The importance of long-term monitoring to assess the effectiveness of seagrass beds within a marine protected areas network in Palau, Micronesia

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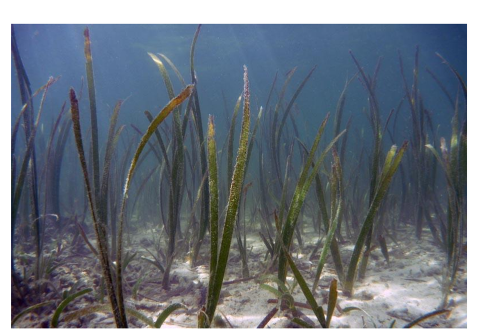
INTRODUCTION

Seagrass beds are an important marine ecosystem worldwide. Even though they only cover 0.1 -0.2% of the ocean, they provide an estimated $1.9 trillion per year in ecosystem benefits including providing habitat and nurseries for many economically-important fish and invertebrates, reducing land-based nutrients and suspended solids from flowing into the surrounding reefs, and sequestering atmospheric carbon (Costanza et al. 1997; Duarte, C.M. 2000; Duarte, C.M. 2002; Waycott, M. 2009). Human disturbances have resulted in major losses of seagrass beds throughout the world (Orth, R.J. et al., 2006; Waycott, M. 2009). In response to the loss of seagrass beds, resource managers have developed a variety of monitoring and management strategies aimed at assisting resource managers in making effective management decisions (Orth, R.J. et al., 2006). In the Republic of Palau, resource management has evolved from traditional practices to a government-supported network of sites, the Palau Protected Areas Network (PAN). The goal of PAN is to effectively and sustainably conserve both the terrestrial and marine habitats of Palau.
In order to effectively and sustainably conserve the seagrass beds in Palau and meet the goals of PAN, the Palau International Coral Reef Center (PICRC) has conducted surveys within four seagrass Marine Protected Areas (MPAs) since 2011, with three main goals: 1. to gauge the effectiveness of protection; 2. to better understand the status of the seagrass beds throughout Palau; and 3. to assess the status of fish populations within the seagrass beds. This monitoring effort is intended to give resource managers an indication of the general trends of fish, invertebrate and seagrass populations within their seagrass MPAs, from 2011 to present (2015).

METHODS

3 haphazardly chosen stations in each MPA and corresponding reference site

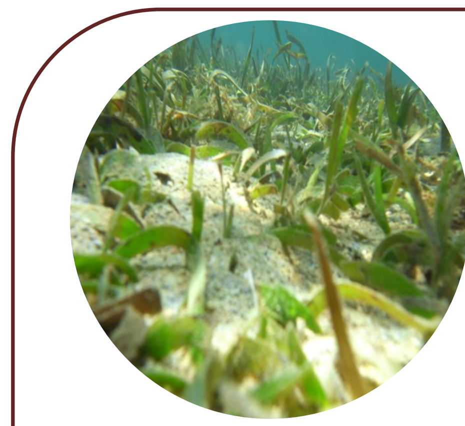
Underwater Visual Census (UVC) surveys were conducted along 5 x 5m (wide) x 25m (long) belt transect. Survey targeted 34 commercially important fish species twice a year. Fish length was converted to biomass using the standard length-weight relationship, using a and b constants from Kulbricki et al (2005).



Invertebrate surveys were conducted once a year along 5 x 2m (wide) x 25m (long) belt transect s. Commercially important macro-invertebrate species and abundance were recorded.

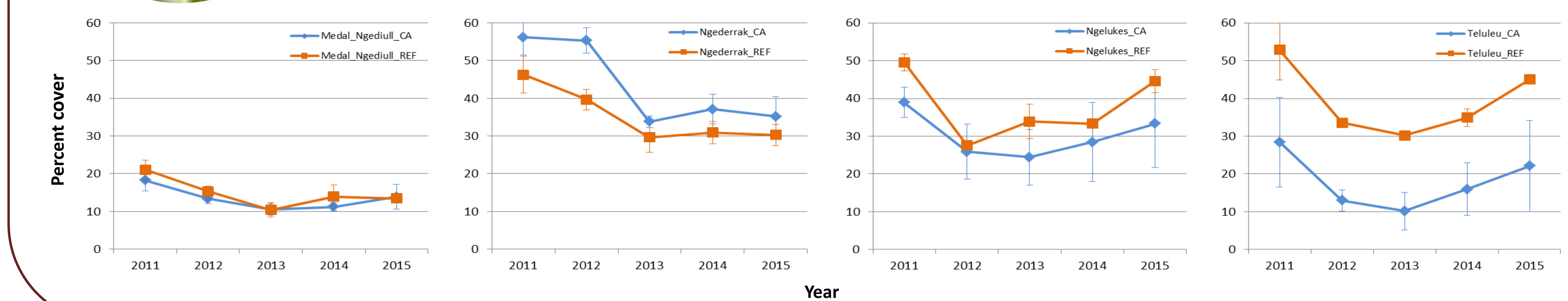
Seagrass cover was estimated once a year using a 0.5m x 0.5m quadrat placed at 5 meter intervals on each of the 5 transects.

