7.5.70. Distribution of points to estimate the likelihood that the status of *Acropora rudis* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora rudis* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution) and a particularly narrow and somewhat disjunct biogeographic range with limited latitudinal extent. No specific factors are known at this time that notably reduced the potential extinction risk estimate (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora rudis*.

The overall likelihood that *Acropora rudis* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “likely” risk category with a mean likelihood of 70% and a standard error (SE) of 11% (Fig. 7.5.70). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 33%–99% (Fig. 47.5.70) and the average range of likelihood estimates of the seven BRT voters (49%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora rudis*.

7.5.17 *Acropora speciosa* Quelch, 1886



Figure 7.5.71. *Acropora speciosa* photos from Veron (2000).

Characteristics

Colonies of *Acropora speciosa* form thick cushions or bottlebrush branches. They have large and elongate axial corallites; radial corallites are small and tubular or pocketed. Colonies are cream in color with delicately colored branch tips (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora speciosa* is similar to *Acropora echinata* (which does not form cushions) and *Acropora granulosa* (Veron, 2000). Taxonomically, it belongs to the *Acropora loripes* group (Wallace, 1999).

Family: Acroporidae.

Evolutionary and geologic history: No species-specific geologic information has been found for *Acropora speciosa*. *Acropora speciosa* is genetically related to *Acropora vaughani* and *Acropora caroliniana* (Richards, 2009).

Global Distribution

Acropora speciosa has been reported to have a moderately broad range overall, having the 63rd largest range of 114 *Acropora* species examined (Richards, 2009). It has been reported in Fiji, Indonesia, Papua New Guinea, Australia, the Philippines, Polynesia, and Micronesia.

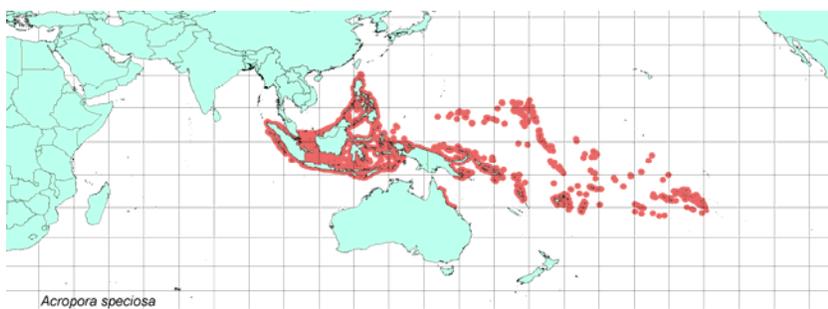


Figure 7.5.72. *Acropora speciosa* distribution from IUCN copied from <http://www.iucnredlist.org>.

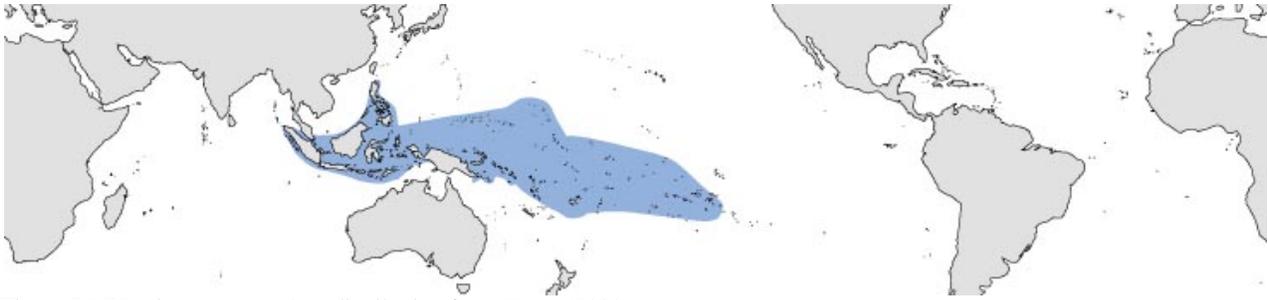


Figure 7.5.73. *Acropora speciosa* distribution from Veron (2000).

U.S. Distribution

The CITES database does not list *Acropora speciosa* as occurring in U.S. waters. The IUCN database lists it in American Samoa, and U.S. minor outlying islands.

The IUCN lists the supporting reference as Fenner (pers. comm.). Fenner reports *Acropora speciosa* in American Samoa at Tutuila at around 20 m depth, where its abundance was characterized as “occasional.” The area where it was found was heavily impacted by the tsunami of 29 September 2009, and it has not been searched for since then.

Acropora speciosa is not listed as occurring in American Samoa in Lovell and McLardy (2008). This species was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta’u, Rose Atoll, Swains, and South Bank in March 2010 (CRED, unpubl. data).

Within federally protected waters, *Acropora speciosa* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Kingman Atoll)

Habitat

Habitat: *Acropora speciosa* has been reported to occupy protected environments with clear water and high diversity of *Acropora* (Veron, 2000) and steep slopes or deep, shaded waters (IUCN, 2010).

Depth range: *Acropora speciosa* has been reported in water depths ranging from 12 m to 30 m (Carpenter et al., 2008) and 15 m to 40 m (Richards, 2009). It is found in mesophotic assemblages in American Samoa (Bare et al., 2010), suggesting the potential for deep refugia.

Abundance

Abundance of *Acropora speciosa* has been reported as uncommon (Veron, 2000).

Life History

Although species-specific research on the life history of *Acropora speciosa* has been limited, it has been assumed to be a hermaphroditic spawner with lecithotrophic larvae (Baird et al., 2009). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora speciosa* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora speciosa*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in *Acropora* juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: There is little species-specific information, although in general *Acropora* species are moderately to highly susceptible to disease. *Acropora speciosa* experiences skeletal growth anomalies, black-band disease, pigmentation response, skeleton-eroding band, tissue necrosis, and white-band/white-plague diseases (UNEP, 2010). The ecological and population impacts of disease have not been established for this species. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is some evidence that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

Predation: The specific effects of predation are poorly known for *Acropora speciosa*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci*, (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora speciosa*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia traded (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora speciosa* could be impacted. However, no trade quotas or reported exports are listed for this particular species.

