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Mangroves of the Eastern Coral Triangle EN

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Abstract

Mangroves of the Eastern Coral Triangle are a regional ecosystem subgroup (level 4 unit of the IUCN Global Ecosystem Typology). It includes the marine ecoregions of the Bismarck Sea, Solomon Archipelago, Solomon Sea, and Southeast Papua New Guinea. The mapped extent of mangroves in this province in 2020 was 2128.9 km^2, representing 1.4% of the global mangrove area. The Eastern Coral Triangle is home to 46 true mangrove species and seven mangrove plant associates. Three mangrove species are on the IUCN Red List of Threatened Species: *Avicennia rumphiana* (VU = vulnerable), *Sonneratia ovata* (NT = near threatened), and *Bruguiera hainesii* (CR = critically endangered). Of 242 animal species associated with mangroves, five species are near threatened, four are endangered, and three are critically endangered.

The province's mangroves inhabit a variety of sediment types, including carbonate deposits, with many fringing mangrove patches on the many hundreds of islands in the Eastern Coral Triangle. Mangroves are threatened by illegal logging, conversion for agriculture and aquaculture, various types of urban development, including land reclamation, and mining. Climate change, especially sea-level rise, is a potent threat as is increasingly more frequent and stronger cyclones and tropical storms.

Today, the Eastern Coral Triangle mangroves cover approximately 15% less than our estimate for 1970 based on national studies. However, the mangrove net area change has been –0.36% since 1996. If this trend continues, an overall change of –1.0% is projected over the next 50 years. However, under a high sea-level rise scenario (IPCC RCP8.5), roughly –61.5% of the Eastern Coral Sea mangroves will be submerged by 2060. Moreover, 1.3% of the province's mangrove ecosystems are undergoing degradation, with the potential to increase to 4% within a 50-year period, based on a vegetation index decay analysis. Overall, the mangrove ecosystems in the Eastern Coral Triangle are assessed as **Endangered (EN).**

Citation:
Alongi, D.M., Duke, N.C., Ellison, J.C., Tahu, M. & Suárez E.L., (2024). *'IUCN Red List of Ecosystems, Mangroves of the Eastern Coral Triangle'*. EcoEvoRxiv.

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Keywords:
Mangroves; IUCN red List of ecosystems; ecosystem collapse; threats; Vulnerable.

Ecosystem classification:
MFT1.2 Intertidal forests and shrublands
Assessment's distribution:
The Eastern Coral Triangle province
Summary of the assessment:

Criterion	A	B	C	D	E	Overall
Subcriterion 1	**LC**	**LC**	**DD**	**DD**	**NE**	
Subcriterion 2	**LC**	**LC**	**EN**	**LC**	**NE**	**EN**
Subcriterion 3	**DD**	**LC**	**DD**	**DD**	**NE**	

EN: Endangered, LC: Least Concern,
DD Data Deficient, NE: Not Evaluated

Mangroves of The Eastern Coral Triangle

EN

1. Ecosystem Classification

IUCN Global Ecosystem Typology (version 2.1, Keith *et al.* 2022):

Transitional Marine-Freshwater-Terrestrial realm

MFT1 Brackish tidal biome

MFT1.2 Intertidal forests and shrublands

MFT1.2_4_MP_31 Mangroves of the Eastern Coral Triangle

IUCN Habitats Classification Scheme (version 3.1, IUCN 2012):

1 Forest

1.7 Forest – Subtropical/tropical mangrove vegetation above high tide level*below water Level* [1]

12 Marine Intertidal

12.7 Mangrove Submerged Roots

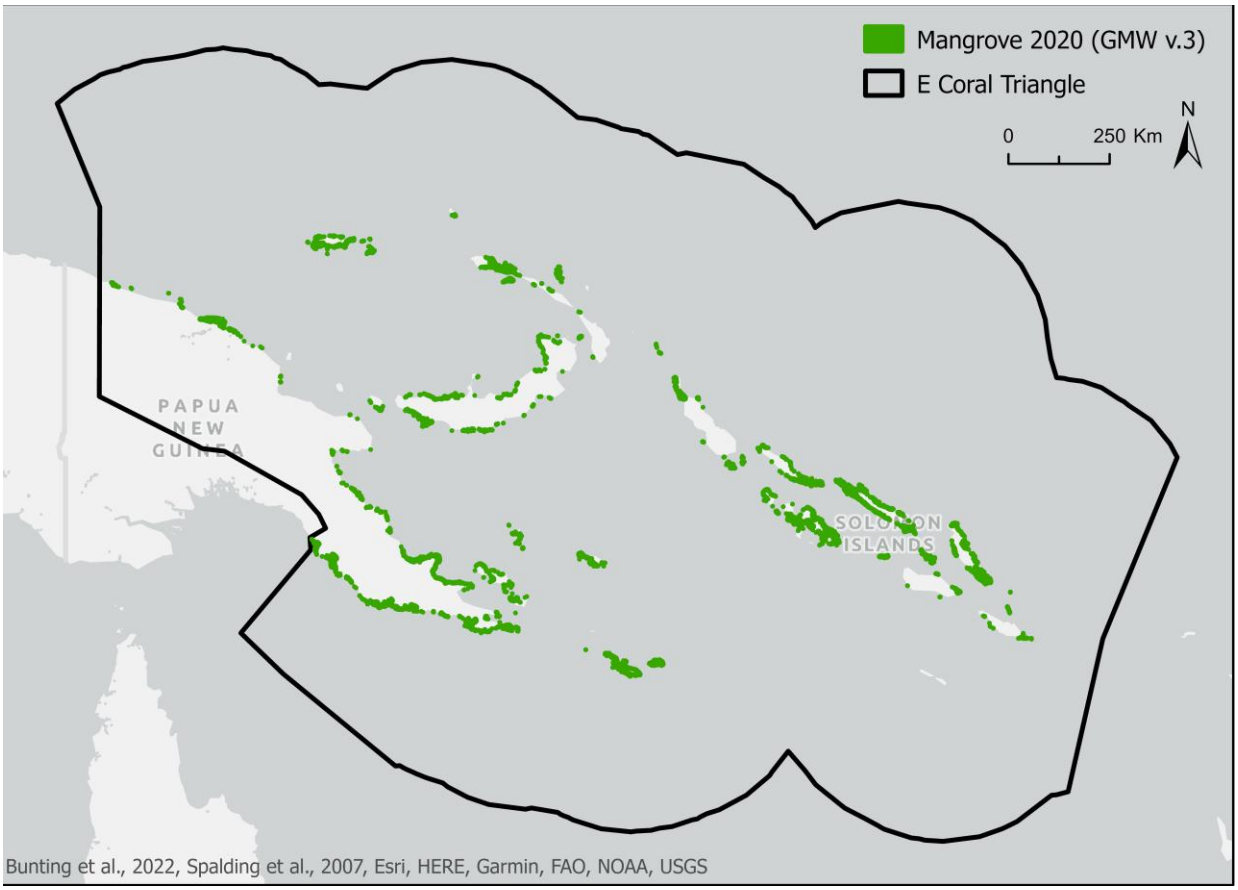

Figure 1. The mangroves of the Eastern Coral Triangle province.

[1] Note on the original classification scheme. This habitat should include mangrove vegetation below water level. Mangroves have spread into warm temperate regions to a limited extent and may occasionally occur in supratidal areas. However, the vast majority of the world's mangroves are found in tropical/subtropical intertidal areas.

A mixed Rhizophora-Bruguiera forest growing on coastal mud in Marovo Lagoon on the island of New Georgia, Solomon Islands; this is the largest saltwater lagoon in the world. Here, local people harvest mangrove propagules to eat and harvest wood for fuel. (Photo credit: Mary Tahu)

2. Ecosystem Description

Spatial distribution

Mangroves of the Eastern Coral Triangle province include intertidal forests and shrublands of the marine ecoregions of the Bismarck Sea, Solomon Archipelago, the Solomon Sea and northern and southeastern Papua New Guinea, extending across Papua New Guinea and the Solomon Islands (Figure 1). Biodiversity of mangrove flora and fauna peaks in this province (Appendix I). In Papua New Guinea, mangroves are located mostly in proximity to medium and large river systems, such as the Sepik and Ramu Rivers, and in relatively sheltered coastlines and bays such as near Lae and along the southeast coast of north and south Papua New Guinea. Mangroves also occur in sheltered locations on the islands of Manus, northwestern New Ireland and on mainly the western and southern coasts of New Britain. The spatial distribution of mangroves on these islands can be classified into a series of zones transitioning from fully marine to estuarine as determined by the dominant species type: (1) a *Rhizophora apiculata, R. mucronata and R. stylosa* zone on actively accreting shores (subdominants include *Sonneratia alba, Ceriops tagal* and *Avicennia* spp.; (2) a *Bruguiera sexangula, B. gymnorhiza, B. cylindrica,* and *B. parviflora* zone attaining canopy heights of up to 30m (subdominants include *Heritiera littoralis, Xylocarpus granatum,* and *X. moluccensis*); and (3) a *Nypa* zone in low salinity muds (Arihafa, 2016; Veitayaki *et al*., 2017).

In the Solomon Islands, species of *Rhizophora* and *Bruguiera* dominate most forests, with *Lumnitzera* also being relatively common. On Malaita, large mangrove stands are found at Lau Lagoon, Langa Langa Lagoon, Are'are Lagoon and Maramasike Passage. The mangroves of Malaita are dominated by *B. gymnorhiza* and *R. apiculata.* On Guadalcanal, mangroves are confined to Marau Sound on the east end of

the island; the dominant species are *R. stylosa, R. apiculata, B. gymnorhiza* and *L. littorea.* On San Cristobal, mangroves occur only in Star Harbour and the Three Sisters Islands where *Rhizophora* species are dominant. Mangroves are found around Hawthorn Sound, the southern coast of New Georgia Island and in the Marovo Lagoon in the Western Province. Large mangrove forests can be found on western Santa Isabel, the Arnarvon Isalnds, between San Jorge Islands and the mainland., the Thousand Ships Bay and the Ortega Channel. Mangroves on Choiseul occur around Waghena and Rob Roy Islands on the southeastern and northwestern ends of the island. The largest mangrove forests in the Central Province cover the entire length of the Mboli Passage between Nggela Sule and Nggela Pile islands. Almost all other islands of Papua New Guinea and the Solomon Islands contain a narrow fringe of mangroves in estuarine and sheltered areas (Veitayaki *et al*., 2017).

