NGERMEDELLIM MARINE SANCTUARY AREA BASELINE

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Abstract

In Palau, conservation has evolved from the traditional *Bul* to the now commonly used Marine Protected Areas (MPAs). Throughout time, research on MPAs and conservation has enhanced the effectiveness of MPAs through use of traditional knowledge combined with expert science and the development of MPA networks. The focus has now shifted towards addressing anthropogenic impacts, thus creating a resilient system to better handle increasing natural stresses. Palau has enacted the Protected Areas Network (PAN) in order to create a resilient and effective network of MPAs in Palau by providing a source of relavent science and sustainable finance for PAN sites. We conducted a baseline survey in the Ngermedellim Marine Sanctuary, located in Melekeok State, in order to support the goals of PAN. Our results show that the Ngermedellim Marine Sanctuary was hit hard by the typhoon Bopha and Haiyan in 2012 and 2013 but the ecosystem is showing potential signs of recovery. High seagrass cover allows for a sanctuary and nursery for important herbivorous reef fish while low turf and macroalgal cover provides a suitable habitat for coral recruitment to occur. Long-term monitoring is highly recommended to identify if recovery is occuring.

Introduction

The people of Palau and other island nations rely on the coral reef ecosystems for the services they provide such as protection from storms and surges, revenue gained from tourism, and of course, food (Costanza et al. 1997). Due to local threats and changes in the climate, coral reef are becoming increasingly threatened, necessitating a need for conservation and management. One management practice is the use of Marine Protected Areas (MPAs). MPAs can be used to reduce the effects of some of the major threats to reefs such as overfishing and increased land-use (Anthony et al. 2011 & Halpern 2003).

After residence of the state of Melekeok raised concerns about fishing activities within the Ngerang reefs, the Melekeok State Legislature established the Ngermedellim Marine Sanctuary in November 1999. The goal of this survey was to protect the Ngerang reef flats primarily as a clam conservation area, which prohibits the removal of giant clams, to prevent further loss of marine flora and fauna and as a potential area for regulated activities. In 2010, the Ngermedellim Marine Sanctuary became an established Protected Areas Network (PAN) site. The goal of PAN is to provide a form of sustainable funding in order to effectively conserve and protect the biodiversity of Palau.

To support management, monitoring is needed to determine if management objectives are being met. On (this date), PICRC researchers conducted surveys to assess the conditions of fish, invertebrates and the benthic communities within the Ngermedellim Marine Sanctuary.

Methods

Study Location

The Ngermedellim Marine Sanctuary is located in Melekeok State along the northwestern barrier reef of Palau in 07°31.2200'N, 134°38.1900'E. It covers approximately 0.45 km^2 and has two major habitats, a reef flat and a seagrass bed. The monitoring protocol followed a stratified sampling design. Random stations locations were allocated within each habitat present in the MPA (reef flat and seagrass beds) depending on their size using Hawths Tools (Arcview Extension) (Figure 1). Areas smaller than 900,000m^2 were allocated 3 random points; areas from 1km^2 to 5km^2 in size were allocated 1 random point per 300,000m^2.

A hand-held GPS was used to locate the survey stations in the field. Three 30-m transects were laid at each station at a depth of maximum 5 meters in the same direction than the current, one after the other with few meters separating them.

