TELULEU MARINE PROTECTED AREA BASELINE ASSESSMENT

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ABSTRACT

With the increasing demand of marine resources throughout the world, it is important to establish a foundation to determine how the use of resources is affecting the health of marine habitats. An initial assessment of Peleliu's Teluleu protected area was conducted to determine baseline data for long term adaptive management of the protected areas in Palau. Three randomly selected sites were chosen and surveyed. The assessment is specifically geared to establish initial data for the benthic community, coral recruit, commercially important invertebrates, and the abundance and biomass of commercially important fish. Teluleu is a seagrass meadow located just off the main dock in Peleliu. Results show that there is a variation of fish and biomass which means that Teluleu is a habitat for smaller juvenile fish as well as large, possibly reproductive fish. This falls in line with the goals and objective of Peleliu's management plan. During the survey, two invertebrates were observed and coral recruits were recorded in one of the three surveyed sites. This surveyed MPA is predominately a seagrass meadow, being made up of *T. hemprichii* and *E. acroides.*

1. INTRODUCTION

Marine Protected Areas (MPAs) are conservation tools that protect biodiversity and assist in sustainable resource practices. This conservation tool is increasingly used in Palau, as well as throughout Micronesia and the rest of the world. Palau has over 44 protected areas nationwide, 33 of which cover marine habitats.

Biological monitoring is an essential component of adaptive management to measure the effectiveness and progress of MPAs. In order to effectively manage protected areas, resource managers and relevant stakeholders need information on the changes and trends in the condition of resources. MPA monitoring data provide the resource managers key information that will assist in decision-making (Walkinson *et al 2003)*.

In 2001, Peleliu State Government made the proactive decision to designate 540,016 m² (0.83 km²) of their waters as a conservation area (Mengirario *et al 2013*). Teluleu Conservation Area (CA) is a strict no-take, no entry zone that acts as a nursery ground for various important marine organisms that are heavily targeted for consumption. As a predominantly seagrass meadow, Teluleu is a reservoir for many species of fish and macro-invertebrates such as clams and sea cucumbers (Nestor *et al 2013)*.

This study is a baseline assessment that was conducted by the Palau International Coral Reef Center in May of 2015. The objective of this assessment of the Peleliu conservation area was to collect baseline data on commercially important fish abundance and biomass, invertebrate densities, benthic cover, and coral recruitment. This information will act as the original data that will be used for comparison with future assessments.

2. METHODS

This study was conducted on May 12, 2015 and targeted the reef flat habitat at a depth between 1-5 m. A total of three randomly selected sites were surveyed with three 30 m belt transects at each site. The monitoring protocol follows an established method from determining location to analyzing the data in order to ensure uniformity among all MPA assessments. Random station locations were allocated within each habitat present in the MPA

depending on their size using QGIS (QGIS Development Team 2015) (Fig 1). According to protocol, areas smaller than 900,000 m^2 were allocated three random points; areas from 1 km^2 to 5 km^2 in size were allocated one random point per 300,000 m^2.

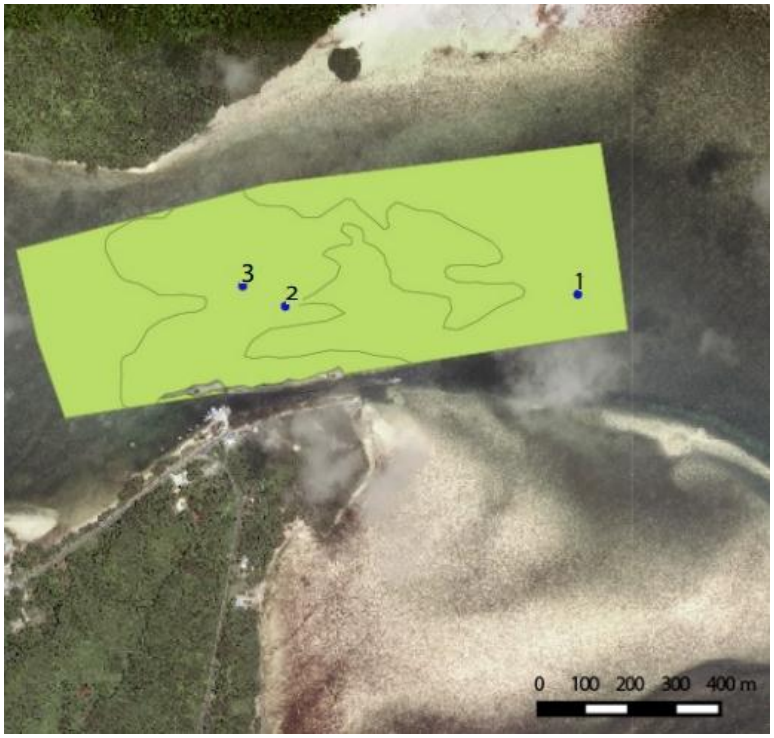

Figure 1: A map of Peleliu's Teluleu MPA, *showing the three randomly selected locations of the surveyed sites.*

Fish surveys targeted those that are commercially important and were conducted on 30 m x 5 m belt transects (150 m^2 total area per transect) where the abundance as well as the estimated length of each fish (in centimeters) was recorded. Commercially targeted invertebrates were identified and recorded along a reduced width of 30 m x 2 m (60 m^2 total area per transect).