Biotic components of the ecosystem (characteristic native biota)

The mangroves of the Eastern Coral Triangle province are biologically diverse with 46 true mangrove plant species and seven mangrove associates (see Appendices). There are three threatened mangrove species in the IUCN Red List of Threatened Species database (IUCN, 2022): *Avicennia rumphiana* (VU = vulnerable), *Sonneratia ovata* (NT = near threatened), and *Bruguiera hainesii* (CR = critically endangered). There are at least 242 animal species within the taxa associated with mangrove habitats in the IUCN Red List of Threatened Species (IUCN, 2022) that have natural history collection records, or observations, within the distribution of this province (GBIF, 2022). There are currently 108 fish species, 93 bird species, 15 skate, shark and ray species, 12 gastropod species, 11 mammalian species and four reptile species on the list (see Appendices). Thirteen species are data deficient whereas the vulnerable species are *Albula glossodonta* (Shortjaw bonefish), *Haliaeetus sanfordi* (Sea eagle), *Carcharhinus amblyrhynchoides* (Graceful shark), *C. amboinensis* (Pigeye shark), *C. melanopterus* (Blacktip reef shark), *Himantura leoparda* (Leonard whipray), *Pastinachus ater* (Broad cowtail ray), and the dugong *(Dugong dugon*). Near threatened species are *Symposiachrus infelix* (Manus monarch), *Zosterops meeki* (Tagula white-eye), *Hemitrygon longicauda* (Merauke stingray), *Pateobatis hortlei* (Hortle's whipray), and *Taphozous australia* (Coastal Sheath-tailed bat).

There are four endangered species: the Sharp tooth lemon shark *(Negaprion acutidens*), the Narrow sawfish (*Anoxypristis cuspidata*), the Solomons free-tailed bat *(Chaerephon solomonis), and* the Spectacled flying fox *(Pteropus conspiillatus).* Three sawfish species are critically endangered: the Dwarf sawfish (*Pristis clavata*), the Large tooth sawfish (*P. pristis*), and the Green sawfish *(P. zijsron).*

The mangrove-associated biota of the Eastern Coral Triangle province is not only highly diverse, but it also provides critical food resources and services to coastal and island communities. Many resources are harvested, including fish and shellfish, and mangroves provide considerable alternative foods such as propagules that can be eaten directly, often with coconut milk and fish. Moreover, mangrove-seagrass-coral reef connectivity in this province offers not only nursery functions but also fish species from the adjacent habitats that are not ordinarily available in mangrove waterways.

Mangrove forests in the lower Sepik River delta, Papua New Guinea, are now receiving increased sediment loads from mining upstream leading to a shallowing of the lower estuary of a once pristine ecosystem (Photo courtesy of countercurrents.org)

Abiotic Components of the Ecosystem

Mangrove ecosystems have been classified recently using a biophysical typology (Worthington *et al*., 2020) according to their geomorphic setting as deltaic, estuarine, lagoonal or open coastal systems, and further classified based on their sedimentary setting with carbonate mangroves being less abundant (< 10%) than terrigenous environments. The continental margin of the north coast of Papua New Guinea is an active, narrow shelf with strong wind waves and currents. Thus, mangroves inhabit sheltered environments where fine sediments deposit in quiescent areas, such as within the deltaic plain of the Sepik River and within the estuarine complex of Lae. A much more complex geological history dominates the Solomon Islands, occupying a geological juncture between the Indo-Australasian and Pacific Plates with subsequent growth of a 1700 km island arc. High habitat diversity over small spatial scales makes the Solomons truly unique. The most extensive mangroves occur in the lee of larger islands and in the mouths of rivers and creeks, such as southern Choiseul, western Isabel, southern Malaita and Marau Sound in Guadalcanal. Almost all other islands contain open coast, fringing mangrove formations. Some mangroves can be found growing on highly exposed raised limestone reefs and barrier islands with carbonate and mixed carbonate-terrigenous deposits, often in association with seagrasses and coral reefs.

Mangroves of the Eastern Coral Triangle province are subjected to the El Niño-Southern Oscillation (ENSO) system which leads to highly variable hydrology, sea level, tidal currents, climate and sediment supply, resulting in localized geochemical and physicochemical differences in sediment and water-column pH, salinity, temperature, oxygen content, redox potential, and in carbon and nutrient concentrations and fluxes. Further, inhabiting different typological settings results in different biogeochemical attributes. Mangroves living in deltaic settings for instance experience greater rates of sedimentation and organic carbon burial than those inhabiting carbonate or mixed carbonate-terrigenous environments. This leads to

greater rates of organic carbon (and often nutrient) fluxes between deltaic mangroves and adjacent coastal waters.

Environmental factors and their gradients across time and space are important drivers of any ecosystem. Water, carbon dioxide and other gases, and inorganic and organic solutes, such as nitrogen, sulphur and phosphorus, are important players in regulating mangroves. For instance, mangroves of the ECT living on carbonate sediments or with low sand concentrations would very likely be nitrogen-, phosphorus- and /or iron-limited. This issue would have dramatic negative impacts on forest productivity.

Key Processes and Interactions

Mangrove ecosystems are unique in possessing many characteristics of both terrestrial and marine biota and are subject to physical factors such as tides, waves, marine and terrigenous sedimentation. They also have clear functional similarities to tropical terrestrial lowland forests, and those in the Eastern Coral Triangle are likely to be no different. While the carbon flow values depicted in Figure 2 are global averages and are not specific to the ECT, they do illustrate that mangrove ecosystems serve as major blue carbon sinks, incorporating organic carbon into sediments and living biomass. Mangroves, including those within the ECT play a key role in coastal carbon sequestration (Table1). The model illustrates that mangroves, in most cases regardless of location, are net autotrophic ecosystems, gaining more carbon in tree biomass and sediment burial than they lose to the atmosphere and adjacent coastal ocean.

Mangroves have many attributes that make them well adapted to saline sediments and harsh intertidal conditions. Salt and anoxia are the greatest factors influencing mangrove growth and reproduction; benthic and pelagic fauna and other flora are similarly affected by these drivers. Temperature, oxygen availability, redox potential, anoxia, sediment type and carbon and nutrient concentrations, and pH assist in structuring and regulating the tempo of life in mangrove ecosystems.

The mangrove ecosystem supports an equally rich and diverse associated fauna, with most invertebrate phyla represented on both the forests and adjacent tidal waterways. Many vertebrates, such as reptiles, fish and mammal species, are also dependant on mangroves for food and space, including visitors such as crocodiles, birds and bats. Mangroves harbour many commercially important species such as oysters, clams, gastropods, cephalopods and crustaceans, especially prawns *(Penaeus* spp.), mud crabs (*Scylla* spp.*)* and coconut crabs *(Birgus latro).* Coastal fisheries landings for both nations range from about 30,000 to 35,000 tonnes per year (Solomon Islands Ministry of Fisheries and Marine Resources, 2019; https://png-data.sprep.org/dataset/coastal-fisheries, accessed 17 March 2024) indicating substantial landings by coastal inhabitants. Indeed, the largest source of protein for people in both countries is seafood.

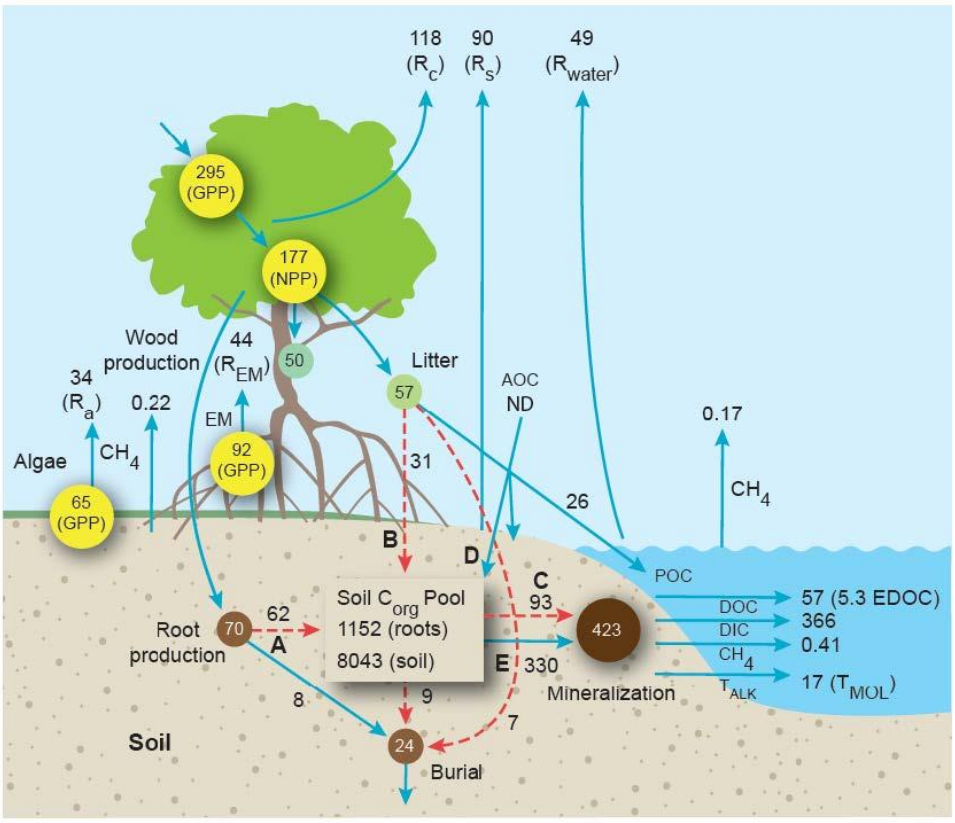

Figure 2. Model of key ecosystem processes and blue carbon flows and standing stocks through global mangrove ecosystems (Alongi, 2022). Carbon fluxes are Tg C per yr. Solid blue arrows represent mean values based on published data. Dashed red arrows are mean values estimated by difference. The soil CORG pool (roots + soil) to a depth of 1 m is represented as a box in the forest floor with units of Tg C. Abbreviations: GPP = gross primary production; NPP = net primary production; Ra = microalgal respiration; REM = epiphytic macroalgal respiration; EM = epiphytic macroalgae; AOC = allochthonous CORG input from phytoplankton, seaweed, seagrass, coral reef, and upstream terrestrial C4 plant detritus, etc.; RC = canopy respiration; RS = surface soil respiration; RWATER = waterway respiration; DC = dissolved carbon; POC = particulate organic carbon; DIC = dissolved inorganic carbon; DOC = dissolved organic carbon; EDOC = exchangeable dissolved organic carbon; CH4 = methane; ND = no data. Total subsurface lateral DC flux from the forest floor (423 Tg C per yr) = 'C' (93 Tg C per yr) + 'E' (330 Tg C per yr), where 'C' is the sum of fluxes 'A' (roots) + 'B' (litter). These porewater DC components are transported via subsurface water flow to the adjacent mangrove waterway. Reproduced under the CC Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0).