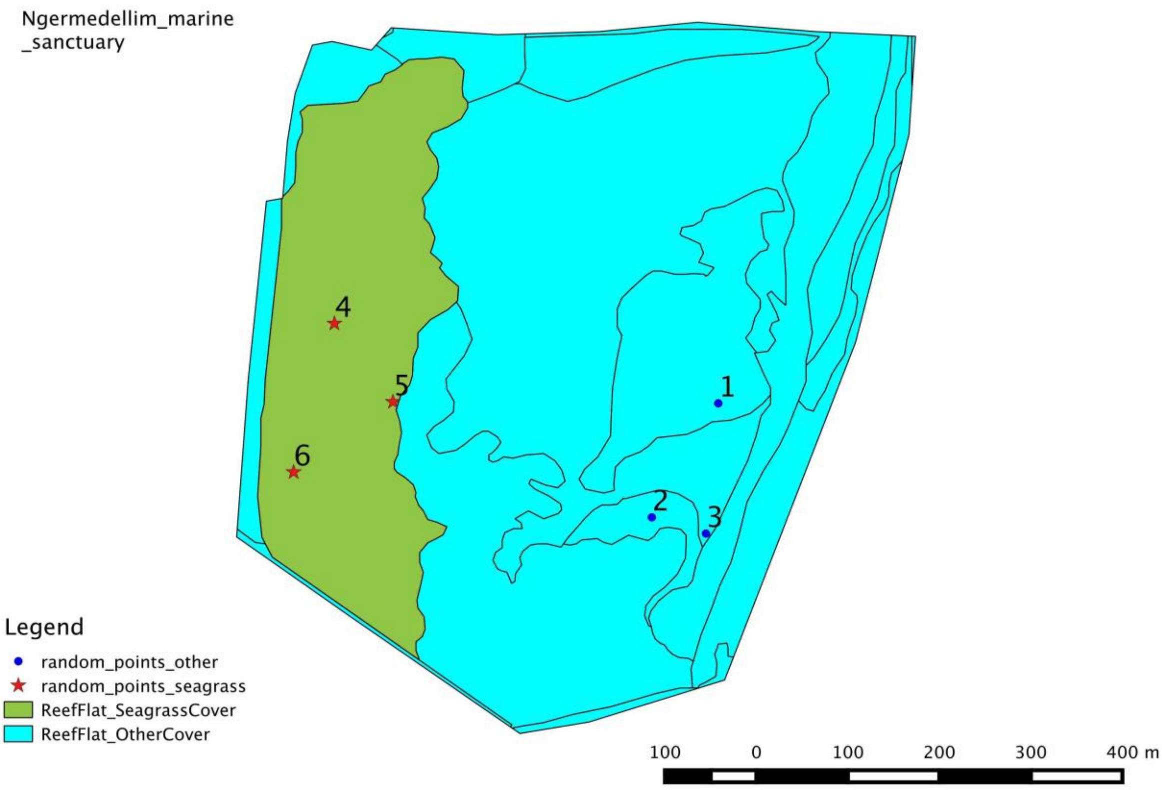

Figure 1. This is a map of the sites surveyed in the Ngermedellim Marine Sanctuary.

Field Sampling

Underwater Visual Census (UVC) surveys were conducted along a 5 m (wide) x 30 m (long) belt transect, where fish size and abundance were estimated. Thirty four commercially important fish species were surveyed due to their importance within Palauan fisheries (Table 1). Invertebrate surveys were conducted along a 2m (wide) x 30m (long) belt transect, where commercially important invertebrate abundances were counted (Table 2). Benthic cover were conducted using a 1 x 1 m photoquadrat sampled every meter along the 30 m transect (Table 3). Coral recruits smaller than 5 cm along the longest axis were also recorded within the 0.30 m (wide) x 10 m (long) belt transect.

Data Analysis

All analyses were conducted using Microsoft Excel.

Fish density, size and biomass.

Fish density and biomass were compared among habitat types within the Ngermedellim Marine Sanctuary and the biomass was determined using the total length-weight conversion equation below:

Biomass = a*Total Length^b

The a and b coefficeints can be found on FishBase (http://www.fishbase.org) and in Kulbiki, et al. 2005.

Invertebrate density

The mean density of commerically-important invertebrates was determined within the reef flat and the seagrass habitats.

Benthic cover

Photoquadrats were analyzed using Coral Point Count with Excel Extension (CPCe®). Five points were placed randonly on each photo and the benthic cover was identified underneath each point with corals identified to the genus level. The average value over the 3 transects of each benthic category identified was determined within the reef flat and the seagrass habitats.

Coral recruit density

The mean density of coral recruits per habitat was analyzed using Microsoft Excel.

Results

Fish Density, Biomass and Size

The average density of commercially-important fish was about 25 ± 0.5 individuals per $150m^2$ within the reef flat and about 3 ± 0.7 individual fish per $150m^2$ within the seagrass habitat (Figure 2). Also the mean biomass of fish within the reef flat was about 195 ± 66.5g per $150m^2$ and then aobut 178 ± 152.5g per $150m^2$ (Figure 3). In Figure 4, the average fish size was about 18.5 ± 0.5 cm within the reef flat and then 17 ± 1.1 cm within the seagrass.

