

# Biological Survey of Ebiil Marine Protected Area

Koshiba S, Idechong JW, Isechal AL, Nakaya S, Merep A, Mereb G, Oldiais NW, Olsudong D, Yobeck KM



## Ngarchelong State

Palau International Coral Reef Center, 1 M-Dock Road, P.O. Box 7086, Koror, Palau 96940, Republic of Palau

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## 1. INTRODUCTION

Marine Protected Areas (MPAs) have become widely used throughout Palau and Micronesia as a strategy in conserving ecologically important and commercially targeted marine resources. Protection of such important coral reef resources requires monitoring overtime to assess changes and trends in resources. Through consistent monitoring, resource managers and relevant stakeholders are able to determine their progress towards achieving their objectives. One of the main goals of MPAs is to increase the density and biomass of fish populations as well as the abundance of coral communities inside and outside protected areas. However, it is unknown the degree to which the benthic organisms on coral reefs respond to such no-fishing bans. Previous studies have showed the positive effects of MPAs. Studies have demonstrated that MPAs increase fish biomass (Abemis et. al., 2006) as well as abundance (Hamilton et. al., 2011). Other studies have also showed that Marine Protected Areas increase species biodiversity (Francis et. al., 2002). Not only do MPAs increase fish biomass and abundance, MPAs also have a positive impact on benthic communities. As primary producers in a marine ecosystem, corals provide essential habitat for fisheries and other marine organisms. Protection of coral reef ecosystems can lead to a spillover effect, which essentially is the larval export of fisheries from a marine reserve to surrounding reef areas. Recent studies have provided evidence that protected reserve networks can make a considerable amount of contribution to the replenishment of populations on both reserve and fished reefs at a scale that benefits local stakeholders (Harrison et. al., 2011).

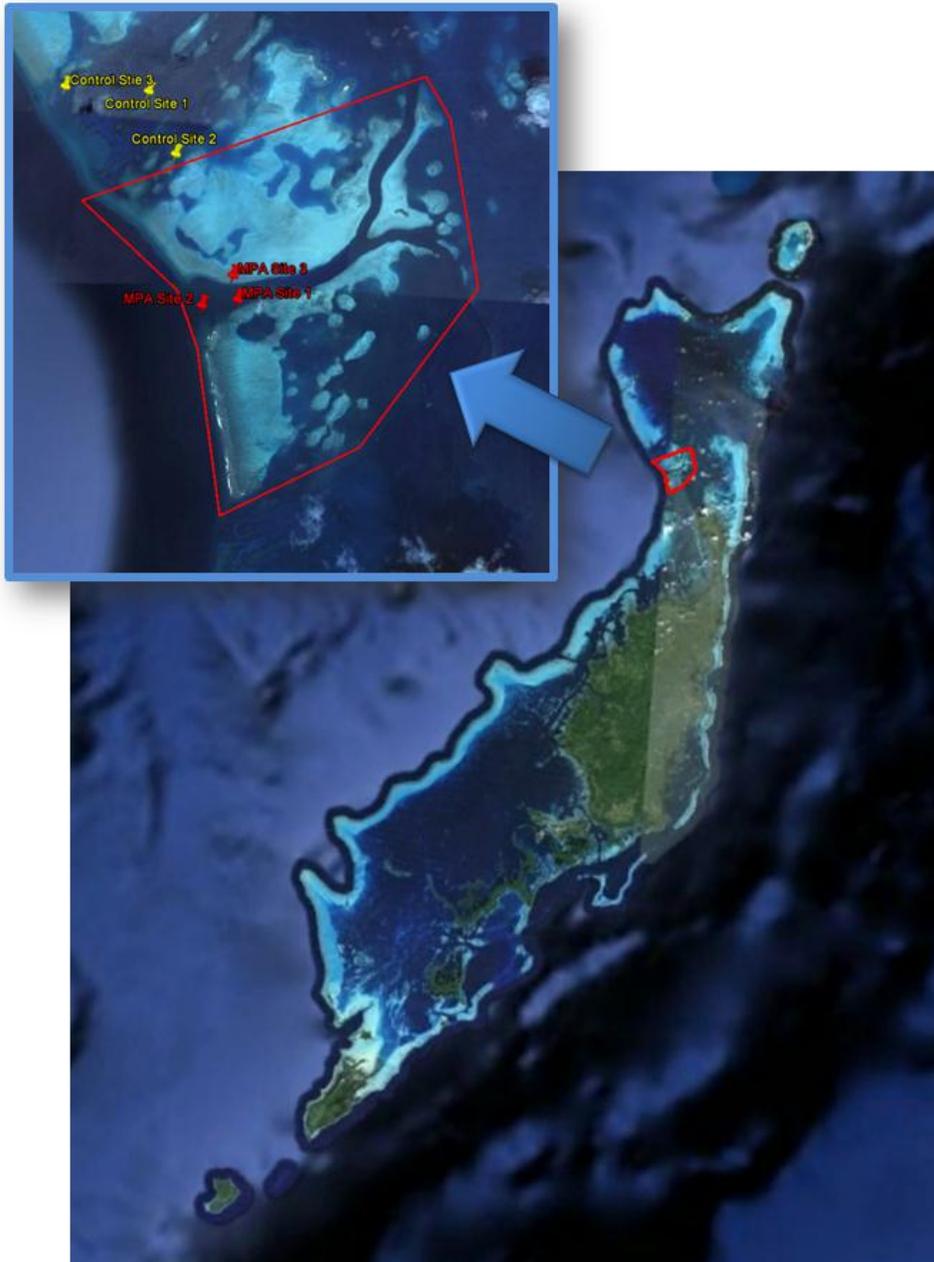
This study took place in Ebiil MPA, a known grouper spawning aggregation area, located in Ngarchelong in the northern reef of Babeldaob Island. In 2000, the marine area was placed under a traditional cease policy called *bul* by the traditional chiefs of Ngarchelong. Enforcement of the *bul* restricted entry and harvesting of marine resources in Ebiil. That same year, Ngarchelong State Government ratified the Ebiil

