

Rock Islands Southern Lagoon

2020 Conservation Outlook Assessment

SITE INFORMATION

Country: Palau

Inscribed in: 2012

Criteria: (iii) (v) (vii) (ix) (x)



Rock Islands Southern Lagoon covers 100,200 ha and includes 445 uninhabited limestone islands of volcanic origin. Many of them display unique mushroom-like shapes in turquoise lagoons surrounded by coral reefs. The aesthetic beauty of the site is heightened by a complex reef system featuring over 385 coral species and different types of habitat. They sustain a large diversity of plants, birds and marine life including dugong and at least thirteen shark species. The site harbours the highest concentration of marine lakes anywhere, isolated bodies of seawater separated from the ocean by land barriers. They are among the islands' distinctive features and sustain high endemism of populations which continue to yield new species discoveries. The remains of stonework villages, as well as burial sites and rock art, bear testimony to the organization of small island communities over some three millennia. The abandonment of the villages in the 17th and 18th centuries illustrates the consequences of climate change, population growth and subsistence behaviour on a society living in a marginal marine environment. © UNESCO

SUMMARY

2020 Conservation Outlook

Finalised on 02 Dec 2020

GOOD WITH SOME CONCERNS

Overall, the conservation outlook for the Rock Islands Southern Lagoon remains optimistic. Koror State has put in place a number of excellent management practices to protect the values of the Rock Islands Southern Lagoon. Potential issues include visitor impacts from large numbers of visitors to Jellyfish Lake and popular scuba dive and snorkeling spots as well as impacts associated with climate change and fishing pressure. However, the 2020 COVID-19 pandemic has had significant impacts on the levels of visitation and how tourism in the World Heritage site recovers in the future will need to be seen. Current and future potential climate variability and severe weather events represent a much higher future threat to the site and its World Heritage values. While Rock Islands corals have previously shown excellent recovery and while so far impacts of climate change on corals have been minor in comparison to other reef areas in the world, the severity and frequency of bleaching events is likely to increase in the future. Other values of the site appear to have been well preserved so far, although up-to-date data is lacking to determine trends in some species and habitats. While some concerns remain about the numbers of the jellyfish in the Jellyfish Lake, the recovery trend is encouraging.

FULL ASSESSMENT

Description of values

Values

World Heritage values

- ▶ **Sharks and turtles** **Criterion:(x)**

13 species of sharks and manta rays and 2 species of marine turtle listed on IUCN's Red List are found in the Rock Islands (World Heritage Committee, 2012).
- ▶ **Terrestrial biodiversity** **Criterion:(x)**

All of Palau's endemic birds, mammals, herpetofauna and nearly half of Palau's endangered plants are found in Rock Islands Southern Lagoon (World Heritage Committee, 2012).
- ▶ **Fish** **Criterion:(x)**

746 species of fish occur in the Rock Islands Southern Lagoon, including endemic and threatened species (World Heritage Committee, 2012).
- ▶ **Corals** **Criterion:(x)**

385 species of coral are known to occur in the Rock Islands Southern Lagoon (World Heritage Committee, 2012).
- ▶ **Marine lakes and associated species** **Criterion:(ix)**

The Rock Islands Southern Lagoon contains 52 marine lakes, more than at any other site in the world. Furthermore, the marine lakes of the property are at different stages of geological and ecological development, ranging from lakes with high connectivity to the sea to highly isolated lakes with notably different species composition, including unique and endemic species. These features represent an outstanding example of how marine ecosystems and communities develop, and make the lakes valuable as "natural laboratories" for scientific study of evolution and speciation (World Heritage Committee, 2012). Five new subspecies of the *Mastigias papua* jellyfish have been described from the marine lakes, and new species discoveries continue to be made both in the marine lakes as well as in the complex reef habitats of the property (World Heritage Committee, 2012).
- ▶ **Exceptional area with high variety of habitats** **Criterion:(vii)**