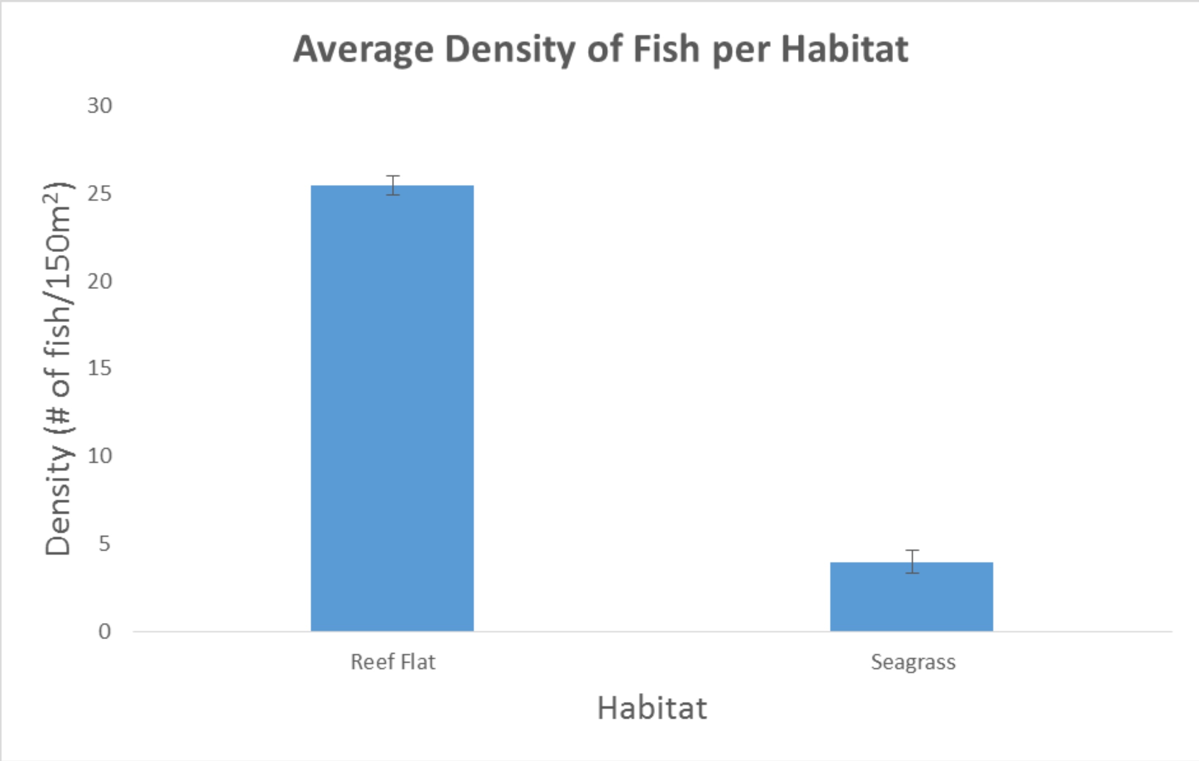

Figure 2. The average density of commercially-important fish per habitat with standard error.

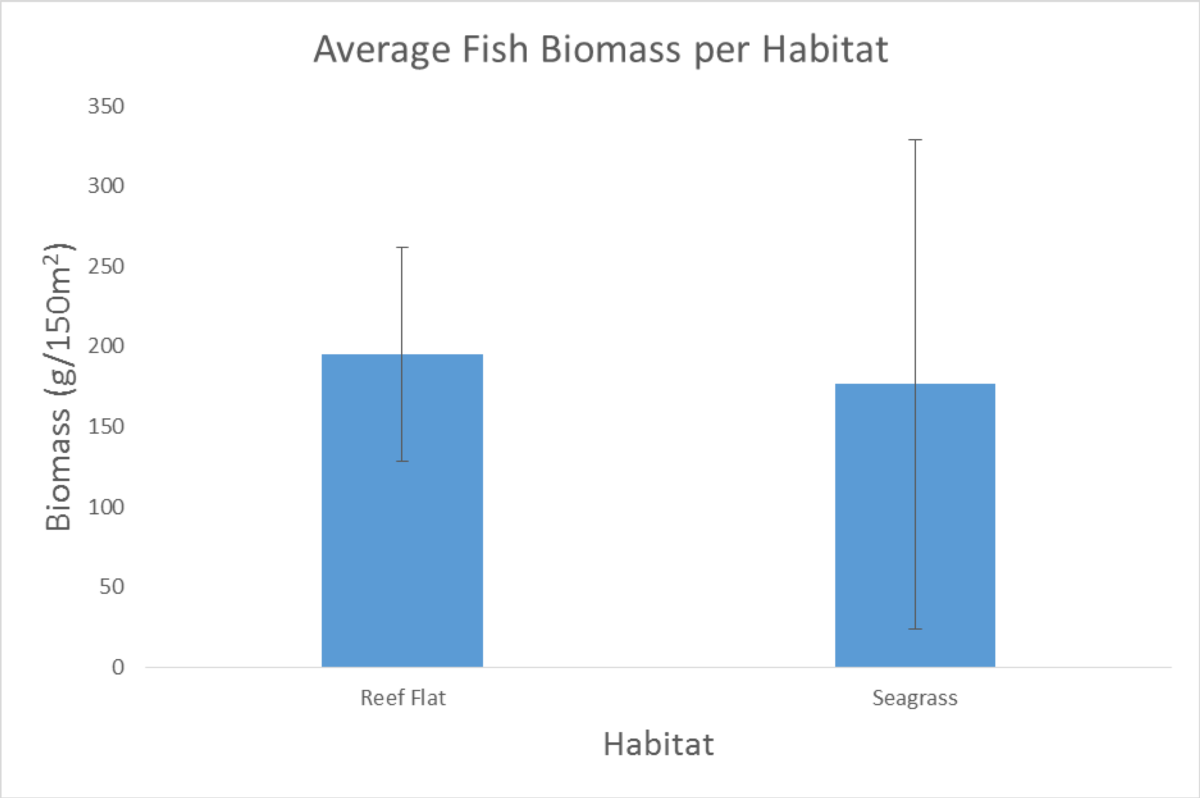

Figure 3. Mean biomass of commercially-important fish species per habitat.

