Baseline Assessment of Ngederrak Marine Protected Area

Shirley Koshiba, Marine Gouezo, Lincoln Rehm, Dawnette Olsudong, Geory Mereb

Palau International Coral Reef Center

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Abstract

Marine Protected Areas (MPAs) have become a widely used tool worldwide, including Palau and Micronesia. In 2003, the Palau Protected Areas Network (PAN) was created to protect and conserve Palau's biodiversity. Today, the PAN is Palau's mechanism to achieving the goals of the Micronesia Challenge (MC), a regional initiative to conserve at least 30% of near-shore marine resources and 20% of terrestrial resources by the year 2020. Although the PAN is a network of numerous MPAs within Palau, little information has been collected on the baseline status of existing and new MPAs in Palau. This report is based on baseline ecological data of the marine resources in Ngederrak MPA, a marine protected area located in Koror state. The results of this assessment demonstrate that the marine resources currently within Ngederrak MPA have the potential to increase overtime, given that proper biological monitoring is conducted overtime, to assess trends and changes of the marine resources in Ngederrak MPA. Commercially important fish species were most abundant in the fore-reef habitat. Similarly, fish biomass was the highest in the fore-reef habitat with an average biomass of 14,248.5 g per 150 m^2. Invertebrate densities were also highest in the fore-reef compared with the reef-flat, channel and lagoon habitats. Lastly, coral cover was the highest in the lagoon (33%), with sea grass percentages occurring mainly in the reef-flat habitat.

1. Introduction

The use of Marine Protected Areas (MPAs) as a conservation measure has become widely used not only in Palau, but as well as Micronesia and the rest of the world. Studies have indicated the positive benefits of MPAs, including the spillover effect to adjacent non-protected areas (Mclanahan and Mangi 2000) as well as providing a significant source of recruitment in fished and protected areas on a regional scale (Harrison et al 2012). MPAs, when properly managed and monitored over time, can generate many biological and social benefits to coastal communities, including the protection of coral reef ecosystems, which provide a wide range of ecosystem services such as protection from storms or surges, economic gains from tourism activities, and sources of food or protein for human consumption (Costanza et al 1998).

In 2003, the government of the Republic of Palau enacted a legislation to create a network of protected areas in Palau with the overall aim to conserve and protect Palau's biodiversity. Known as the Palau Protected Areas Network (PAN), the PAN has become Palau's mechanism to achieving the goals of the Micronesia Challenge (MC). In 2006, the governments of the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, the Commonwealth of the Northern Marianas, and Guam launched the MC with the goals of each MC jurisdiction to effectively conserve at least 30% of near-shore marine resources and 20% of terrestrial resources by the year 2020 (Micronesia Challenge Report, 2011).

Although such advancements for marine and terrestrial conservation have been made in Palau and the region, little information is known on the baseline status of all MPAs across Palau. With the aim of supporting coral reef stewardship and marine conservation through research and its application for Palau, the Palau International Coral Reef Center (PICRC) made a commitment to conduct baseline surveys of all MPAs within Palau. This report is based on baseline data collected in Ngederrak Marine Protected Area, an MPA located within Koror State.

In 2001, the Koror State legislature enacted a legislation to designate Ngederrak as a marine protected area, and to prohibit any taking of marine flora or fauna within the MPA. Ngederrak MPA is also a no entry zone and consists of four major habitats namely: Channel, Reef-flat, Lagoon and Fore-reef. The MPA has a total area of 5.8 square km and is in close proximity to the Malakal harbor located in Koror State.