The Rock Islands Southern Lagoon contains an exceptional variety of habitats within a relatively limited area. Barrier and fringing reefs, channels, tunnels, caves, arches, and coves, as well as the highest number and density of marine lakes in the world, are home to diverse and abundant marine life (World Heritage Committee, 2012).
- ▶ **Exceptional beauty of Rock islands** **Criterion:(vii)**

The maze of dome-shaped and green Rock Islands seemingly floating in the turquoise lagoon surrounded by coral reef is of exceptional aesthetic beauty (World Heritage Committee, 2012).
- ▶ **Exceptionally high biological and marine habitat diversity** **Criterion:(x)**

The Rock Islands Southern Lagoon has exceptionally high biological and marine habitat diversity. The marine lakes are unique in terms of number, the density at which they occur, and their varying physical conditions. With low fishing pressure, limited pollution and human impact, as well as an exceptional variety of reef habitat, the resilience of reefs of the property makes it a critical area for protection,

including as an area important for climate change adaptation of reef biota, and potentially as a source of larvae for reefs in the region (World Heritage Committee, 2012). The corals in the Rock Islands are more thermally tolerant than patch and outer reefs. Rock Island corals also appear to be adapted to naturally acidified waters and may be uniquely resistant to ocean acidification (Shamberger et al., 2014, Barkley et al., 2015, Barkley et al., 2017).

Assessment information

Threats

Current Threats

High Threat

Increasing tourist numbers is the most serious current threat, and impacts from dive tourism is evident in some frequently visited dive sites. Although regulations are in place there is a need to improve and enforce them to help protect the values of the site from the negative impact of activities such as snorkeling. Visitation rates have led to increased pressure on resources through greater freshwater usage, mostly reef-sourced seafood consumption in restaurants, rapid coastal development to accommodate and provide for a greater influx of people, and increased waste generation. However, the 2020 COVID-19 pandemic has reduced the levels of visitation, and how tourism in the World Heritage site recovers in the future is unknown. The potentially devastating impacts of climate change, particularly through temperature extremes leading to increased bio-erosion and impacts from coral bleaching are a stark reminder of the potential damage that could be caused in the future.

► **Ocean acidification**

Low Threat

(Ocean acidification)

Inside site, throughout(>50%)
Outside site

The Rock Islands are naturally more acidic than the patch and outer reefs of Palau due to the long residence time of seawater in the bays, and the effects of calcification and respiration on seawater pH. The Rock Islands corals are adapted to low pH (Shamberger et al., 2014; Barkley et al., 2015; Barkley et al., 2017) but bioerosion rates in the Rock Islands are already high due to the low pH (DeCarlo et al., 2015) and rates of Net Ecosystem Calcification are the lowest ever measured (Shamberger et al., 2017). As pH declines further due to anthropogenic CO₂, the Rock Islands reefs will eventually shift to a state of net dissolution. It is not yet known when this will happen. Reducing local stressors, including land based sources of nutrient pollution, will slow the effects of ocean acidification (DeCarlo et al., 2015; Prouty et al., 2017).

► **Fishing / Harvesting Aquatic Resources**

Low Threat

(Fishing / Harvesting Aquatic Resources)

Inside site, extent of threat not known
Outside site

The local population is heavily dependent on fishing for livelihoods, revenue, employment and development. Subsistence and small-scale commercial artisanal, generally coastal, fisheries provide work for tens of thousands of people. Fishing occurs in the Rock Islands Southern Lagoon outside of no-take zones, but has been known to occur illegally inside no-take zones (Matthews, 2004).