Benthic coverage which includes coral cover was recorded by taking pictures using a wide angle lens camera (model: CANON G6 with attachable *Fantasea line* fish eye) and a 1 m^2 photo-quadrat alongside each of the 30 m transect. Coral recruits were measured on a further reduced width of 0.3 m x 10 m (3 m^2 total area per transect).

Back in the laboratory, the photographs of benthic and coral coverage were analyzed using the program called Coral Point Count with excel extensions, otherwise known as CPCe (Kohler and

Gill 2006). Using CPCe, five random points from each frame was used to determine benthic cover classified into categories (Appendix 3).

Fish surveys were conducted to estimate density and biomass, where size was recorded in centimeters and biomass was calculated using the length-weight relationship, a(L^b), where *L* = length in centimeters, and *a* and *b* as constants values published biomass-length relationships from Kulbicki et al. (2005) and from Fishbase (www.fishbase.org). At the Palau International Coral Reef Center, all data was entered into Microsoft (MS) excel spread sheets and later analyzed.

3. RESULTS

3.1 Fish Abundance

Mean abundance for all commercially important fish (Appendix 1) observed in Teluleu was 5 fish (± 1.6 SE) per 150 m². Site 1 had a mean of 4.7 fish (± 2.4 SE) while site 2 and 3 had a mean fish of 3.7 (± 2.3 and ± 2 respectively) (Fig 2).

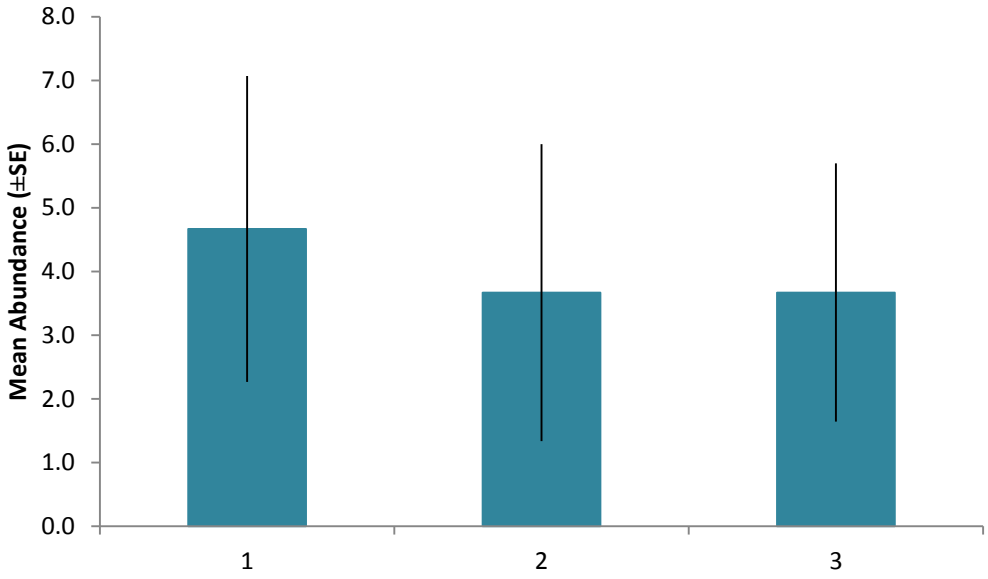

Figure 2 shows the fish abundance among the three surveyed sites.

A total of 36 fish were observed and surveyed within Teluleu. Of the 36, 8 different commercially important fish were recorded: 8 *Hipposcarus longiceps* (Ngyaoch), 6 *Scarus sp.* (Mellemau), 6 *Cheilinus undulatus* (Maml), 5 *Siganus fuscescens* (Meyas), 4 *Choerodon angchorago* (Budech), 3 *Lethrinus obsoletus* (Udech), 2 *Siganus puellus* (Reked), and 2 *Siganus punctatus* (Bebael) (Fig 3).

