Seagrass meadows support biodiversity and people in Busuanga and Roxas, Palawan Philippines

TECHNICAL REPORT
For the IKI Seagrass Ecosystem Services Project

Supported by:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
based on a decision of the German Bundestag

Report prepared as a contribution to the IKI Project "Conservation of biodiversity, seagrass ecosystems and their services – safeguarding food security and resilience in vulnerable coastal communities in a changing climate" funded through the International Klimate Initiative (IKI)

The IKI Project is a partnership between the CMS, Edith Cowan University, Project Seagrass, Seagrass Watch Ltd, Murdoch University, MRS, Blue Ventures, SAN, C3, ZSL, MareCet and Yapeka. The collaboration enhances understanding of seagrass ecosystem services and the capacity to develop and deliver science-based policy solutions in seagrass conservation. It brings together scientists, policy experts, business development experts and conservation NGOs to provide expert and independent advice on seagrass ecosystems services and how these might be relevant to policy and financial solutions to marine conservation issues. This report deals specifically with the assessment of seagrass blue carbon ecosystem services.

Seagrass meadows support biodiversity and people in Busuanga and Roxas, Palawan Philippines

Author: C3 Philippines, Inc.

Summary

Seagrasses are considered one of the most important shallow marine ecosystems. They are found within the depths of 3 to 9 feet (1 to 3 meters), but the deepest growing seagrass (*Halophila decipiens*) has been found at depths of 190 feet (58 meters). In many coastal areas, one or a small number of seagrass species typically predominate, but in the tropical waters of the Indian and western Pacific oceans, a very diverse species of seagrasses was recorded with up to 14 different species coexisting (Larkum et al., 2006; Short et al., 2011)

They provide essential ecosystem services, including nutrient absorption, wave attenuation, sediment stabilization, water clarity improvement, carbon sequestration, habitat and nursery areas, and food sources for various marine animals. While they are recognized for their vital ecological roles and benefits, they often face a lack of comprehensive data and are not always given the same level of conservation priority as other habitats such as salt marshes, coral reefs and mangrove ecosystems in certain contexts (Orth et al., 2006). Repeated studies confirm a lack of recognition of the value of these ecosystems.

As such, this study investigates the ecological and socio-economic significance of seagrass meadows in Busuanga and Roxas, coastal regions in Palawan, Philippines. Through data collection and analysis this study begins to examine the complex interactions between humans and seagrass ecosystems, contributing to the sustainable management and conservation of these critical habitats.

The study provides insights into the complex relationship between seagrass ecosystems, biodiversity, and local communities, shedding light on seagrass meadows' value in supporting ecological health and human well-being. This research findings can potentially inform conservation strategies, policy-making, and sustainable resource management efforts. Historically, seagrass beds have been largely neglected in terms of management, resulting in substantial worldwide reductions in their coverage. However, there has been a growing recognition of the importance of seagrass beds and other blue carbon ecosystems in mitigating climate change. Consequently, certain countries, like Belize in 2021, have incorporated blue carbon ecosystems into their Nationally Determined Contributions (NDC) as they acknowledge their potential significance in climate mitigation (Grimm et al., 2023),

Introduction

The world's oceans and their diverse ecosystems are essential for supporting life on our planet. Seagrass beds are vital and ecologically significant habitats among these ecosystems, providing crucial services to marine organisms and human communities. These habitats are renowned for their high primary productivity, serving as essential nursery areas for many marine species. Within the vast expanse of the Indo-Pacific, the extensive coastline and diverse marine environments in the Philippines provide ideal conditions for the growth and persistence of seagrass habitats, making it a hotspot for seagrass diversity (Fortes, 2013). In the Philippine context, seagrass ecosystems hold significant ecological, economic, and cultural value. They provide essential habitat for commercially important fish species, contributing to the sustenance and livelihoods of coastal communities. Moreover, seagrass meadows in the Philippines are an integral part of the Coral Triangle, a region renowned for its extraordinary marine biodiversity. Numerous marine invertebrates with significant economic value can be found in seagrass beds, such as shrimp, sea urchins, clams, several varieties of fish, endangered species like sea turtles, and dugongs (Fortes, 2012).

Busuanga and Roxas, two coastal regions located in the province of Palawan, Philippines, served as the primary study sites (Figure 1). These areas are known for their extensive seagrass meadows, which serve as crucial marine habitats supporting diverse ecological communities. The seagrass ecosystems in Busuanga and Roxas play a vital role in coastal biodiversity, providing nursery grounds and feeding areas for various marine species, including fish, invertebrates, and endangered species such as dugongs and sea turtles.

However, the local seagrass ecosystems face multiple challenges, including human-induced impacts from coastal development and potential disturbances from riverine systems that transport pollutants and sediments into marine environments, often reducing water quality and reducing light availability leading to seagrass decline (Camacho et al., 2019). Busuanga and Roxas have experienced increasing human pressures due to tourism and fishing activities. While contributing to economic growth, The surrounding landscape has changed due to the increased hotel infrastructure built to handle the inflow of guests, which may have an impact on ecosystems and natural habitats. Particularly in Busuanga where in large resort development had been rampant (Agabin and Travers, 2018). Concurrently, increased tourism-related watercraft activities like island hopping and tours can be adding to the stress on marine environments. The combination of increased fishing and developments pertaining to tourism has resulted in a situation where human strain on the ecosystems of Busuanga and Roxas is increasing.

Despite their critical importance, a comprehensive evaluation of these seagrass ecosystem services has been lacking in these areas. Considering the importance of seagrass ecosystems and the unique context of the Indo-Pacific Philippines, this study utilized Baited Remote Underwater Video (BRUV) surveys and socio-economic assessments, seeking to evaluate seagrass ecosystem services. The results have the potential to inform conservation strategies, policy-making, and sustainable resource management efforts, offering a holistic understanding of the intricate relationship between humans and the seagrass ecosystems for sustainable management and conservation of the seagrass habitats in these areas.