► **Tourism/ visitors/ recreation**

High Threat

(Increasing tourist numbers)

Inside site, extent of threat not known
Outside site

Impacts from dive tourism are evident in some frequently visited dive sites in the Rock Islands Southern Lagoon; numbers of tourists are continually increasing each year (Poonian et al., 2010). The number of tourists visiting Palau increased from 58,000 in 2000 to 79,000 in 2008, 109,000 in 2011, 141,000 in 2014 and to 160,370 in 2015, a figure that is 9 times the local population (World Bank, 2012; World Bank, 2015; Wabnitz et al., 2018). While there was a slight decrease in tourism numbers in 2016 and 2017 (Miyakuni et al., 2018) the numbers remain high and most of these tourists visit the Rock Islands. Concerns have been raised about overcrowding at dive sites and poor diver behaviour (e.g., coral holding or kicking) (Wabnitz et al., 2018). A 2018 study by Nestor et al. (2018) found 1 out of 5 groups of snorkelers to Rock Islands damaged live corals with coral fragments at sites without visitors found to

be half that of sites with visits. In terrestrial areas of the Rock Islands, a significant positive correlation has been found between the presence of tourist and increased occurrence of introduced and invasive rats in littoral beach strand areas (Radley et al., 2020). Around the world, introduced rats have been shown to have serious negative impacts on native terrestrial island species of plants and animals (e.g., Harper and Bunbury 2015). Tourist presence in littoral strand forest has likewise been found to have a direct negative affect on nesting by the IUCN endangered Micronesian Megapode in the Rock Islands (Radley et al., 2020). Tourism also brings an increase in wastewater and increased demand for hotel and road-building that can cause erosion, sedimentation and nutrient pollution to the reefs. However, the 2020 COVID-19 pandemic has reduced the levels of visitations, which may be a temporary relief to the increasing pressure of tourism, how tourism in the World Heritage site recovers in the future remains to be seen.

► **Habitat Shifting/ Alteration, Temperature extremes**
(*Temperature changes*)

High Threat
Inside site, throughout(>50%)
Outside site

World Heritage sites that contain coral reefs have been increasingly exposed to heat stress during recent years, and while the Rock Islands have experienced severe heat stress (Heron et al., 2017), the impacts to date have been less severe than on outer reefs (Bruno et al. 2001; van Woesik et al. 2012). In 1998 and 2010, coral bleaching occurred across the Palau archipelago. In 1998, bleaching induced mortality was as high as 90% on some sites patch and outer reefs. In the Rock Islands, water temperatures were also high but coral bleaching and mortality levels were considerably lower than on patch and outer reefs (Bruno et al., 2001; Golbuu et al., 2007; van Woesik, 2012; Barkley and Cohen, 2016). While the temperatures to date have allowed the corals of the Rock Islands to do relatively better than corals on the outer reefs (Bruno et al 2001; van Woesik et al. 2012), the increasing global temperatures will however increase all marine temperatures, including the temperatures in the Rock Islands. Therefore, it seems highly likely that the temperature threats to the Rock Islands are real and ever increasing. In addition, temperature extremes have also been found to impact the ability of reef-building corals to accrete calcium carbonate, which can impair the capacity of reefs to keep up with sea-level rise. Studies in Palau have suggested inner reefs tend to produce less carbonate than other reefs and therefore those inner reefs need higher coral cover to produce sufficient carbonate to keep up with sea-level rise than outer patch reefs (van Woesik and Cacciapaglia, 2018). Because the Rock Islands have lower carbonate production capacity than the outer reefs of Palau (van Woesik and Cacciapaglia, 2018), increases in ocean temperatures will increase the vulnerability of the Rock Islands.

► **Invasive Non-Native/ Alien Species**
(*Introduced and invasive species*)

High Threat
Inside site, extent of threat not known

Invasive species, both flora and fauna, are serious threats to terrestrial areas of the World Heritage site. Rats (*rattus rattus*) are found throughout the site on both islands regularly visited by humans/tourists and those that may receive only infrequent visits by the local populace (Radley et al., 2020). Invasive rats are extremely detrimental and destructive to island flora and fauna and have been one of the leading causes of decreases and extinctions of native birds throughout the Pacific and islands elsewhere (e.g., Harper and Bunbury 2015). Island Conservation is working to address rats in the Rock Islands and executed a pilot eradication on Ngeanges or Neco island in early 2017. Introduced cats are another serious threat. Cats have been observed on Ngeremdiu and evidence of their occurrence has been found on Ngchus (IUCN Consultation, 2020). There is currently little information pertaining to how wide spread introduced cats are in the Rock Islands and thus the extent of this threat, but cats would greatly affect the populations of many native terrestrial species.

