Baseline Marine Assessment of Ngerukewid Islands Wildlife Preserve

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Abstract

The Ngerukewid Islands Wildlife Preserve is Palau's oldest legislated protected area, under full protection (no take, no entry) for nearly 63 years having been established in 1956. The natural preserve, also famously known as Palau's 'seventy islands' encompasses both marine and terrestrial habitats, including a high number of birds and endemic species. It is also a member site of the Palau Protected Areas Network (PAN) and part of Palau's only World Heritage site, the Rock Islands Southern Lagoon (RISL). As part of the Palau International Coral Reef Center's (PICRC) ecological monitoring of Marine Protected Areas (MPAs), this report serves as the marine component for the baseline assessment of Ngerukewid preserve. In 2018, PICRC conducted a baseline ecological survey at 21 randomly selected sites within the two major marine habitats (lagoon and reef hole), collecting data on several ecological indicators. The parameters measured included abundance and size of commercially important fish assemblages, coral recruits, and edible macro-invertebrates as well as percentage coverage of benthic organisms and abiotic substrata. The findings of the baseline results demonstrate that fish biomass and abundance were similar in all habitats but overall low with 6 (±1.0 SE) individuals and 8.7 (±3.0 SE) individuals per 150 m^2 for the lagoon and reef hole habitats, respectively. In terms of fish biomass, the lagoon habitat hosted an average of 1,174 (g) (±247) of food fish, while the reef hole habitat had an average fish biomass of 1,351(g) (±864) per 150 m^2. The abundance of macro-invertebrates was less than 2 individuals per 60 m^2. Benthic cover showed a high coverage of sand, rubble and carbonate, while macroalgal cover was low with less than one percent cover in both habitats. Coral coverage was overall low with less than 10% for both habitats. The lagoon coral cover was slightly higher with 9.5% coverage compared with the reef hole habitat which had a mean coral coverage of 3.5%. Our results showing low coral-reef associated diversity are likely attributed to the distinctive natural environmental characteristics of Ngerukewid's Rock Islands system that is highly dominated by bottom sediments. The preserve is a relatively isolated group of islands, with shallow waters and high sediment bottom which may limit coral populations (Colin et al, 2009). As previously discussed in Colin et al, 2009, the preserve was protected for its isolation and terrestrial and marine diversity. Continuous ecological monitoring of Ngerukewid Wildlife preserve is crucial in order to assess the trends and protection effectiveness of its marine resources overtime.

Introduction

Marine Protected Areas (MPAs) have been widely used globally as a tool for sustaining fisheries, protection of marine biodiversity and against anthropogenic threats such as overfishing (Lester, 2009). In Palau, the concept of natural resource conservation has been a common practice in Palauan cultural tradition. The notion of 'bul' is a Palauan tradition of placing restrictions on the use of natural resources for specified periods of time (Johannes, 1981). Today, the cultural tradition of 'bul' has somewhat evolved to include modern conservation practices such as MPAs. To date, there are now 35 legislated MPAs in Palau located in various locations across the archipelago (Friedlander et al. 2017). In 2003, the National government of Palau established the Protected Areas Network (PAN), which is a collection of protected areas for the purposes of conserving Palau's natural biodiversity. The PAN has now become one of the main mechanisms for achieving goals of regional conservation initiatives, such as the Micronesia Challenge (MC).

The Palau International Coral Reef Center provides scientific support for the PAN, in an effort to determine the effectiveness of the PAN MPAs overtime. This report serves as the baseline marine component survey report for the Ngerukewid Islands Wildlife Preserve, located in Koror State.