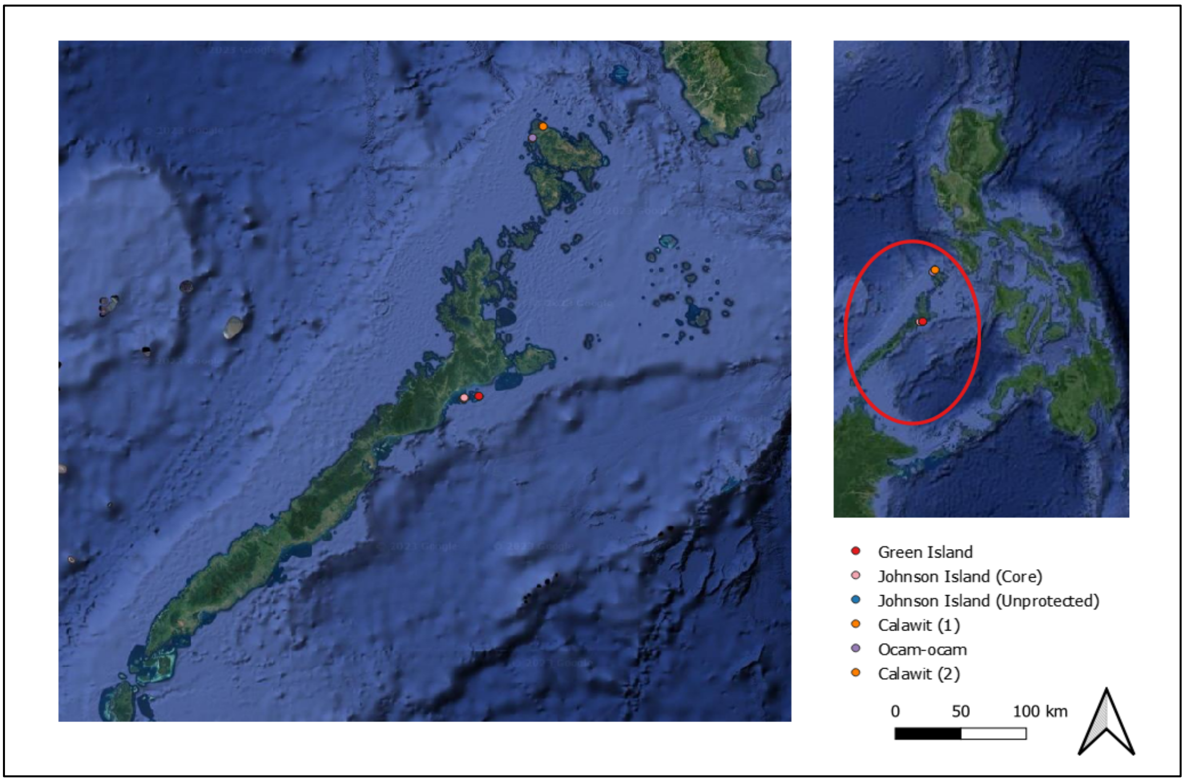


Figure 1. Study Sites in Busuanga (Calawit and Ocam-ocam), and Roxas (Johnson Island and Green Island), Palawan, Philippines.

Objectives and activities completed

Seagrass meadows are crucial and highly diverse marine ecosystems that play a vital role in supporting marine biodiversity and coastal communities' livelihoods. These seagrass meadows in Busuanga and Roxas in Palawan, Philippines are particularly abundant and ecologically significant. This study aims to investigate the intricate relationship between seagrass meadows, biodiversity, and local communities.

The objectives of this study are manifold, each contributing to an understanding of the value that seagrass ecosystems hold:

1. **Knowledge transfer: stakeholder-engaged research aimed at informing strategic marine management**
    a. Assess the influence of different protected area statuses' on seagrass-associated fish assemblages
    b. Investigate the Impact of Seasonal Fluctuations Between Wet and Dry Periods on Fish Assemblages Associated with Seagrass Habitats
    c. Policymakers, Marine protected area managers, local community members, and fishers were involved in the identification of the research areas as well as in the data-gathering procedures.

2. **Establish contribution of seagrass fisheries to the local people and food security**
    a. Household interviews were conducted in four (4) communities within Busuanga and Roxas, Palawan, Philippines, with a total number of 160 households.

b. Database compiled and available for further analysis (and use as required)
c. Summary statistics for the value of seagrass created.

3. **Determine species composition and seagrass habitat usage of fish assemblages**
   a. Seagrass fish surveys using Baited Remote Underwater Video (BRUV) systems across four (4) sites.
   b. Rapid habitat and ecological assessment alongside BRUV surveys.
   c. Database compiled and available for further analysis (and use as required).
   d. Summary statistics available for key fishery species (data available for all fishery species).

Methods

This study employed the use of Baited Remote Underwater Video (BRUV) surveys and social assessments to investigate the relationships between seagrass ecosystems, biodiversity, and human communities in the Busuanga and Roxas regions of Palawan, Philippines. Through these methods, the study aimed to investigate the study area's ecological and socio-economic dimensions, providing a holistic understanding of the ecosystem services seagrass meadows provide.

Site Selection

Data collection using Baited Remote Underwater Video (BRUV) was conducted on Green Island and Johnson Island in Roxas, and in Calawit Island and Ocam-Ocam in Busuanga, Palawan in January and April 2023. These sites were selected since they have seagrass beds within existing or proposed protected areas, and no baseline studies on fish community structure have been conducted in these seagrass beds.

Prior to the conduct of the study, pilot testing was done, and the final study sites were selected. Initially, there were three study sites selected in Roxas, Palawan: San Nicolas, New Barbacan, and Barangay Minara, but during several observations on the three sites, it was noted that there had been a significant loss in the seagrass bed in the area which could be caused by Typhoon Rai, locally named Odette that hit the area last December 2021. There is also very low visibility in the three sites that may be brought upon by siltation from the river, making it impossible to conduct underwater video analysis. Due to these reasons, the sites were relocated to Green Island in Barangay Tumarbong and Johnson Island in Barangay VI. As for Busuanga, two sites were selected: Calawit Island and in Ocam-ocam. Sampled areas in Calawit Island were Diapnay and Cheey-cheey which are both within declared Dugong Conservation Areas (DCAs) (C3 Philippines, Inc., 2018). Aban-aban, which is also within a DCA, was supposed to be sampled instead of Diapnay but the current in the area was strong during the survey in January. The sampled areas in Ocam-Ocam are its seagrass bed's northern and southern portions. These areas are within the proposed 111-hectare marine protected area in Ocam-Ocam. Study sites were selected as representatives of Marine Protected areas and potential protected areas in Busuanga and Roxas, Palawan. The selected study sites within the seagrass meadow are representative of the area of interest and have suitable conditions for BRUV surveys. Factors that were considered in site selection also include water depth, visibility, and current.