Potential Threats

High Threat

Potential threats include impacts from tsunamis and typhoons. Previous super typhoons impacted on the reefs within the World Heritage site and the frequency and intensity of such storms are not only likely to increase but also have a greater impact on the Outstanding Universal Value. Sea-level rise and increasing temperatures will continue to affect the site and the values for which it was inscribed. This is likely to include impacts on of a number of species found within the site in addition to the impacts on corals,

including some birds and turtles as well as mangroves and other coastal plant species found on the islands within the site.

► **Habitat Shifting/ Alteration, Ocean acidification, Temperature extremes, Storms/Flooding**
(Temperate extremes)

High Threat
Inside site, widespread(15-50%)
Outside site

Sea-level rise and increasing temperatures will continue to affect the World Heritage site and the values for which it was inscribed. This is likely to include impacts on the number of species, including some birds and turtles as well as mangroves and other coastal plant species found on the islands within the site. Reefs throughout Palau experienced considerable bleaching and as high as 90% mortality during the 1997–1998 El Niño event, with further mortality recorded during the 2001 and 2010 thermal stress episodes (Bruno et al., 2001; van Woesik et al., 2012). While species richness recovered 10 years after the first El Niño, reef composition has changed (van Woesik et al., 2012; Golbuu et al., 2007). Large, massive colonies were lost from many outer reefs. Reefs located in bays suffered lower bleaching rates and coral mortality than on outer and patch reefs (van Woesik et al., 2012), and while those nearshore reefs may therefore shelter some species from climate change, these reefs are more vulnerable to land-use modifications and other human impacts. Rising sea temperatures will continue to stress coral reefs, increasing bleaching severity, ultimately reducing the resilience of many species critical to the reefs and diverse marine habitats. Severe weather events, such as typhoons (mentioned above) will also increase in both in frequency and intensity. If worst-case climate change scenarios occur, the Outstanding Universal Value of the site is likely to be severely affected despite research indicating that the reefs in the site have recovered well from previous bleaching events.

► **Habitat Shifting/ Alteration**
(Sea Level Rise)

High Threat
Inside site, throughout(>50%)

Sea level rise is a future threat that may have serious implications to terrestrial flora and fauna within the World Heritage site. The average rate of sea-level rise is currently at approximately 2-3 mm per year. That rate is expected to increase substantially from 2 mm to 9 mm a year, into the 21st century (Vermeer and Rahmstorf, 2009), depending on the rate of greenhouse gas emissions. The rates of contemporary carbonate reef production of the Rock Islands indicate that reefs should be able keep up with sea-level rise under low greenhouse gas emissions, but may not be able to keep up with rates of sea-level rise under high greenhouse gas emissions (van Woesik et al. 2015). Temperature extremes have also been found to impact the ability of reef-building corals to grow reefs, which therefore impair the capacity of reefs to keep up with sea-level rise. Studies in Palau have suggested inner reefs tend to produce less carbonate than other reefs and therefore those inner reefs need higher coral cover to produce sufficient carbonate to keep up with sea-level rise than outer patch reefs (van Woesik and Cacciapaglia, 2018). As the Rock Islands have lower carbonate production capacity than the outer reefs of Palau (van Woesik and Cacciapaglia, 2018), increases in ocean temperatures will increase the vulnerability of the Rock Islands. Another example showing the potential effects of sea level rise on the values of the site is the endangered [EN] Micronesian Megapode (*Megapodius laperouse senex*), a subspecies of ground nesting bird endemic to Palau (the other subspecies occurs in the Mariana Archipelago). This species nests in littoral strand habitat generally well within 1 m of high tide. Olsen et al. (2016) found 86% (n = 149) of this species' incubation mounds (active nest sites) occur cumulatively in the Rock Islands and Kayangel Atoll. Of these, 62% (n = 92) were found within the World Heritage site itself (Olsen et al., 2016). Sea level rise modelling by Radley (2018) indicated that megapodes will lose at the very least 43.3% of known breeding habitat. These figures should be considered very conservative given the shortcomings of the spatial data available for analysis in ArcGIS. Much of the currently extant littoral strand forest megapode rely on may be heavily affected by eustatic sea level rise projected to occur before 2100 by the Intergovernmental Panel for Climate Change (IPCC) (Church et al. 2013) and Jevrejeva et al. (2014). Other species of birds may very well be similarly affected but perhaps not to the extent of megapodes given the limited suitable breeding habitat available to the species in the World Heritage site.