The key ecological factors that sustain all mangroves are net primary production (NPP) of mangrove vegetation (canopy, wood, roots), tidal water and creek phytoplankton, and benthic microalgal mats and macroalgae, which often live on mangrove tree stems, aboveground roots and/or fallen timber. The resulting net production of fixed carbon is then available for consumption and decomposition by pelagic and forest floor food webs, as well as tidal exchange of dissolved and particulate matter with adjacent coastal waters. Indeed, after ecosystem respiration, export of such materials constitutes the largest loss of carbon from mangrove ecosystems. The few data available, mostly from Papua New Guinea, indicate highly productive forests (Ellison, 1997). Mangrove NPP near Port Moresby, for instance, ranges from 8.3-14.3 tonnes dry weight (DW) per hectare per year, within the range of empirical productivity measurements in both the Fly and Purari deltas (12-27 tonnes DW per hectare per year. No such data exists for Solomon Islands, but the

large aboveground (190-430 Mg C per hectare) and belowground (350-2100 Mg C per hectare) carbon stocks measured in managed forests (Albert *et al*., 2012) also suggest high productivity.

Mangrove blue carbon in the Solomon Islands was first estimated in 2012 (Albert *et al*., 2012), which at current harvesting levels of 12-72% trees cut, was equivalent to 102 tonnes CO_2eq per hectare of aboveground carbon biomass lost due to deforestation. In a more recent study (Table 1), it was estimated that Papua New Guinea had a negative offsetting potential, meaning that the nation's mangrove inventory contributed more emissions than they sequestered. However, both Papua New Guinea and the Solomon Islands have a large potential to offset carbon emissions if deforestation can be stopped or slowed, and both are currently initiating blue carbon programmes (Friess, 2023).

Table 1. Offsetting potential for carbon sequestration for existing mangroves (rows 1 and 2); potential avoided deforestation offsetting (rows 3 and 4); and net balance of mangroves against AFOLU (refers to emissions from agriculture, forestry and other land uses). Summarized from Friess (2023).

	Papua New Guinea	Solomon Islands
(1) C sequestration for existing mangroves (Tg C per year)	0.762 (in 2019)	0.089 (in 2019)
(2) Potential of stable mangroves to offset AFOLU emissions (100%)	382.8	433.5
(3) Emissions from mangrove loss (Tg C per year)	0.830	0.087
(4) Potential of avoided deforestation to offset AFOLU emissions (%)	418.1	428.1
(5) Net carbon balance of mangroves (Tg C per year)	-0.070	0.001
(6) Mangrove potential to offset AFOLU emissions (%)	-35.3	5.4

3. Ecosystem Threats and vulnerabilities

Main threatening processes and pathways to degradation

Mangrove deforestation in the Eastern Coral Triangle arises from various factors, including aquaculture, urbanization, associated coastal development, over-harvesting, and pollution stemming from domestic, industrial, and agricultural land-use. The intertidal location of mangrove forests renders them vulnerable to predicted sea-level rise due to climate change. Further, tropical storms and their predicted increasing intensity and frequency can damage mangrove forests through direct defoliation and destruction of trees, as well as through the mass mortality of mangrove-associated animal communities. These identified threats are likely to cause perceptible symptoms of ecosystem collapse, including changes in ecosystem distribution, changes in the physical environment or disturbances in key processes or interactions within or between biotic and abiotic ecosystem components.

Satellite altimetry data from 1993-2017 showed that the East Coral Triangle province experiences above-

average rates of relative sea-level rise (RSLR) of 4-6 mm/year, particularly northern Solomons, which was attributed to regional trade winds (Aucan, 2018). Tide gauge records show RSLR at Honiara (Solomons) to be +4.85±1.18 mm/ year (1974-2017) (Aucan, 2018) and 1.7±0.7 (1966-2009) at Rabalu (East Bismarck). Variability occurs owing to ENSO fluctuations, as evident from interannual trends, causing higher sea-level for periods that may stress mangroves. To the east, survey of mangroves in Pohnpei showed that they occupy 75% of the tidal range, likely related to El Niño-Southern Oscillation (ENSO) variability (Ellison *et al*., 2022).

The beginning of mangrove diebacks due to sea-level rise in Marovo Lagoon, Solomon Islands. (*Photo credit: Mary Tahu*)

Cutting of mangroves and replacement with stone walls, Marovo Lagoon (Photo credit: Mary Tahu)

This province is also subject to vertical ground movement that contributes to RSLR, as exemplified by

Lombrum (Eastern Manus Island) which has vertical land motion of up to -1.3±0.4 mm /year as shown by GPS measurements (Becker *et al*., 2012), while northern PNG shows uplift (Chapell *et al*. 1996). Manus's tide gauge record (1995-2020) shows RSLR of +5.6±1.4 mm/ year (Raj et al. 2022).

Increasing surface elevation through net accretion processes is needed to maintain mangrove forests relative to local sea level (Ellison *et al*., 2022). The surface elevation table is a common technique to assess surface elevation change, which is a combination of accretion, root expansion and peat collapse (Krauss *et al*., 2003; Cahoon, 2015). There are no measurements available from the East Coral Triangle province, but high island settings to the east showed net surface elevation change to be lower than RSLR (Lovelock *et al*., 2015), indicating inundation stress to mangroves. Coastal sediment delivery could be restricted by anthropogenic damming of rivers (Lovelock *et al*., 2015), increasing vulnerability of mangroves to RSLR.

Definition of the collapsed state of the ecosystem

Mangroves possess specialized traits that facilitate highly efficient energetic processes such as high rates of nutrient-use efficiency and close microbial-tree interrelationships which underlie critical processes and functions within their ecosystem. Ecosystem collapse would be recognized when the tree cover of diagnostic true mangrove species dwindles to zero, indicating complete loss (100%). This happens in areas where mangroves have been completely deforested and where a large proportion of the critical sediment carbon and nutrient reservoirs have been degraded and possibly exported by tides.

Mangroves exhibit remarkable dynamism, with species distributions adapting to local shifts in sediment distribution, tidal patterns, and variations in local inundation and salinity gradients. Disruptive processes can trigger shifts in this dynamism, potentially leading to ecosystem collapse. Ecosystem collapse may manifest through the following mechanisms: (a) restricted recruitment and survival of diagnostic true mangroves due to adverse climatic conditions (e.g., drought or floods); (b) alterations in rainfall, river inputs, waves and tidal currents that destabilize and erode substrates, hindering recruitment and growth; and (c) shifts in rainfall patterns, river inputs and tidal flushing altering salinity and nutrient levels, thereby impacting overall survival. Collapse of an ecosystem also results in disjointed biogeochemical cycles and food web interactions, such as declines or a complete severing of biogeochemical and/or ecological connectivity (e.g., fish migration) between mangroves and adjacent tidal flats, seagrass beds, coral reefs and coastal waters and sediments.

Threat Classification

IUCN Threat Classification (version 3.3, IUCN-CMP, 2022) relevant to mangroves of the Eastern Coral Triangle province:

1. Residential and commercial development

1.1 Housing & urban areas
1.2 Commercial & industrial areas
1.3 Tourism & recreation areas

2. Agriculture and aquaculture
- 2.4 Marine and freshwater aquaculture
  - 2.4.1 Subsistence/artisanal aquaculture
  - 2.4.2 Industrial aquaculture

3. Energy production and mining
- 3.2 Mining and quarrying

4. Transportation and service corridors
- 4.1 Roads & railroads

5. Biological resource use
- 5.1 Hunting and collecting terrestrial animals
- 5.3 Logging and wood harvesting
- 5.4 Fishing and harvesting aquatic resources

6. Human intrusions & disturbance
- 6.3. Work & other activities

7. Natural system modifications
- 7.2 Dams and water management/use

8. Invasive and other problematic species, genes and diseases
- 8.1 Invasive non-native/alien species/diseases

9. Pollution
- 9.1 Domestic and urban wastewater
  - 9.1.1 Sewage
  - 9.1.2 Runoff
- 9.2 Industrial effluents
  - 9.2.1 Oil spills
  - 9.2.2 Seepage from mining
- 9.3 Agricultural and forestry effluents
  - 9.3.1 Nutrient loads
  - 9.3.2 Soil erosion, sedimentation
- 9.4 Garbage and solid waste

10. Geological events
- 10.1 Volcanoes
- 10.2 Earthquakes/tsunamis

11. Climate change and severe weather
- 11.1 Habitat shifting and alteration
- 11.4 Storms and flooding
- 11.5 Other impacts (sea-level rise)

Channel cutting and harvesting of mangroves in the Murik Lakes region of the lower Sepik delta, Papua New Guinea. Photo taken and used under the Creative Commons license from Lipset (2014).

Log ponds in the Marovo Lagoon, Solomon Islands, where severe logging once occurred (Photo credit: Mary Tahu)

Dense mangrove forests where local villagers harvest downed stems for firewood, the Solomon Islands (Photo credit: Mary Tahu)

4. Ecosystem Assessment

Criterion A: Reduction in Geographic Distribution

Subcriterion A1 measures the trend in ecosystem extent during the last 50-years. Unfortunately, there is no regional dataset that provides information for the entire Eastern Coral Triangle in 1970. However, country-level estimates of mangrove extent can be used to extrapolate the trend between 1970 and 2020. Accordingly, we compiled reliable published sources (see Appendix 3) that contain information on mangrove area estimates close to 1970 (both before and after) for both countries within the province. These estimates were then used to interpolate the mangrove area in 1970 in each country. By summing these estimates, we calculated the total mangrove area in the province. We only considered the percentage of each country's total mangrove area located within the province and the estimated values for 1970 should be considered only indicative (see Appendix 3 for further details of methods and limitations).