The Ngerukewid Islands Wildlife Preserve, also famously known as Palau's Seventy Islands, is located within the Palau Rock Islands Southern lagoon (RISL), and was the first established conservation area for Palau. In 1956, it was established as Palau's first national protected area and declared a no take and no entry area, to ensure the preservation of an area that is representative of the Rock Islands ecosystem. Subsequently in 1999, it became a state legislated protected area under the State of Koror, in which more prohibitions included no use or lighting of fires, possession or transport of any firearms of any description or other weapons and no transport of any domestic animals (Koror State Government, K6-101-99). Ngerukewid Islands Wildlife Preserve, encompasses a range of ecosystems, inclusive of a cluster of limestone islands which are home to Palau's endemic Rock Island palm tree as well as other native plants. It not only serves as a refuge for numerous birds and bats, but is also a critical breeding site for hawksbill turtles and marine flora and fauna. As part of a larger area of protected areas, Ngerukewid together with Ngemelis Island Complex, Ulong island, Ngeruktabl complex, Mecherchar complex, Kmekumer and Babelomekang group of islands make up the Rock Islands Southern Lagoon and several of Palau's world class famous snorkeling and dive sites (Koror State Government, 2012). It is a part of the Palau PAN and in 2012, it was inscribed as a World Heritage site, making it Palau's only world heritage site to date (Olkeriil, 2012).

Methods

Study site

This study focuses on the Ngerukewid Islands Wildlife preserve located within the Koror State Rock Islands Southern Lagoon (RISL) which has a total area of approximately 11.4 square kilometers. A total of 21 survey sites were randomly allocated within the boundaries of Ngerukewid, and various ecological indicators were measured within the main habitats. The lagoon habitat had a total of 18 sites, while the remaining 3 sites were located within the reef hole habitat.