RESULTS



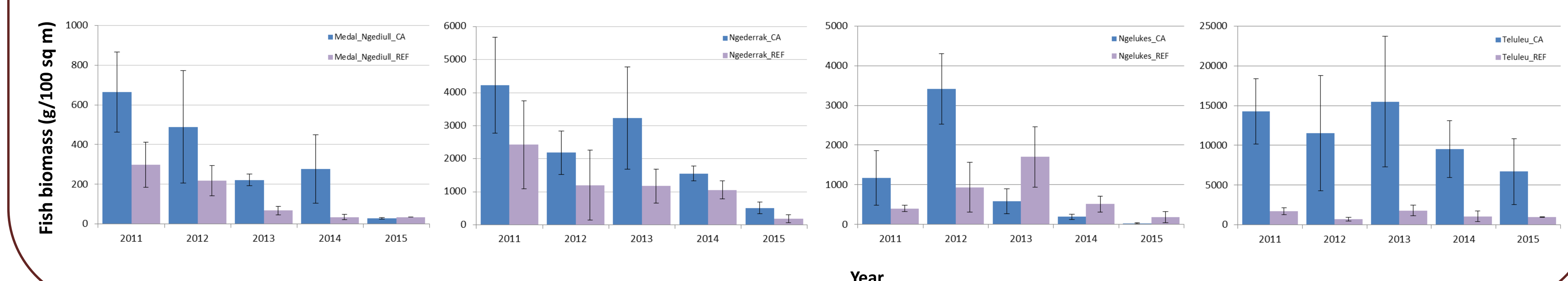
Seagrass cover

- There is a general decline in seagrass cover from the 2011 to 2013 in all MPAs and reference sites
- Two sites (3 and 4) seagrass seems to be increasing in cover from 2013 to present
- The other two sites (1 and 2) seagrass cover does not appear to be recovering
- MPA 4 has significantly lower seagrass cover than the reference



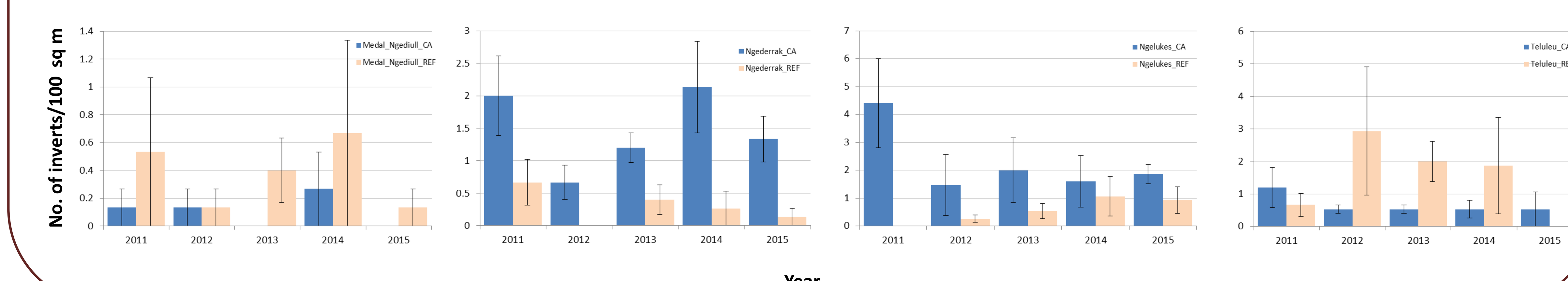
Fish biomass

- Fish biomass in MPAs and reference sites on a decline since 2011
- Fish biomass is significantly higher in MPAs than in reference sites
- Exception occurs in MPA 1 in 2015 and in MPA 3 from 2013-2015
- Highest biomass in MPA 4 and MPA 2



Macro-invertebrate density

- Generally low macro-invertebrate density across all MPAs and reference sites
- Macro-invertebrate density is significantly higher in the MPA than reference at only one site (MPA 2)
- Macro-invertebrate density is significantly higher in the reference than MPA 4 in 2012 and 2013



DISCUSSION

Seagrass cover in the MPAs and reference sites decreased from 2011 to 2013. Two of the MPAs appear to be increasing in cover while the other two have remained low relative to 2011. While fish biomass is higher in MPAs than reference sites, there is a general decline of biomass from 2011 to 2015 in both MPAs and reference sites. Macro-invertebrate densities are quite low and remained so over years.

In Palau, the steep topography, high rainfall, and coastal development have resulted in increased sedimentation levels throughout Palau, which has become significant issue due to its negative effects on coastal ecosystems and a possible driver for the decreases in fish populations, low invertebrate densities and decline within seagrass habitats (Koshiba et al. 2013; Norkko et al. 2002; Hewitt et al. 2003).

MPAs provide benefits and services but without proper management of resources outside these MPAs, the services they provide may not be completely recognized. And though the outlook may look bleak, this updated survey serves as a tool for resource managers as they continue to effectively manage their respective MPAs. Continued monitoring as well as strategies to raise awareness of the importance of seagrass beds and mitigate potential threats will enable resource managers to develop a more resilient network of MPAs (Bjork M. et al. 2008).

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ACKNOWLEDGEMENT

This project was funded by the NOAA Coral Reefs Conservation Program and the David & Lucile Packard Foundation.

Palau International Coral Reef Center