Risk Assessment

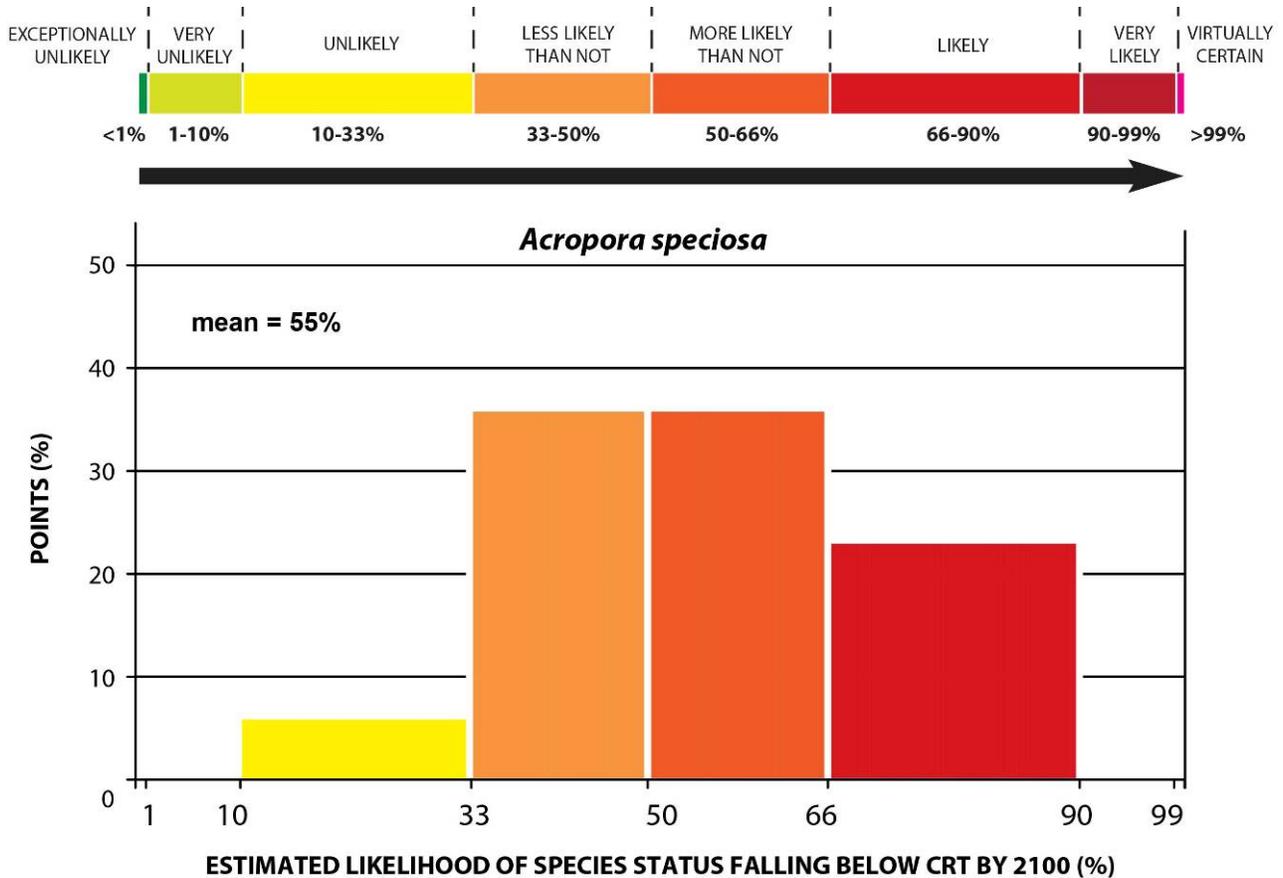


Figure 7.5.74. Distribution of points to estimate the likelihood that the status of *Acropora speciosa* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora speciosa* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution). Factors that reduce the potential extinction risk (lower likelihood of falling below the Critical Risk Threshold) for *Acropora speciosa* include its fits broad global distribution, broad local distribution, and high local abundance—these characteristics tend toward species persistence (Occupancy Type 8: Richards, 2009). Vulnerability of this species was considered to be somewhat ameliorated by the fact that it occurs in deeper water than many acroporids and perhaps experiences disturbances and surface-based threats less frequently.

The overall likelihood that *Acropora speciosa* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 55% and a standard error (SE) of 10% (Fig. 7.5.74). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–90% (Fig. 7.5.74) and the average range of likelihood estimates of the seven BRT voters (54%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for this species.

7.5.18 *Acropora striata* Verrill, 1866

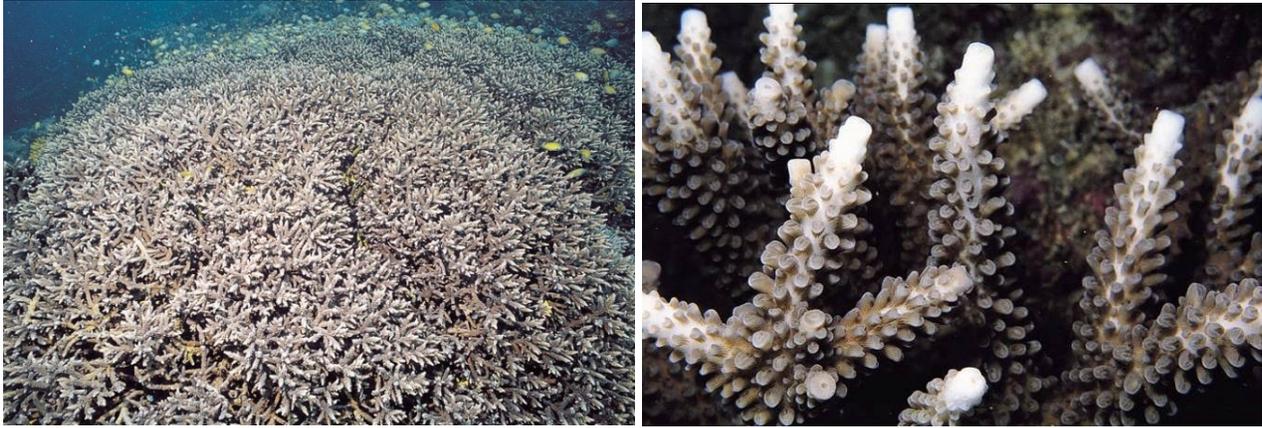


Figure 7.5.75. *Acropora striata* photos from Veron (2000).

Characteristics

Colonies of *Acropora striata* form dense thickets with short cylindrical branches. They have small axial corallites and irregular radial corallites. Exsert corallites have prominent lower lips. Colonies are grey-brown in color with white branch tips and white coenosteum; coloration is distinctive in Japan only (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora striata* is similar to *Acropora tumida* (which has radial corallites along branches and without prominent lower lips), *Acropora sekiseiensis*, and *Acropora parahemprichii* (Veron, 2000). Taxonomically, it belongs to the *Acropora seleago* group (Wallace, 1999).

Family: Acroporidae.

Evolutionary and geologic history: *Acropora* is the most diverse extant coral genus (Veron, 2000). Some *Acropora* species are known from the Eocene (49–34 Ma), with extensive diversification in the central Indo-Pacific over the last 2 million years (Wallace and Rosen, 2006). No fossil records of *Acropora striata* have been reported.

Global Distribution

Acropora striata has been reported to have a moderately broad range overall, having the 54th largest range of 114 *Acropora* species examined (Richards, 2009). However, there is conflicting information on the range of this species. The IUCN Red List range map does not list the species in Australia (IUCN, 2010), but CITES personal communication from Dr. Carden Wallace indicates that it does., However, an earlier reference specifically asserts *Acropora striata* is not found in Australia (Wallace et al., 1991). The species has also been reported to occur in Mozambique (Riegl, 1996), while others think this may be unlikely (IUCN, 2010).

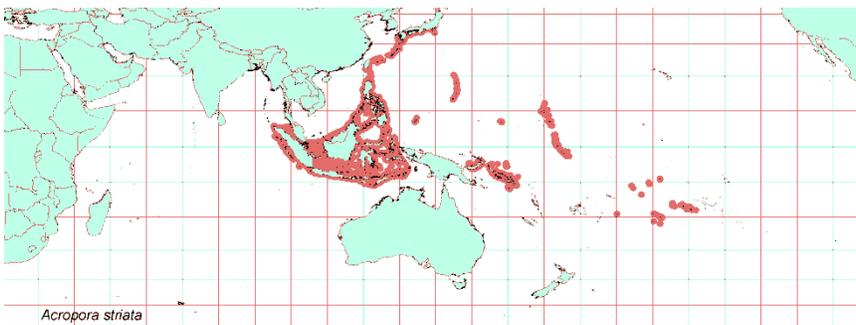


Figure 7.5.76. *Acropora striata* distribution from IUCN copied from <http://www.iucnredlist.org>.

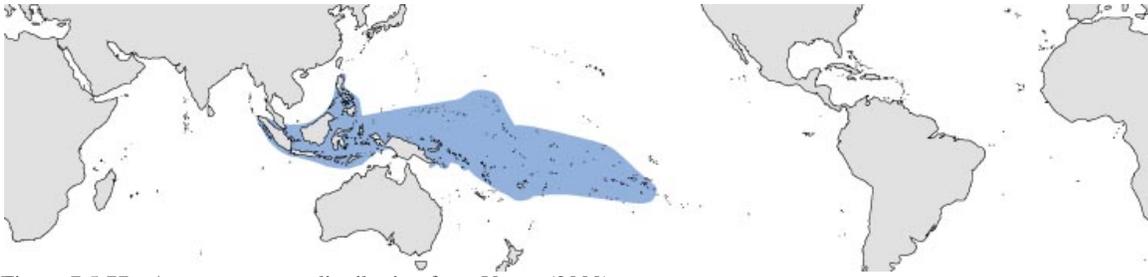


Figure 7.5.77. *Acropora striata* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora striata* occurs in U.S. minor outlying islands. The CITES species database does not list its occurrence in U.S. waters.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora striata* has been reported from Ofu Lagoon in American Samoa (Birkeland, unpubl. data), Guam (Burdick, unpubl. data; Randall, 2003), Commonwealth of the Northern Mariana Islands, and Kingman Reef (CRED, unpubl. data).