Conservation Area Act of 2000 designating the Ebiil channel and its surrounding reefs as a marine protected area. The purpose of this study was to assess the changes in resources inside and outside the Ebiil MPA. The objectives of this study were to: 1) determine the size, biomass, and density of fish populations inside and outside the MPA, 2) to determine the density and coverage of the benthic community. As these biological indicators are measured and monitored overtime, we will then be able to detect the changes and trends in the resources of Ebiil MPA as well as measure its progress in meeting its objectives.

## **2. MATERIALS AND METHODS**

### *Study Location*

Ebiil Marine Protected Area is located on the northern reefs of Palau Island. It is situated on the west coast barrier reef and has an area of 19 km<sup>2</sup>. It is a known grouper spawning aggregation site and has a channel shape habitat to which the channel extends 2.5 km into the lagoon. In 2000 it was closed to all forms of fishing.



**Figure 1. Map of Palau Island and the location of the Ebiil marine protected area and reference site. Inset figure shows the boundary of Ebiil marine protected area, the MPA sites, and reference sites.**

*Field methods*

Monitoring in Ebiil conservation area took place on October 15, 2010 to April 10, 2012, however the data presented in this report is only from 2011-2012 due to inconsistencies in data collection. This survey was carried out using the Palau Protected Area Network (PAN) Marine Protected areas (MPAs) monitoring protocol. In each MPA and reference site, 3 stations were randomly selected and marked by a Global Positioning System (GPS), with five 50m replicate transects in each station. Fish surveys were conducted using the visual-census technique, along five 50m x 5 m wide belt transects (total area per transect=250m<sup>2</sup>), with the fish surveyor swimming at approximately 1 m sec<sup>-1</sup>. Fish biomass was calculated using the length-weight relationship where TL is the total length in cm, and *a* and *b* are constants obtained from Fishbase. Invertebrate size and abundance were recorded along 2 m x50 m belt transects (total area per transect =100m<sup>2</sup>). Surveys of the benthic community were recorded using a digital camera that was installed on a 0.5 x 0.5 m photo quadrat. Photos of the benthos were taken on every meter on each transect (total of 50 photos per transect). The images were later analyzed in the laboratory using CPCe (Coral Point Count with excel extensions). Coral recruit surveys were conducted on a 0.3 x 10 m belt transect (total area per transect = 3m<sup>2</sup>) and were measured (diameter <5cm) and identified to the genus level. Data collected from the field were compiled and entered into an Excel spreadsheet and later analyzed with R Studio, and where appropriate data were transformed.

### 3. RESULTS

#### Fish

Fish biomass in the Ebiil MPA was significantly higher compared to the reference site. In 2011, fish biomass in the Ebiil MPA was 56,191 g 250m<sup>2</sup> while fish biomass in the reference site was 29,798 g 250 m<sup>2</sup>. Similarly, in 2012 fish biomass was significantly higher in the MPA 31, 984 g 250 m<sup>2</sup>, compared to the reference site which had an average biomass of 3,676 g 250 m<sup>2</sup> (Fig.1).