Overall assessment of threats

High Threat

The greatest threat to the marine life of the Rock Islands is increasing ocean temperatures. Extreme temperature events, or marine heat waves, have already shown to negatively impact the marine life of Palau. Increasing tourist numbers is also a serious current threat and impacts from dive tourism are evident in some frequently visited dive and snorkeling sites. Efforts are needed to tackle some of these more manageable threats to the values of the World Heritage site with mitigation measures put in place and effective enforcement of regulations. However, the 2020 COVID-19 pandemic has caused significant declines on the levels of visitation. Current and future potential climate variability and severe weather events are the biggest future threat to the site and its World Heritage values. The reefs of Rock Island have already been impacted by bleaching events linked to temperature increases and the low calcification levels is likely to further confound whether these reefs can keep up with sea-level rise. The Rock Island reefs are more tolerant to temperature stress than the outer reefs, but wise land-use practices are necessary to ensure that these reefs maintain their resilience. While Rock Islands corals have previously shown excellent recovery, the severity and frequency of bleaching events is likely to increase in the future. If worst-case climate change scenarios occur, the Outstanding Universal Value of the site will be severely affected.

Protection and management

Assessing Protection and Management

► Management system

Mostly Effective

The World Heritage site falls in its entirety in Koror State, and the management practices of Koror State Rangers is well known and respected. Management authorities are operating on relatively reliable revenue from tourism. The strength of traditional value systems including resource governance systems is an asset, and can enable management and zoning that accommodate both cultural/traditional and biodiversity conservation needs. Management objectives and priorities are defined in the Rock Islands Southern Lagoon Management Plan (World Heritage Committee, 2012).

► Effectiveness of management system

Mostly Effective

The Nature Conservancy conducted a management effectiveness evaluation of the Rock Islands Southern Lagoon in 2012; results showed that the management is mostly effective. Management would benefit from a repeat evaluation to assess improvements and actions to address key points from the previous assessment and identify important actions in the face of threats from outside Palau (e.g. climate change).

► Boundaries

Mostly Effective

The boundaries of the World Heritage site are clearly delineated, but as with all primarily marine World Heritage sites, there is room for some improvement in boundary markers. High levels of engagement with local communities and a national commitment to the preservation of the marine environment assists the knowledge and awareness of the boundaries.

► Integration into regional and national planning systems

Mostly Effective

Palau's Protected Areas Network is working to integrate the World Heritage site and state and national planning. Palau was instrumental in establishing the Micronesia Challenge, an initiative between the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, Guam, and the Commonwealth of the Northern Mariana Islands to protect more than 30% of the region's nearshore marine ecosystems. The Rock Islands Southern Lagoon along with 23 other MPAs account for over 45%

of Palau's coastal habitats being under some form of protection.

► **Relationships with local people**

Mostly Effective

Overall, the Rock Islands Southern Lagoon is a source of pride for Palauans and the management of the area is supported by local residents. However, there is room for improvement to increase the involvement of local stakeholders. One project aiming to improve this is the Koror State Rare campaign (www.rareplanet.org).