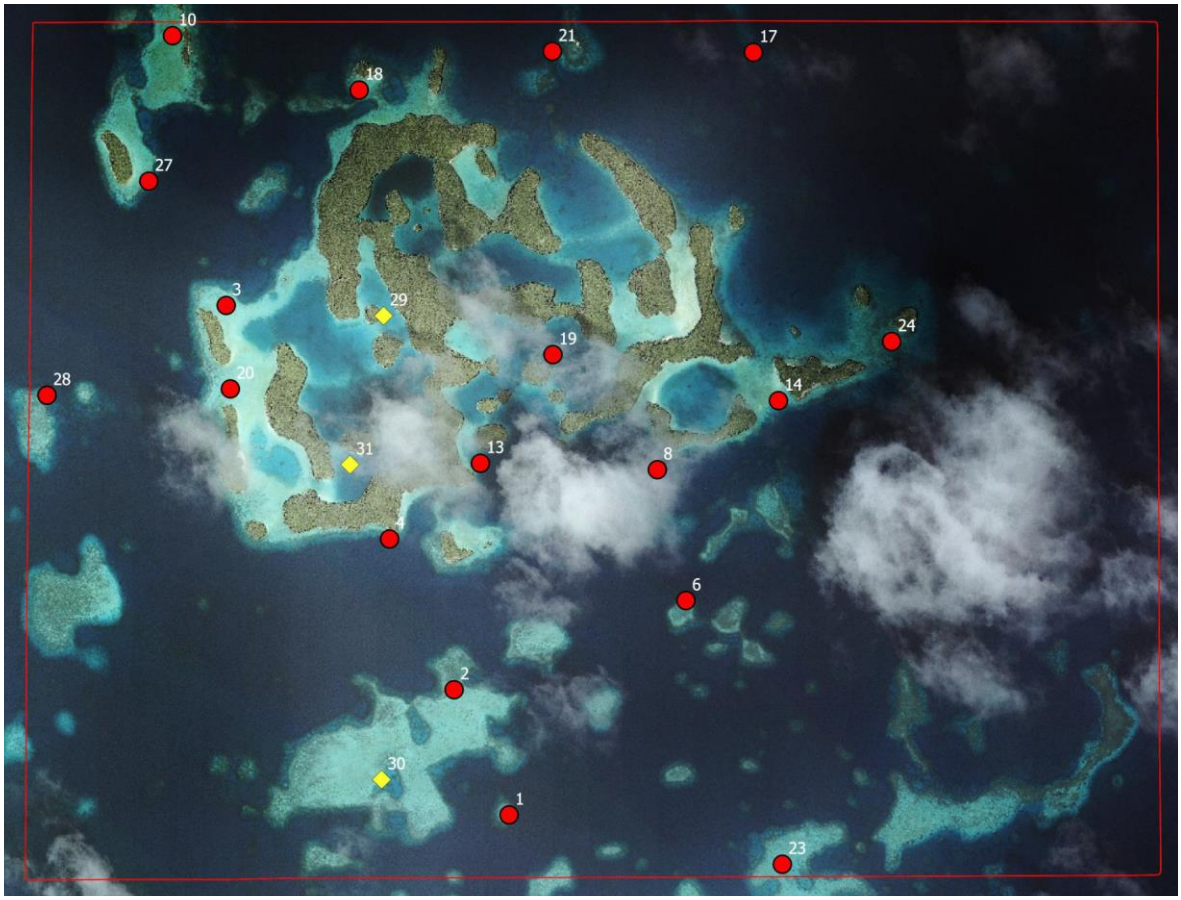

Figure 1. Map of Ngerukewid Islands Wildlife Preserve showing random allocated points as baseline survey sites. The red points indicate the Lagoon habitat survey sites, while the yellow points indicate the reef hole habitats.

Fish surveys

Commercially valuable fish were recorded using stereo-DOV (Dive Operated Video) within a 5 m wide belt along three 30 meter transects laid consecutively with a few meters separating them at each site (see Appendix – Table 1 for list of commercially important fish). Fish biomass was calculated using the weight-length equation below. Where L represents the fish length in centimeters, and a and b values are constants obtained from Kulbicki et al. (2005) and the website Fish base (www.fishbase.org).

Biomass: $W = aTL^b$

Commercially important and edible macro-invertebrates surveys

Edible and commercially valuable macro-invertebrates were identified visually by an observer within a 2 meter wide belt along each transect at each site (see Appendix – Table 2 and 3 for list of commercially important invertebrates). Invertebrates were counted, identified to the lowest possible taxonomic level and measured in centimeters.

Coral recruits

Coral recruits, specifically corals that are less than 3 cm were visually counted, identified and recorded within the first 10 m of each transect in 0.3 meter belt width.

Benthic coverage

At each site, a wide-angle lens camera was mounted on a 1 m^2 photo-quadrat and used to photograph the benthic community at every meter along the transect. A total of 30 photos were taken on each transect. These photos were then analyzed using the Coral Point Count with Excel extension program (CPCe). In each photograph, 5 points were randomly allocated, and manually categorized based on the benthic composition of each habitat.

Results

Fish density and biomass

The abundance of commercially valuable fish was on average 6 (±1.0 SE) individuals per 150 m^2 within the lagoon habitat. Similarly, the fish abundance in the reef hole habitat had an average of 8.7 (±3.0 SE) individuals per 150 m^2 (Figure 2). In terms of fish biomass, the lagoon habitat hosted an average of 1,174 (g) (±247) of food fish per 150 m^2, while the reef hole habitat had an average fish biomass of 1,351(g) (±864) per 150 m^2 (Figure 3).

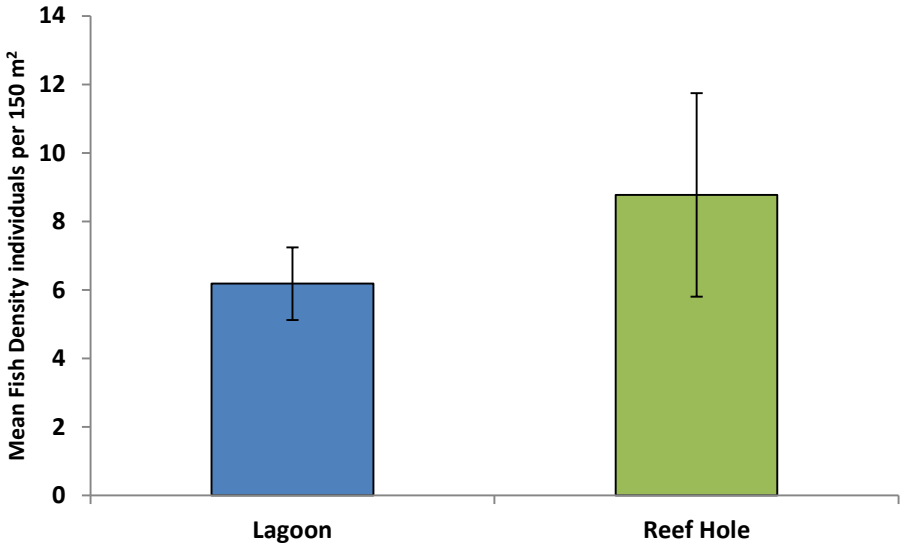

Figure 2. The mean density of commercially important fish (mean ± SE) observed within the lagoon (n=18) and reef hole (n=3) habitats.