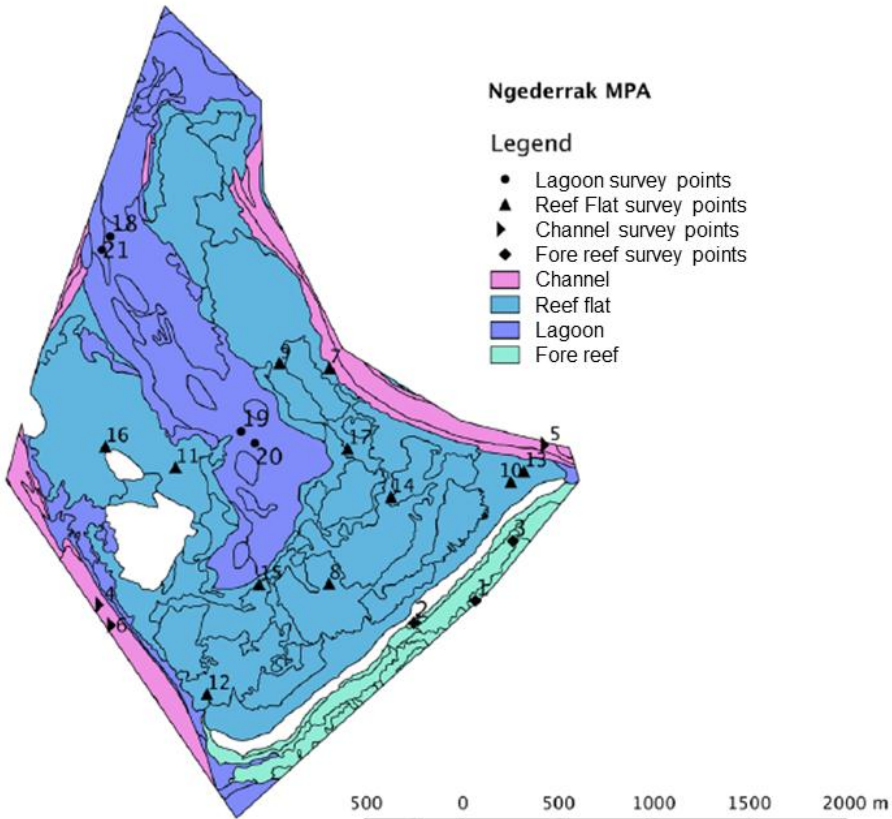

Figure 1. Map of Ngederrak Marine Protected Area and randomly selected survey sites within each habitat: Channel (pink), reef-flat (blue), lagoon (purple) and fore-reef (light blue).

2. Methods

Study site

This study was conducted in Ngederrak MPA in October 2014. Within the protected area, twenty randomly selected sites were surveyed in each habitat (Channel, Reef-flat, Lagoon, Fore-reef) found within Ngederrak MPA. At each site, three 30 m belt transects were laid following the reef contour at 3 – 5 m and several ecological indicators were measured and recorded.

Fish Surveys

Commercially-valuable fish species were surveyed for density and biomass along each 30 x 5m transect (total area per transect = 150 m^2), where the length of each fish species was estimated to the nearest centimeter. Fish density and biomass calculations, were calculated using the length-weight relationship, $a(L^b)$, where L= length in centimeters, and a and b as constants obtained from published papers (Kulbicki et al 2005) and fish base (www.fishbase.org).

Benthic, Invertebrate, and Coral Recruits Surveys

Edible and commercially targeted macro-invertebrates were identified and measured in centimeters along a reduced belt width of 30 x 2m transect (total area per transect = 60 m^2). The benthic community was surveyed using 1 m^2photo-quadrats recorded with a wide-angle camera lens, in which photos of the entire 30 m transect were taken (30 quadrats per transect which equals to 90 photos per site). Benthic composition was analyzed using CPCe (Coral Point Count with excel extensions); a visual basic program for the determination of coral and substrate coverage in which five random points from each quadrat were used to generate estimates of coral cover, with corals being identified to the genus level. The abundance of coral recruits (< 5cm in diameter) was recorded to the genus level within a 30 cm width of the first 10-m of each transect. All data were collated and analyzed in Microsoft (MS) excel.

3. Results

3.1 Fish density and biomass

The habitat showing the highest mean density of commercially important species in Ngederrak MPA was the fore-reef habitat with 27.5 (SE ± 7.2) individuals per 150 m^2 (Fig. 2).The lowest mean density of commercially important species occurred in the Channel habitat with a mean density of 15.2 (SE ± 0.8) individuals per 150 m^2 (Fig. 2). The mean fish biomass was the highest in the fore-reef habitat with a mean biomass of 14,248.5 (SE ± 3821) g per 150 m^2 (Fig. 3). The habitat showing the lowest mean biomass of fish was the Channel habitat with 3,170 (SE ± 2115) g per 150 m^2 (Fig. 3).