► **Legal framework**

Mostly Effective

The legislative framework regulating use and management of the environment and its resources is comprehensive and clear (World Heritage Committee, 2012). The Koror State Legislature has zoned all of the property World Heritage site as a "Conservation Zone" (State Party of Palau, 2012). Rules and regulations for the Rock Islands Southern Lagoon are clearly delineated in the management plan and enforced by the Koror State Rangers. Enforcement is mostly effective, with some room for improvement.

► **Law enforcement**

Data Deficient

There are reports of fishing within the no-take zones of the MPA but this issue is largely data deficient and there is little information available in regard to specific enforcement efforts. On January 1, 2020, the Palau National Marine Sanctuary (PNMAS) went into effect, closing 80% of Palau's Exclusive Economic Zone to fishing. The Sanctuary and the remaining marine areas will require enforcement.

► **Implementation of Committee decisions and recommendations**

Data Deficient

Rock Islands Southern Lagoon was inscribed onto the World Heritage List in 2012 (World Heritage Committee, 2012). The site has only been referenced in one other Committee Decision (12EXTCOM 4), which was an international assistance request.

► **Sustainable use**

Mostly Effective

Fishing is the main extractive industry in the Rock Islands and it is relatively well managed. However, subsistence and recreational fishing taking place within the World Heritage site and in designated zones require constant monitoring (World Heritage Committee, 2012). The effects of the newly established Palau National Marine Sanctuary on fishing stocks across the country, including in the World Heritage site, remain to be seen.

► **Sustainable finance**

Highly Effective

The Rock Islands Southern Lagoon is relatively well financed. The Koror State Government provides funding for the management of the Rock Islands (State Party of Palau, 2012) and the Koror State Department of Conservation and Law Enforcement receives an annual budget to pay for staff and implement relevant programmes. Funds are contributed through user fees from tourists visiting the area (World Heritage Committee, 2012).

► **Staff capacity, training, and development**

Data Deficient

Koror State Rangers receive training in law enforcement and educational enforcement. However, no recent information on the current staffing levels and capacity could be found.

► **Education and interpretation programs**

Some Concern

A number of partners provide education programs in the Rock Islands. However, a more systemized approach to provide educational opportunities to Palau's students would improve effectiveness and standard approaches to the interpretation programs provided to tourists would be of benefit.

► **Tourism and visitation management**

Some Concern

Tourism and interpretation are carried out by private industry, with many dive shops taking tourists to the Rock Islands. Some of these dive shops have commitments to sustainability and excellent

interpretation, while other dive shops have room for improvement on both (Poonian, 2010). Some work has been undertaken to identify a tourism carrying capacity (see Miyakuni et al., 2018b) but further work is needed to limit the impacts from divers and snorkelers in particular.

► **Monitoring**

Mostly Effective

The Palau International Coral Reef Center and other partners such as the Coral Reef Research Foundation and The Nature Conservancy regularly monitor coral reefs and fish populations (Golbuu, 2005). Monitoring programs for other species and the terrestrial biodiversity would be of benefit, particularly in the face of impacts from climate change.

► **Research**

Mostly Effective

The Palau International Coral Reef Center leads research efforts in the Rock Islands Southern Lagoon, including impacts of climate change on coral reefs (Golbuu, 2005). The site is also important for research on coral reef resistance to ocean acidification (Shamberger et al., 2014). The Koror State Department of Conservation and Law Enforcement collaborates with the Palau Historic Preservation Office, Bureau of Arts and Culture in working with locally based agencies and organisations on management and research activities within the World Heritage site (World Heritage Committee, 2012).

Overall assessment of protection and management

Mostly Effective

Overall, the protection and management of the Rock Island Southern Lagoon is mostly effective. The legislative framework regulating use and management of the environment and its resources is comprehensive and clear but would benefit from improved implementation. There is also some room for improvement in education, enforcement, and involvement of local residents.