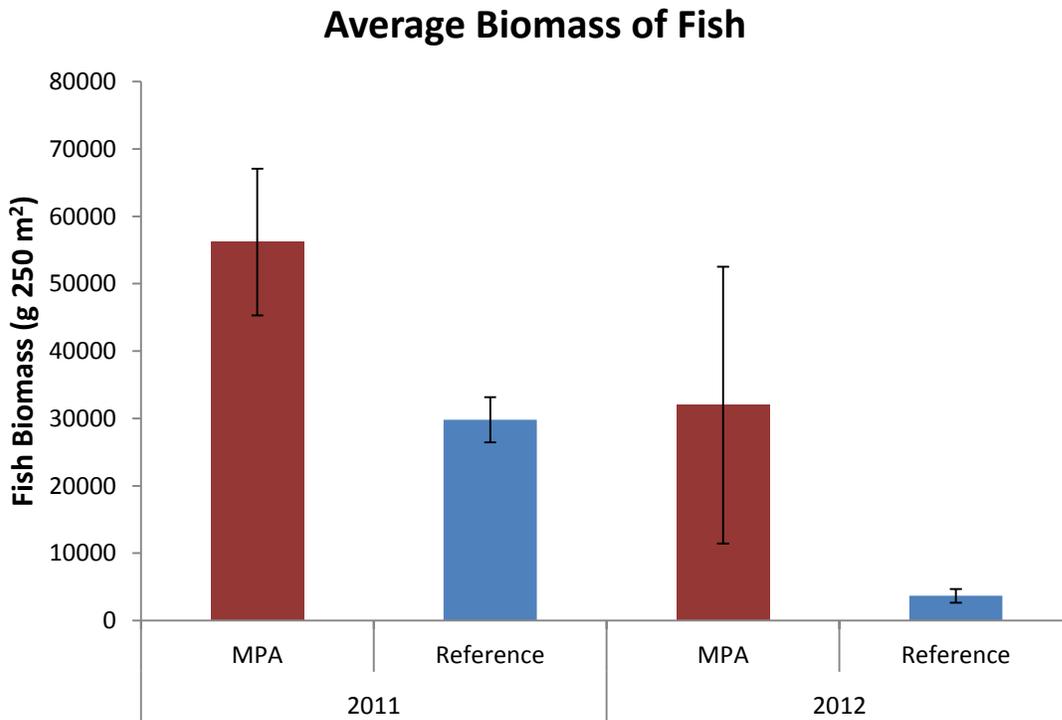


Figure 2. Shows the average biomass of fish per 250m<sup>2</sup> in the Ebiil MPA and reference site from 2011-2012.

Fish densities were higher in the Ebiil MPA compared to the reference site. In 2011, fish density in the Ebiil MPA had a mean value of 37.8 fish per station, while the reference site had an average of 30.7 fish per station. In 2012, fish density in the MPA was 15.06 fish per station and 10.1 fish per station, in the reference site. Although there was a trend of higher fish densities in the MPA compared to the reference site, these differences were not statistically different (Fig. 2).