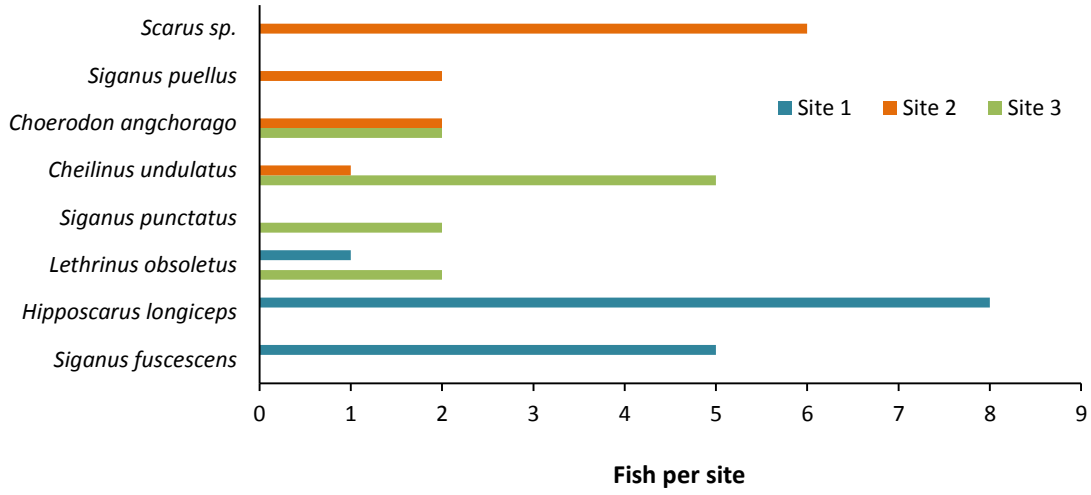

Figure 3: Commercially important fish observed within each site surveyed

3.2 Fish Biomass

The mean biomass for all the commercially important fish observed fish within Teluleu was 259.1 g (± 119.8 g SE). Site 1 had an average biomass of 24.9 g (±12.7 g SE), site 2 with 419.9 g (± 210.1 g SE), and site 3 with 332.5 g (± 282.7 g SE) (Fig 4).

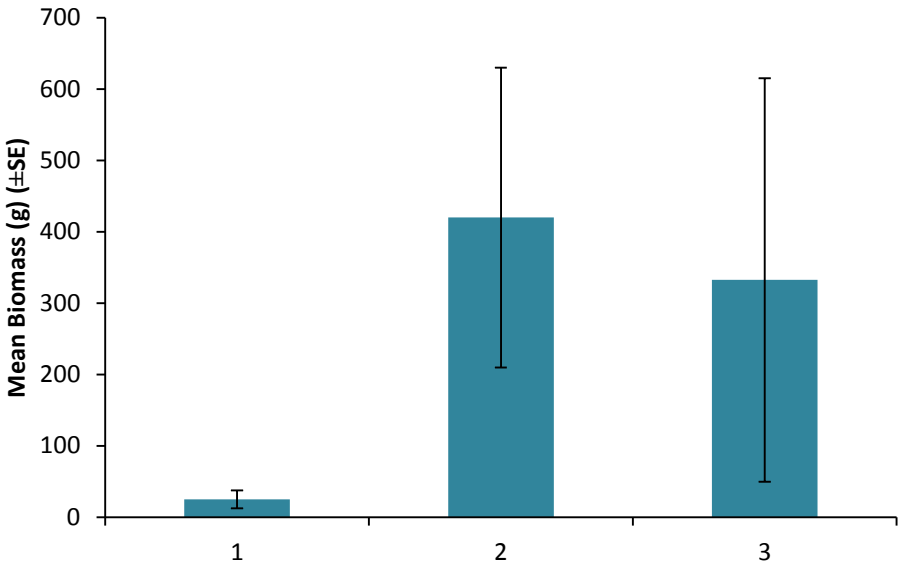

Figure 4: Mean biomass of all commercially important fish observed within Teluleu

3.3 Invertebrates

Mean density of invertebrates for Teluleu was 0.2 (± 0.1 SE) per 60 m². Site 1 did not have any invertebrates observed, site 2 and 3 each had an average of 0.3 invertebrates (± 0.3 SE) (Fig 5a). Of the 35 commercially important invertebrates (Appendix 2) two were observed among all three sites. *Stichopus hermanni* (Delal a ngimes) was observed once in site 2 and *Bohadschia vitiensis* (Meremarch) was observed once in site 3 (Fig 5b).