► **Assessment of the effectiveness of protection and management in addressing threats outside the site**

Some Concern

Management of the World Heritage site is largely effective but as the main threats from outside the site come from climate change and these threats can not be managed locally. However, this increases the need for management to address local stressors including the impacts of tourism, including both direct and indirect threats such as freshwater use, consumption of fish in restaurants and waste water. Management of land-based sources of pollution is also critically important to protect the local marine life.

State and trend of values

Assessing the current state and trend of values

World Heritage values

► **Sharks and turtles**

Low Concern
Trend:Stable

Palau has abundant shark populations and recent measures to ban shark fishing (including the government declaring the EEZ as a shark sanctuary in partnership with Pew) will need strong enforcement to ensure that these species persist.

► **Terrestrial biodiversity**

Data Deficient
Trend:Data Deficient

The forests of the islands found within the World Heritage site include all of Palau's endemic birds, mammals, herpetofauna and nearly half of Palau's endemic plants. There is no current monitoring data

on the status of these species or the forests.

► **Fish**

Low Concern
Trend:Data Deficient

Reducing fishing impacts, particularly to endangered and threatened species will be important to prevent irreversible losses.

► **Corals**

High Concern
Trend:Data Deficient

Coral reefs are threatened by climate change and management practices to reduce other stressors such as overfishing, visitor impacts, and poor land use that causes nutrient pollution and sedimentation on the reefs, will be key to limiting the impacts from climate change including ocean acidification and extreme temperatures (Poonian et. al., 2010; Gouezo et al., 2016; TNC, n.d.).

► **Marine lakes and associated species**

Low Concern
Trend:Improving

Most marine lakes are not visited, which means they receive protection. Due to declining numbers of jellyfish as a result of drought conditions, the Jellyfish Lake had been temporarily closed to visitors to reduce pressures. The Lake has been subsequently reopened once recovery of the jellyfish could be observed (Ministry of Natural Resources, Environment and Tourism, 2019), with 630,000 jellyfish reported in 2018 according to the latest survey (CNN, 2019). However, this estimated population size is considerably lower than historic population sizes.

► **Exceptional area with high variety of habitats**

Good
Trend:Stable

The site remains a unique area with exceptionally high variety of habitats, particularly in the marine environment. The islands, and the forests found on them, provide critical habitats for terrestrial species.

► **Exceptional beauty of Rock islands**

Good
Trend:Stable

The aesthetic values of the site are well preserved with no current change.

► **Exceptionally high biological and marine habitat diversity**

High Concern
Trend:Deteriorating

Coral reefs be are threatened by climate change but management practices to reduce other stressors such as overfishing, visitor impacts, and poor-land use that causes nutrient pollution and sedimentation on the reefs, will help reduce stress to the coral reefs (Poonian, et. al 2010; Gouezo et al., 2016; van Woesik and Cacciapaglia, 2018; TNC, n.d.). There is evidence of impacts from climate change induced marine heat waves that cause coral bleaching and coral mortality, albeit relatively less severe in comparison to other reef areas in the world (Heron et al., 2017).

Summary of the Values

► **Assessment of the current state and trend of World Heritage values**

Low Concern
Trend: Stable

Overall, based on the information available, the current state of the site's values is good. However, for many of the values for which the site was inscribed on the World Heritage List up-to-date data is lacking and further information is required for a comprehensive assessment of their state and trend. The coral reefs within the World Heritage site are threatened by climate change, which will also impact on other values. Management practices to reduce other stressors such as overfishing, visitor impacts, and poor-land use that causes nutrient pollution and sedimentation on the reefs, will be key for the persistence of these systems. While some concerns remain about the numbers of

the jellyfish in the Jellyfish Lake, the recovery trend is encouraging.