Baited Remote Underwater Video Systems (BRUVS)

Three replicate BRUV units were deployed in each area during the high tide and facing the direction of the current. The time of deployment was between 0900h to 1700h. Each replicate had a minimum distance of 50 meters away from each other and were all retrieved one hour after deployment. A BRUV unit consisted of a GoPro HERO 9 in an underwater housing that is attached to the bait cage by a 1-m PVC pole. Units have steel weights to minimize movement underwater and marker buoys for easier retrieval. Oily fish in can were used as baits on all deployments.

There was a total of 24 BRUV drops in Busuanga and 36 drops in Roxas covering both the wet and dry seasons (12 in each season in Busuanga and 18 in each season in Roxas) . Four of these drops (Calawit = 1, Ocam-Ocam = 2, Green Island=1) failed due to issues with the internal SD cards. The videos were examined to record the MaxN for each fish species and the richness of fish species. MaxN, a widely employed metric for quantifying the relative abundance of fish seen in underwater videos, represents the highest count of a fish species observed on a single frame of the video. Field guides, including Randall (2005) and Allen et al. (2015) and publicly available information from FishBase (Froese & Pauly, 2023) were used in the identification of fish species.

Seagrass health assessments

In addition to the BRUV samples, a total of 300 quadrats (150 for the dry and 150 for the wet season) were positioned across the seagrass meadows at the study area. Five quadrats were placed around each BRUV location to provide supplementary seagrass data to support BRUV biodiversity data where necessary. These quadrats captured data similarly to SeagrassWatch, including the overall percentage cover, the composition of segrass species, and the height of the canopy (measured in centimeters).

Socio-economic surveys

Socio-economic surveys were also conducted in order to evaluate and to understand how local communities interact, perceive seagrass ecosystem services. Through a structured interview, the study explored the dependence of local communities on seagrass and seagrass-associated resources. Social interviews involved a predetermined set of questions to ensure consistency in data collection allowing a systematic and organized approach in gathering information from the local residents of the study sites.

A total of 160 number of households were randomly selected as respondents for the survey conducted in Busuanga and in Roxas, Palawan. The assessment covered multiple questions surrounding marine and coastal resource use as well as their common practices within the study sites, particularly on the seagrass areas. The focus of the interviews was to explore the extent to which local communities depend on seagrass and seagrass-associated resources.

Results & Discussion

This section synthesizes the empirical findings derived from Baited Remote Underwater Video (BRUV) surveys and social assessments, delving into the ecological and socio-economic dimensions that characterize the Busuanga and Roxas regions.

Summary of habitat data

The habitat surveys conducted in the Busuanga and Roxas, Palawan, revealed crucial insights into the state of seagrass ecosystems, their species composition, canopy characteristics, and variations across different sites. This section presents the key findings from these surveys, highlighting notable differences in seagrass species, canopy height, and cover.

Seagrass meadows in Busuanga and Roxas, Palawan, are typically characterized by the presence of a diversity of seagrass species. In the study sites, there were 8 species of seagrass species recorded (*see Table 1*). *H. pinifolia* were both found in Roxas and Busuanga but only in one site from each area which is in Green Island and in Ocam-ocam, while *S. isoetifolium* was not observed in Green Island, and *C. serrulata* which was not found in Johnson Island. These seagrass species are just among the different species that contribute to the intricate tapestry of marine life by creating a complex and dynamic habitat. These seagrass meadows provide several services such as forming extensive underwater meadows that play a critical role in stabilizing sediments and promoting water clarity, providing crucial feeding, and nesting grounds for marine animals, and as shelter for various small fish and invertebrates (Cullen-Unsworth & Unsworth, 2013). This diverse range of seagrass species further enhances the ecological value of these meadows, providing essential ecosystem services that support both marine biodiversity and the well-being of local communities.

Table 1. Presence or absence of seagrass species in the four study sites.

Species	Johnson Island	Green Island	Calawit	Ocam-Ocam
Cymodocea rotundata Asch. & Schweinf.	+	+	+	+
Halophila ovalis (R.Brown) Hooker f., 1858	+	+	+	+
Thalassia hemprichii (Ehrenberg) Ascherson, 1871	+	+	+	+
Halodule uninervis (Forssk.) Asch.	+	+	+	+
Halodule pinifolia (Miki) Hartog	-	+	-	+
Syringodium isoetifolium (Asch.) Dandy	+	-	+	+
Enhalus acoroides (Linnaeus f.) Royle, 1839	+	+	+	+
Cymodocea serrulata (R.Brown) Ascherson & Magnus, 1870	-	+	+	+

*(Absent:**-** ; Present: **+**)*

The presence of diverse seagrass species within the meadows of Busuanga and Roxas, Palawan can be attributed to a combination of ecological factors and local environmental conditions. Seagrass species' occurrence depends on several environmental conditions, and determining the relative role that each factor plays is one of the challenges in predicting seagrass habitat suitability (Adams et al., 2016). Seagrass distribution often responds to variations in water depth, sediment type, light availability, and water quality.

In this context, the occurrence of *H. pinifolia* in both Roxas and Busuanga, but limited to one site each, suggests that specific ecological conditions in these sites favor this species. Variations in water depth, nutrient levels, and substrate composition could influence the distribution of different seagrass species across these locations. Seagrass species have varying tolerance ranges for environmental conditions, which can influence their distribution patterns. Similarly, the absence of *C. serrulata* on Johnson Island could be due to factors like water movement patterns, sediment dynamics, or light penetration, all of which play roles in shaping seagrass habitat suitability. These observed distribution patterns highlight the sensitivity of seagrass species to local environmental factors. They also underscore the importance of conducting thorough ecological assessments to understand the complex interplay between these factors and seagrass distribution. But for this study, this activity is among its limitations. Such insights are essential for effective conservation and management strategies, as they help identify key areas for protection and inform decisions aimed at preserving the diverse seagrass ecosystems in these regions.