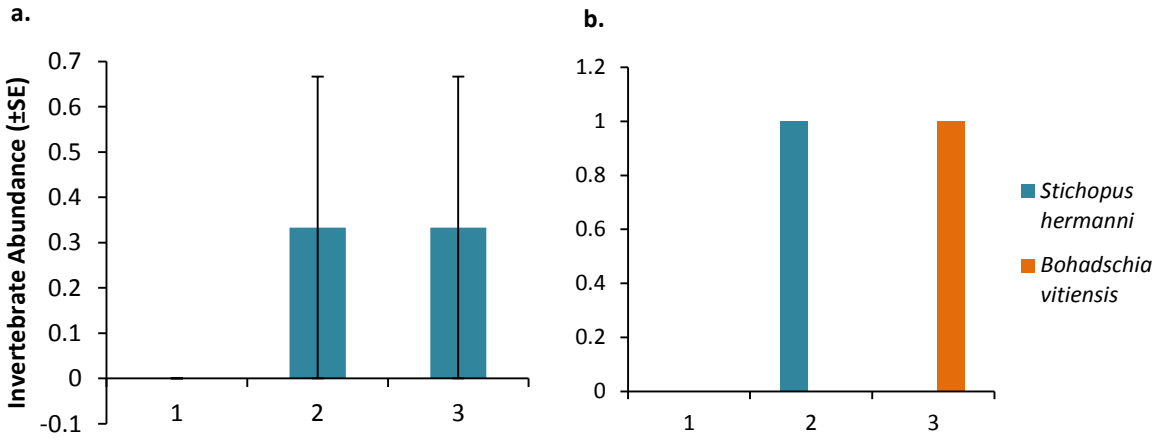

Figure 5 (a) shows mean density of invertebrates within the three sites, (b) shows the species of invertebrates recorded

3.4 Coral Recruit

Mean density of coral recruits for Teluleu was 2.1 (± 2.1 SE). Site 1 and 2 did not have any recorded recruits within the first 10 m of the transect. Site 3 had a mean density of 6.3 (± 5.8 SE) (Fig 6a). Within site 3, three different species were recorded: 8 counts of *Montipora,* 10 counts of *Psammacora,* and 1 count of *P.* massive (Fig 6b).

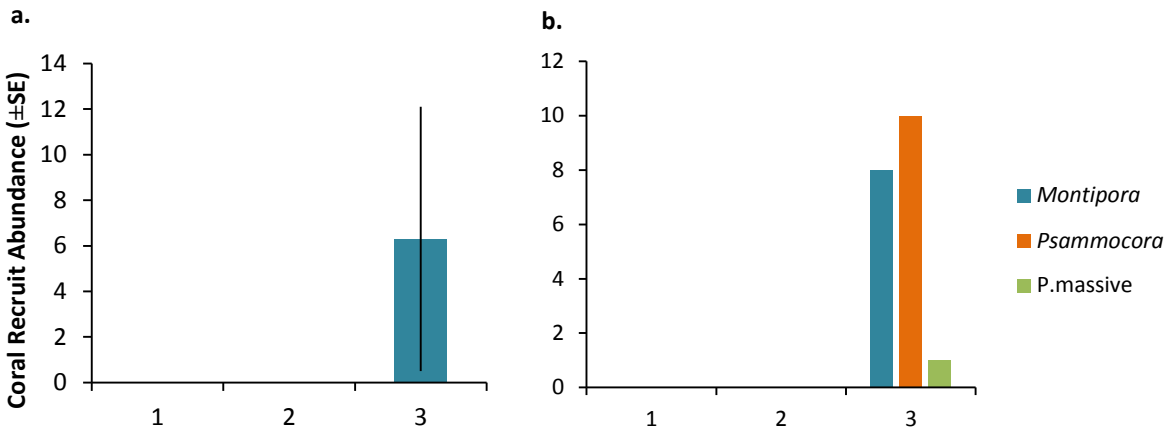

Figure 6 (a) shows mean density of coral recruits within the three sites, (b) shows the species recorded

3.5 Benthic cover

The most predominate benthic cover over all the sites are seagrass with 21.3% (± 2.9% SE) and sand with 32.8% (± 9.3% SE). Halimeda and turf are present in each site with an average coverage of 10.6% (± 5% SE) and 2.1% (± 1.2%) respectively (Fig 7).