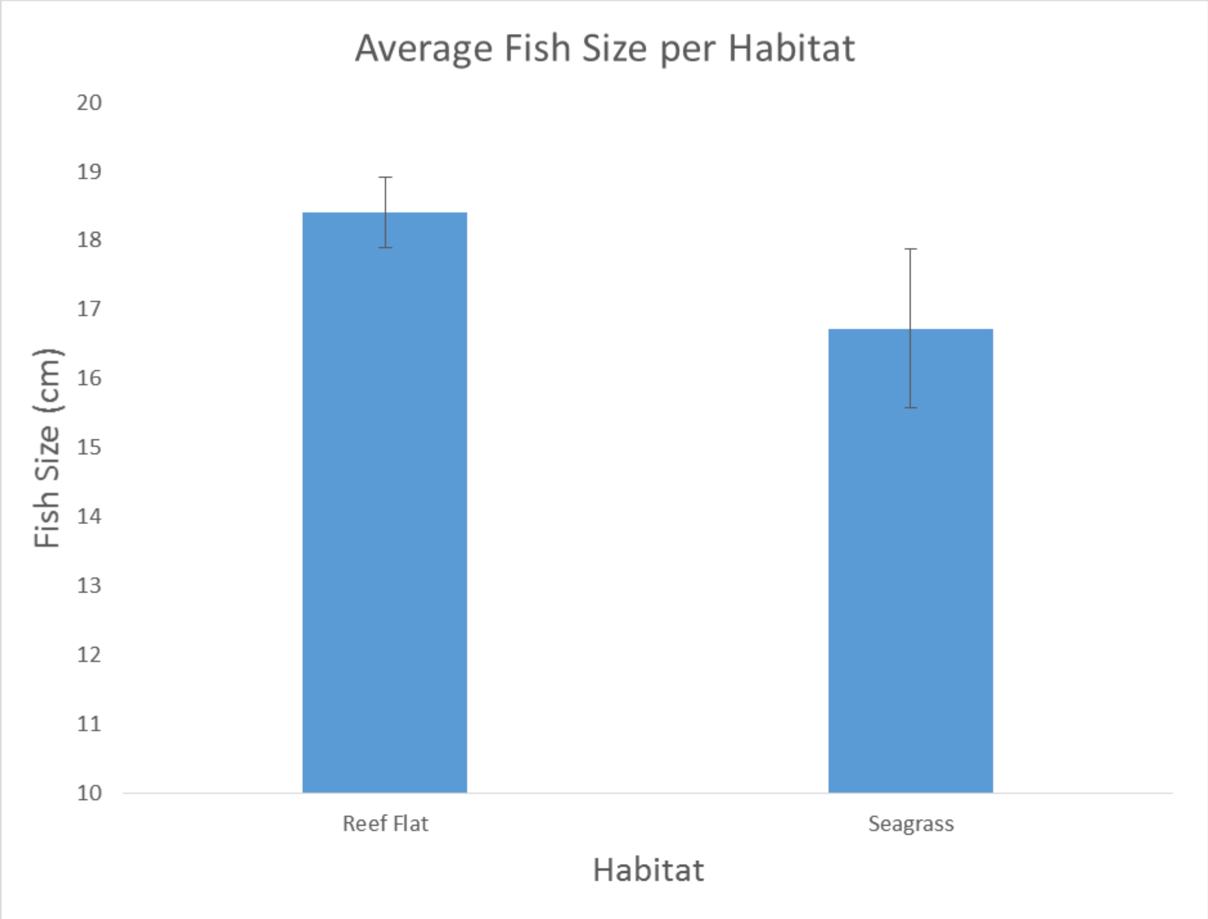

Figure 4. The average size of commercially-important fish species per habitat.

Invertebrate Density

The mean density of commercially-important invertebrates was 5.3 ± 0.3 invertebrates per $10m^2$ within the reef flat and within the seagrass the mean density was slightly lower at about 2.8 ± 0.4 invertebrates per $10m^2$ (Figure 5).