In contrast, to estimate the Eastern Coral Triangle mangrove area from 1996 to 2020, we used the most recent version of the Global Mangrove Watch (GMW v3.0) spatial dataset. The mangrove area in the province (and in the corresponding countries) was corrected for both omission and commission errors, utilizing the equations in Bunting *et al.* (2022).

Results from the analysis of subcriterion A1 (Annex 3) show that the Eastern Coral Triangle mangrove province has undergone a 18.1% decline of its mangrove area over the last 50 years (1970-2020). Given that the change in geographic distribution is relatively unchanged except in urban areas, the ecosystem is assessed having been of **Least Concern (LC)** under subcriterion A1.

Mangroves of the Eastern Coral Triangle	Area 2020* (km^2)	Area 1970* (km^2)	Net Area Change (km^2)	% Net Area Change	Rate of change (% per year)
	1,569	1,916.6	-347.6	18.1	0.36%

** Details on the methods and references used to estimate the mangrove area in 1970 are listed in Appendix 3. Total mangrove area in 2020 is based on the Global Mangrove Watch Version 3 (GMW v3.0) dataset.*

Subcriterion A2 measures the change in ecosystem extent in any 50-year period, including from the present into the future: The Eastern Coral Triangle province mangroves show a net area change of -0.36% (1996-2020, fig. 2) based on the Global Mangrove Watch time series (Bunting et al., 2022). This value reflects the offset between areas gained (+ 0.1% per year) and lost (- 0.1% per year). Initially, mangrove extent in the province increased between 1996 and 2007, but then showed a downward trend from 2007 to 2020. If this downward trend continues the next 50 years projections suggest a potential decline of -3.35% in mangrove extent within the Eastern Coral Triangle by 2070. The Tropical Southwestern Pacific mangrove ecosystem is therefore assessed as **Least Concerned (LC**) under subcriterion A2.

Subcriterion A3 measures changes in mangrove area since 1750. Unfortunately, there are no reliable data on the mangrove extent for the entire province during this period, and therefore the Eastern Coral Triangle mangrove ecosystem is classified as **Data Deficient (DD)** for this subcriterion.

Overall, the ecosystem is assessed as of **Least Concern (LC)** under criterion A.

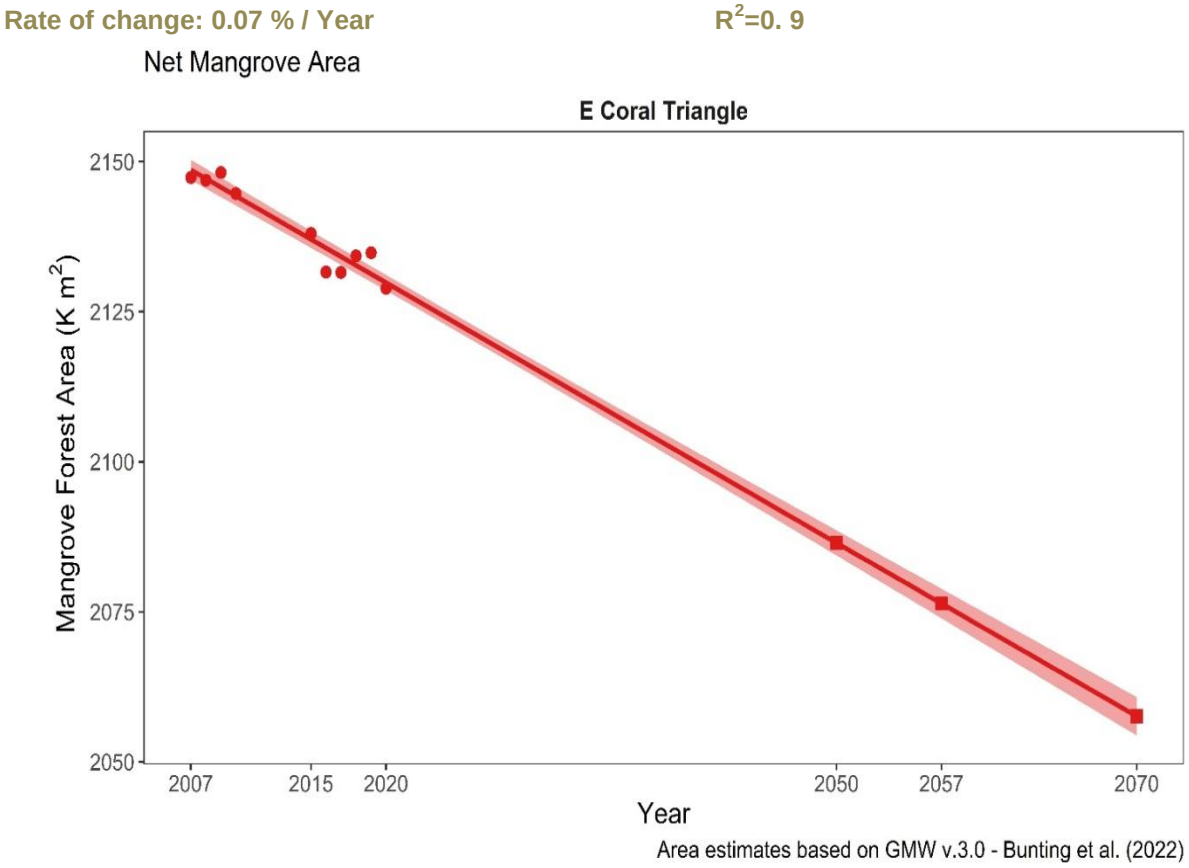

Figure 3. Eastern Coral Triangle mangrove ecosystem to between 1996 and 2020. Circles represent the province mangrove area between 1996 and 2020 based on the GMW v3.0 dataset and equations in Bunting *et al.* (2022). The solid line and shaded area are the linear regression and 95% confidence intervals.

Criterion B: Restricted Geographic Distribution

Criterion B measures the risk of ecosystem collapse associated with restricted geographical distribution, based on standard metrics (Extent of Occurrence (EOO), Area of Occupancy (AOO), and Threat-defined locations). These parameters were calculated based on the 2020 Eastern Coral Triangle province mangrove extent (GMW v.3).

Province	Extent of Occurrence EOO (km^2)	Area of Occupancy (AOO)	Criterion B
The Eastern Coral Triangle	1,420,790.0	377	**LC**

For 2020, AOO and EOO were measured as 377 grid cells (10 x 10 km) and 1,420,790.0 km^2, respectively (figure 3). Excluding from the total of 847 those grid cells that contain patches of mangrove forest that account for < 1% of the grid cell area (< 1 km^2), the AOO is measured as 377 (10 x 10 km grid cells) (Figure 3, red grids).

Considering the very high number of threat-defined-locations, there is no evidence of plausible catastrophic threats leading to potential disappearance of mangroves across their extent. As a result, the Eastern Coral Triangle mangrove ecosystem is assessed as **Least Concern (LC)** under criterion B.

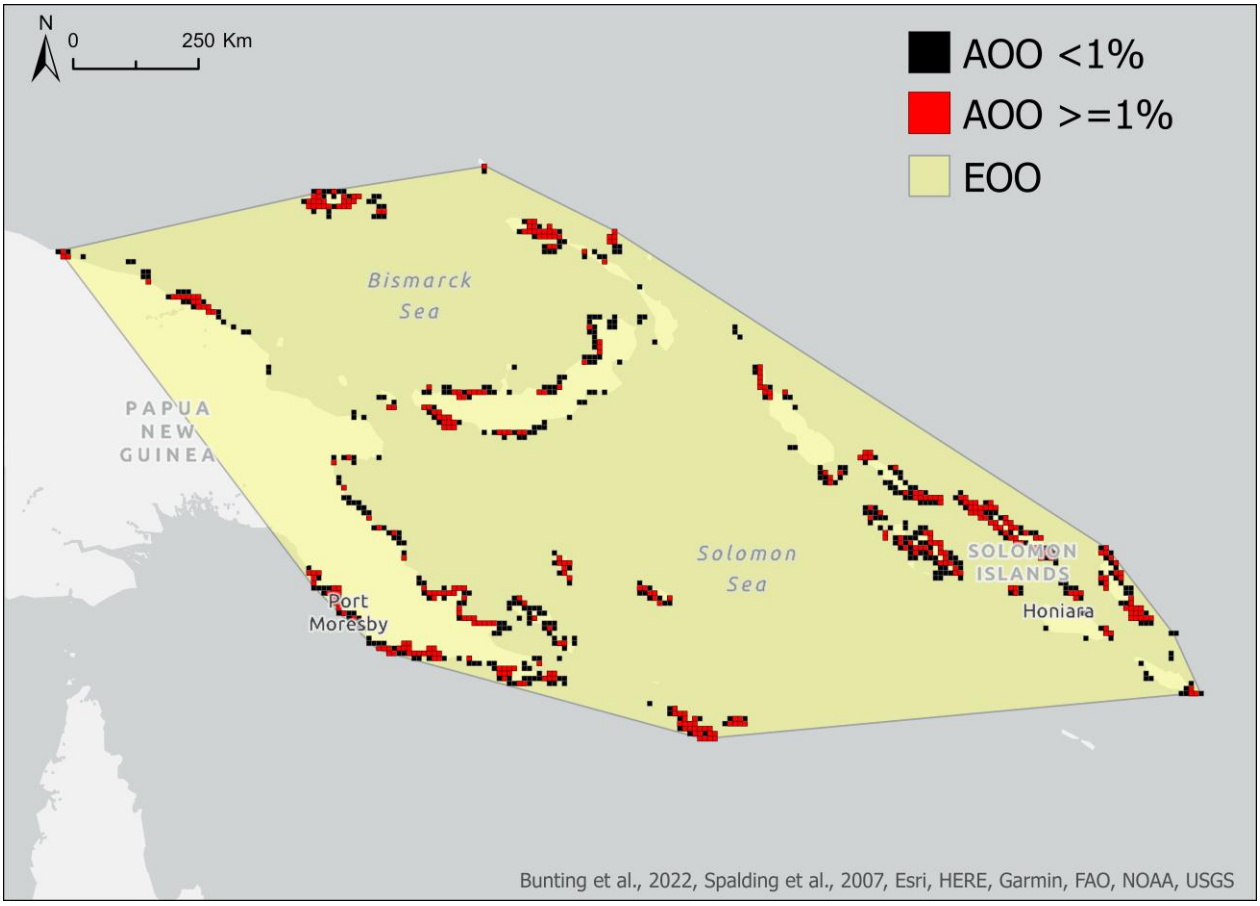

Figure 4. The Eastern Coral Triangle mangroves, Extent of Occurrence (EOO) and Area of Occupancy (AOO) in 2020. Estimates based on 2020 GMW v3.0 spatial layer (Bunting et al., 2022). The red 10 x 10 km grids (n=377) are more than 1% covered by the ecosystem, and the black grids <1% (n= 470).