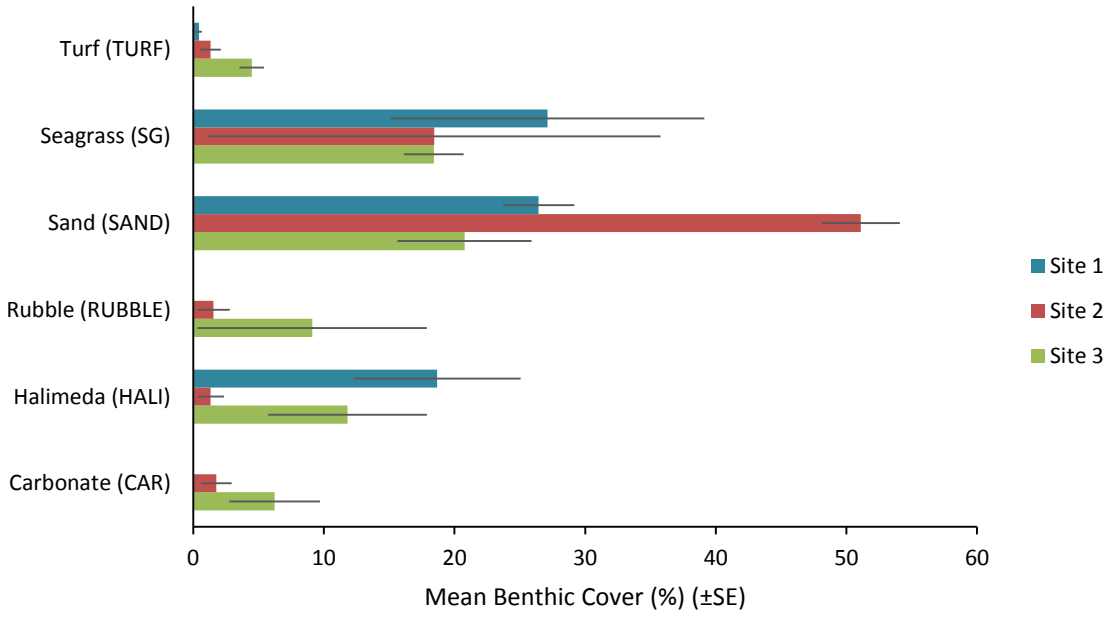

Figure 7: Mean benthic cover in percentage

Two types of seagrass are represented within the Teluleu MPA, *T. hemprichii* and *E. acroides.* Total average seagrass cover of *T. hemprichii* is 12.3% (±5.8 % SE) and *E. acroides* is 30.3% (±7.2 SE) (Fig 8).

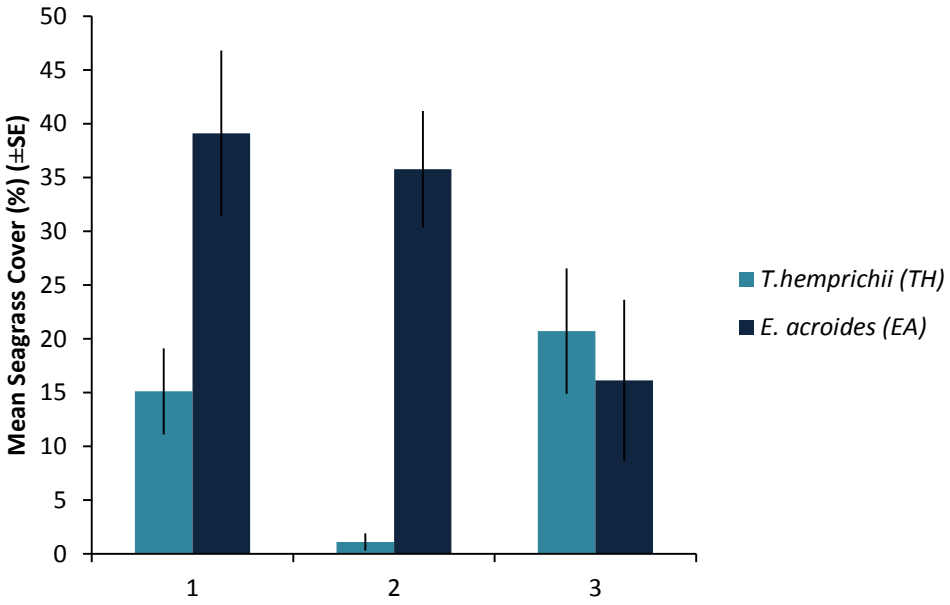

Figure 8: Mean seagrass cover in percentage

4. Discussion

The overall objective of this study was to collect environmental baseline information within the Teluleu Conservation Area. Since 2001, this conservation area has been restricted to a no-take zone to provide a safe nursery ground for juvenile fish and other important marine organisms. This study illustrated an interesting picture of the marine life within the conservation area. As the first overall assessment of the protected area, it is not required within the protocol to cross-reference a similar, non-conservation site. Over time, no-take marine protected areas have the ability to increase in benthic and marine life, given that enforcement and compliance is strictly regulated. Though strict enforcement is not enough, MPAs only function well when the local users accept and support the effort (Wilkinson *et al 2003)*.