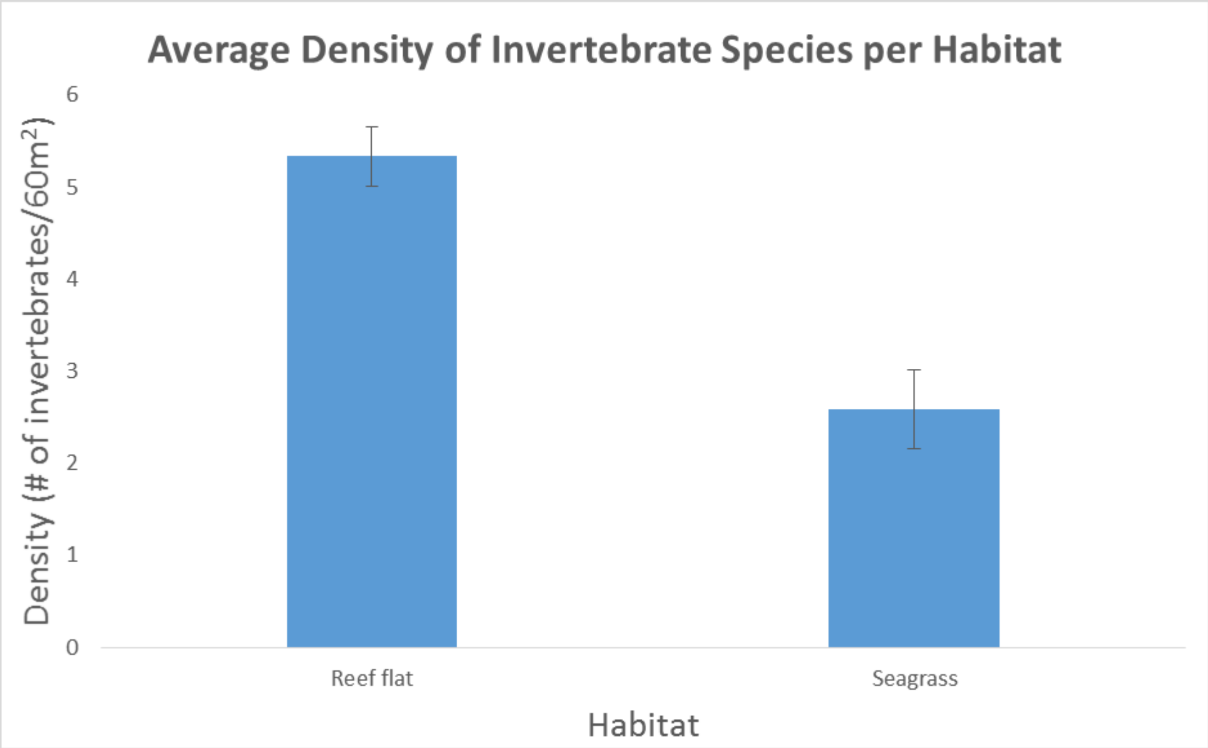

Figure 5. Mean density of commercially-important invertebrate across habitat types with standard error included.

Benthic Cover

Within the reef flat, the dominant substrate was rubble at about 46 ± 12.5% cover followed by carbonate at 35 ± 8.6% and sand at 12 ± 4.6%. Turf, crustose-coralline algae and coral cover were all below 5% cover (Figure 6).