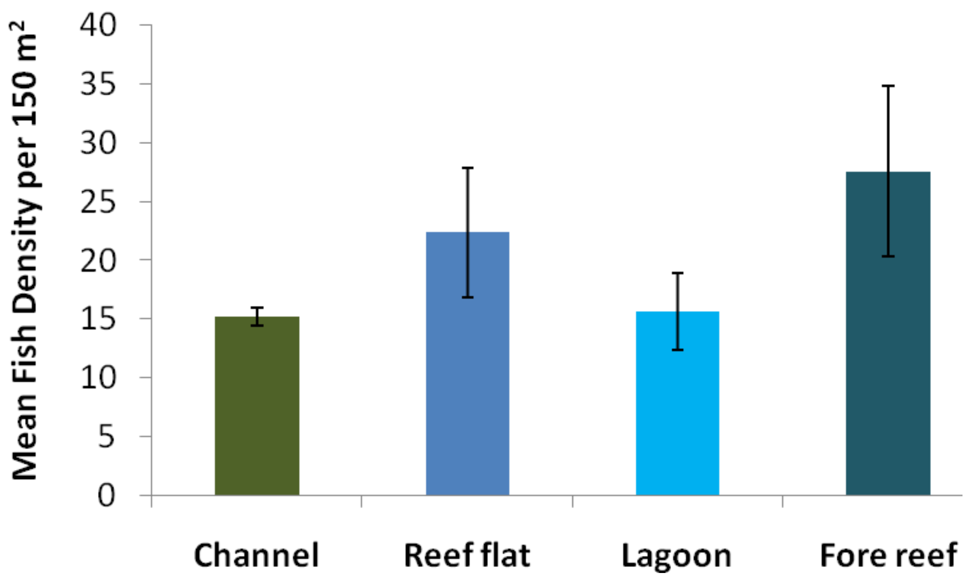

Figure 2. Mean fish density for each habitat in Ngederrak Marine Protected Area. Error bars indicate standard errors.

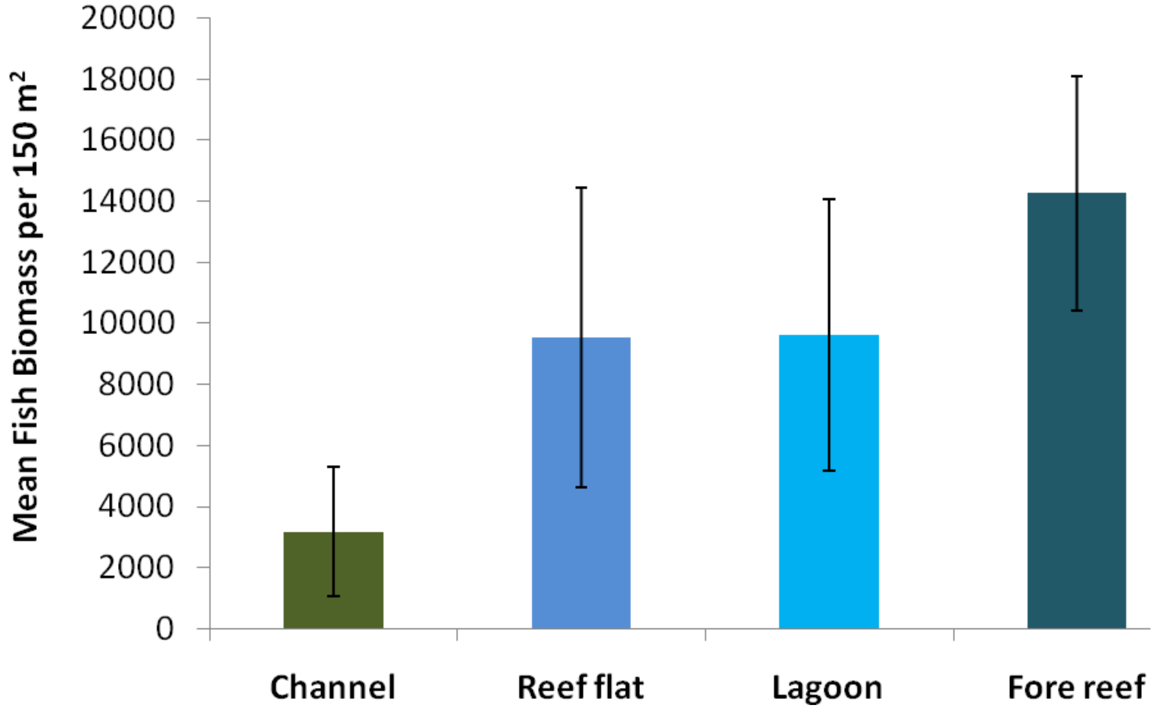

Figure 3. Mean fish biomass for each habitat in Ngederrak Marine Protected Area. Error bars indicate standard errors.