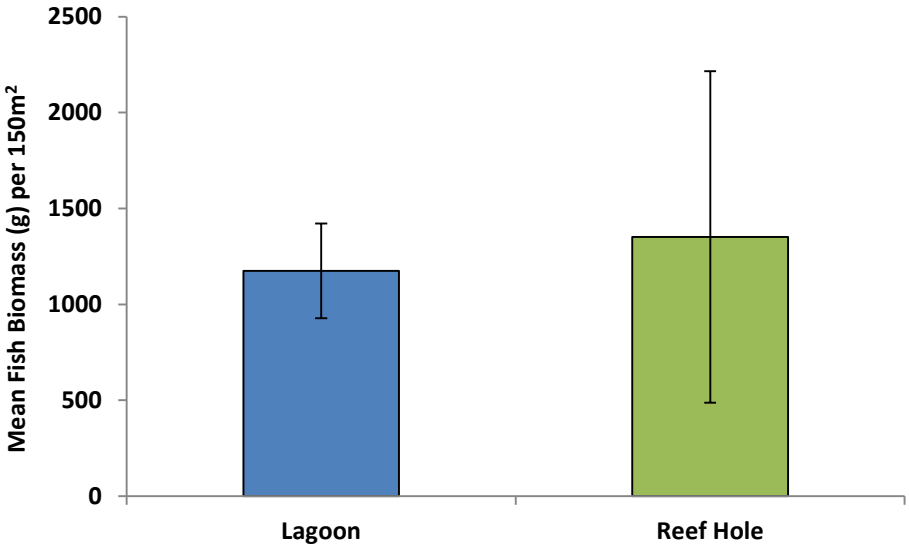

Figure 3. The mean biomass of commercially important fish (mean ± SE) per 150m^{-2} within the lagoon (n=18) and reef hole (n=3) habitats.

In both habitats, the protected fish species, *Bolbometopon muricatum* (kemedukl) was recorded with an average biomass of 274 (g) and 205 (g) per 150 m^2 for the lagoon and reef hole habitats, respectively (Figure 4). In the lagoon habitat, *Lutjanus gibbus* (keremlal) had an average biomass of 262 (g) per 150 m^2, while the reef hole habitat showed a higher biomass of 537 (g) per 150 m^2 of *Scarus Prasiognathos* (melechotech a chau) (Figure 4). The most abundant species in the reef hole habitat included *Acanthurus nigricauda* (chesengel), and *Scarus Prasiognathos* (melechotech a chau) (Figure 4). Whereas in the lagoon habitat, the most abundant fish species recorded was *Scarus sp.* (mellemau) with *Lutjanus gibbus* (keremlal) as the second most abundant species (Figure 4).