Within federally protected waters, *Acropora striata* has been recorded from the following areas (Kenyon et al., 2010b):

- Pacific Remote Islands Marine National Monument (Kingman)
- National Park of American Samoa, Ofu Island unit

Habitat

Habitat: *Acropora striata* has been reported to occupy shallow rocky foreshores and shallow reef flats (Veron, 2000).

Depth range: *Acropora striata* has been reported in water depths ranging from 10 m to 25 m (Carpenter et al., 2008).

Abundance

Abundance of *Acropora striata* has been reported as rare overall but may be locally dominant in some areas in Japan (Veron, 2000).

Life History

Early reproductive studies suggest *Acropora striata* is a brooder, releasing planulae during the winter new moon in Enewetak (Stimson, 1978). More recent work shows *Acropora striata* to be a simultaneous hermaphroditic spawner; in Moorea, gamete release peaks in October (Carroll et al., 2006). Egg size and fecundity have not been specifically determined for this species, but fecundity in *Acropora* colonies is in the range of 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999).

Larval development and settlement have been reported to take 5–10 days, but larvae are competent for 31 days (Carroll et al., 2008). Spawning may be asynchronous with other *Acropora* species. While different individuals of a given species spawn at different times, *Acropora striata* lacked pigmented eggs prior to the Australian secondary spawning season in November 2007 (Rosser and Baird, 2008).

For more genus level information, see Section 7.5: Genus *Acropora*.

Acropora striata has been reported to have indeterminate growth, reaching a maximum size of 200 cm (Wallace, 1999). Growth can be fairly rapid; outplants in Moorea (depth = 4 m–6 m) averaged an 8% increase in mass after 5 weeks (Boyer et al., 2009).

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora striata* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora striata*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: There is little species-specific information, although in general *Acropora* species are moderately to highly susceptible to disease. *Acropora striata* experiences skeletal growth anomalies, black-band disease, pigmentation response, skeleton-eroding band, tissue necrosis, and white-band/white-plague disease (UNEP, 2010). The ecological and population impacts of disease have not been well established for this species. However, ample evidence show that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is some evidence that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

Predation: The specific effects of predation are poorly known for *Acropora striata*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci*, (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora striata*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by non experts, it is possible that *Acropora striata* could be impacted. However, little species-specific information is available in the international trade databases. The only record for *Acropora striata* is for the year 2000, when three pieces were exported (CITES, 2010).

Risk Assessment

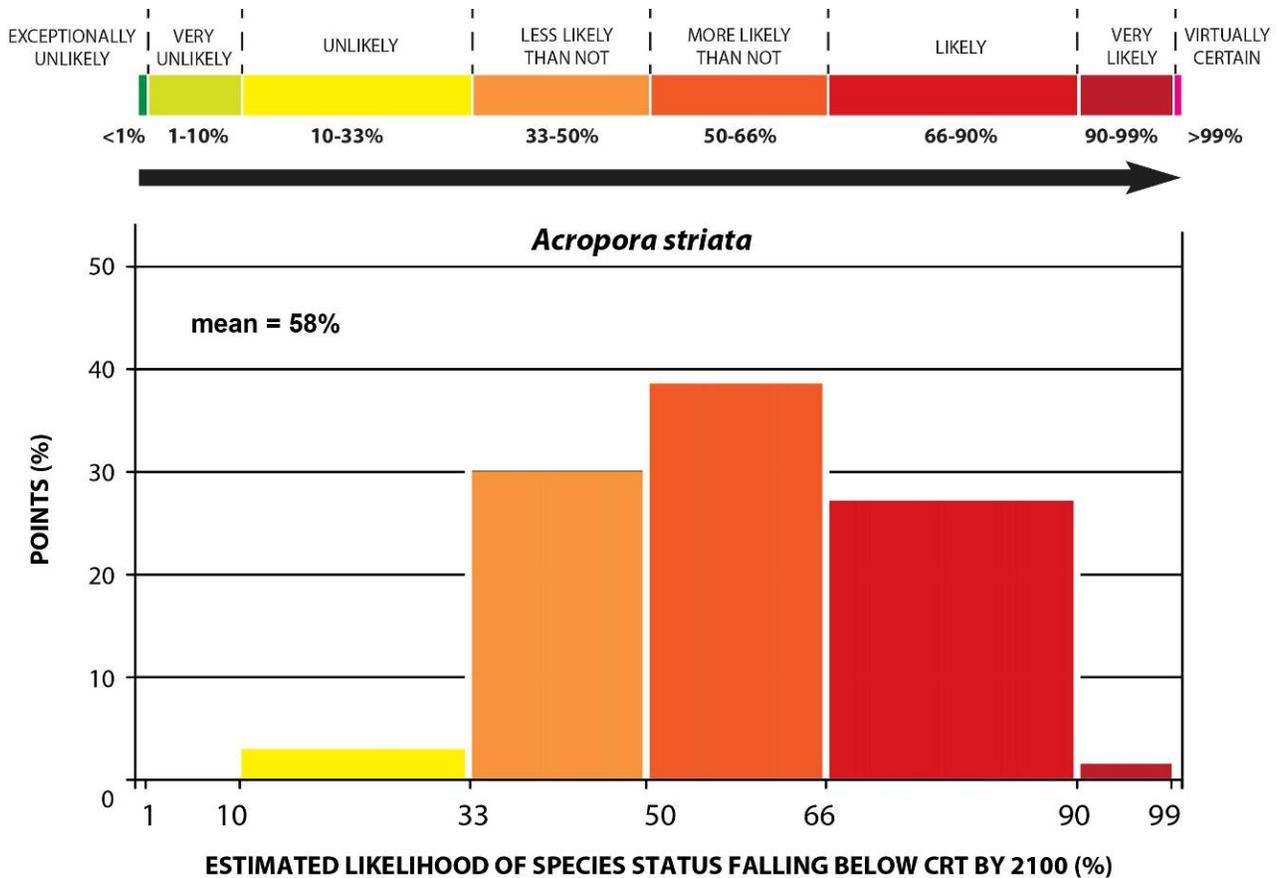


Figure 7.5.78. Distribution of points to estimate the likelihood that the status of *Acropora striata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acropora striata* include that its genus has high susceptibility to common threats (bleaching, acidification, disease, predation, and pollution), its relatively narrow latitudinal distribution, and its mostly rare abundance. Factors that reduce the potential extinction risk (decrease likelihood of falling below the Critical Risk Threshold) for *Acropora striata* include its relatively broad global distribution, broad local distribution, and high local abundance—these characteristics tend toward species persistence (Occupancy Type 8:Richards, 2009).

The overall likelihood that *Acropora striata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 58% and a standard error (SE) of 8% (Fig. 7.5.78). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.5.78) and the average range of likelihood estimates of the seven BRT voters (58%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora striata*.

7.5.19 *Acropora tenella* Brook, 1892



Figure 7.5.79. *Acropora tenella* photos from Veron (2000).

Characteristics

Acropora tenella has been reported to have horizontal, platy, caespitose colonies with flattened branches. The branches have usually had a central ridge, with little branch fusion. Colonies are reported to have distinct axial and radial corallites; radial corallites are scattered over branch surfaces but only occur laterally on old branches. Colonies are cream color with blue/white tips (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora tenella* is similar to *Acropora pichoni*, which has highly fused branches that are less elongate and more platy (Veron, 2000). Taxonomically, it belongs to the *Acropora elegans* group (Wallace, 1999).

Family: Acroporidae.

Evolutionary and geologic history: *Acropora* is the most diverse extant coral genus (Veron, 2000). Species are known from the Eocene (49–34 Ma), with extensive diversification in the central Indo-Pacific over the last 2 million years (Wallace and Rosen, 2006). *Acropora tenella* is genetically related to *Acropora chesterfieldensis* and *Acropora pichoni* (Richards, 2009).