Criterion C: Environmental Degradation

Criterion C measures the environmental degradation of abiotic variables necessary to support the ecosystem. Subcriterion C1 measures environmental degradation over the past 50 years. There are no reliable data to evaluate this subcriterion for the entire province, and therefore the Eastern Coral Triangle mangrove ecosystem is classified as **Data Deficient (DD)** for subcriterion C1.

Subcriterion C2 measures environmental degradation in the future, or over any 50-year period, including from the present. In this context, the impact of future sea level rise (SLR) on mangrove ecosystems was assessed by adopting the methodology presented by Schuerch et al. (2018). The published model was designed to calculate both absolute and relative change in the extent of wetland ecosystems under various regional SLR scenarios (i.e medium: RCP 4.5 and high: RCP 8.5), with consideration for sediment accretion. Therefore, the Schuerch *et al.* (2018) model was applied to the Eastern Coral Triangle mangrove ecosystem boundary, with spatial extent based on Giri *et al.* (2011) and assuming mangrove landward migration was not possible.

The model results indicate that under an extreme sea-level rise scenario of a 1.1 m rise by 2100, the projected submerged area will be ~ -61.5% by 2060, which is above 50% but below the 80% risk threshold. This estimate is greater than the estimate of a 0.5 m rise by 2100 based on extrapolation of current tide gauge and satellite altimetry data (see Section 3, 'Main threatening processes and pathways to degradation', pages 7-8). Therefore, considering that no mangrove recruitment can occur in a submerged system (100% relative severity), but that -61.5% of the ecosystem extent will be affected by rising sea-level, the Eastern Coral Triangle mangrove ecosystem is assessed as **Endangered (EN)** for subcriterion C2.

Subcriterion C3 measures change in abiotic variables since 1750. There is a lack of reliable historic data on environmental degradation covering the entire province, and therefore the Eastern Coral Triangle province is classified as **Data Deficient (DD)** for this subcriterion.

Overall, the ecosystem is assessed as **Endangered (EN)** under criterion C.

Criterion D: Disruption of biotic processes or interactions

The global mangrove degradation map developed by Worthington and Spalding (2018) was used to assess the level of biotic degradation in the Eastern Coral Triangle province. This map is based on degradation metrics calculated from vegetation indices (NDVI, EVI, SAVI, NDMI) using Landsat time series (≈ 2000 and 2017). These indices represent vegetation greenness and moisture condition.

Mangrove degradation was calculated at a pixel scale (30 m resolution) on areas intersecting with the 2017 mangrove extent map (GMW v2). Mangrove pixels were classified as degraded if two conditions were met: (1) at least 10 out of 12 degradation indices showed a decrease of more than 40% compared to the previous period; and (2) all twelve indices did not recover to within 20% of their pre-2000 value (detailed methods and data are available at: maps.oceanwealth.org/mangrove-restoration/). The decay in vegetation indices was

used to identify mangrove degradation and abrupt changes, including mangrove die-back events, clear-cutting, fire damage, and logging, as well as to track mangrove regeneration (Lovelock et al., 2017; Santana, 2018; Murray et al., 2020; Aljahdali et al., 2021; Lee et al., 2021). However, it is important to consider that changes observed in the vegetation indices can also be influenced by data artifacts (Akbar et al., 2020). Therefore, a relative severity level of more than 50%, but less than 80%, was assumed.

The results from this analysis show that over a period of 17 years (~2000 to 2017), 0.8% of the Eastern Coral Triangle mangrove area is classified as degraded, resulting in an average annual rate of degradation of 0.05%. Assuming this trend remains constant, +4% of the Eastern Coral Triangle mangrove area will be classified as degraded over a 50-year period. Since less than 30% of the ecosystem will meet the category thresholds for criterion D, the Eastern Coral Triangle mangrove province is assessed as **Least Concern** (**LC)** under subcriterion D2b.

No data were found to assess the disruption of biotic processes and degradation over the past 50 years (subcriterion D1) or since 1750 (subcriterion D3). Thus, both subcriteria are classified as **Data Deficient (DD).**

Overall, the Eastern Coral Triangle ecosystem remains **Least Concern (LC)** under criterion D.

Criterion E: Quantitative Risk

No model was used to quantitatively assess the risk of ecosystem collapse for this ecosystem; hence criterion E was **Not Evaluated (NE)**.

5. Summary of the Assessment

CRITERION			
A. Reduction in Geographic Distribution	**A1** Past 50 years	**A2** Future or any 50y period	**A3** Historical (1750)
	LC	**LC**	**DD**
B. Restricted Geo. Distribution	**B1** Extent of Occurrence	**B2** Area of Occupancy	**B3** # Threat-defined Locations (< 5)
	LC	**LC**	**LC**
C. Environmental Degradation	**C1** Past 50 years (1970)	**C2** Future or any 50y period	**C3** Historical (1750)
	DD	**EN**	**DD**
D. Disruption of biotic processes	**D1** Past 50 years (1970)	**D2** Future or Any 50y period	**D3** Historical (1750)
	DD	**LC**	**DD**
E. Quantitative Risk analysis		**NE**	
OVERALL RISK CATEGORY	**EN**		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated; EN= Endangered

Overall, the status of the Eastern Coral Triangle mangrove ecosystems is assessed as **Endangered (EN)**

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Acknowledgments
We would also like to thank the IUCN SSC Mangrove Specialist Group and the Global Mangrove Alliance Science Working group, for their support in the delineation of the level 4 mangrove units that were the basis for this analysis. Special thanks to José Rafael Ferrer-Paris for his contribution to the production of the general ecosystem description template for the RLE mangrove assessments. We also wish to acknowledge Thomas Worthington for kindly providing the spatial data on mangrove degradation.

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7. Appendices

1. List of Key Mangrove Species

List of plant species considered true mangroves according to Red List of Threatened Species (RLTS) spatial data (IUCN, 2022) followed by additional species based on Duke *et al*. (1998) and Duke (2017). We included species whose range maps intersected with the boundary of the marine provinces/ecoregions described in the distribution section.

Class	Order	Family	Scientific name	RLTS category
Equisetopsida	Ericales	Ebenaceae	*Diospyros littoralis*	LC
Equisetopsida	Fabales	Fabaceae	*Cynometra iripa*	LC
Liliopsida	Arecales	Arecaceae	*Nypa fruticans*	LC
Magnoliopsida	Caryophyllales	Plumbaginaceae	*Aegialitis annulata*	LC
Magnoliopsida	Ericales	Lecythidaceae	*Barringtonia racemosa*	LC
Magnoliopsida	Ericales	Primulaceae	*Aegiceras corniculatum*	LC
Magnoliopsida	Gentianales	Rubiaceae	*Scyphiphora hydrophylacea*	LC
Magnoliopsida	Lamiales	Acanthaceae	*Acanthus ilicifolius*	LC
Magnoliopsida	Lamiales	Acanthaceae	*Acanthus ebracteatus*	LC
Magnoliopsida	Lamiales	Acanthaceae	*Avicennia alba*	LC
Magnoliopsida	Lamiales	Acanthaceae	*Avicennia marina*	LC
Magnoliopsida	Lamiales	Acanthaceae	*Avicennia officinalis*	LC
Magnoliopsida	Lamiales	Acanthaceae	*Avicennia rumphiana*	VU
Magnoliopsida	Malpighiales	Euphorbiaceae	*Excoecaria agallocha*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera cylindrica*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera dundarra*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera exaristata*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera gymnorhiza*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera hainesii*	CR
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera parviflora*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera rhynchopetala*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Bruguiera sexangula*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Ceriops australis*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Ceriops pseudodecandra*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Ceriops tagal*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Ceriops zippeliana*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Rhizophora annamalayana*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Rhizophora apiculata*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Rhizophora lamarckii*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Rhizophora mucronata*	LC
Magnoliopsida	Malpighiales	Rhizophoraceae	*Rhizophora stylosa*	LC
Magnoliopsida	Malvales	Malvaceae	*Camptostemon schultzii*	LC
Magnoliopsida	Myrtales	Combretaceae	*Lumnitzera littorea*	LC
Magnoliopsida	Myrtales	Combretaceae	*Lumnitzera racemosa*	LC
Magnoliopsida	Myrtales	Lythraceae	*Pemphis acidula*	LC
Magnoliopsida	Myrtales	Lythraceae	*Sonneratia alba*	LC
Magnoliopsida	Myrtales	Lythraceae	*Sonneratia caseolaris*	LC
Magnoliopsida	Myrtales	Lythraceae	*Sonneratia gulngai*	LC
Magnoliopsida	Myrtales	Lythraceae	*Sonneratia lanceolata*	LC
Magnoliopsida	Myrtales	Lythraceae	*Sonneratia ovata*	NT
Magnoliopsida	Myrtales	Lythraceae	*Sonneratia urama*	LC
Magnoliopsida	Myrtales	Myrtaceae	*Osbornia octodonta*	LC

Magnoliopsida	Scrophulariales	Bignoniaceae	*Dolichandrone spathacea*	LC
Polypodiopsida	Polypodiales	Pteridaceae	*Acrostichum aureum*	LC
Polypodiopsida	Polypodiales	Pteridaceae	*Acrostichum speciosum*	LC
Magnoliopsida	Sapindales	Meliaceae	*Xylocarpus granatum*	LC
Magnoliopsida	Sapindales	Meliaceae	*Xylocarpus moluccensis*	LC

2. List of Associated Species

List of taxa that are associated with mangrove habitats in the Red List of Threatened Species (RLTS) database (IUCN, 2022). We included only species with entries for Habitat 1.7: "Forest - Subtropical/Tropical Mangrove Vegetation Above High Tide Level" or Habitat 12.7 for "Marine Intertidal - Mangrove Submerged Roots", and with suitability recorded as "Suitable", with presence recorded as "Extant", "Possibly Extant" or "Possibly Extinct", Origin recorded as "Native" or "Reintroduced" , with any value of Seasonality except "Passage", suitability recorded as "Suitable", and with "Major Importance" recorded as "Yes". The common names are those shown in the RLTS, except common names in brackets, which are from other sources.