3.2 Invertebrate Density

The highest invertebrate densities occurred in the fore-reef habitat, which had an average invertebrate density of 7 (SE ± 2.3) individuals per 60 m^2, while the Channel, reef-flat and lagoon habitats had average invertebrate densities of less than 6 individuals per 60 m^2 (Fig. 4). The giant clam, *Tridacna crocea* was the predominant invertebrate in all four major habitats in Ngederrak MPA.

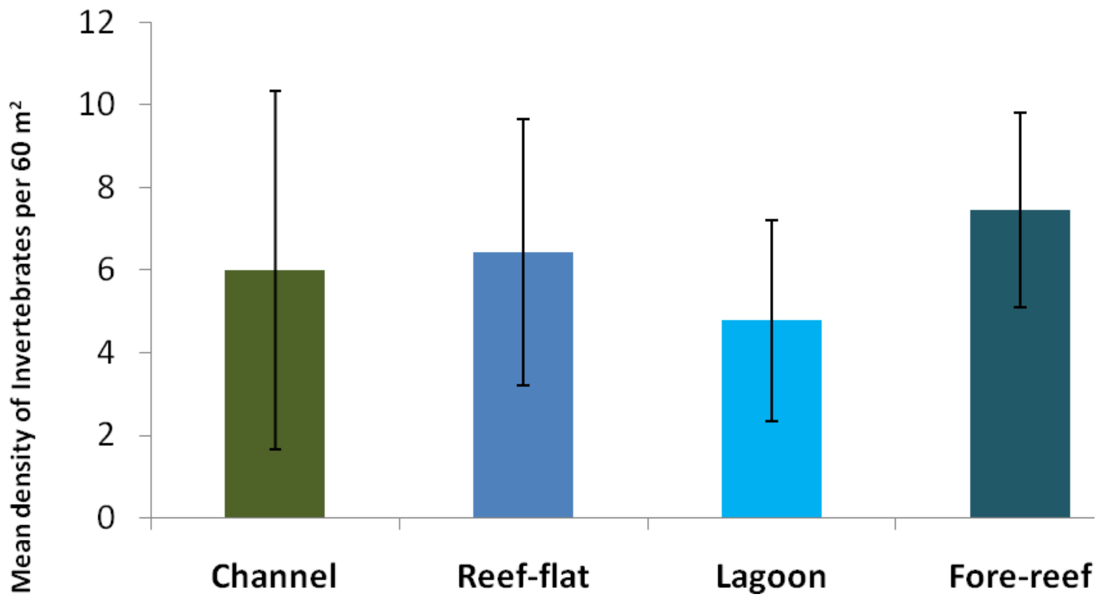

Figure 4. Mean Invertebrate density for each habitat in Ngederrak Marine Protected Area. Error bars indicate standard errors.

3.3 Coral Recruits Density

The mean coral recruitment density was the highest in the reef-flat habitat with 11.6 (SE ± 3.8) individuals per $3m^2$, with the lowest recruitment density occurring in the Channel habitat with 4 (SE ± 1.4) individuals per $3m^2$ (Fig. 5).