Global Distribution

Acropora tenella has been reported to have a moderately broad range overall, having the 72nd largest range of 114 *Acropora* species examined (Richards, 2009). Known records for *Acropora tenella* have originated primarily from the central Indo-Pacific, Japan, the East China Sea, and Southeast Asia.

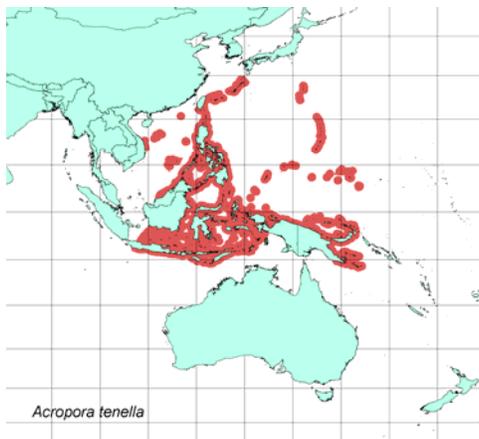


Figure 7.5.80. *Acropora tenella* distribution from IUCN copied from <http://www.iucnredlist.org>.

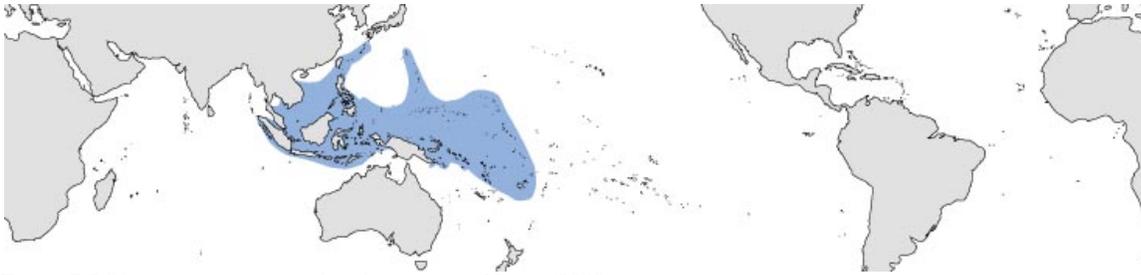


Figure 7.5.81. *Acropora tenella* distribution from Veron (2000).

U.S. Distribution

The CITES species database does not include any record of occurrence of this species in U.S. waters. The IUCN database lists *Acropora tenella* as occurring in the Marianas Archipelago. Veron (2000) also lists this species in the Marianas, but that is a result of a misidentification of the origin of photographic records (Kenyon et al. 2010). G. Paulay (University of Florida, Gainesville, FL, pers. comm., 28 February 2010) indicates a number of photos submitted by him to Veron from Palau, the Cook Islands, and other locations in the Pacific were mistakenly attributed to Guam (similar to the *errata* later acknowledged by Veron (2002) for *Acanthastrea regularis* and *Porites napopora*).

Acropora tenella has not been recorded from federally protected U.S. waters.

Habitat

Habitat: *Acropora tenella* has been reported to occupy lower slopes below 40 m (Veron, 2000), protected slopes and shelves as deep as 70 m (Richards, 2009), apparently specialized to calm, deep conditions (Wallace et al., 2000).

Depth range: *Acropora tenella* has been reported in water depths ranging from 25 m to 70 m (Carpenter et al., 2008). *Acropora tenella* is known primarily from mesophotic habitats, suggesting the potential for deep refugia.

Abundance

Abundance of *Acropora tenella* has been reported as locally common in some locations (Veron, 2000).

Life History

Acropora tenella is assumed to be a hermaphroditic spawner with lecithotrophic larvae (Baird et al., 2009). *Acropora tenella* reaches a maximum size of 150 cm (Wallace, 1999). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: *Genus Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora tenella* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a).

Acidification: No specific research has addressed the effects of acidification on *Acropora tenella*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Anthony et al., 2008; Renegar and Riegl, 2005; Schneider and Erez, 2006) and productivity (Anthony et al., 2008), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have already caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: In general, *Acropora* species are moderately to highly susceptible to disease. *Acropora tenella* experiences skeletal-growth anomalies, black-band disease, pigmentation response, skeleton-eroding band, tissue necrosis, and white-band/white-plague diseases (UNEP, 2010). The ecological and population impacts of disease have not been established for *Acropora tenella*. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is some evidence that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

Predation: The specific effects of predation are poorly known for *Acropora tenella*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci*, (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora tenella*. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, this genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora tenella* could be impacted. However, little species-specific information is available in the trade databases. In 1998, 123 pieces were exported from Fiji to the United States (CITES, 2010).

Risk Assessment

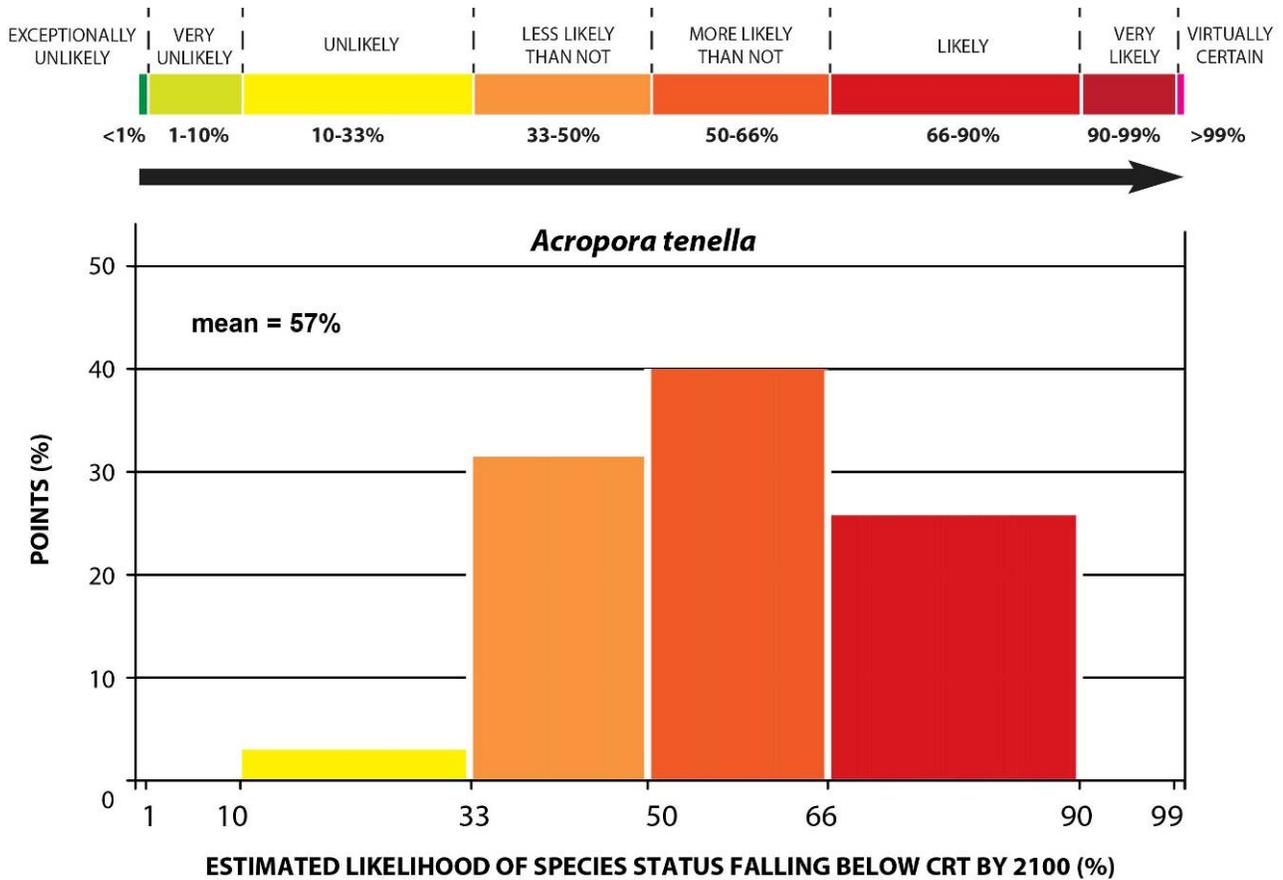


Figure 7.5.82. Distribution of points to estimate the likelihood that the status of *Acropora tenella* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below Critical Risk Threshold) for *Acropora tenella* include that its genus has high susceptibility to common threats (bleaching, acidification, disease, predation, and pollution). *Acropora tenella* fits Richards' Occupancy Type 2 (see Section 7.5: Genus *Acropora*), with moderate latitudinal and longitudinal distribution but locally restricted in both distribution and abundance, making this species potentially vulnerable to local extinction (Richards, 2009). A factor that reduces the potential extinction risk (lower likelihood of falling below the Critical Risk Threshold) for *Acropora tenella* was that the broad distribution makes extinction unlikely across its full range. Additionally, *Acropora tenella* is known exclusively from deep waters, where it potentially experiences less frequent disturbance than other acroporids and is more remote from surface-based environmental variability and threats.