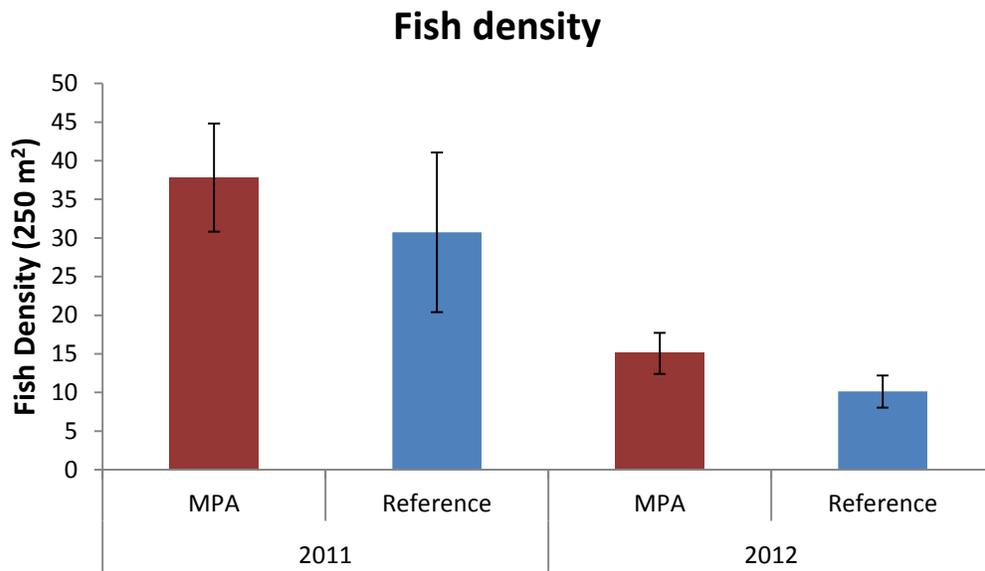
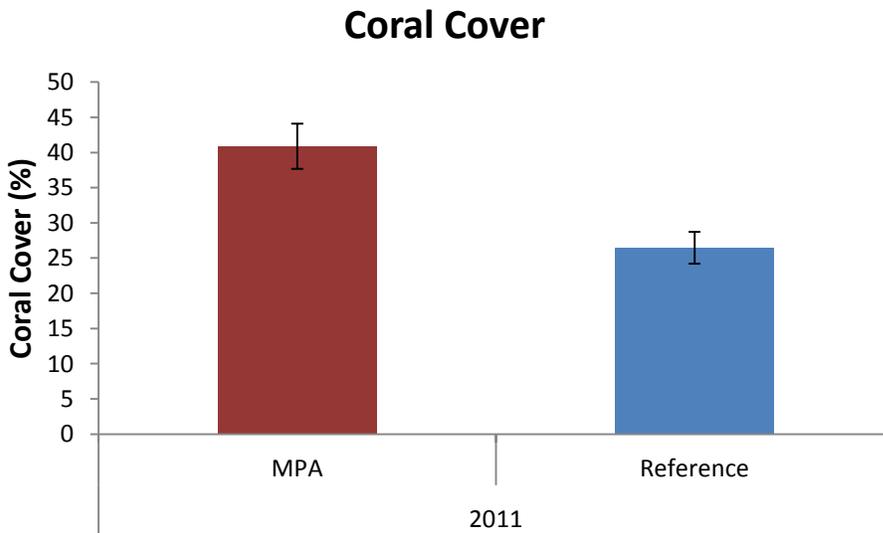


Figure 2. Shows the density of fish per 250m<sup>2</sup> in the Ebiil MPA and reference site from 2011-2012.

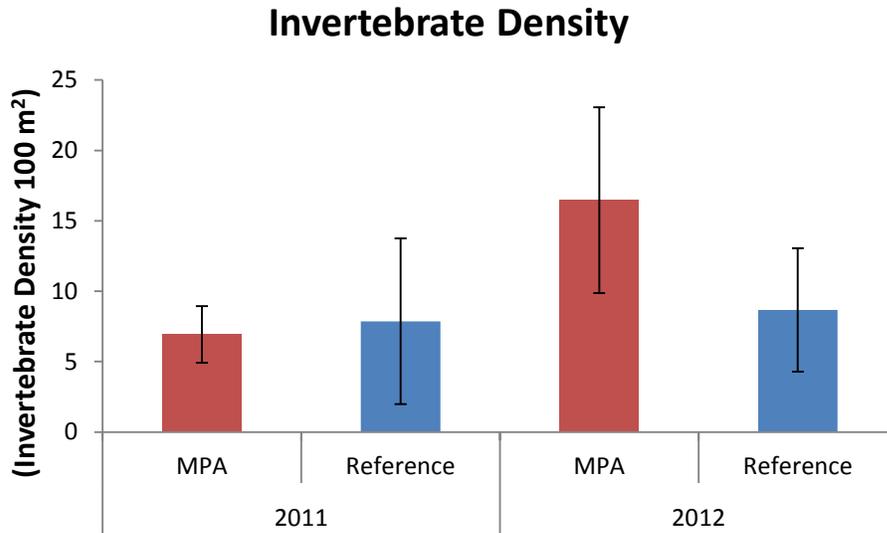
**Benthos**

Coral cover within the Ebiil MPA was significantly higher than that of the reference site. Mean coral cover inside the MPA was 40.88% while the reference site was 26.45% (Fig. 3).