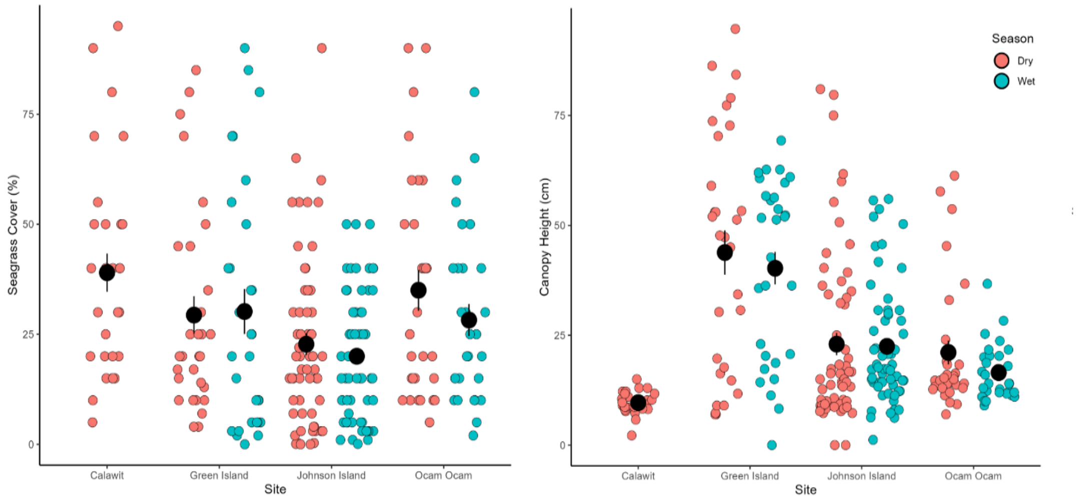


Figure 2. Average seagrass cover (%) and canopy height (cm) across sites and seasons. Black points represent Mean + SE while the pink and blue points represent raw quadrat values.

Results showed that there is no significant difference in seagrass cover across all the sites during the wet season (p= 0.2886), but a significant difference across the study sites was observed during the dry season (p= 0.0094). In terms of canopy height, results showed that there are significant differences along all the study sites, both in dry (p=8.10E-09) and wet (p= 1.38E -05) seasons. The differences in seagrass cover between each site were also compared in the context of seasonal variation (wet and dry seasons), and it was found out that sites have relatively the same seagrass cover regardless of the season, except for the site in Calawit wherein data in the wet season was not obtained due to weather conditions.

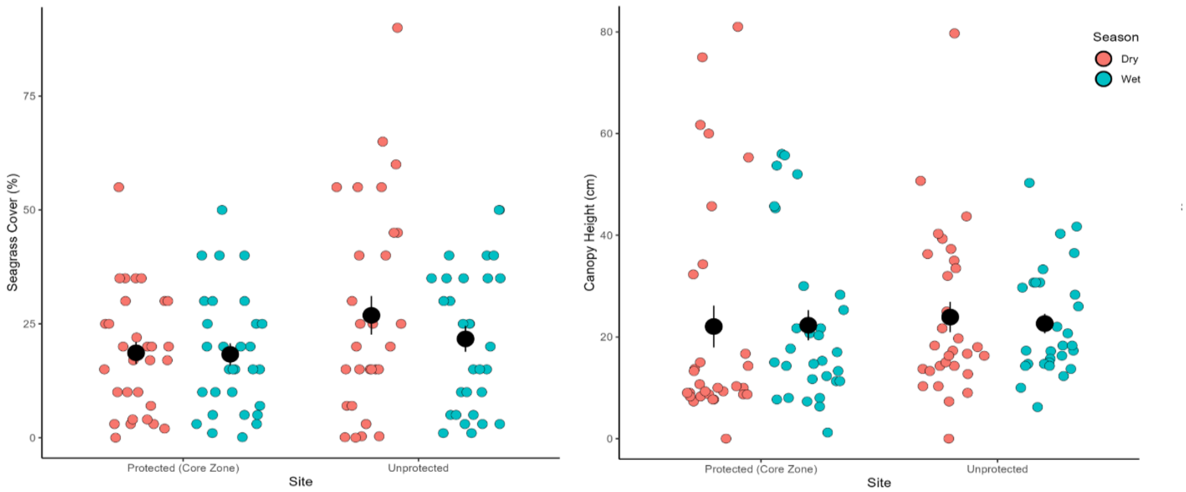


Figure 3. Average seagrass cover (%) and canopy height (cm) in protected and unprotected areas in Johnson Island, Roxas, Palawan during the dry and wet season. Black points represent Mean + SE, while the pink and blue points represent raw quadrat values.

In terms of variation in seagrass cover and canopy height between the core zone of Johnson Island and its unprotected site, it was deduced that there is no significant difference in the two sites both in terms of seagrass cover in wet (p=0.3633) and dry (p=0.0986) season, as well as in canopy height in wet (p=0.952) and dry (0.7138) periods.

Summary of seagrass-associated biodiversity

BRUV surveys conducted in the study sites provided valuable insights into fish species' composition, abundance, and distribution within seagrass. It revealed a diverse array of fish species inhabiting seagrass ecosystems within the research area. Across the surveyed sites, we documented a range of species, showcasing the vital role that seagrass habitats play in supporting marine biodiversity.

We found an average of 27.4 ± 11.15 and 24 ± 6.44 number of fishes per $200m^2$ of seagrass across sites during the wet and dry seasons, respectively. Species richness for the sites in two different seasons were presented in Table 2 below.

Table 2. Species Richness during the Wet and Dry Seasons in the Study Sites

Site	Species Richness	
	Wet Season	**Dry Season**
Johnson Island (Protected)	**29**	**20**
Johnson Island (Unprotected)	**36**	**17**
Green Island	**33**	**34**
Calawit	**8**	**25**
Ocam-ocam	**31**	**24**

Notably, during the wet season, it was found that the unprotected site in Johnson Island and Green Island had a higher species richness than the protected area in Johnsohn Island. Same as with that in Calawit which is a protected site and the Ocam-ocam which is the unprotected one. These findings emphasize the importance of conservation efforts targeted at specific locations to ensure the preservation of high-abundance seagrass-associated fish species.