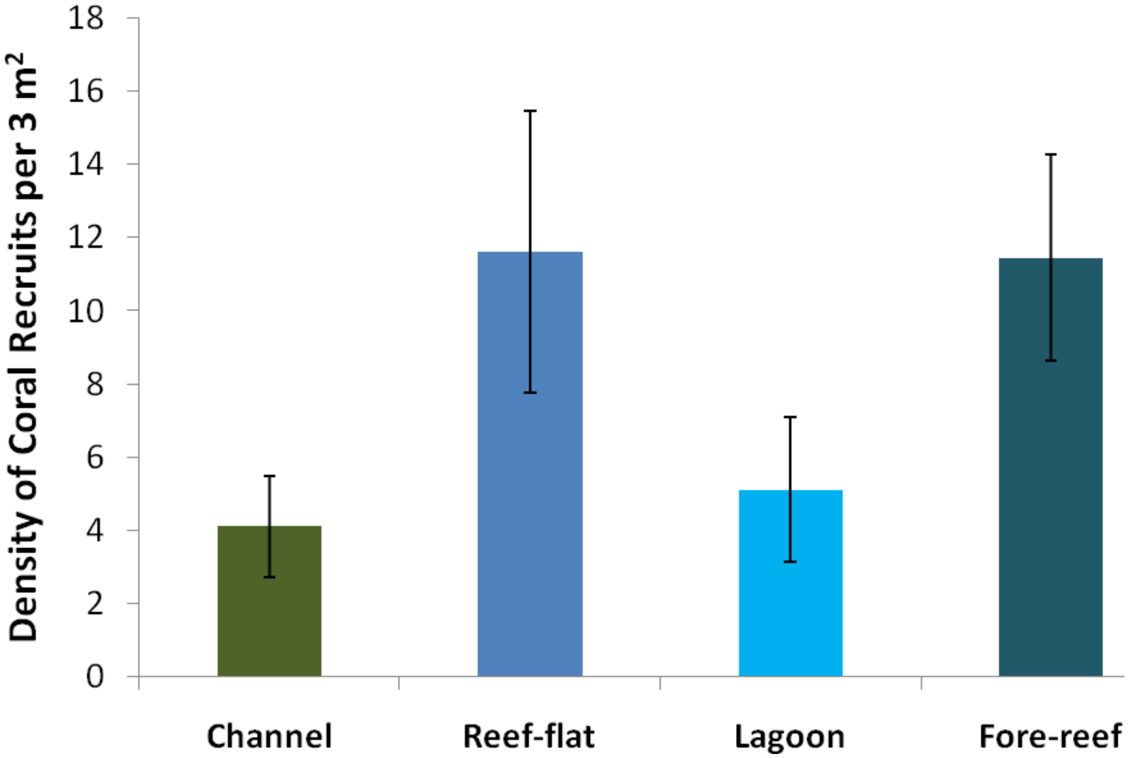

Figure 5. Mean Coral Recruits density for each habitat in Ngederrak Marine Protected Area. Error bars indicate standard errors.

3.4 Benthic composition

The habitat showing the highest coral cover was the lagoon which had an average coral cover of 33% (SE ± 12) , while the habitat showing the lowest coral coverage was the fore-reef with an average coral coverage of 5.4% (SE ± 0.6) (Fig.6). Carbonate percentages were the highest in the fore-reef habitat (43% SE ± 9.3), and lowest in the reef-flat habitat (6.8% SE ± 2.7) (Fig. 6). Sea grass coverage occurred in the reef-flat habitat with a mean sea grass cover of 14% and mainly composed of *Thalassia hemprichii* (Fig. 6).