**Figure 3. Shows the percentage of coral cover per 250m<sup>2</sup> in the Ebiil MPA and reference site in 2011.**

Invertebrate densities were higher in the Ebiil MPA compared with the reference site (Fig. 4), but were not significantly different. In 2011, invertebrate density in the Ebiil MPA was higher than the reference site with a mean value of 6.9 individuals per station, while the reference site had a mean value of 7.9 individuals per station. Similarly, invertebrate density in the Ebiil MPA in 2012 was 16.5 individuals per station compared to the reference site which had a mean value of 16.4 individuals per station.



**Figure 4. Shows the density of invertebrates per 100m<sup>2</sup> in the Ebiil MPA and reference site in 2011.**

Coral recruit densities was higher in the Ebiil MPA compared to the reference site however this was not statistically different. Density of coral recruits (i.e. < 5cm maximum diameter) in the Ebiil MPA was 25.4 individuals per 250 m<sup>2</sup>, while the reference site had an average density of 24 individuals per 250 m<sup>2</sup> (Fig. 5).

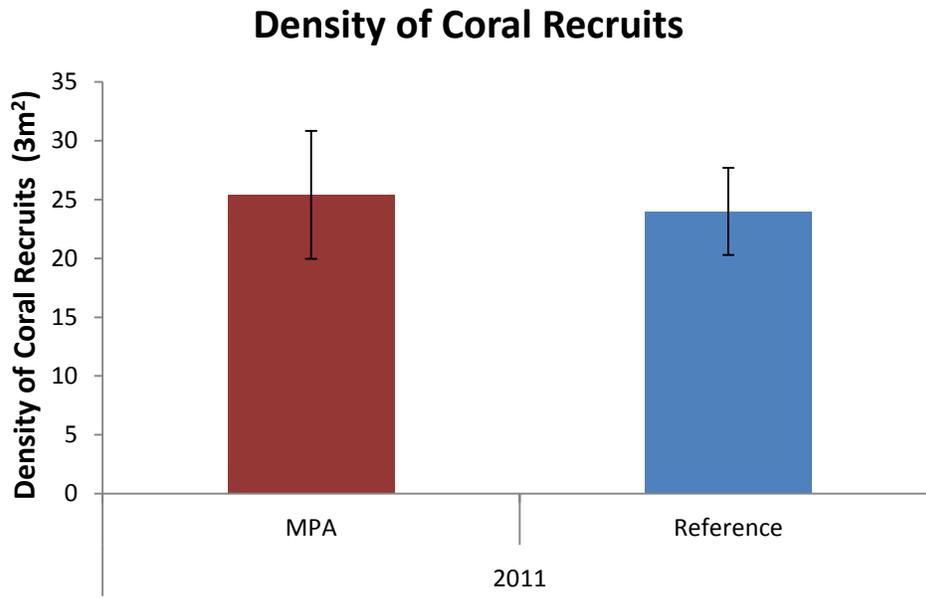


Figure 5. Shows the density of coral recruits per 3m<sup>2</sup> in the Ebiil MPA and reference site in 2011.

#### 4. DISCUSSION

Fish biomass was significantly higher in the Ebiil MPA compared to the reference site (Fig.1). Similarly, Ebiil MPA had a significantly higher coral coverage compared with the reference site (Fig.3). In terms of Fish densities, Ebiil MPA had higher fish densities compared to the reference site (Fig.2), similar to invertebrate and coral recruit densities which were higher in the Ebiil MPA compared to the reference site (Fig.4 and Fig. 5). Even though there was a trend in higher densities of fish, invertebrates, and coral recruits in the MPA, these differences were not statistically significant. Based on the data collected in Ebiil MPA and the reference site, our results show that there is a trend of higher fish biomass and an increase in coral coverage in Ebiil MPA compared with the reference site. This trend shows a positive impact of the protected area, as well as a positive relationship between fish populations and coral communities. Although there is no significant difference in fish, invertebrate and coral recruit densities between Ebiil MPA and the reference site, monitoring of these resources overtime, including stricter law enforcement will ensure a positive overall impact of Ebiil MPA. As studies have demonstrated the positive spillover effects of MPAs to fished reef areas, a study from the Great Barrier Reef, Australia, demonstrated that marine reserves covering 28% of a reef can supply approximately 50% of total fish recruits up to 30-km from the center of the reserve (Harrison et. al., 2012). Monitoring of marine resources overtime is an important component of adaptive management as resource managers and relevant stakeholders need to make informed decisions regarding management of protected areas. Given the trend in higher coral coverage and fish biomass in Ebiil MPA, continuous monitoring of these benthic organisms is needed to detect positive changes overtime, together with the implementation of consistent survey methods by trained individuals.

## **ACKNOWLEDGEMENTS**

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