Class	Order	Family	Scientific name	RLTS category	Common name
Angiospermae	Fabales	Fabaceae	*Inocarpus fagifer*	LC	Tahitian chestnut
Equisetopsida	Malvales	Malvaceae	*Hibiscus tilliaceous*	LC	(Sea hibiscus)
Equisetopsida	Malvales	Malvaceae	*Thespesia populnea*	LC	(Portia tree)
Equisetopsida	Sapindales	Anacardiaceae	*Schinus terebinthifolia*	LC	(Brazilian pepper tree) - invasive
Magnoliopsida	Fabales	Fabaceae	*Dalbergia candenatensis*	LC	trắc một hột
Magnoliopsida	Malpighiales	Rhizophoraceae	*Ceriops zippeliana*	LC	
Magnoliopsida	Malvales	Malvaceae	*Brownlowia argentata*	DD	
Actinopterygii	Albuliformes	Albulidae	*Albula glossodonta*	VU	Shortjaw bonefish
Actinopterygii	Anguilliformes	Muraenidae	*Gymnothorax monochrous*	LC	
Actinopterygii	Anguilliformes	Ophichthidae	*Scolecenchelys macroptera*	LC	
Actinopterygii	Atheriniformes	Atherinidae	*Atherinomorus lacunosus*	LC	Hardyhead silverside
Actinopterygii	Aulopiformes	Synodontidae	*Saurida nebulosa*	LC	Clouded lizardfish
Actinopterygii	Beloniformes	Zenarchopteridae	*Zenarchopterus dispar*	LC	Feathered river-garfish
Actinopterygii	Beloniformes	Zenarchopteridae	*Zenarchopterus gilli*	LC	Shortnose river garfish
Actinopterygii	Clupeiformes	Clupeidae	*Anodontostoma selangkat*	LC	Indonesian gizzard shad
Actinopterygii	Clupeiformes	Clupeidae	*Sardinella albella*	LC	White sardinella
Actinopterygii	Clupeiformes	Clupeidae	*Sardinella fijiense*	LC	Fiji sardinella
Actinopterygii	Clupeiformes	Clupeidae	*Sardinella melanura*	LC	Blacktip sardinella
Actinopterygii	Clupeiformes	Engraulidae	*Encrasicholina punctifer*	LC	Buccaneer anchovy
Actinopterygii	Clupeiformes	Engraulidae	*Stolephorus andhraensis*	LC	Andhra anchovy

Class	Order	Family	Scientific name	RLTS category	Common name
Actinopterygii	Clupeiformes	Engraulidae	*Thryssa brevicauda*	LC	Short-tail thryssa
Actinopterygii	Elopiformes	Elopidae	*Elops hawaiensis*	DD	Giant herring
Actinopterygii	Elopiformes	Megalopidae	*Megalops cyprinoides*	DD	Indo-pacific tarpon
Actinopterygii	Gobiiformes	Eleotridae	*Bostrychus sinensis*	LC	Four-eyed sleeper
Actinopterygii	Gobiiformes	Eleotridae	*Butis amboinensis*	LC	Ambon gudgeon
Actinopterygii	Gobiiformes	Eleotridae	*Butis butis*	LC	Crimson-tipped gudgeon
Actinopterygii	Gobiiformes	Eleotridae	*Butis gymnopomus*	LC	Striped crazy fish
Actinopterygii	Gobiiformes	Eleotridae	*Butis koilomatodon*	LC	Marblecheek sleeper
Actinopterygii	Gobiiformes	Eleotridae	*Eleotris fusca*	LC	Brown spinecheek gudgeon
Actinopterygii	Gobiiformes	Eleotridae	*Eleotris melanosoma*	LC	Broadhead sleeper
Actinopterygii	Gobiiformes	Eleotridae	*Ophiocara porocephala*	LC	Spangled gudgeon
Actinopterygii	Gobiiformes	Gobiidae	*Amblygobius esakiae*	LC	Snout-spot goby
Actinopterygii	Gobiiformes	Gobiidae	*Amblygobius linki*	LC	Link's goby
Actinopterygii	Gobiiformes	Gobiidae	*Asterropteryx semipunctata*	LC	
Actinopterygii	Gobiiformes	Gobiidae	*Caragobius urolepis*	LC	Scaleless worm goby
Actinopterygii	Gobiiformes	Gobiidae	*Cryptocentrus leptocephalus*	LC	Pink-speckled shrimpgoby
Actinopterygii	Gobiiformes	Gobiidae	*Drombus triangularis*	LC	Brown drombus
Actinopterygii	Gobiiformes	Gobiidae	*Feia nympha*	LC	Nymph goby
Actinopterygii	Gobiiformes	Gobiidae	*Glossogobius circumspectus*	LC	Circumspect goby
Actinopterygii	Gobiiformes	Gobiidae	*Gnatholepis ophthalmotaenia*	LC	
Actinopterygii	Gobiiformes	Gobiidae	*Mahidolia mystacina*	LC	Flagfin prawn goby
Actinopterygii	Gobiiformes	Gobiidae	*Mangarinus waterousi*	DD	Uchiwahaze
Actinopterygii	Gobiiformes	Gobiidae	*Mugilogobius cavifrons*	LC	Bandfin mangrove goby
Actinopterygii	Gobiiformes	Gobiidae	*Oligolepis acutipennis*	LC	Paintedfin goby
Actinopterygii	Gobiiformes	Gobiidae	*Oligolepis stomias*	DD	Plain teardrop goby
Actinopterygii	Gobiiformes	Gobiidae	*Oxyurichthys ophthalmonema*	LC	Eyebrow goby
Actinopterygii	Gobiiformes	Gobiidae	*Oxyurichthys takagi*	LC	
Actinopterygii	Gobiiformes	Gobiidae	*Paratrypauchen microcephalus*	LC	Comb goby
Actinopterygii	Gobiiformes	Gobiidae	*Psammogobius biocellatus*	LC	Sleepy goby
Actinopterygii	Gobiiformes	Gobiidae	*Redigobius balteatus*	LC	Girdled goby

Class	Order	Family	Scientific name	RLTS category	Common name
Actinopterygii	Gobiiformes	Gobiidae	*Sicyopterus lagocephalus*	LC	
Actinopterygii	Gobiiformes	Gobiidae	*Taenioides cirratus*	DD	Whiskered eel goby
Actinopterygii	Mugiliformes	Mugilidae	*Planiliza subviridis*	LC	Greenback mullet
Actinopterygii	Ophidiiformes	Carapidae	*Encheliophis homei*	LC	Silver pearlfish
Actinopterygii	Ophidiiformes	Dinematichthyidae	*Alionematichthys plicatosurculus*	LC	Folded viviparous brotula
Actinopterygii	Perciformes	Ambassidae	*Ambassis macracanthus*	DD	Estuarine glass perchlet
Actinopterygii	Perciformes	Ambassidae	*Ambassis nalua*	LC	Scalloped perchlet
Actinopterygii	Perciformes	Ambassidae	*Ambassis vachellii*	LC	Vachell's glassfish
Actinopterygii	Perciformes	Apogonidae	*Apogonichthyoides melas*	LC	Black cardinalfish
Actinopterygii	Perciformes	Apogonidae	*Fowleria variegata*	LC	Variegated cardinalfish
Actinopterygii	Perciformes	Apogonidae	*Pseudamia amblyuroptera*	LC	White-jawed cardinalfish
Actinopterygii	Perciformes	Apogonidae	*Sphaeramia orbicularis*	LC	Orbiculate cardinalfish
Actinopterygii	Perciformes	Apogonidae	*Yarica hyalosoma*	LC	Mangrove cardinalfish
Actinopterygii	Perciformes	Caesionidae	*Caesio cuning*	LC	Redbelly yellowtail fusilier
Actinopterygii	Perciformes	Carangidae	*Atule mate*	LC	Yellowtail scad
Actinopterygii	Perciformes	Datnioididae	*Datnioides polota*	LC	Silver tiger fish
Actinopterygii	Perciformes	Ephippidae	*Platax orbicularis*	LC	Orbiculate batfish
Actinopterygii	Perciformes	Epinephelidae	*Epinephelus coeruleopunctatus*	LC	Whitespotted grouper
Actinopterygii	Perciformes	Epinephelidae	*Epinephelus coioides*	LC	Orange-spotted grouper
Actinopterygii	Perciformes	Epinephelidae	*Epinephelus malabaricus*	LC	
Actinopterygii	Perciformes	Epinephelidae	*Epinephelus miliaris*	LC	Netfin grouper
Actinopterygii	Perciformes	Epinephelidae	*Epinephelus polystigma*	LC	White-dotted grouper
Actinopterygii	Perciformes	Epinephelidae	*Epinephelus tauvina*	DD	Greasy grouper
Actinopterygii	Perciformes	Gerreidae	*Gerres erythrourus*	LC	Deep-bodied mojarra
Actinopterygii	Perciformes	Haemulidae	*Plectorhinchus gibbosus*	LC	Brown sweetlips
Actinopterygii	Perciformes	Haemulidae	*Pomadasys argenteus*	LC	Silver javelin
Actinopterygii	Perciformes	Haemulidae	*Pomadasys kaakan*	LC	Javelin grunter
Actinopterygii	Perciformes	Kuhliidae	*Kuhlia munda*	DD	Silver flagtail
Actinopterygii	Perciformes	Leiognathidae	*Gazza minuta*	LC	Toothed ponyfish