The overall likelihood that *Acropora tenella* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "more likely than not" risk category with a mean likelihood of 57% and a standard error (SE) of 8% (Fig. 7.5.82). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–90% (Fig. 7.5.82) and the average range of likelihood estimates of the seven BRT voters (58%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for this species. The wide range of votes also reflects the uncertainty in reconciling an occupancy type that is susceptible to local extinction with the fact that disturbance may be relatively rare given very broad geographical distribution and occurrence in mesophotic habitats of *Acropora tenella*.

7.5.20 *Acropora vaughani* Wells, 1954

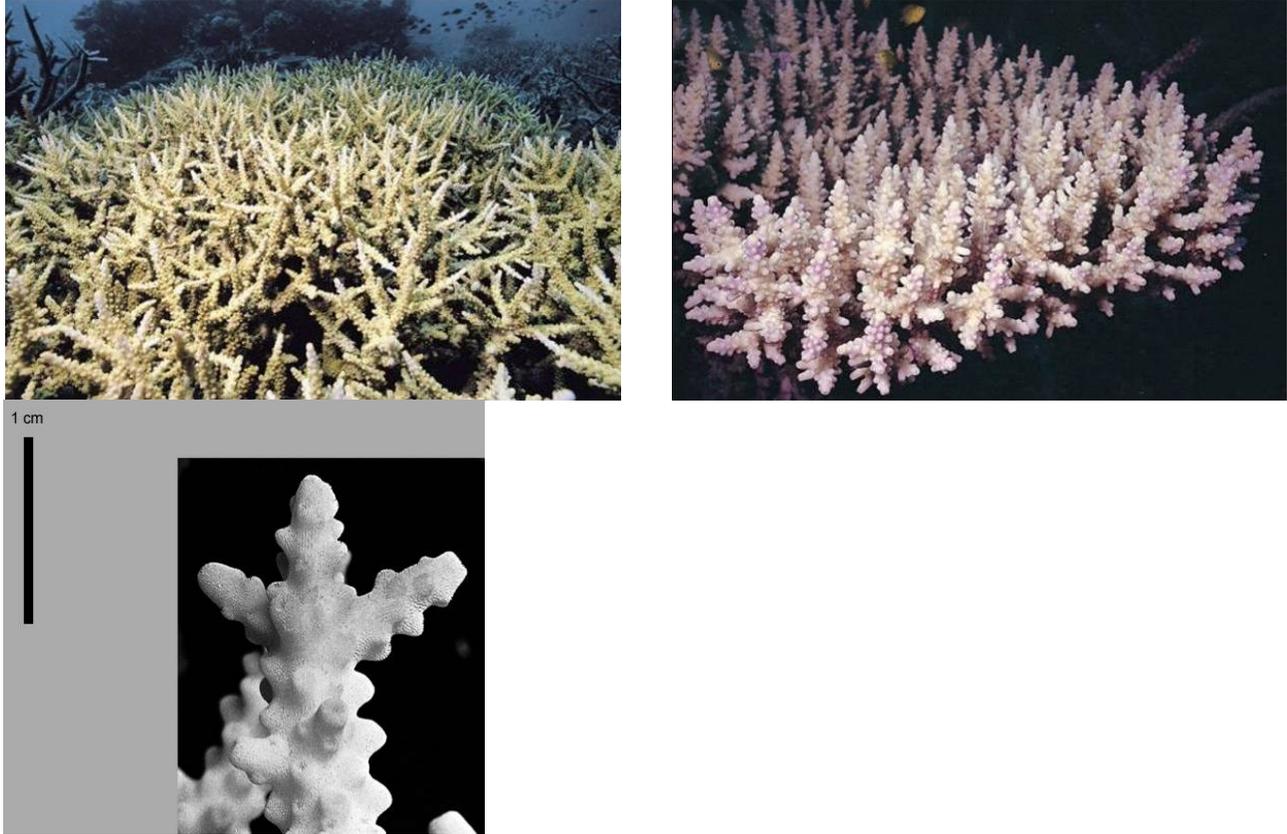


Figure 7.5.83. *Acropora vaughani* photos and corallite plan from Veron (2000).

Characteristics

Acropora vaughani has been reported to have open-branched, bushy, arborescent colonies. The main branches may have compact branchlets, lending to a bushy appearance. Colonies have abundant incipient axial corallites, but radial corallites are widely spaced and variable. They have fine, smooth coenosteum. Colonies are uniform blue, cream or pale brown in color (Veron, 2000).

Taxonomy

Taxonomic issues: None. *Acropora vaughani* is morphologically similar to *Acropora horrida*, *Acropora tortuosa*, and *Acropora rufus*. *Acropora austera* is similar in shape but has larger, more compact radial corallites (Veron, 2000). Taxonomically, it belongs to the *Acropora horrida* group (Wallace, 1999). Genetically related to *Acropora speciosa*, *Acropora microthalma*, and *Acropora valida* (Richards, 2009).

Family: Acroporidae.

Evolutionary and geologic history: Fossil records of *Acropora vaughani* have been reported from the Pliocene (5.6–3 Ma) and Pleistocene (1.8–0.01 Ma) (Wallace, 1999). *Acropora* is the most diverse extant coral genus (Veron, 2000). Species are known from the Eocene (49–34 Ma), with extensive diversification in the central Indo-Pacific over the last 2 million years (Wallace and Rosen, 2006).

Global Distribution

Reported ranges of *Acropora vaughani* have been somewhat disjunct, with disagreements over whether the species exists in Australia, the Red Sea, and southwest Indian Ocean. *Acropora vaughani* has been reported to have a relatively broad range overall, having the 34th largest range of 114 *Acropora* species examined (Richards, 2009).

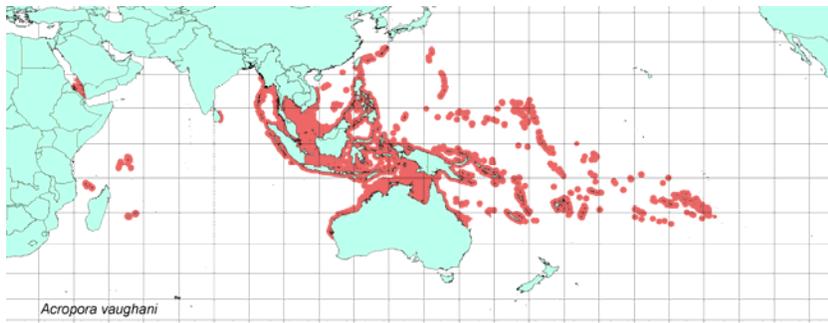


Figure 7.5.84. *Acropora vaughani* distribution from IUCN copied from <http://www.iucnredlist.org>.