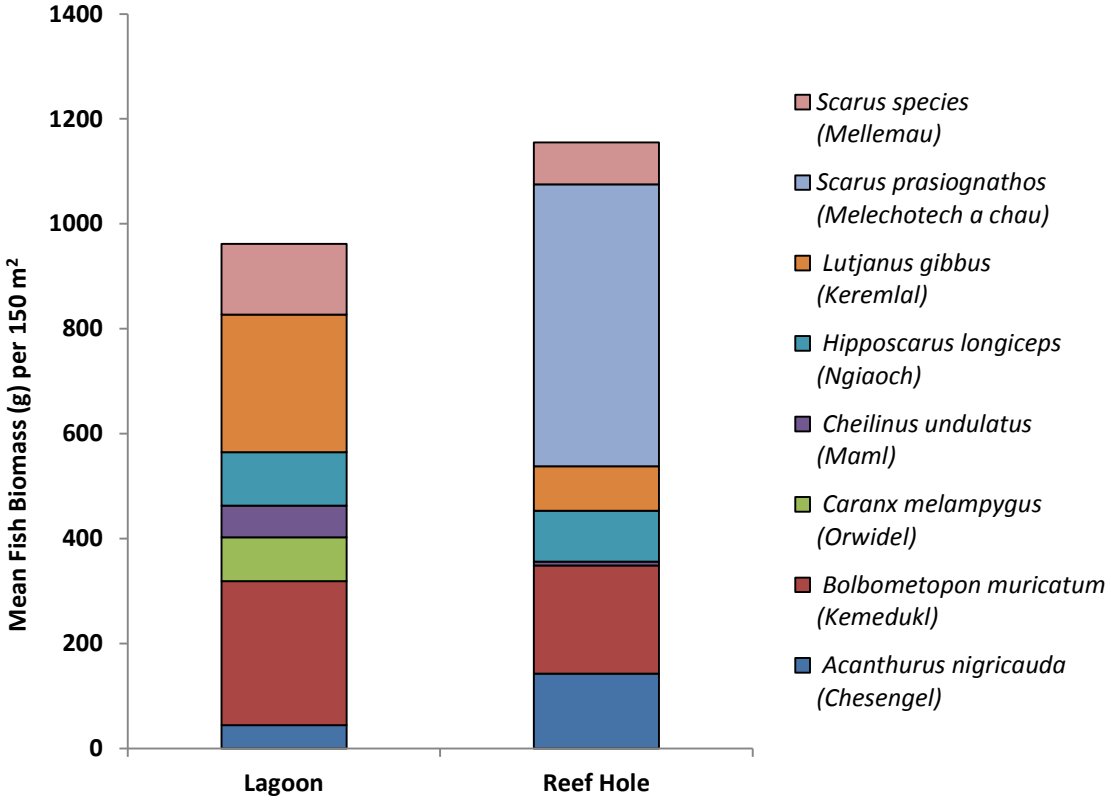

Figure 4. Bar plot showing the mean biomass of the most abundant commercially-targeted fish species in each habitat, lagoon (n=18) and reef hole (n=3).

Coral recruits

The mean abundance of juvenile corals was 5 (± 0.5 SE) individuals per 3 m^2 for the lagoon habitat, and 2.3 (± 1.0 SE) individuals per 3 m^2 for the reef hole habitat (Figure 5).

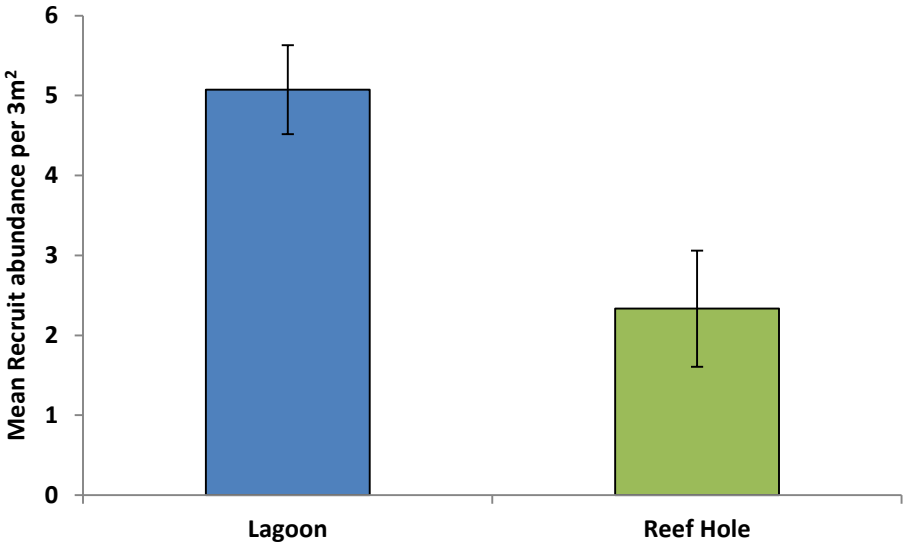

Figure 5. The mean abundance of coral recruits (mean ± SE) observed within 3 m^2, for the lagoon (n=18) and reef hole habitats (n=3).