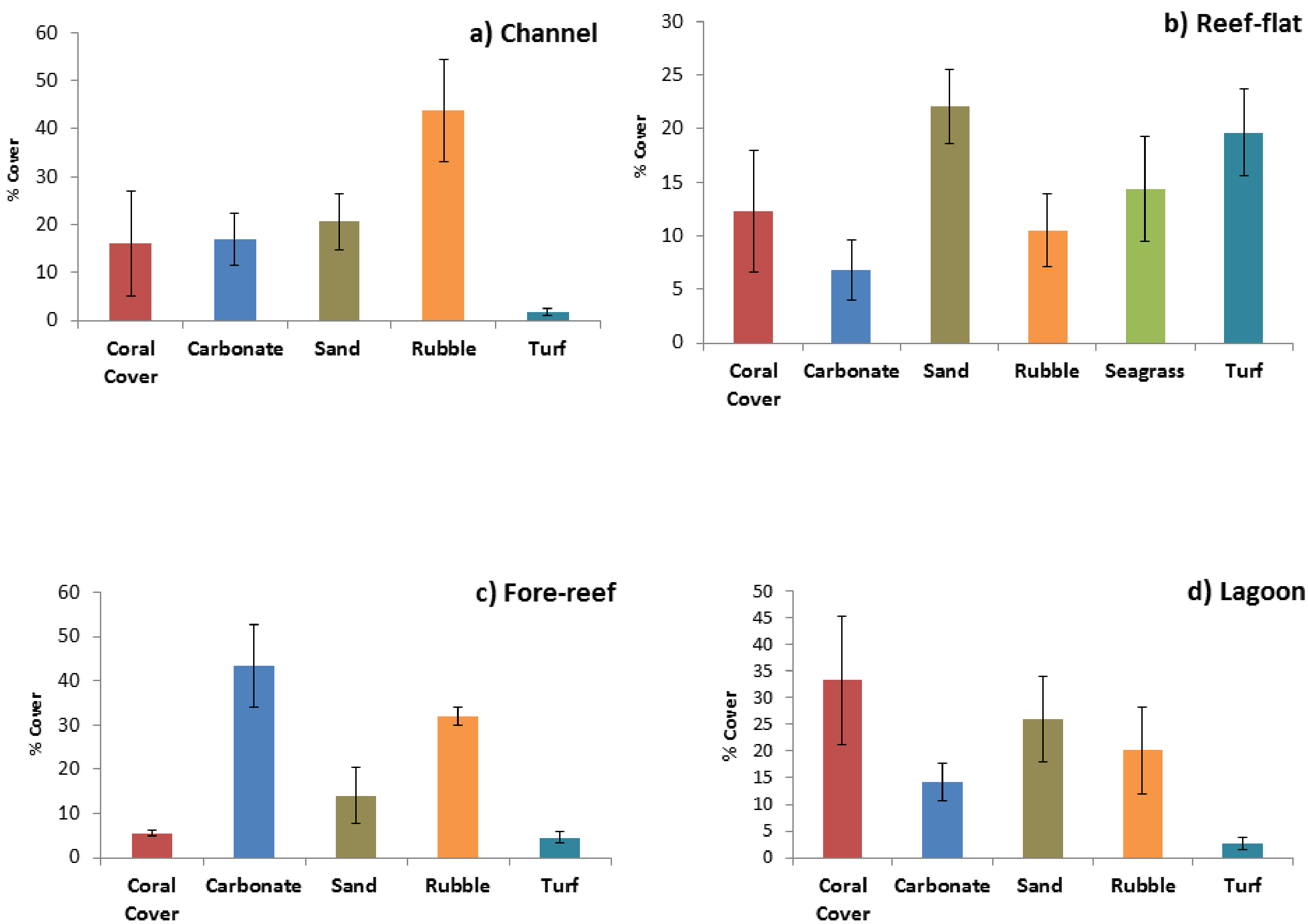

Figure 6. Benthic coverage in the a) Channel b) reef-flat c) fore-reef, and d) lagoon habitats within Ngederrak Marine Protected Area. Error bars indicate standard errors.

4. Discussion

The focus of this study in Ngederrak MPA was to collect baseline data on specific ecological indicators that will provide resource managers and relevant stakeholders the necessary information for adaptive management of MPAs.

In terms of commercially important fish species, the mean biomass of fish was the highest in the fore-reef habitat with an average biomass of 14,284.5 (SE ± 3821) g per 150 m^2 (Fig. 3). Fish densities within Ngederrak MPA were also the highest in the fore-reef habitat with an average density of 27.5 (SE ± 7.2) individuals per 150 m^2 (Fig. 4). This shows that there are larger and more fish in the fore-reef compared to the other habitats. Additionally, because reserves hold more and larger fish, protected populations can potentially produce many times more offspring than can exploited populations (Roberts et al 2001).

Invertebrate densities were also the highest in the fore-reef habitat with 7 (SE ± 2.3) individuals per 60 m^2, compared with the channel, reef-flat and lagoon habitats, with *Tridacna crocea* as the predominant species in all habitats. Coral cover was the highest in the lagoon with a mean coverage of 33% (SE ± 12), with carbonate (43%) SE ± 9.3 cover being the highest in the fore-reef habitat (Fig. 6).

The low percentage of coral coverage in the fore-reef habitat could highly be influenced by recent natural disturbances such as typhoon Bopha in Palau in 2012. However, the high densities of coral recruitment in the fore-reef habitat, could indicate a positive sign for reef recovery after such natural disturbances. In addition, the reef-flat habitat is also composed of a large sea grass meadow, which acts as a nursery for juvenile fish.

All of the four major habitats within Ngederrak MPA provide a good system for ecosystem connectivity, as most marine organisms have a larvae stage and migrate throughout various ecosystems throughout their lifespan. The results presented in this report serve as baseline information of the marine resources within Ngederrak MPA. In order to assess the effectiveness of Ngederrak MPA as an effective marine conservation tool, continuous monitoring of the ecological indicators as outlined in this report is required. Future biological monitoring overtime will also enable resource managers and relevant stakeholders to make better informed decisions regarding the management of Ngederrak MPA.