Class	Order	Family	Scientific name	RLTS category	Common name
Actinopterygii	Perciformes	Leiognathidae	*Leiognathus equulus*	LC	Common ponyfish
Actinopterygii	Perciformes	Lethrinidae	*Lethrinus harak*	LC	Thumbprint emperor
Actinopterygii	Perciformes	Lethrinidae	*Lethrinus laticaudis*	LC	Grass emperor
Actinopterygii	Perciformes	Lethrinidae	*Lethrinus nebulosus*	LC	Spangled emperor
Actinopterygii	Perciformes	Lethrinidae	*Lethrinus ornatus*	LC	Ornate emperor
Actinopterygii	Perciformes	Lethrinidae	*Lethrinus semicinctus*	LC	Black-spot emperor
Actinopterygii	Perciformes	Lutjanidae	*Lutjanus fulviflamma*	LC	Dory snapper
Actinopterygii	Perciformes	Lutjanidae	*Lutjanus fulvus*	LC	Blacktail snapper
Actinopterygii	Perciformes	Microdesmidae	*Parioglossus formosus*	LC	
Actinopterygii	Perciformes	Microdesmidae	*Parioglossus lineatus*	DD	
Actinopterygii	Perciformes	Microdesmidae	*Parioglossus palustris*	LC	
Actinopterygii	Perciformes	Microdesmidae	*Parioglossus rainfordi*	LC	
Actinopterygii	Perciformes	Mullidae	*Parupeneus barberinus*	LC	Dash-and-dot goatfish
Actinopterygii	Perciformes	Nemipteridae	*Scolopsis ciliata*	LC	Saw-jawed monocle bream
Actinopterygii	Perciformes	Pomacentridae	*Dascyllus trimaculatus*	LC	Threespot damselfish
Actinopterygii	Perciformes	Pomacentridae	*Dischistodus perspicillatus*	LC	White damsel
Actinopterygii	Perciformes	Pomacentridae	*Dischistodus pseudochrysopoecilus*	LC	Monarch damsel
Actinopterygii	Perciformes	Pomacentridae	*Neopomacentrus azysron*	LC	Yellowtail damsel
Actinopterygii	Perciformes	Pomacentridae	*Neopomacentrus taeniurus*	DD	Freshwater damsel
Actinopterygii	Perciformes	Sciaenidae	*Johnius borneensis*	LC	Hammer croaker
Actinopterygii	Perciformes	Siganidae	*Siganus lineatus*	LC	Lined rabbitfish
Actinopterygii	Perciformes	Siganidae	*Siganus randalli*	LC	Randall's rabbitfish
Actinopterygii	Perciformes	Siganidae	*Siganus vermiculatus*	LC	Vermiculated spinefoot
Actinopterygii	Perciformes	Terapontidae	*Mesopristes argenteus*	LC	Silver grunter
Actinopterygii	Perciformes	Terapontidae	*Mesopristes cancellatus*	LC	Tapiroid grunter
Actinopterygii	Perciformes	Toxotidae	*Toxotes jaculatrix*	LC	Banded archerfish
Actinopterygii	Pleuronectiformes	Cynoglossidae	*Cynoglossus puncticeps*	LC	
Actinopterygii	Pleuronectiformes	Cynoglossidae	*Paraplagusia sinerama*	LC	Dusky tongue sole
Actinopterygii	Pleuronectiformes	Paralichthyidae	*Pseudorhombus arsius*	LC	Largetooth flounder

Class	Order	Family	Scientific name	RLTS category	Common name
Actinopterygii	Pleuronectiformes	Soleidae	*Brachirus aspilos*	LC	Dusky sole
Actinopterygii	Pleuronectiformes	Soleidae	*Paradicula setifer*	LC	
Actinopterygii	Scorpaeniformes	Platycephalidae	*Cymbacephalus beauforti*	LC	Crocodile fish
Actinopterygii	Syngnathiformes	Syngnathidae	*Hippichthys penicillus*	LC	Beady pipefish
Actinopterygii	Tetraodontiformes	Tetraodontidae	*Arothron manilensis*	LC	Narrow-lined puffer
Actinopterygii	Tetraodontiformes	Tetraodontidae	*Arothron reticularis*	LC	Reticulated pufferfish
Actinopterygii	Tetraodontiformes	Tetraodontidae	*Arothron stellatus*	LC	Stellate puffer
Aves	Accipitriformes	Accipitridae	*Accipiter hiogaster*	LC	Variable goshawk
Aves	Accipitriformes	Accipitridae	*Accipiter melanochlamys*	LC	Black-mantled goshawk
Aves	Accipitriformes	Accipitridae	*Haliaeetus sanfordi*	VU	Sanford's sea-eagle
Aves	Accipitriformes	Accipitridae	*Megatriorchis doriae*	NT	Doria's goshawk
Aves	Caprimulgiformes	Caprimulgidae	*Eurostopodus papuensis*	LC	Papuan nightjar
Aves	Charadriiformes	Charadriidae	*Charadrius mongolus*	LC	Lesser sandplover
Aves	Charadriiformes	Charadriidae	*Pluvialis fulva*	LC	Pacific golden plover
Aves	Charadriiformes	Scolopacidae	*Actitis hypoleucos*	LC	Common sandpiper
Aves	Charadriiformes	Scolopacidae	*Xenus cinereus*	LC	Terek sandpiper
Aves	Coraciiformes	Alcedinidae	*Alcedo atthis*	LC	Common kingfisher
Aves	Coraciiformes	Alcedinidae	*Ceyx pusillus*	LC	Little kingfisher
Aves	Coraciiformes	Alcedinidae	*Dacelo gaudichaud*	LC	Rufous-bellied kookaburra
Aves	Coraciiformes	Alcedinidae	*Syma torotoro*	LC	Yellow-billed kingfisher
Aves	Coraciiformes	Alcedinidae	*Tanysiptera nympha*	LC	Red-breasted paradise-kingfisher
Aves	Coraciiformes	Alcedinidae	*Todiramphus chloris*	LC	Collared kingfisher
Aves	Coraciiformes	Alcedinidae	*Todiramphus macleayii*	LC	Forest kingfisher
Aves	Coraciiformes	Alcedinidae	*Todiramphus sanctus*	LC	Sacred kingfisher
Aves	Coraciiformes	Alcedinidae	*Todiramphus saurophagus*	LC	Beach kingfisher
Aves	Falconiformes	Falconidae	*Falco severus*	LC	Oriental hobby
Aves	Gruiformes	Rallidae	*Megacrex inepta*	LC	New guinea flightless rail
Aves	Passeriformes	Acanthizidae	*Gerygone chloronota*	LC	Green-backed gerygone
Aves	Passeriformes	Acanthizidae	*Gerygone levigaster*	LC	Mangrove gerygone

Class	Order	Family	Scientific name	RLTS category	Common name
Aves	Passeriformes	Acanthizidae	*Gerygone magnirostris*	LC	Large-billed gerygone
Aves	Passeriformes	Artamidae	*Melloria quoyi*	LC	Black butcherbird
Aves	Passeriformes	Campephagidae	*Coracina boyeri*	LC	Boyer's cuckooshrike
Aves	Passeriformes	Campephagidae	*Coracina novaehollandiae*	LC	Black-faced cuckooshrike
Aves	Passeriformes	Campephagidae	*Coracina papuensis*	LC	White-bellied cuckooshrike
Aves	Passeriformes	Campephagidae	*Coracina welchmani*	LC	North melanesian cuckooshrike
Aves	Passeriformes	Campephagidae	*Edolisoma melas*	LC	New guinea cicadabird
Aves	Passeriformes	Campephagidae	*Edolisoma remotum*	LC	Melanesian cicadabird
Aves	Passeriformes	Campephagidae	*Edolisoma salomonis*	LC	Makira cicadabird
Aves	Passeriformes	Campephagidae	*Edolisoma tenuirostre*	LC	Slender-billed cicadabird
Aves	Passeriformes	Campephagidae	*Lalage atrovirens*	LC	Black-browed triller
Aves	Passeriformes	Campephagidae	*Lalage leucomela*	LC	Varied triller
Aves	Passeriformes	Dicruridae	*Dicrurus bracteatus*	LC	Spangled drongo
Aves	Passeriformes	Meliphagidae	*Conopophila albogularis*	LC	Rufous-banded honeyeater
Aves	Passeriformes	Meliphagidae	*Gavicalis versicolor*	LC	Varied honeyeater
Aves	Passeriformes	Meliphagidae	*Lichmera alboauricularis*	LC	Silver-eared honeyeater
Aves	Passeriformes	Meliphagidae	*Melithreptus albogularis*	LC	White-throated honeyeater
Aves	Passeriformes	Meliphagidae	*Microptilotis analogus*	LC	Mimic honeyeater
Aves	Passeriformes	Meliphagidae	*Microptilotis cinereifrons*	LC	Elegant honeyeater
Aves	Passeriformes	Meliphagidae	*Myzomela cardinalis*	LC	Cardinal myzomela
Aves	Passeriformes	Meliphagidae	*Myzomela erythrocephala*	LC	Red-headed myzomela
Aves	Passeriformes	Meliphagidae	*Myzomela lafargei*	LC	Red-capped myzomela
Aves	Passeriformes	Meliphagidae	*Myzomela obscura*	LC	Dusky myzomela
Aves	Passeriformes	Meliphagidae	*Philemon buceroides*	LC	Helmeted friarbird
Aves	Passeriformes	Meliphagidae	*Ptilotula flavescens*	LC	Yellow-tinted honeyeater
Aves	Passeriformes	Meliphagidae	*Ramsayornis modestus*	LC	Brown-backed honeyeater
Aves	Passeriformes	Meliphagidae	*Xanthotis flaviventer*	LC	Tawny-breasted honeyeater
Aves	Passeriformes	Monarchidae	*Monarcha frater*	LC	Black-winged