Macro-invertebrate density

The mean abundance of edible and commercially important macro-invertebrates in the lagoon habitat was overall low with 1.5 (± 0.1 SE) individuals per 60 m^2, while the reef hole habitat had a similar mean abundance of 1.7 (± 0.3 SE) individuals per 60 m^2 (Figure 6). The most observed macro-invertebrate in the lagoon habitat was *Tridacna Crocea* (oruer) and *Stichopus sp.* (ngims), while the reef hole habitat showed slightly lower number of various species of edible macro-invertebrates (Figure 6).

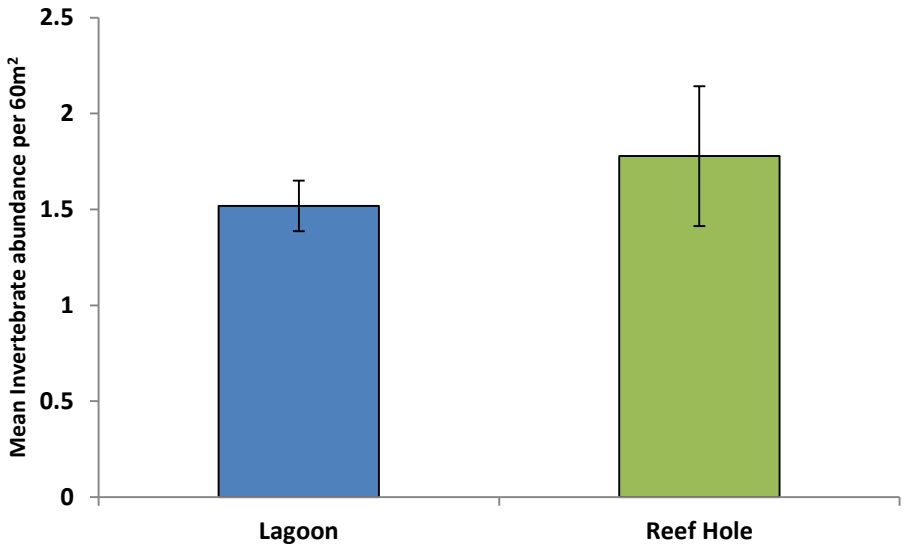

Figure 6. Mean abundance of macro-invertebrates (mean ± SE) observed within 60 m^{-2} for the lagoon (n=18) and reef hole habitats (n=3).

Benthic cover

Overall, both habitats had a similar benthic composition. Of the total benthic cover of the lagoon habitat, coral cover was lowest at 9.54%, while sand/sediments cover was 35.39%, followed by carbonate cover (23.84%) and rubble (15.9%) (Figure 7). The benthic composition in the reef hole habitat also showed similar coverage. Benthic composition in the reef hole habitat consisted largely by sand/sediments cover (35.26%), followed by carbonate cover (30.89%) and rubble (21.93%) (Figure 7). In terms of macroalgal coverage, there was less than 1% of macro-algae in both habitats, while turf algae was overall less than 14% in the lagoon and reef hole habitats.