Our survey illustrates that Teluleu has a higher fish density and biomass compared to previous studies done on three reference sites. This shows that the MPA is acting as a successful nursing habitat, as predicted in Peleliu's management plan. Though our survey results are positive and supportive of the MPA, threats such as poaching, pollution, and impacts of climate change such as ocean temperature increase are still very real issues that threaten the Teluleu CA. According to the long term seagrass monitoring report, there is a continuous decline in invertebrates, fish, and seagrass both within the MPA and the reference site used (Rehm *et al 2015)*. This effect might not be due to poaching since it is present in the MPA as well as the reference but might be a cause of environmental change such as climate change, and temperature increase. Another reason for this effect could be that fish caught outside of the MPA are too small or too many are being taken. Doing so causes stress on the population since the fish cannot replenish themselves sustainably.

Because baseline assessment methods cover a smaller area, results cannot be compared to those of the long term seagrass monitoring program. Therefore, future assessments in these areas would be able to project a progression and determine whether or not the management practices are working. If the management practices are found not to be working, this assessment compared with future ones will indicate how to adapt and where it is needed. Without an overabundance of the commercially targeted fish, the threat of poaching will apply to the invertebrates.

This data will be used by management to track the progress of the Peleliu's Teluleu Conservation Area. It is essential for policy makers and managers to keep an adaptive management style to ensure maximum growth over time. This is a present day assessment and results are subject to change with over time. This information will indicate trends in each of the ecological indicators surveyed and will help management make necessary adjustments to ensure the effectiveness of the MPA.

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REFERENCE

Assessment of the Enabling Conditions for Rights-Based Management of Fisheries and Coastal Marine Resources. (2013). Conservation and Community Investment Forum. Retrieved May 11, 2015, from http://www.trustforconservationinnovation.org/sponsored/inc/CCIF_Palau_web.pdf

Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology

Mengirario, E., Rrull, T., Uchel, E., Nobuo, J., Isechal, A., Okada, J., Tkel, G., Tsuneo, H., Blesam, R., Chin, L., Sengebau, M., Shioichi, M. (2012) Teluleu conservation area-5 year management plan (2013-2018). Retrieved June 3, 2015, from http://www.palaupanfund.org/pdf/managementplan/peliliu/TeluleuMP_Peleliu.pdf

Kohler KE, Gill SM (2006) Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Comput. Geosci. 32:1259–1269

Kulbicki M, Guillemot N, Amand M (2005) A general approach to length-weight relationships for New Caledonian lagoon fishes. Cybium 29:235–252

Nestor, V., Isechal, A., Koshiba, S., Idechong, J., Merep, A., Mereb, G., & Olsudong, D. (2013). Marine Protected Area Effectiveness Report: Teluleu Conservation Area. (PICRC Technical Report No. 13-01).

Samoilys, M., Martinsmith, K., Giles, B., Cabrera, B., Anticamara, J., Brunio, E., & Vincent, A. (2007). Effectiveness Of Five Small Philippines' Coral Reef Reserves For Fish Populations Depends On Site-specific Factors, Particularly Enforcement History. Biological Conservation, 584-601.

Rehm, L., Mereb, G., Olsudong, D., & Gouezo, M. (2015). Gaining insight on MPA health through long-term seagrass monitoring in Palau (2014 Update). (PICRC Technical Report No. 15-10).

QGIS Development Team (2015) QGIS Geographic Information System. Open Source Geospatial Foundation Project.

Wilkinson, C., Green, A., Almany, J., & Dionne, S. (2003). Monitoring coral reef marine protected areas: A practical guide on how monitoring can support effective management of MPAs (Version 1. ed., p. 2). Townsville, Qld., Australia: Australian Institute of Marine Science.