Acknowledgements

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Appendix 1: Commercially important fish species.

	Scientific name	**Palauan name**
1	*Caranx ignobilis*	Erobk
2	*Caranx melampygus*	Oruidel
3	*Cetoscarus bicolor*	Beadel/Ngesngis
4	*Cetoscarus/Scarus Spp.*	Mellemau
5	*Choerodon anchorago*	Budech
6	*Hipposcarus longiceps*	Ngiaoch
7	*Hiposcarus harid*	Bekism
8	*Kyphosus spp (vaigiensis)*	Komud, Teboteb
9	*Lethrinus obsoletus*	Udech
10	*Lethrinus olivaceus*	Melangmud
11	*Lethrinus rubrioperculatus*	Rekruk
12	*Lethrinus xanthochilis*	Mechur
13	*Liza vaigiensis*	Uluu
14	*Lutjanus argentimaculatus*	Kedesau'liengel
15	*Lutjanus bohar*	Kedesau
16	*Lutjanus gibbus*	Keremlal
17	*Naso lituratus*	Cherangel
18	*Naso unicornis*	Chum
19	*Plectorhinchus albovittatus*	Melimralm, Kosond/Bikl
20	*Plectorhinchus crysotaenia*	Merar
21	*Scarus micorhinos*	Otord

22	*Siganus argenteus*	Beduut
23	*Siganus lineatus*	Kelsebuul
24	*Siganus puellus*	Reked
25	*Siganus punctatus*	Bebael
26	*Valamugil seheli*	Kelat
Protected Fish Species (yearly and seasonal fishing closure)		
27	*Bolbometopon muricatum*	Kemedukl
28	*Cheilinus undulatus*	Maml
29	*Epinephelus fuscoguttatus*	Meteungerel'temekai)
30	*Epinephelus polyphekadion*	Ksau'temekai
31	*Plectropomus areolatus*	Tiau
32	*Plectropomus laevis*	Tiau, Katuu'tiau, Mokas
33	*Plectropomus leopardus*	Tiau
34	*Siganus fuscescens*	Meyas

Appendix 2: Edible and Commercially valuable Macro-invertebrates.

	Scientific name	**Palauan name**
1	*Actinopyga echinites*	Eremrum, cheremrum
2	*Actinopyga lecanora*	Ngelau
3	*Actinopyga mauritiana*	Badelchelid
4	*Actinopyga miliaris*	Eremrum, cheremrum edelekelk
5	*Actinopyga palauensis*	Eremrum, cheremrum
6	*Actinopyga sp.*	Eremrum, cheremrum
7	*Bohadschia argus*	Meremarech, esobel
8	*Bohadschia similis*	Meremarech
9	*Bohadschia vitiensis*	Meremarech
10	*Hippopus hippopus*	Duadeb
11	*Holothuria atra*	Cheuas
12	*Holothuria coluber*	Cheuas
13	*Holothuria edulis*	Cheuas
14	*Holothuria fuscogilva*	Bakelungal-cherou
15	*Holothuria fuscopunctata*	Delal a molech
16	*Holothuria impatiens*	Sekesaker
17	*Holothuria lessoni*	Delal a molech
18	*Holothuria leucospilota*	Cheuas
19	*Holothuria nobilis*	Bakelungal-chedelkelek
20	*Holothuria scabra*	Molech
21	*Holothuris falvomaculata*	Cheuas

22	*Pearsonothuria graeffei*	Meremarech
23	*Stichopus chloronotus*	cheuas
24	*Stichopus hermanni*	Delal a ngimes/ngimes ra tmolech
25	*Stichopus horrens*	Irimd
26	*Stichopus vastus*	Ngimes
27	*Thelenota ananas*	Temetamel
28	*Thelenota anax*	Belaol
29	*Tridacna crocea*	Oruer
30	*Tridacna derasa*	Kism
31	*Tridacna gigas*	Otkang
32	*Tridacna maxima*	Melibes
33	*Tridacna squamosa*	Ribkungel
34	*Tripneustes gratila*	Ibuchel
35	*Tectus nilotichus*	Semum