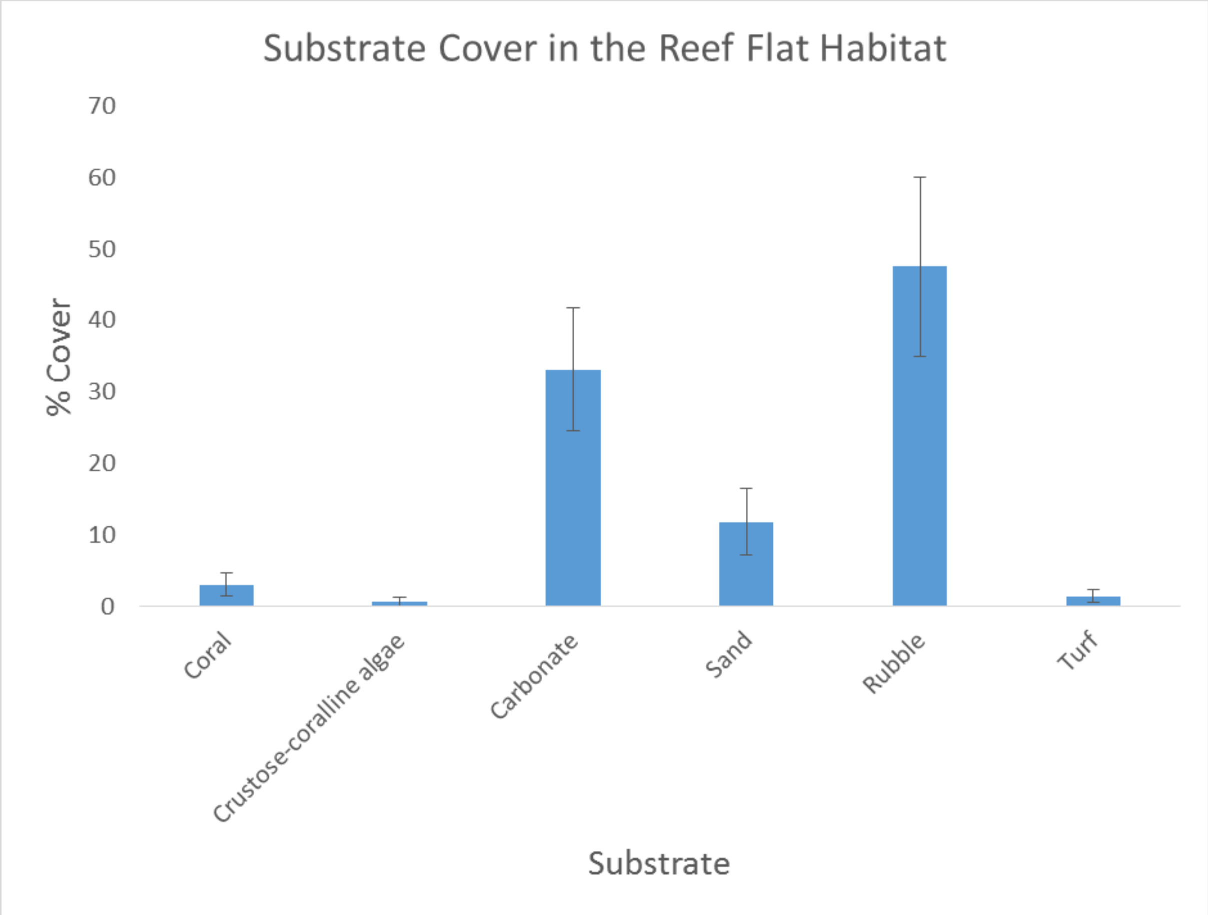

Figure 6. This graph depicts the average substrate cover within the reef flat of the Ngermedellim Marine Sanctuary.

The dominant substrate within the seagrass habitat was the seagrass at about 70 ± 4.5% cover with the most dominant species being *Thalassia hemprichii*. Sand and turf followed at 10 ± 2.5% and 20 ± 3.2% respectively (Figure 7).

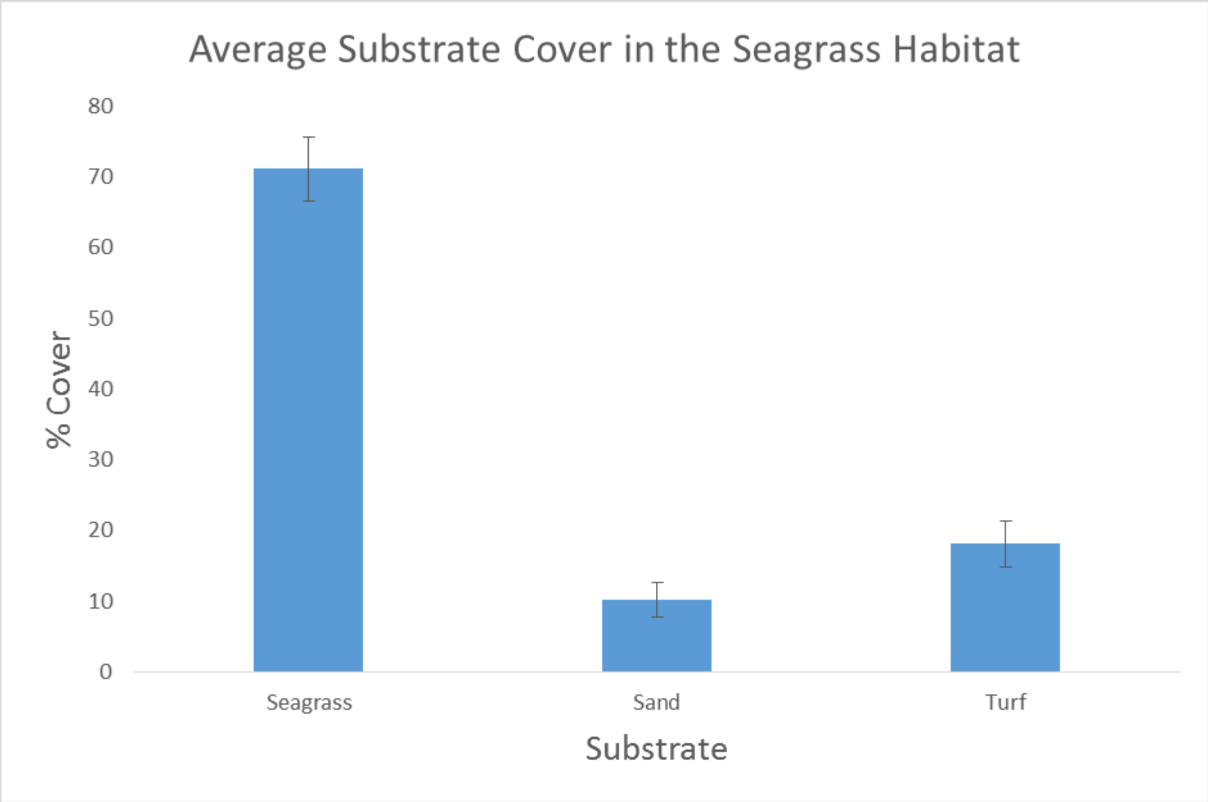

Figure 7. The figure below shows the average substrate cover of the three most prevalent substrates within the seagrass habitat.