Table 3. Most common fish species found across study sites

		Wet Season (January)					Dry Season (April)				
Family	**Fish Species**	**Johnsohn Island (Protected)**	**Johnsohn Island (Unprotected)**	**Green Island**	**Calawit**	**Ocam-Ocam**	**Johnsohn Island (Protected)**	**Johnsohn Island (Unprotected)**	**Green Island**	**Calawit Island**	**Ocam-Ocam**
Monacanthidae	*Acreichthys tomentosus*	+	+	+	-	+	+	+	+	-	+
Labridae	*Choerodon anchorago*	+	-	+	-	+	+	+	+	+	+
Labridae	*Cheilio inermis*	+	+	+	-	+	-	-	-	+	+
Mullidae	*Parupeneus barberinus*	-	+	+	+	+	-	+	+	-	-
Nemipteridae	*Pentapodus bifaciatus*	+	+	+	-	-	+	+	+	-	-
Gerreidae	*Gerres oyena*	+	+	+	-	-	+	-	+	-	-
Apogonidae	*Cheilodipterus quinquelineatus*	+	-	+	-	-	+	+	+	-	-
Tetraodontidae	*Arothron manilensis*	+	+	-	-	+	-	-	-	-	+
Atherinidae	*Atherinomorus lacunosus*	+	+	+	-	-	-	+	-	-	-
Labridae	*Leptojulis cyanopleura*	+	+	+	-	-	-	-	+	-	-
Mullidae	*Parupeneus barberinoides*	-	+	-	+	+	-	-	-	+	-
Lethrinidae	*Lethrinus harak*	-	-	-	+	+	-	-	-	+	+
Nemipteridae	*Pentapodus trivittatus*	-	-	-	+	+	-	-	-	+	+
Siganidae	*Siganus rivulatus*	+	-	+	-	-	+	+	-	-	-

*(Absent:**-** ; Present: **+**)*

The most common fish species found across study sites are presented in Table 3. Several key fishery species, such as rabbitfish, emperors, groupers, and snappers from the family of Siganidae, Lethrinidae, Serranidae, and Lutjanidae, were found in the study areas. Interestingly, specific sites showed the presence of these economically valuable species, suggesting potential hotspots for sustainable fishing activities.

The MaxN and species richness were also recorded. MaxN was used to determine the maximum number of individuals of a particular species observed within a specified timeframe and was utilized in this study as a measure of species abundance.

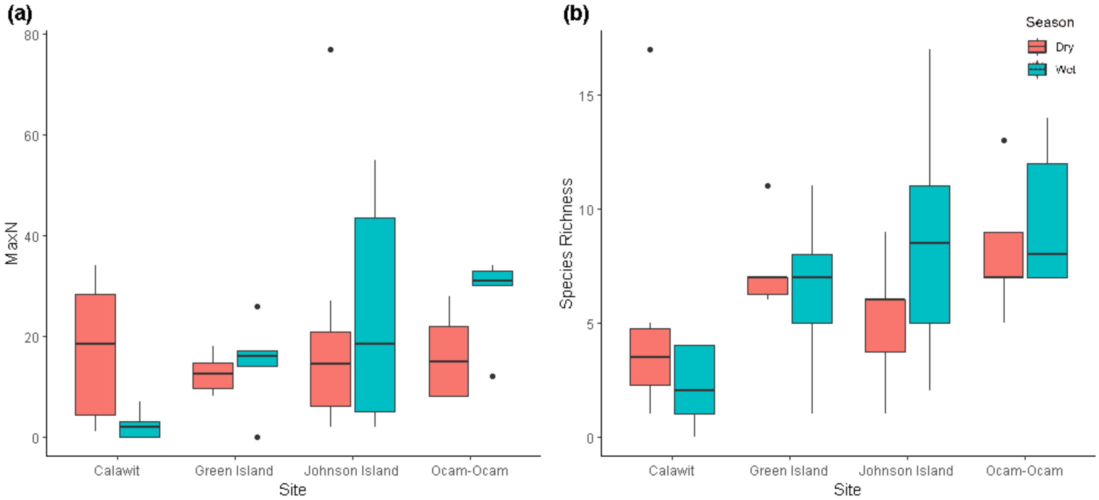
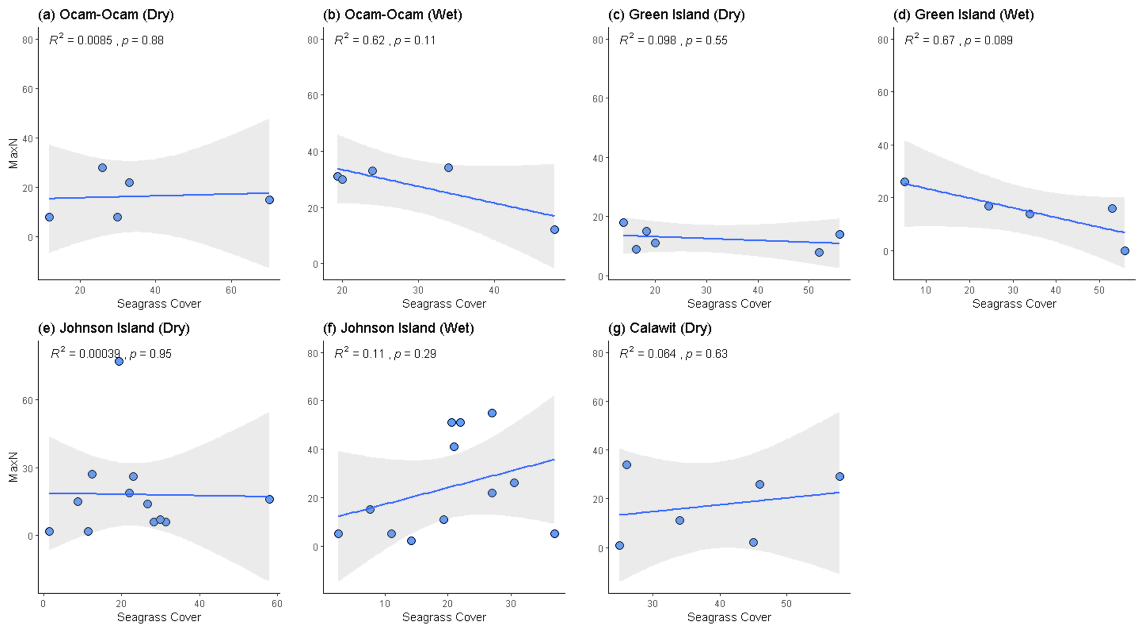


Figure 4. Boxplots representing MaxN and fish species richness across sites in the wet and dry seasons. Outliers (MaxN ≥50) were not included.