Additional information

Benefits

Understanding Benefits

► Outdoor recreation and tourism

Tourism is about 50% of Palau's GDP (one of the highest rates in the world), with most tourists to the country visiting the Rock Islands (IMF, 2012). The Rock Islands Lagoon provides recreational opportunities for Palauans and visitors, including boating, BBQ'ing, fishing, diving, snorkeling, and beach visits.

Factors negatively affecting provision of this benefit :

- Climate change : Impact level - Low, Trend - Increasing
- Pollution : Impact level - Low, Trend - Increasing
- Habitat change : Impact level - Low, Trend - Continuing

► Importance for research

The Rock Islands Lagoon provides a natural laboratory for scientific research on coral reef health and climate change impacts to coral reefs and has spawned numerous scientific and research publications (e.g. Golbuu, 2007; van Woesik et al., 2012; Shamberger et al., 2014; DeCarlo et al., 2015; van Woesik and Cacciapaglia, 2018).

Factors negatively affecting provision of this benefit :

- Climate change : Impact level - Low, Trend - Increasing
- Pollution : Impact level - Low, Trend - Increasing
- Habitat change : Impact level - Low

► Cultural identity and sense of belonging

Palauans have a long history of a strong relationship with the ocean and it remains central to their culture and social organization as well as providing a source of food and livelihood. A 2003 survey indicated that 87% of Palauan households are linked to fishing and subsequently the marine environment in some way (Wabnitz et al., 2018).

Factors negatively affecting provision of this benefit :

- Climate change : Impact level - Low, Trend - Increasing
- Pollution : Impact level - Low, Trend - Increasing
- Habitat change : Impact level - Low, Trend - Continuing

► Direct employment, Tourism-related income

Tourism, primarily centered around the marine environment and specifically Rock Islands, contributes to about three quarters of Palau's GDP growth, 15% of tax revenue, and 40% of total employment (Wabnitz et al., 2018). The value to Palau's economy of protecting sharks, one of the main tourist attractions and found in particularly high densities in the World Heritage site, has been estimated at US\$1.9 million through dive tourism (Vianna et al., 2012).

Factors negatively affecting provision of this benefit :

- Climate change : Impact level - Low, Trend - Increasing
- Pollution : Impact level - Low, Trend - Increasing

- Habitat change : Impact level - Low

Summary of benefits

Benefits provided by the Rock Islands Lagoon include health and recreation, and scientific research. Tourism to the World Heritage site provides significant economic benefit through employment and indirect contributions to the local economy. Tourism contributes significantly to Palau's GDP and 40% of total employment and as such is a significant benefit from the site, a location that is visited by the majority of Palau's tourists. There are also cultural and spiritual benefits through the strong relationship Palauans have with the ocean and marine environment.

Projects

Compilation of active conservation projects

№	Organization	Project	Brief description of Active Projects
1	Palau Ministry of the Natural Resources, Environment, and Tourism		Assessment of carrying capacity for tourists at dive sites
2	University of the Ryukyus and Palau International Coral Reef Center (PICRC) / Palau Community College (PCC)		Sustainable Management of Coral Reef and Island Ecosystems: Responding to the Threat of Climate Change. Ensuring the Future of Palau's Wonderful Coral Reefs - a Paradise of Life in the Pacific Ocean. Palau and other Pacific states have abundant coral ecosystems and some of the world's richest biodiversity. However, they face a changing global environment, including climate change and ocean acidification, as well as the growing impact of regional development issues like coastal development and water pollution. This project takes both global and local perspectives, working through activities such as environmental monitoring, environmental impact assessments for coral island ecosystems, social scientific assessments, and assessments of impact on biodiversity to produce suggestions concerning sustainable approaches for island society. Through gaining an understanding of the structure of island coral ecosystems, the project aims to construct sustainable management systems, with conservation of the coral reef driven by local initiative. At the same time, the project is training human resources with specialist knowledge. Coral reef islands are directly influenced by climate change, and as such they epitomize the action that needs to be taken, and may become a model for the world as a whole.

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