Appendix 1: Commercially important fish species in Palau

Commercially important fish species in Palau			
1	Bluefin trevally	Erobk	*Caranx ignobilis*
2	Giant trevally	Oruidel	*Caranx melampygus*
3	Bicolor parrotfish	Beyadel/Ngesngis	*Cetoscarus bicolor*
4	Parrotfish species	Melemau	*Cetoscarus/Chlorurus/ Scarus Spp.*
5	Yellow cheek tuskfish	Budech	*Choerodon anchorago*
6	Indian Ocean longnose parrotfish	Bekism	*Hipposcarus harid*
7	Pacific longnose parrotfish	Ngeaoch	*Hipposcarus longiceps*
8	Rudderfish (lowfin)	Komud, Teboteb	*Kyphosus spp (vaigiensis)*
9	Orangestripe emperor	Udech	*Lethrinus obsoletus*
10	Longface emperor	Melangmud	*Lethrinus olivaceus*
11	Red gill emperor	Rekruk	*Lethrinus rubrioperculatus*
12	Yellowlip emperor	Mechur	*Lethrinus xanthochilis*
13	Squaretail mullet	Uluu	*Liza vaigiensis*
14	River snapper	Kedesau`liengel	*Lutjanus argentimaculatus*
15	Red snapper	Kedesau	*Lutjanus bohar*
16	Humpback snapper	Keremlal	*Lutjanus gibbus*
17	Orangspine unicornfish	Cherangel	*Naso lituratus*
18	Bluespine unicornfish	Chum	*Naso unicornis*
19	Giant sweetlips	Melim ralm/Kosond/Bikl	*Plectorhinchus albovittatus*
20	Yellowstripe sweetlips	Merar	*Plectorhinchus crysotaenia*
21	Pacific steephead parrotfish	Otord	*Scarus micorhinos*
22	Greenthroat parrotfish	Udouungelel	*Scarus prasiognathus*
23	Forktail rabbitfish	Beduut	*Siganus argenteus*
24	Lined rabbitfish	Kelsebuul	*Siganus lineatus*
25	Masked rabbitfish	Reked	*Siganus puellus*
26	Goldspotted rabbitfish	Bebael	*Siganus punctatus*
27	Bluespot mullet	Kelat	*Valamugil seheli*
Protected Fish Species (yearly and seasonal fishing closure)			
28	Bumphead parrotfish	Kamedukl	*Bolbometopon muricatum*
29	Humphead wrass	Nimger/Maml	*Cheilinus undulatus*
30	Brown-marbled grouper	Meteungerel`temekai	*Epinephelus fuscoguttatus*
31	Marbled grouper	Kesau`temekai	*Epinephelus polyphekadion*
32	Squaretail grouper	Tiau	*Plectropomus areolatus*
33	Saddleback grouper	Katuu`tiau, Mokas	*Plectropomus laevis*
34	Leopard grouper	Tiau (red)	*Plectropomus leopardus*
35	Dusky rabbitfish	Meyas	*Siganus fuscescens*

Appendix 2: Invertebrates targeted by the local fisheries

Common names	Palauan name	Scientific name
Deepwater red fish	Eremrum, cheremrum	*Actinopyga echinites*
Stonefish	Ngelau	*Actinopyga lecanora*
Surf red fish	Badelchelid	*Actinopyga mauritiana*
Hairy blackfish	Eremrum, cheremrum edelekelk	*Actinopyga miliaris*
Deepwater blackfish	Eremrum, cheremrum	*Actinopyga palauensis*
Hairy greyfish	Eremrum, cheremrum	*Actinopyga sp.*
Leopardfish /tigerfish	Meremarech, esobel	*Bohadschia argus*
Chalk fish	Meremarech	*Bohadschia similis*
Brown sandfish	Meremarech	*Bohadschia vitiensis*
Bear paw giant clam	Duadeb	*Hippopus hippopus*
Lolly fish	Cheuas	*Holothuria atra*
Snakefish	Cheuas	*Holothuria coluber*
Pinkfish	Cheuas	*Holothuria edulis*
White teatfish,	Bakelungal-cherou	*Holothuria fuscogilva*
Elephant trunkfish	Delal a molech	*Holothuria fuscopunctata*
Slender sea cucumber	Sekesaker	*Holothuria impatiens*
Golden sandfish	Delalamolech	*Holothuria lessoni*
White snakefish	Cheuas	*Holothuria leucospilota*
Black teatfish	Bakelungal-chedelkelek	*Holothuria nobilis*
Sandfish	Molech	*Holothuria scabra*
Red snakefish	Cheuas	*Holothuris falvomaculata*
Flowerfish	Meremarech	*Pearsonothuria graeffei*
Greenfish	cheuas	*Stichopus chloronotus*
Curryfish	Delal a ngimes/ngimes ra tmolech	*Stichopus hermanni*
Dragonfish	Irimd	*Stichopus horrens*
Brown curryfish	Ngimes	*Stichopus vastus*
Prickly redfish	Temetamel	*Thelenota ananas*
Amberfish	Belaol	*Thelenota anax*
Fluted giant clam	Ribkungel	*Tridacna squamosa*
Crocus giant clam /	Oruer	*Tridacna crocea*
Smooth giant clam	Kism	*Tridacna derasa*
True giant clam	Otkang	*Tridacna gigas*
Elongate giant clam	Melibes	*Tridacna maxima*
Sea urchin	Ibuchel	*Tripneustes gratilla*
Trochus	Semum	*Trochus niloticus*