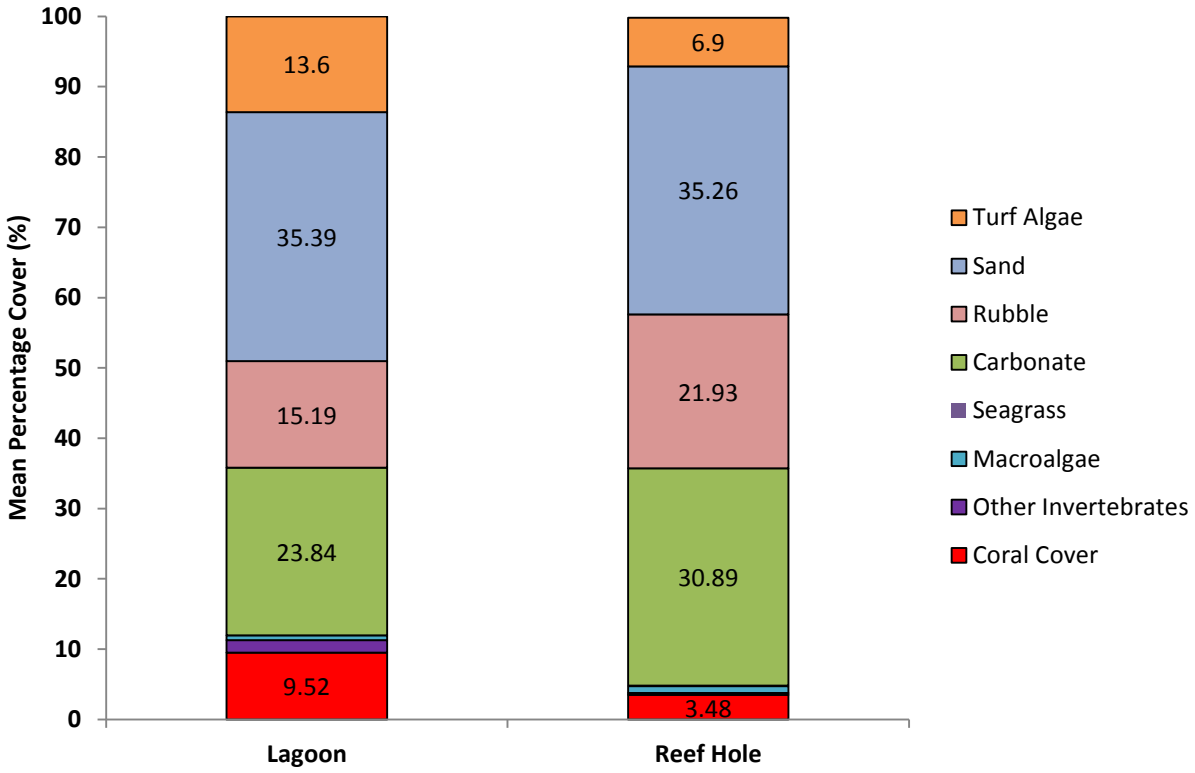

Figure 7. Mean Benthic coverage (%) for the lagoon (n=18) and reef hole habitats (n=3).

Discussion

Ngerukewid Islands Wildlife Preserve serves as Palau's first protected area, and has been under full protection with no entry and no harvesting or taking of any resources for nearly 63 years. The results presented in this report serve as quantitative baseline information of the marine resources, inclusive of corals, benthic composition, fish and invertebrates within the preserve.

Live coral cover within the preserve appeared to be low overall with less than 10% mean coverage in the lagoon habitat and less than 4% coral coverage in the reef hole habitat. Sand and carbonate displayed the highest coverage within the benthic community, while macro-algal cover was low with less than 1% in both habitats. The high coverage of sand could be attributed

to the natural characteristics of this rock island system as described in Colin et al. (2009). With very shallow waters and sandy bottoms as a natural attribute (Colin et al, 2009), these characteristics may also lead to coral recruitment failure and low coral cover. The low coverage of substrate suitable for recruitment led to an overall low abundance of coral recruits (<5 individuals per 3 m^2) for the lagoon and even less within the reef hole habitat. This lack of suitable habitat structure could also be a contributing factor to the overall low coral reef diversity.

The high sediment environment and low live coral habitat structure that makes up the benthic assemblages of Ngerukewid likely affected the fish assemblages. For the commercially-important fish, the abundance and biomass were overall low with little difference between the two habitats. There were similar mean abundances of fish in the lagoon and reef hole habitats with 6 and 8 individuals per 150 m^2, respectively. Fish biomass was between 1,000 (g) to 1,200 (g) per 150 m^2 indicating that both habitats have similar fish abundance and biomass. A large portion of the fish assemblages in the reef hole habitat included groups of *Scarus prasiognathos* (melechotech a chau) which contributed largely to overall fish biomass. Protected fish species such as *Bolbometopon muricatum* (kemedukl) and *Cheilinus undulatus* (maml) were also observed in the preserve as well. It should be noted that during the duration of these ecological surveys, several sites had very low visibility due to high sediments and therefore could have impacted the overall fish abundance and biomass. Macro-invertebrates such as clams were surveyed, however did not appear to be high in abundance. Although a high sediment environment is favorable for sea cucumber populations, it was not reflected in the data, as there seems to be low abundance of sea cucumbers.