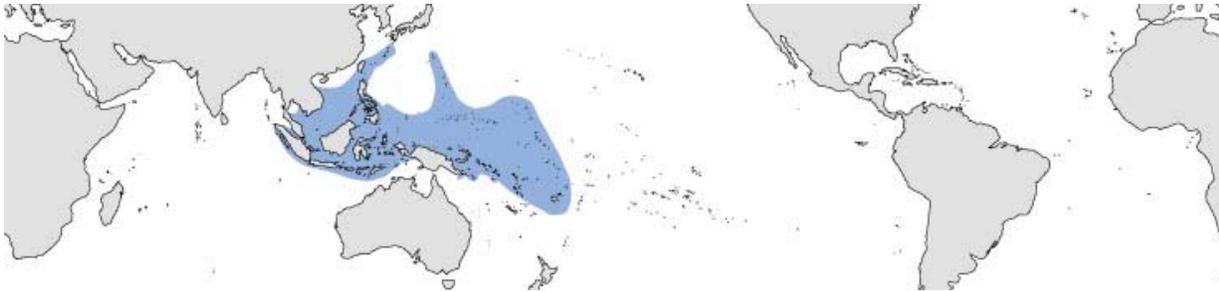


Figure 7.5.85. *Acropora vaughani* distribution from Veron (2000).

U.S. Distribution

According to the IUCN Species Account, *Acropora vaughani* occurs in American Samoa and U.S. minor outlying islands. The IUCN Species Account also lists its occurrence in the Northern Mariana Islands, but the CITES species database does not.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora vaughani* has been reported from Tutuila, Ofu-Olosega, and Swains in American Samoa (Birkeland, unpubl. data; CRED, unpubl. data; Fisk and Birkeland, 2002; Lovell and McLardy, 2008; Maragos et al., 1994; National Park Service, 2009), Guam (Burdick, unpubl. data; Randall, 2003), Howland and Baker Islands (CRED, unpubl. data), and Palmyra Atoll (Williams et al., 2008b),.

Within federally protected waters, *Acropora vaughani* has been recorded from the following areas (Kenyon, 2010):

- Pacific Remote Islands Marine National Monument (Howland, Baker, Palmyra, Kingman)
- National Park of American Samoa, Ofu Island unit

Habitat

Habitat: *Acropora vaughani* has been reported to occupy fringing reefs with turbid water (Veron, 2000), protected lagoons and sandy slopes (IUCN, 2010), or protected subtidal waters (Richards, 2009).

Depth range: *Acropora vaughani* has been reported in water depths ranging from low tide levels (Piller and Riegl, 2003) to 20 m (IUCN, 2010) or to 30 m (Richards, 2009).

Abundance

Abundance of *Acropora vaughani* has been reported as uncommon (Veron, 2000).

Life History

Acropora vaughani is a hermaphroditic spawner with lecithotrophic larvae (Baird et al., 2009). It is one of several *Acropora* that achieve reproductive isolation by spawning earlier in the evening than other species (Fukami et al., 2003). *Acropora vaughani* has been used in rehabilitation and transplantation studies (Lindahl, 2003), which implies they have a high growth and/or low mortality rate. For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora vaughani* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). Bleaching-induced mortality can be severe—*Acropora* in the southeastern Arabian Gulf suffered > 90% mortality during the 1996 bleaching event (Riegl, 1999). However, cryptic remnants of *Acropora vaughani* survived after the 1998 mass bleaching event (Riegl and Piller, 2001), contributing to potentially accelerated recovery.

Acidification: No specific research has addressed the effects of acidification on *Acropora vaughani*, but experiments on acidification have demonstrated negative effects on *Acropora* calcification (Renegar and Riegl, 2005; Anthony et al., 2008; Schneider and Erez, 2006) and productivity (Anthony et al., 2008), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). Most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to cause appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: There is little species-specific information, although in general *Acropora* species are moderately to highly susceptible to disease. *Acropora vaughani* experiences skeletal-growth anomalies, black-band disease, pigmentation response, skeleton-eroding band, tissue necrosis, and white-band/white plague diseases (UNEP, 2010). The ecological and population impacts of disease have not been established for this species. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is some evidence that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Sutherland et al., 2004; Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora vaughani*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci*, (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora vaughani*, although the species has been alleged to have disappeared from Jakarta Bay between 1920 and 2005 based on heavy coastal development (Van der Meij et al., 2010). LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora vaughani* could be impacted. The species-specific information that is available suggests *Acropora vaughani* has some involvement in trade. From 1989–2002, gross export averaged 2181 pieces, primarily originating in Fiji, Indonesia, the Philippines, and Vietnam (CITES, 2010).

Risk Assessment

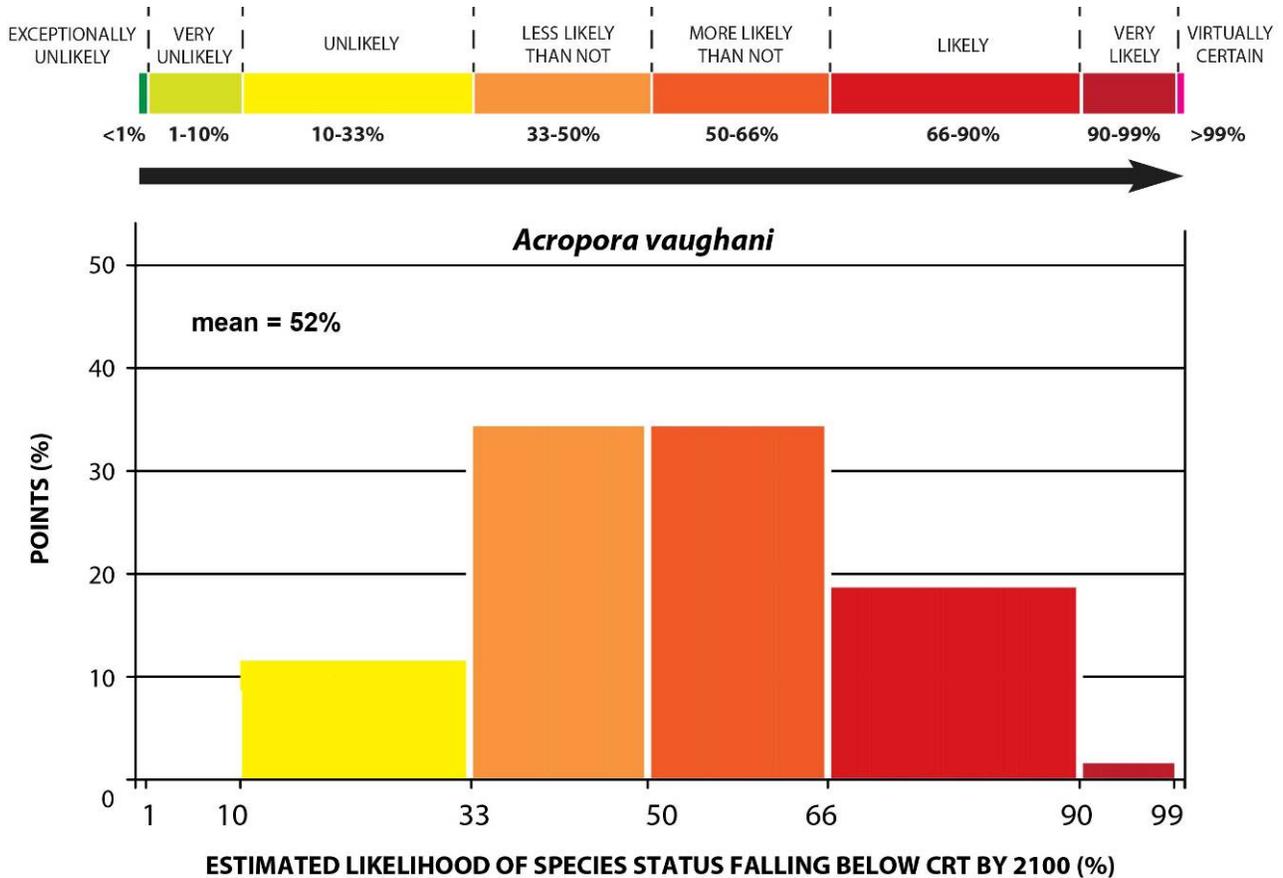


Figure 7.5.86. Distribution of points to estimate the likelihood that the status of *Acropora vaughani* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below Critical Risk Threshold) for *Acropora vaughani* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution), and *Acropora vaughani* has documented (though small) traffic in the aquarium trade (suggesting desirability in the marketplace). Factors that reduce the potential extinction risk (lower likelihood of falling below Critical Risk Threshold) were that *Acropora vaughani* fits occupancy model 8 (see Section 7.5: Genus *Acropora*), with broad global distribution, broad local distribution, and high local abundance—these characteristics tend toward species persistence (Richards, 2009). The wide range of habitats occupied by *Acropora vaughani*, its use in restoration and replantation, and its known recovery after bleaching events via tissue remnants from within the reef framework (Riegl and Piller, 2001) suggests a relatively high tolerance to physiological stressors and a degree of resilience.