Appendix 3: Benthic categories

CPCe Code	Benthic Categories
"C"	"Coral"
"SC"	"Soft Coral"
"OI"	"Other Invertebrates"
"MA"	"Macroalgae"
"SG"	"Seagrass"
"BCA"	"Branching Coralline Algae"
"CCA"	"Crustose Coralline Algae"
"CAR"	"Carbonate"
"S"	"Sand"
"R"	"Rubble"
"FCA"	"Fleshy Coralline algae"
"CHRYS"	"Chrysophyte"
"T"	"Turf Algae"
"TWS"	"Tape
"G"	"Gorgonians"
"SP"	"Sponges"
"ANEM"	"Anenome"
"DISCO"	"Discosoma"
"DYS"	"Dysidea Sponge"
"OLV"	"Olive Sponge"
"CUPS"	"Cup Sponge"
"TERPS"	"Terpios Sponge"
"Z"	"Zoanthids"
"NoIDINV"	"Not Identified Invertebrate"
"AMP"	"Amphiroa"
"ASC"	"Ascidian"
"TURB"	"Turbinaria"
"DICT"	"Dictyota"
"LIAG"	"Liagora"
"LOBO"	"Lobophora"
"SCHIZ"	"Schizothrix"
"HALI"	"Halimeda"
"SARG"	"Sargassum"
"BG"	"Bluegreen"
"Bood"	"Boodlea"
"GLXU"	"Galaxura"
"CHLDES"	"Chlorodesmis"
"JAN"	"Jania"
"CLP"	"Caulerpa"

"MICDTY"	"Microdictyton"
"BRYP"	"Bryopsis"
"NEOM"	"Neomeris"
"TYDM"	"Tydemania"
"ASP"	"Asparagopsis"
"MAST"	"Mastophora"
"DYCTY"	"Dictosphyrea"
"PAD"	"Padina"
"NOIDMAC"	"Not ID Macroalgae"
"CR"	"C.rotundata"
"CS"	"C.serrulata"
"EA"	"E. acroides"
"HP"	"H. pinifolia"
"HU"	"H. univervis"
"HM"	"H. minor"
"HO"	"H. ovalis"
"SI"	"S. isoetifolium"
"TH"	"T.hemprichii"
"TC"	"T. ciliatum"
"SG"	"Seagrass"
"ACAN"	"Acanthastrea"
"ACROP"	"Acropora"
"ANAC"	"Anacropora"
"ALVEO"	"Alveopora"
"ASTRP"	"Astreopora"
"CAUL"	"Caulastrea"
"CRUNK"	"Coral Unknown"
"COSC"	"Coscinaraea"
"CYPH"	"Cyphastrea"
"CTEN"	"Ctenactis"
"DIPLO"	"Diploastrea"
"ECHPHY"	"Echinophyllia"
"ECHPO"	"Echinopora"
"EUPH"	"Euphyllia"
"FAV"	"Favia"
"FAVT"	"Favites"
"FAVD"	"Faviid"
"FUNG"	"Fungia"
"GAL"	"Galaxea"
"GARD"	"Gardininoseris"
"GON"	"Goniastrea"
"GONIO"	"Goniopora"

"HELIO"	"Heliopora"
"HERP"	"Herpolitha"
"HYD"	"Hydnophora"
"ISOP"	"Isopora"
"LEPT"	"Leptastrea"
"LEPTOR"	"Leptoria"
"LEPTOS"	"Leptoseris"
"LOBOPH"	"Lobophyllia"
"MILL"	"Millepora"
"MONT"	"Montastrea"
"MONTI"	"Montipora"
"MERU"	"Merulina"
"MYCED"	"Mycedium"
"OULO"	"Oulophyllia"
"OXYP"	"Oxypora"
"PACHY"	"Pachyseris"
"PAV"	"Pavona"
"PLAT"	"Platygyra"
"PLERO"	"Plerogyra"
"PLSIA"	"Plesiastrea"
"PECT"	"Pectinia"
"PHYSO"	"Physogyra"
"POC"	"Pocillopora"
"POR"	"Porites"
"PORRUS"	"Porites-rus"
"PORMAS"	"Porites-massive"
"PSAM"	"Psammocora"
"SANDO"	"Sandalolitha"
"SCAP"	"Scapophyllia"
"SERIA"	"Seriatopora"
"STYLC"	"Stylocoeniella"
"STYLO"	"Stylophora"
"SYMP"	"Symphyllia"
"TURBIN"	"Turbinaria"
"CCA"	"Crustose Coralline"
"CAR"	"Carbonate"
"SC"	"Soft Coral"
"Sand"	"Sand"
"Rubble"	"Rubble"
"Tape"	"Tape"
"Wand"	"Wand"
"Shadow"	"Shadow"

"FCA"	"Fleshy-Coralline"
"CHRYOBRN"	"Brown Chysophyte"
"TURF"	"Turf"
"BCA"	"Branching Coralline general"
"BC"	"Bleached Coral"

Appendix 4: GPS Coordinates (in UTM)

Site	Lat	Long
1	779492.344	419796.721
2	779466.257	419152.778
3	779510.635	419059.095