As this is the baseline study for Ngerukewid Islands Wildlife preserve, continued ecological monitoring of the MPA is crucial and required overtime using the same survey methods for data comparability. This would ensure that changes and trends are documented regarding fish assemblages, live coral cover and benthic composition, as well as edible macro-invertebrates. Detecting changes to the overall marine biodiversity would allow for a more in-depth understanding of the effectiveness of Ngerukewid Islands MPA as a tool for marine resource conservation in Koror State and Palau.

Acknowledgments

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Appendix

Table 1. List of commercially important fish, including the protected fish for seasonal harvests and fish closed for harvest.

Species	Palauan name	Note
Caranx ignobilis	Erobk	_
Caranx melampygus	Oruidel	_
Cetosacarus bicolor	Beadel, Ngesngis	_
Cetoscarus/Scarus spp.	Melemau	_
Choerodon anchorago	Budech	_
Hipposcarus harid	Bekism	_
Hipposcarus longiceps	Ngiaoch	_
Kyphosus spp. (vaigiensis)	Komud, Teboteb	_
Lethrinus obsoletus	Udech	_
Lethrinus olivaceus	Melangmud	_
Lethrinus rubrioperculatus	Rekruk	_
Lethrinus xanthochilis	Mechur	_
Liza vaigiensis	Uluu	_
Lutjanus argentimaculatus	Kedesau'l iengel	_
Lutjanus bohar	Kedesau	_
Lutjanus gibbus	Keremlal	_
Naso lituratus	Cherangel	_
Naso unicornis	Chum	_
Plectorhinchus albovittatus	Melim ralm, Kosond, Bikl	_
Plectorhinchus crysotaenia	Merar	_
Scarus microrhinos	Otord	_
Siganus argenteus	Beduut	_
Siganus lineatus	Kelsebuul	_
Siganus puellus	Reked	_
Siganus punctatus	Bebael	_
Valamugil seheli	Kelat	_
Bolbometopon muricatum	Kamedukl	Protected Fish (seasonal harvest and species closed for harvest)
Cheilinus undulatus	Maml	
Epinephelus fuscoguttatus	Meteungerel'temekai	
Epinephelus polyphekadion	Ksau'temekai	
Plectropomus areolatus	Tiau	
Plectropomus laevis	Tiau, Katuu'tiau, Mokas	
Plectropomus leopardus	Tiau	
Siganus fuscescens	Meyas	

Table 2. List of commercially important and edible Macro-invertebrates.

Species	Palauan name
Hippopus hippopus	Duadeb
Tridacna crocea	Oruer
Tridacna derasa	Kism
Tridacna gigas	Otkang
Tridacna maxima	Melibes
Tridacna squamosa	Ribkungel

Table 3. List of commercially important sea cucumber, sea urchin, and trochus.

Species	Palauan name
Actinopyga echinites	Eremrum
Actinopyga lecanora	Ngelau
Actinopyga mauritiana	Badelchelid
Actinopyga miliaris	Eremrum, cheremrum edelekelk
Actinopyga palauensis	Eremrum
Actinopyga sp.	Eremrum
Bohadschia argus	Mermarech, esobel
Bohadschia similis	Mermarech
Bohadschia vitiensis	Mermarech
Holothuria impatiens	Sekesaker
Holothuria atra	Cheuas
Holothuria coluber	Cheuas
Holothuria edulis	Cheuas
Holothuria fuscogilva	Bakelungal-cherou
Holothuria fuscopunctata	Delal a molech
Holothuria lessoni	Delal a molech
Holothuria leucospilota	Cheuas
Holothuria nobilis	Bakelungal-chedelkelek
Holothuria scabra	Molech
Holothuris falvomaculata	Cheuas
Pearsonothuria graeffei	Meremarech
Stichopus chloronotus	Cheuas
Stichopus hermanni	Delal a ngimes, ngimes ra tmolech
Stichopus horrens	Irimd
Stichopus vastus	Ngimes
Thelenota ananas	Temetamel
Thelenota anax	Belaol

Tripneustes gratilla	Ibuchel
Trochus maculatus	Semum