Class	Order	Family	Scientific name	RLTS category	Common name
					monarch
Aves	Passeriformes	Monarchidae	*Monarcha melanopsis*	LC	Black-faced monarch
Aves	Passeriformes	Monarchidae	*Myiagra alecto*	LC	Shining flycatcher
Aves	Passeriformes	Monarchidae	*Myiagra caledonica*	LC	Melanesian flycatcher
Aves	Passeriformes	Monarchidae	*Myiagra ferrocyanea*	LC	Steel-blue flycatcher
Aves	Passeriformes	Monarchidae	*Myiagra rubecula*	LC	Leaden flycatcher
Aves	Passeriformes	Monarchidae	*Myiagra ruficollis*	LC	Broad-billed flycatcher
Aves	Passeriformes	Monarchidae	*Symposiachrus infelix*	NT	Manus monarch
Aves	Passeriformes	Monarchidae	*Symposiachrus trivirgatus*	LC	Spectacled monarch
Aves	Passeriformes	Oriolidae	*Oriolus szalayi*	LC	Brown oriole
Aves	Passeriformes	Oriolidae	*Pitohui dichrous*	LC	Hooded pitohui
Aves	Passeriformes	Oriolidae	*Sphecotheres vieilloti*	LC	Australasian figbird
Aves	Passeriformes	Pachycephalidae	*Colluricincla harmonica*	LC	Grey shrike-thrush
Aves	Passeriformes	Pachycephalidae	*Colluricincla megarhyncha*	LC	Little shrike-thrush
Aves	Passeriformes	Pachycephalidae	*Pachycephala griseiceps*	LC	Brown whistler
Aves	Passeriformes	Pachycephalidae	*Pachycephala leucogastra*	LC	White-bellied whistler
Aves	Passeriformes	Pachycephalidae	*Pachycephala melanura*	LC	Black-tailed whistler
Aves	Passeriformes	Pachycephalidae	*Pachycephala orioloides*	LC	Oriole whistler
Aves	Passeriformes	Pachycephalidae	*Pachycephala pectoralis*	LC	Golden whistler
Aves	Passeriformes	Paradisaeidae	*Lophorina intercedens*	LC	Growling riflebird
Aves	Passeriformes	Paradisaeidae	*Lophorina magnifica*	LC	Magnificent riflebird
Aves	Passeriformes	Paradisaeidae	*Manucodia ater*	LC	Glossy-mantled manucode
Aves	Passeriformes	Paradisaeidae	*Phonygammus keraudrenii*	LC	Trumpet manucode
Aves	Passeriformes	Petroicidae	*Microeca flavigaster*	LC	Lemon-bellied flyrobin
Aves	Passeriformes	Petroicidae	*Peneoenanthe pulverulenta*	LC	Mangrove robin
Aves	Passeriformes	Pittidae	*Pitta novaeguineae*	LC	Eastern hooded pitta
Aves	Passeriformes	Pittidae	*Pitta versicolor*	LC	Noisy pitta
Aves	Passeriformes	Ptilonorhynchidae	*Chlamydera cerviniventris*	LC	Fawn-breasted bowerbird
Aves	Passeriformes	Rhipiduridae	*Rhipidura dryas*	LC	Arafura fantail

Class	Order	Family	Scientific name	RLTS category	Common name
Aves	Passeriformes	Rhipiduridae	*Rhipidura phasiana*	LC	Mangrove fantail
Aves	Passeriformes	Rhipiduridae	*Rhipidura rufifrons*	LC	Rufous fantail
Aves	Passeriformes	Sturnidae	*Aplonis metallica*	LC	Metallic starling
Aves	Passeriformes	Zosteropidae	*Zosterops meeki*	NT	Tagula white-eye
Aves	Pelecaniformes	Ardeidae	*Butorides striata*	LC	Green-backed heron
Aves	Pelecaniformes	Ardeidae	*Egretta garzetta*	LC	Little egret
Aves	Pelecaniformes	Ardeidae	*Egretta sacra*	LC	Pacific reef-egret
Aves	Pelecaniformes	Ardeidae	*Ixobrychus sinensis*	LC	Yellow bittern
Aves	Pelecaniformes	Threskiornithidae	*Threskiornis moluccus*	LC	Australian ibis
Aves	Psittaciformes	Psittacidae	*Eclectus polychloros*	LC	Papuan eclectus
Aves	Psittaciformes	Psittacidae	*Psittaculirostris cervicalis*	LC	Red-faced fig-parrot
Aves	Struthioniformes	Casuariidae	*Casuarius casuarius*	LC	Southern cassowary
Aves	Suliformes	Fregatidae	*Fregata ariel*	LC	Lesser frigatebird
Aves	Suliformes	Fregatidae	*Fregata minor*	LC	Great frigatebird
Aves	Suliformes	Phalacrocoracidae	*Microcarbo melanoleucos*	LC	Little pied cormorant
Chondrichthyes	Carcharhiniformes	Carcharhinidae	*Carcharhinus amblyrhynchoides*	VU	Graceful shark
Chondrichthyes	Carcharhiniformes	Carcharhinidae	*Carcharhinus amboinensis*	VU	Pigeye shark
Chondrichthyes	Carcharhiniformes	Carcharhinidae	*Carcharhinus cautus*	LC	Nervous shark
Chondrichthyes	Carcharhiniformes	Carcharhinidae	*Carcharhinus melanopterus*	VU	Blacktip reef shark
Chondrichthyes	Carcharhiniformes	Carcharhinidae	*Negaprion acutidens*	EN	Sharptooth lemon shark
Chondrichthyes	Myliobatiformes	Dasyatidae	*Hemitrygon longicauda*	NT	Merauke stingray
Chondrichthyes	Myliobatiformes	Dasyatidae	*Himantura leoparda*	VU	Leopard whipray
Chondrichthyes	Myliobatiformes	Dasyatidae	*Pastinachus ater*	VU	Broad cowtail ray
Chondrichthyes	Myliobatiformes	Dasyatidae	*Pateobatis hortlei*	NT	Hortle's whipray
Chondrichthyes	Myliobatiformes	Dasyatidae	*Taeniura lymma*	LC	Bluespotted lagoon ray
Chondrichthyes	Rhinopristiformes	Pristidae	*Anoxypristis cuspidata*	EN	Narrow sawfish
Chondrichthyes	Rhinopristiformes	Pristidae	*Pristis clavata*	CR	Dwarf sawfish
Chondrichthyes	Rhinopristiformes	Pristidae	*Pristis pristis*	CR	Largetooth sawfish
Chondrichthyes	Rhinopristiformes	Pristidae	*Pristis zijsron*	CR	Green sawfish
Gastropoda	Cycloneritida	Neritidae	*Neritodryas subsulcata*	DD	Weakly cut nerite
Gastropoda	Ellobiida	Ellobiidae	*Auriculastra subula*	LC	
Gastropoda	Ellobiida	Ellobiidae	*Cassidula crassiuscula*	LC	

Class	Order	Family	Scientific name	RLTS category	Common name
Gastropoda	Ellobiida	Ellobiidae	*Ellobium aurisjudae*	LC	Judas ear cassidula
Gastropoda	Ellobiida	Ellobiidae	*Ellobium aurismidae*	LC	Midas ear cassidula
Gastropoda	Ellobiida	Ellobiidae	*Laemodonta bella*	LC	
Gastropoda	Ellobiida	Ellobiidae	*Laemodonta punctigera*	LC	
Gastropoda	Littorinimorpha	Littorinidae	*Littoraria undulata*	LC	
Gastropoda	Neogastropoda	Conidae	*Conus frigidus*	LC	Frigid cone
Gastropoda	Neogastropoda	Conidae	*Conus furvus*	LC	
Gastropoda	Neogastropoda	Conidae	*Conus varius*	LC	
Gastropoda	Stylommatophora	Achatinellidae	*Lamellidea pusilla*	LC	
Mammalia	Chiroptera	Emballonuridae	*Taphozous australis*	NT	Coastal sheath-tailed bat
Mammalia	Chiroptera	Hipposideridae	*Aselliscus tricuspidatus*	LC	Trident leaf-nosed bat
Mammalia	Chiroptera	Hipposideridae	*Hipposideros ater*	LC	Dusky leaf-nosed bat
Mammalia	Chiroptera	Hipposideridae	*Hipposideros calcaratus*	LC	Spurred leaf-nosed bat
Mammalia	Chiroptera	Molossidae	*Chaerephon solomonis*	EN	Solomons free-tailed bat
Mammalia	Chiroptera	Pteropodidae	*Macroglossus minimus*	LC	Dagger-toothed long-nosed fruit bat
Mammalia	Chiroptera	Pteropodidae	*Pteropus conspicillatus*	EN	Spectacled flying fox
Mammalia	Chiroptera	Pteropodidae	*Pteropus macrotis*	LC	Large-eared flying fox
Mammalia	Chiroptera	Pteropodidae	*Pteropus neohibernicus*	LC	Great flying fox
Mammalia	Chiroptera	Vespertilionidae	*Scotorepens sanborni*	LC	Northern broad-nosed bat
Mammalia	Sirenia	Dugongidae	*Dugong dugon*	VU	Dugong
Reptilia	Squamata	Boidae	*Candoia bibroni*	LC	Pacific boa
Reptilia	Squamata	Gekkonidae	*Lepidodactylus browni*	DD	Brown's scaly-toed gecko
Reptilia	Squamata	Scincidae	*Emoia atrocostata*	LC	Littoral whiptail-skink
Reptilia	Squamata	Varanidae	*Varanus bogerti*	LC	Bogert's monitor

3. National Estimates for subcriterion A1

To estimate the Eastern Coral Triangle mangrove ecosystem extent in 1970, we gathered reliable information on the mangrove area for each country within the province around this period. We then estimated the mangrove area in 1970 for each country, assuming a linear relationship between mangrove extent and time. Finally, we summed up the country estimates to determine the total mangrove area in the Eastern Coral Triangle province (Table a). We assumed that the percentage of mangrove extent by country within the province remained constant over time, as the percentages did not change between 1996 and 2020 (GMW v3.0 dataset). However, using mangrove area estimates from different sources can lead to uncertainty (Friess and Webb 2014)[2] and there were no regional statistics or global studies available for this time period. Thus, the estimates for 1970 should be considered only indicative.

Table a. Estimated mangrove area by country in 1970 and 2020. Estimates for 2020* mangrove area are based on the Global Mangrove Watch Version 3 (GMW v3.0) dataset.

Year	Country total 2020*	Within province 2020*	Country total 1970**	Within province 1970**
Papua New Guinea	4,524.74	1,042.52	5,399.0	1,244.0
Solomon Islands	526.51	526.51	672.2	672.2
The Eastern Coral Triangle		**1,569.0**		**1,916.6**

[2] Friess, D. A., & Webb, E. L. (2014). Variability in mangrove change estimates and implications for the assessment of ecosystem service provision: Variability in mangrove ecosystem loss. *Global Ecology and Biogeography*, *23*(7), 715–725. https://doi.org/10.1111/geb.12140