Coral Recruit Density

The mean coral recruit density was about 2.8 ± 0.5 individual recruits per $10m^2$ within the reef flat (Figure 8).

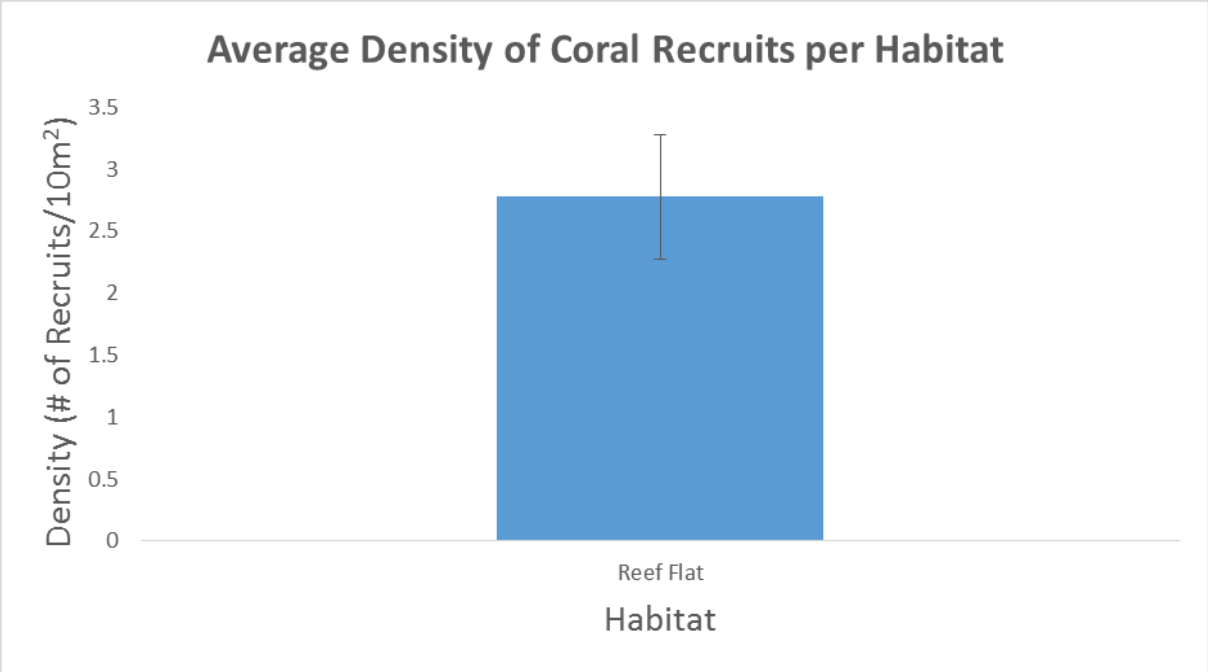

Figure 8. Mean coral recruit (<5 cm) density among the reef flat within the Ngermedellim Marine Sanctuary.

Discussion

Our goal for this survey was to provide the MPA management staff of Melekeok State baseline data on the Ngermedellim Marine Sanctuary so that throughout the years of protection, they can improve and adjust the design of the MPA and see how well enforced the protected area is.

Because of the close proximity between the seagrass and the reef flat, the reef flat supported larger, more mature fish as the seagrass supported more juveniles.

The two dominant benthic substrates within the reef flat was rubble at about 45 ± 12.5% and carbonate, at about 35 ± 8.6%, which may be due to the recent typhoons which hit Palau in 2012 and 2013, respectively, Bopha and Hayian. Coral cover was also very low, at about 5%, but turf and macroalgae cover was lower, at about 1%, which may indicate the presence of healthy hebivorous fish community and will help with the recovery of the reef post-disturbance Coral recruitment rates in the reef flat was relatively low compared to other MPAs in Palau and will have to be closely monitored in the coming years. Again, since macroalgae cover is low, corals will have a greater chance to recover.

In the seagrass bed habitat, the seagrass cover was high compared to other MPAs designated in similar habitats at 70 ± 4.5% which is important as this habitat acts as a nursery for juvenile reef fish to live in.