Figure 4 presents boxplots illustrating the distribution of MaxN and species richness across different sites during both wet and dry seasons. Outliers with MaxN values greater than or equal to 50 have been deliberately excluded to focus on the central tendencies and variability within the primary range of data. These include unidentified species and rabbitfishes that are mostly juvenile and are very hard to identify up to species level, unidentified atherinids, *N. macrolepidotus* (MaxN ranges from 50-150), *A. lacunosus* (50 to hundreds), and *P. lineatus* (hundreds).

(A)



(B)

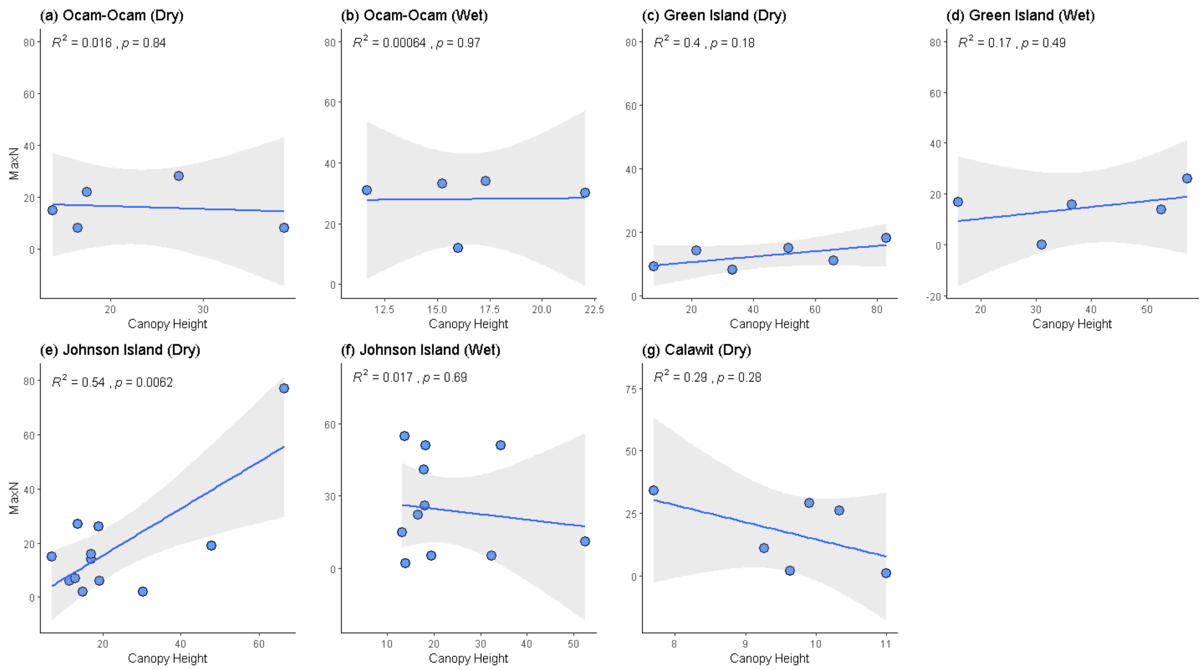


Figure 4. Regression plots between seagrass cover (%) and MaxN (A), and Canopy height and MaxN (B) in Roxas and Busuanga, Palawan in dry and wet seasons.

As shown in Figure 4 Above, a negative trend was observed in Ocam Ocam and Green Island, but a positive trend in Johnson Island. Notably, a difference in the trend between the dry and wet season in Johnson Island is perceived, though there is a weak correlation between MaxN and seagrass cover in all the study sites. No data were collected from Calawit Island in the wet season because of adverse weather conditions.

Aside from investigating the relationship between MaxN and Seagrass cover and canopy height, the relationship between species richness with the two above-mentioned factors was also analyzed.

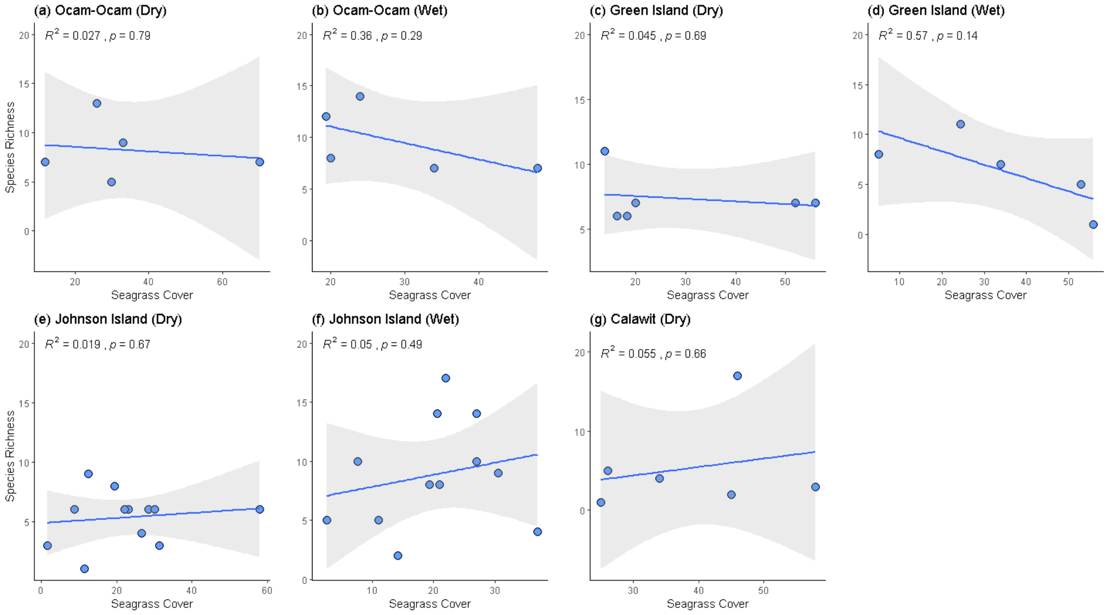


Figure 5. Regression plots between seagrass cover (%) and Species richness in Roxas and Busuanga, Palawan in dry and wet seasons.