The overall likelihood that *Acropora vaughani* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 52% and a standard error (SE) of 11% (Fig. 7.5.86). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.5.86) and the average range of likelihood estimates of the seven BRT voters (61%). This uncertainty is revealed by this species having one of the highest SE of the mean probabilities (see Table 8.1). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora vaughani*, different interpretations of the species’ habitat (is it protected or stressful?), and difficulty in reconciling large observed mortalities with factors that tend towards persistence (occupancy type and observed cryptic refugia).

7.5.21 *Acropora verweyi* Veron and Wallace, 1984



Figure 7.5.87. *Acropora verweyi* photos from Veron (2000).

Characteristics

Acropora verweyi has been reported to typically form corymbose clumps with noticeably rounded or bulb-like calices. Colonies are nearly always a creamy-brown in color with yellow axial corallites (Veron, 2000).

Taxonomy

Taxonomic issues: No taxonomic issues regarding *Acropora verweyi* have been reported.

Family: Acroporidae.

Evolutionary and geologic history: No fossil records of *Acropora verweyi* have been reported (Wallace, 1999).

Global Distribution

Acropora verweyi has been reported to have a relatively broad range, having the 16th largest range of 114 *Acropora* species examined (Richards, 2009), extending from east Africa, the Comorros and Seychelles in the Indian Ocean all the way to Pitcairn Island in the southeastern Pacific Ocean. Latitudinally, it has been reported from Japanese waters in the northern hemisphere across the Great Barrier Reef and southern Africa in the southern hemisphere. Despite this very broad range, Wallace (1999) believes it is not found in the central Indonesian Archipelago. She suggests this absence from a large area in the center of its range might be a result of the scarcity of shallow reef flats in this region.

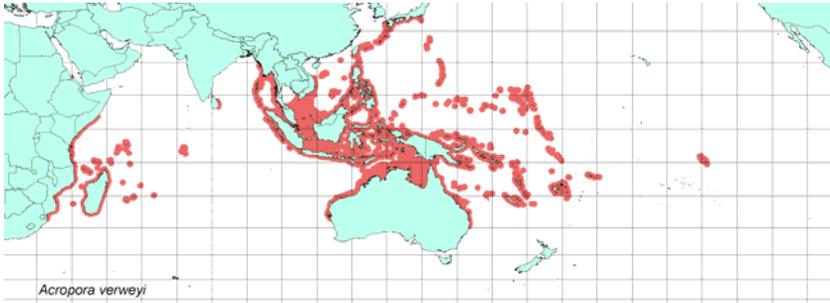


Figure 7.5.88. *Acropora verweyi* distribution from IUCN copied from <http://www.iucnredlist.org>.

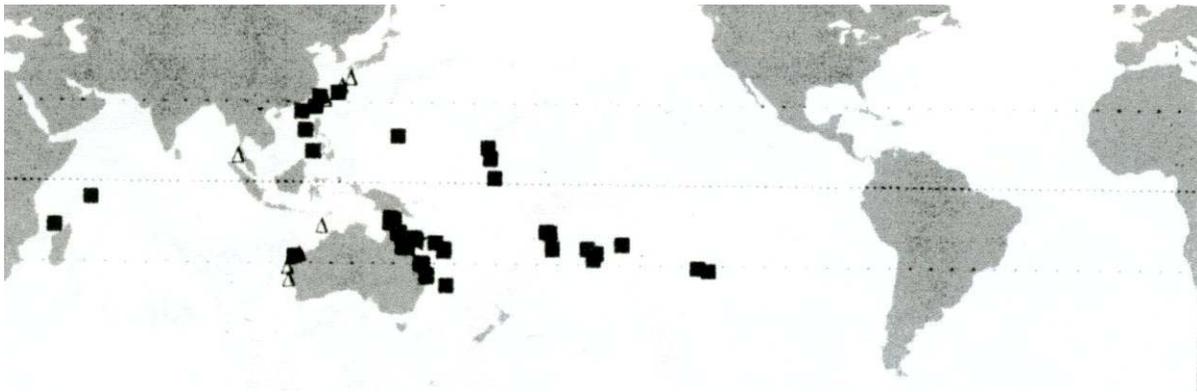


Figure 7.5.89. *Acropora verweyi* distribution from Wallace (1999). The black squares are specimen-based records in the *Acropora* database at the Museum of Tropical Queensland, the stars are type localities of senior and junior synonyms, and the black triangles are taken from records in the literature. When the triangles are open (not black), the records from the literature are possibly misidentifications.

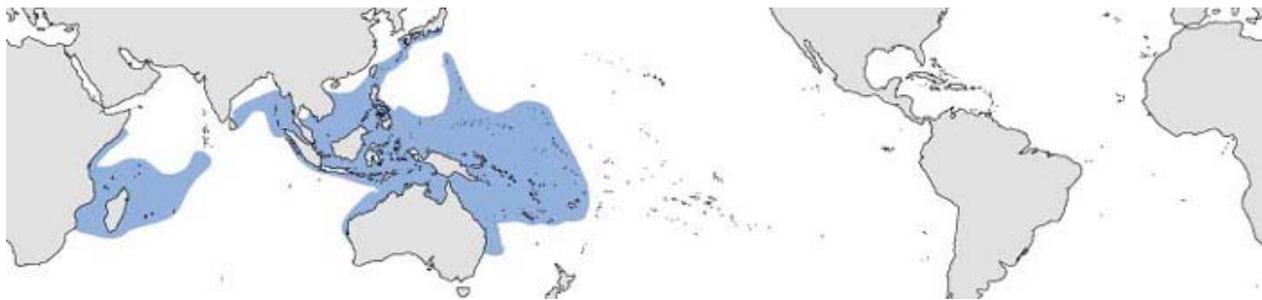


Figure 7.5.90. *Acropora verweyi* distribution from Veron (2000).

U.S. Distribution

According to both the IUCN Species Account and the CITES database, *Acropora verweyi* occurs in American Samoa and the Northern Mariana Islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora verweyi* has been reported from Howland and Baker Islands (CRED, unpubl. data), Tutuila and Ofu-Olosega in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; Fisk and Birkeland, 2002; Lovell and McLardy, 2008; National Park Service, 2009), Guam (Burdick, unpubl. data; Wallace, 1999), the Commonwealth of the Northern Mariana Islands, Jarvis Island, and Kingman Reef (CRED, unpubl. data), and Palmyra Atoll (Williams et al., 2008b).

Within federally protected waters, *Acropora verweyi* has been recorded from the following areas (Kenyon, 2010):

- Pacific Remote Islands Marine National Monument (Howland, Baker, Jarvis, Palmyra, Kingman)
- National Park of American Samoa, Ofu Island unit
- Marianas Trench Marine National Monument (Maug)

Habitat

Acropora verweyi "...seems to be an exclusively shallow-water species" (Wallace, 1999). It lives on upper reef slopes or other parts of the reef where circulation is good (Veron and Wallace, 1984).

Depth range: *Acropora verweyi* has been reported to be an exclusively shallow-water species (Wallace, 1999), living in depths ranging from low tide to at least 10 m.

Abundance

Abundance of *Acropora verweyi* has been reported as generally common—but can be locally abundant, especially in the western Indian Ocean (Veron, 2000).