These baseline data collected within the Ngermedellim Marine Sanctuary helps to provide the information needed to make effective management decisions on the MPA design and marine resource avaiability for the state and people of Melekeok. Also, this baseline survey paired with long-term monitoring surveys helps to recognize if recovery is occuring within the reef and seagrass habitats after the recent typhoon events.

Aknowledgements

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Appendix

Table 1. Scientific names of commercially-important fish surveyed.

Scientific Name
Acanthurus lineatus
Acanthurus maculiceps
Acanthurus nigricaudus
Acanthurus olivaceus
Acanthurus triostegus
Acanthurus xanthopterus
Aethaloperga rogaa
Aprion virescens
Balistoides viridescens
Bulbometopon muricatum
Carangoides ferdau
Carangoides orthogrammus
Caranx ignobilis
Caranx lugubris
Caranx melampygus
Caranx sexfasciatus
Cephalophalus argus
Cetoscarus bicolor
Cheilinus fasciatus
Cheilinus undulatus
Chlorurus bleekeri
Chlorurus microrhinos
Chlorurus sordidus
Choerodon anchorago
Ctenochaetus striatus
Elegatis bipinnulatus
Epibulus insidiator
Epinephelus fuscoguttatus
Epinephelus lanceolatus
Epinephelus malabaricus
Epinephelus merra
Epinephelus polyphekadion
Gymnosarda unicolor
Hipposcarus hariid
Hipposcarus longiceps
Kyphosus vaigiensis
Leptoscarus vaigiensis

	Lethrinus erythracanthus	
	Lethrinus erythropterus	
	Lethrinus harak	
	Lethrinus obsoletus	
	Lethrinus olivaceus	
	Lethrinus xanthochilus	
	Lutjanus bohar	
	Lutjanus ehrengbergii	
	Lutjanus fulvus	
	Lutjanus gibbus	
	Lutjanus kasmira	
	Lutjanus monostigma	
	Macolor niger	
	Monotaxis grandoculis	
	Mulloidichthys flavolineatus	
	Myrispistis adusta	
	Naso brachycentron	
	Naso lituratus	
	Naso tuberosus	
	Naso unicornis	
	Parupeneus barberinus	
	Plectorhinchus chaetodonoides	
	Plectorinchus albovittatus	
	Plectorinchus lineatus	
	Plectropomus areolatus	
	Plectropomus laevis	
	Plectropomus leopardus	
	Pomocanthus sexstriatus	
	Rastelliger kanagurta	
	Sargocentron spiniferum	
	Scarus altipinnis	
	Scarus dimidiatus	
	Scarus globiceps	
	Scarus gohbban	
	Scarus niger	
	Scarus oviceps	
	Scarus prasiognathos	
	Scarus psittacus	
	Scarus rubroviolaceus	
	Scarus tricolor	
	Scarus xanthopleura	

Siganus argenteus
Siganus doliatus
Siganus fuscescens
Siganus guttatus
Siganus lineatus
Siganus puellus
Siganus punctatus
Sphyraena barracuda
Variola louti

Table 2. Scientific names of surveyed invertebrates

Invertebrates
Actinopyga echinites
Actinopyga lecanora
Actinopyga mauritiana
Actinopyga miliaris
Actinopyga palauensis
Actinopyga sp.
Bohadschia argus
Bohadschia similis
Bohadschia vitiensis
Hippopus
Hippopus porcellanus
Holothuria atra
Holothuria coluber
Holothuria edulis
Holothuria fuscogilva
Holothuria fuscopunctata
Holothuria impatiens
Holothuria lessoni
Holothuria leucospilota
Holothuria nobilis
Holothuria scabra
Holothuris falvomaculata
Pearsonothuria graeffei
Stichopus chloronotus
Stichopus hermanni
Stichopus horrens

Stichopus vastus
Thelenota ananas
Thelenota anax
Tridaacna crocea
Tridacna squamosa
Tridacna derasa
Tridacna gigas
Tridacna maxima

Table 3. Coral genera surveyed.

Acanthastrea
Acropora
Alveopora
Anacropora
Astreopora
Caulastrea
Coral Unknown
Coscinaraea
Ctenactis
Cyphastrea
Diploastrea
Echinophyllia
Echinopora
Euphyllia
Favia
Faviid
Favites
Fungia
Galaxea
Gardininoseris
Goniastrea
Goniopora
Heliopora
Herpolitha
Hydnophora
Isopora
Leptastrea
Leptoria
Leptoseris
Lobophyllia
Merulina

Millepora
Montastrea
Montipora
Mycedium
Oulophyllia
Oxypora
Pachyseris
Pavona
Pectinia
Physogyra
Platygyra
Plerogyra
Plesiastrea
Pocillopora
Porites
Porites-massive
Porites-rus
Psammocora
Sandalolitha
Scapophyllia
Seriatopora
Stylocoeniella
Stylophora
Symphyllia
Turbinaria