Figure 5 presents regression plots summarizing the associations between seagrass cover (%) and species richness, and between canopy height and species richness across the study sites. Generally, there is no uniform trend observed across the study sites in dry and wet seasons. As depicted, there is very weak negative relationship between seagrass cover and species richness in Ocam-ocam and Green Island both in the dry and wet seasons, while there is a very weak positive relationship in Johnson Island and in Calawit Island.

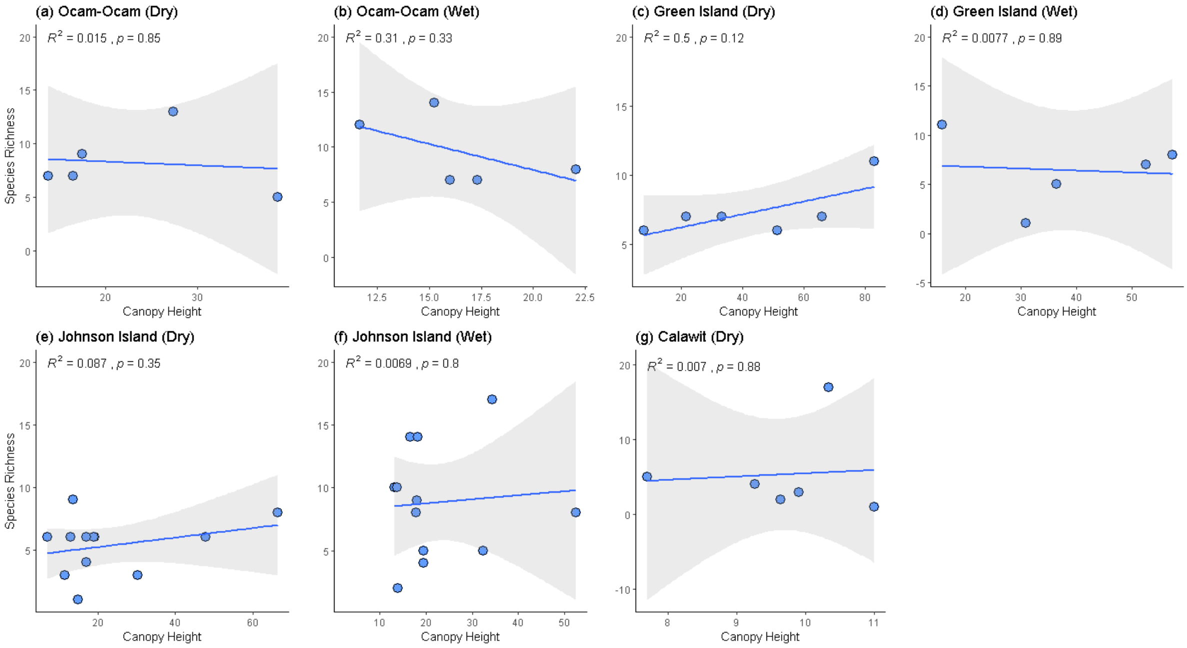


Figure 6. Regression plots between Canopy height and Species richness in Roxas and Busuanga, Palawan in dry and wet seasons.

In several studies, seagrass species diversity has been recorded to have a great effect on the abundance and diversity of the associated fish community and that most seagrass-associated fishes prefer seagrass beds having high canopies (Hori et al., 2009). But based on the results of the study, it showed a weak correlation between MaxN and seagrass cover in all the study sites, both in wet and dry seasons. Seagrass growth is influenced by a multitude of factors, including water quality, temperature, light availability, sediment type, and other factors. While MaxN might be one of those factors, its impact might be overshadowed by other factors that were not considered in this activity. Another aspect that could be regarded is that Seagrass ecosystems can be highly variable at small spatial scales due to factors such as currents and local nutrient sources. Based on the result, as observed in the study sites, the relationship is very weak, and does not suggest causation, changes in MaxN may not have a substantial impact on the amount of seagrass present. In terms of the canopy height and MaxN, a weak relationship was also observed. But a remarkable shift could be seen between the dry and wet seasons in Johnsohn Island. Though there are weak relationships observed, it is still not negligible. As such, further, and more comprehensive studies could be conducted.

In summary, our BRUV surveys showcase the rich biodiversity harbored within seagrass habitats. The findings highlight the significance of seagrass ecosystems as crucial contributors to marine diversity and fisheries resources. These insights could provide a basis for informed decision-making and effective management measures aimed at preserving this essential ecosystem.

Summary of Social Data

In addition to the ecological insights obtained from studying seagrass ecosystems in Busuanga and Roxas, Palawan, the social data provides a comprehensive understanding of the human dimension of these critical habitats. This section presents a condensed overview of the results obtained from the social surveys, offering insights into the utilization of seagrass meadows by people and the underlying reasons driving these engagements.

The results reveal that seagrass meadows play a significant role in the lives of coastal residents. Across the surveyed households, a substantial proportion reported engaging with seagrass meadows, highlighting their importance as a resource. These activities include various uses, including fishing, gathering of marine resources, aquaculture habitat, ecotourism, and cultural practices. The data also underscores the intricate relationship between seagrass utilization and livelihoods, as many households rely on these habitats for economic sustenance.