Life History

Acropora verweyi is a hermaphroditic spawner that is a participant in mass broadcast spawning in some localities (Guest et al., 2005a; Kenyon, 2008). Growth is semi-indeterminate (Wallace, 1999) and increases at high light ($400 \mu\text{mol}/\text{m}^2/\text{s}^1$) and temperatures (29°C) (Reynaud et al., 2004). For more genus level information, see Section 7.5: Genus *Acropora*.

Threats

For each of these possible threats, see also Section 7.5: Genus *Acropora* for additional genus level information.

Thermal stress: Although there is not much species-specific information about the response of *Acropora verweyi* to thermal stress, the genus *Acropora* are consistently ranked among the coral genera as most severely susceptible to bleaching (Marshall and Baird, 2000; McClanahan et al., 2007; McClanahan et al., 2005a). However, the genus may have differential responses across regions during mass bleaching mortalities (McClanahan et al., 2004a). Bleaching-induced mortality can be severe—*Acropora* in the southeastern Arabian Gulf suffered > 90% mortality during the 1996 bleaching event (Riegl, 1999). *Acropora verweyi* tolerates high temperatures in back-reef pools in Ofu, American Samoa (Craig et al., 2001), although it is not abundant and acroporids still bleach in these pools (Fenner et al., 2008). Bleaching reports for *Acropora verweyi* vary in severity; the species was relatively resistant in Moorea during the 1991 event (Gleason, 1993) but bleached heavily in Guam in 1994 (Paulay and Benayahu, 1999). As with all *Acropora*, bleaching is a substantial risk for *Acropora verweyi*.

Acidification: Reduced carbonate concentrations decrease calcification rates in *Acropora verweyi* (Marubini et al., 2003). Although the overall magnitude of calcification was similar to the other coral species tested, *Acropora verweyi* showed reductions in mineral density that other species did not—potentially making it more susceptible to bioerosion or breaking waves. Experiments on acidification have demonstrated negative effects on *Acropora* calcification (Renegar and Riegl, 2005); (Anthony et al., 2008; Schneider and Erez, 2006) and productivity (Anthony et al., 2008), as well as impaired fertilization and settlement success in *Acropora palmata* (Albright et al., 2010) and reduced growth and zooxanthellae uptake in juveniles (Suwa et al., 2010). In general, most corals studied have shown negative relationships between acidification and growth (Table 3.2.2), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

Disease: Susceptibility and impacts of disease on this species are not known, although in general *Acropora* species are moderately to highly susceptible to disease. Additionally, ample evidence indicate that diseases can have devastating

regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and there is evidence that these impacts are occurring in more taxa and at a broader geographic scale (Sutherland et al., 2004, Green and Bruckner, 2000).

Predation: The specific effects of predation are poorly known for *Acropora verweyi*. Most *Acropora* are preferentially consumed by crown-of-thorns seastars, *Acanthaster planci*, (Colgan, 1987) and by corallivorous snails (B. Vargas-Ángel, CRED, Honolulu, HI, pers. comm., September 2010).

Land-based sources of pollution (LBSP): The specific effects of LBSP stresses are largely unknown for *Acropora verweyi*. It is absent from areas of anthropogenic impact in the Red Sea (Ammar et al., 2007), and is susceptible to sediment-induced mortality (Blakeway, 2005). LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

Collection/Trade: As a whole, the genus *Acropora* has been heavily involved in international trade with 50,000–270,000 reported exported pieces per year from Indonesia (CITES, 2010). As the species in this genus can be difficult to distinguish by nonexperts, it is possible that *Acropora verweyi* could be affected.

Risk assessment

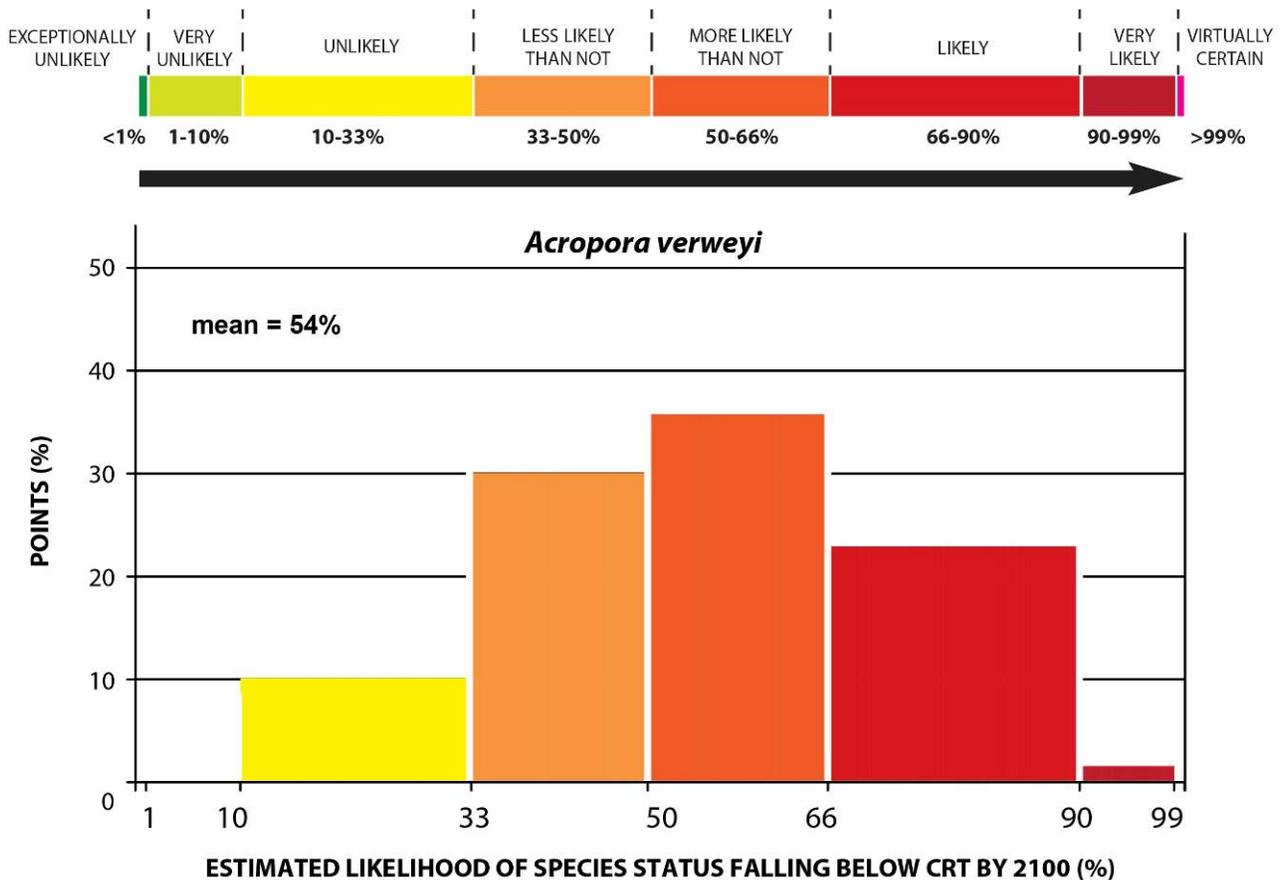


Figure 7.5.91. Distribution of points to estimate the likelihood that the status of *Acropora verweyi* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below Critical Risk Threshold) for *Acropora verweyi* include the relatively high susceptibility of the genus *Acropora* to common threats (bleaching, acidification, disease, predation, and pollution) and limited depth range (0–10 m). Factors that reduce the potential extinction risk (lower likelihood of falling below Critical Risk Threshold) for *Acropora verweyi* were the very wide latitudinal and longitudinal geographic range, the observations of occasional resistance to thermal stress in shallow back-reef pools, and its relatively common abundance. The very wide geographic range was considered to reduce extinction risk as it increases the likelihood the species will evade stressors or catastrophes in at least some locations.

The overall likelihood that *Acropora verweyi* will fall below the Critical Risk Threshold by 2100 was estimated to be in the “more likely than not” risk category with a mean likelihood of 54% and a standard error (SE) of 11.5% (Fig. 7.5.91). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.5.91) and the average range of likelihood estimates of the seven BRT voters (59%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acropora verweyi*.