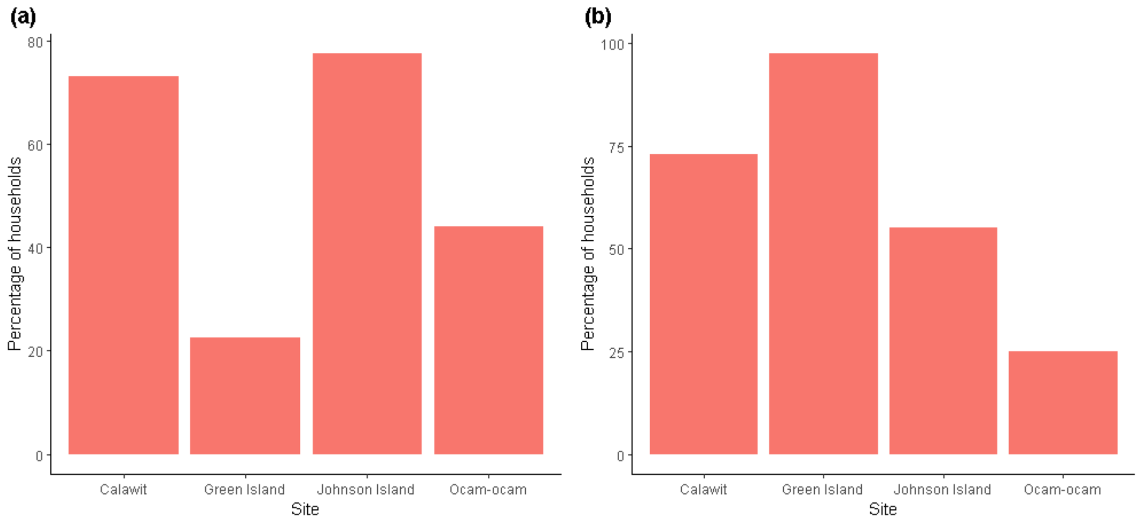


Figure 6. Bar graphs representing the percentage of total households (n = 40) that a) fish in seagrass meadows and b) prefer fishing in seagrass over other habitats across sites.

A total of 160 number of households were randomly selected as respondents for the survey conducted in Busuanga and in Roxas, Palawan. Across 40 household interviews conducted in each study site, the majority of them reported that they collect marine species from the environment. Some of these include different fish species, octopus, sea cucumber, and seashells.

Conclusions, remaining evidence and management gaps

In conclusion, the study underscores the crucial ecological importance of seagrass ecosystems in Busuanga and Roxas, Palawan, elucidating their role in providing ecosystem services. However, it becomes evident that significant knowledge and data gaps persist, impeding a comprehensive understanding of these ecosystems and their important relationships with human communities. While seagrass habitats are intrinsic to the livelihoods of coastal residents, the study reveals an awareness gap among locals regarding the broader ecological and economic services these habitats provide, highlighting the need for educational and outreach initiatives.

Moreover, the study uncovers a regulatory gap in terms of policy and management in the study sites. The potential of marine protected areas to safeguard seagrass meadows remains underutilized due to inadequate regulations and limited community engagement. This gap presents a crucial opportunity for integrated management strategies that involve local stakeholders and account for the cultural significance of these ecosystems. Bridging these gaps demands collaborative efforts between scientists, policymakers, and communities to not only fill the data and knowledge voids but also to foster a deep appreciation for the multifaceted value of seagrass ecosystems. Such activities will be instrumental in crafting effective conservation policies, enhancing awareness, and ensuring sustainable utilization of marine protected areas, thereby safeguarding the resilience of these essential habitats for current and future generations.

References:

Adams, M. P., Saunders, M. I., Maxwell, P. S., Tuazon, D., Roelfsema, C. M., Callaghan, D. P., ... & O'Brien, K. R. (2016). Prioritizing localized management actions for seagrass conservation and restoration using a species distribution model. Aquatic Conservation: Marine and Freshwater Ecosystems, 26(4), 639-659.

Agabin, M., & Travers, R. (Year). IMPACTS OF NEW INFRASTRUCTURE ON TOURISM IN THE PHILIPPINES: Case Study on USAID Support for the Philippines' Tourism Road Infrastructure Program. Chemonics International. Retrieved from https://pdf.usaid.gov/pdf_docs/PA00SZ93.pdf

Allen, G.R., Steene, R., Humann, P., and Deloach, N. (2015). Reef fish identification: Tropical Pacific (2nd ed.). New World Publications Incorporated.

Camacho, O. L., Duque, H., Blanco-Torres, A., & Cebrian, J. (2019). Seagrass meadows in the Philippine archipelago: A review of the current status, threats, and knowledge gaps. Biodiversity and Conservation, 28(14), 3963-3983.

C3 Philippines, Inc. (2018). Report: Processes for establishing the Dugong critical marine habitat in Busuanga, Palawan.

Cullen-Unsworth, L., & Unsworth, R. (2013). Seagrass meadows, ecosystem services, and sustainability. Environment: Science and policy for sustainable development, 55(3), 14-28.

Fortes, M. D. (2012). Historical review of seagrass research in the Philippines. Coastal marine science, 35(1), 187-181.

Fortes, M. D. (2013). A review: biodiversity, distribution and conservation of Philippine seagrasses. Philippine Journal of Science, 142(1), 9.

Froese, R. & Pauly, D. (2023). Fishbase. World Wide Web electronic publication: http://fishbase.org.

Grimm, K. E., Archibald, J. L., Bonilla-Anariba, S. E., Bood, N., & Canty, S. W. (2023). Framework for fostering just and equitable seagrass policy, management, and social-ecological outcomes: Lessons learned from Belizean marine resource managers. Marine Policy, 152, 105606.

Hori, M., Suzuki, T., Monthum, Y., Srisombat, T., Tanaka, Y., Nakaoka, M., & Mukai, H. (2009). High seagrass diversity and canopy-height increase associated fish diversity and abundance. Marine Biology, 156(7).

Larkum, A. W., Orth, R. J., & Duarte, C. M. (2006). Seagrasses: biology, ecology and conservation. Phycologia, 45(5), 5.

Orth, R. J., Carruthers, T. J., Dennison, W. C., Duarte, C. M., Fourqurean, J. W., Heck, K. L., ... & Williams, S. L. (2006). A global crisis for seagrass ecosystems. Bioscience, 56(12), 987-996.

Randall, J.E. (2005). Reef and shore fishes of the South Pacific. University of Hawai'i Press, Honolulu.

Short, F. T., Polidoro, B., Livingstone, S. R., Carpenter, K. E., Bandeira, S., Bujang, J. S., ... & Zieman, J. C. (2011). Extinction risk assessment of the world's seagrass species. Biological Conservation, 144(7), 1961-1971.