



Secondary productivity of the Philippine National Aquasilviculture Program (PNAP): Mangrove rehabilitation area in Brgy. Bagumbayan, Malalag, Davao Del Sur, Philippines

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Abstract

This study was conducted to determine the secondary production of mangrove under PNAP Area of Brgy. Bagumbayan, Malalag, Davao del Sur. There were two sampling stations established in the area. In each station contains 3 transect lines with an interval of 50m and within the transect line a 10x10m plot was established. Quadrat method was also employed. Result revealed that there were 15 species of secondary productivity found in the area which composes of 613 individuals and was classified and identified according its taxonomic classification. Majority of this species commonly belongs to the Phylum Arthropoda, Molluska, Echinodermata and Chordata.

The PNAP mangrove species were composed of *Rhizophora mucronata*, *Avicennia marina* and *Sonneratia alba* wherein the identified species used mangroves as habitat, nursery and breeding grounds. The result further showed that there was no significant difference between the species diversity and abundance of mangrove secondary productivity in PNAP mangrove area ($P < 0.05$).

Keywords: mangroves, aquasilviculture, secondary productivity, PNAP

Introduction

The implementation of the Philippine National Aquasilviculture Program (PNAP), a fishery livelihood and conservation program was launched with the forging of a memorandum of agreement between the Department of Agriculture (DA) – Bureau of Fisheries and Aquatic Resources (BFAR) XI through its Regional Executive Director Fatma M. Idris, and the three (3) State University and Colleges in Davao Region. Among SUCs was the Southern Philippines Agri-Business and Marine and Aquatic School of Technology (SPAMAST) identified as project implementor. The project was geared towards community-based mangrove resource management and aquasilviculture which envisioned attaining food security, ensuring sustainable development of fisheries resources reducing poverty incidence among coastal communities. Specifically, the organized communities were strengthened and capacitated by providing an appropriate education, training and skills in the utilization of the resource ecosystem- a tool in sustainable development. The program has three (3) project components i.e. Mangrove Resource Rehabilitation & Enhancement, Aquasilviculture: Sustainable Livelihood Project and Community-Based Multi-Species Hatchery with allotted budget of P7, 468, 960.00 solely for Davao del Sur (Pacyao and Llameg, 2018) [8].

The coastal resources of Malalag are beset by problems and issues such as coliform pollution, destructive fishing, and

encroachment on the fishing ground by outsiders, lack of alternative livelihood activities, siltation, and absence of revenue from docking vessels. This study focuses on the secondary productivity commonly found in the mangrove area of the Philippine National Aquasilviculture Program (PNAP) Bagumbayan, Malalag, and Davao del Sur.

The study aimed to determine the secondary productivity of the Philippine National Aquasilviculture Program (PNAP) Mangrove Rehabilitation Area in Bagumbayan, Malalag, Davao del Sur and it sought to:

1. Identify common organisms inhabiting in the PNAP mangrove area;
2. Determine the density of relative abundance of species found in the study area; and,
3. Calculate the diversity indices of secondary species found in the study area;

Materials and Methods

This research was conducted in Brgy. Bagumbayan, Malalag, Davao del Sur. Research location was chosen because this has existing 30,000 mangroves planted covering 7 hectares and form part of Philippine National Aquasilviculture Program (PNAP) – Mangrove Rehabilitation Project funded by DA-BFAR (Generalao *et al.*, 2014 as cited by Pacyao and Llameg, 2018) [4, 8].



Fig 1: Map of the study area

The study employed a one shot sampling and was done during low and high tide. There were two sampling stations established in the sampling area. Quadrat method was employed in determining and identifying the different species. Each station was established with three transect lines with an interval of 50 meters. Within the transect line a three (3) 10m x 10m plots were established having a spacing distance of 5 meters in each plot. Evaluation and assessment was done inside the 10m x 10m plot.

The secondary productivity of the study area was quantified through actual fishing using gill net with mesh size #10, 1 m in width and 50 m long. The net was set during high tide and was retrieved after the peak of flood tide. Species caught during fishing was identified using the book “Guide to Philippine Flora and Fauna volume VI (Garcia, 1986)”, and www.fishbase.de, and other available references. Sample specimen was brought to the laboratory and has been preserved with 10% seawater formula for verification by an expert.

Data Analysis

Relative Density. All individuals of secondary productivity found in mangrove within each quadrat were counted per species. The formula developed was followed for calculation (Odum, 1971) [6].

$$D = \frac{\text{Total Number of the same species}}{\text{Area}(m^2)}$$

Relative Density. Relative abundance of each species was based on the formula of Odum (1971) [6].

$$RA \text{ of Species} = \frac{\text{No. of Species A}}{\text{Total No. of all Species}} \times 100$$

Diversity Indices. Species diversity was determined following the formula of Shannon Wiener-Index of Diversity (English et al., 1994) [3].

$$H' = -\sum P_i \ln P_i$$

Where: H’= Index of General Diversity

Pi= Proportional abundance of the species= (ni/N)

Index of Dominance. This was used to determine the

dominant/ abundant of secondary species (English et al., 1994) [3]

$$C = \sum (N_i/N)^2$$

Where: C= Index of Dominance

ni= Number of individuals per species

N= Total number of individual of all species

Index of Evenness. This was used to determine the species evenness in two sampling stations based on the formula:

$$e = H' / \ln S$$

Similarity Index. Stations similarity in respect of species composition and similarity was determined using the Jaccard’s similarity index of English et al. (1994) [3].

$$Cc_j = \frac{c}{a + b + c} \times 100$$

Where: CCj = Jaccard’s Similarity Index

C = is the number of the species found in both a and b.

A = is the number of species found in station a.

B = is the number of species found in station b.

Statistical Analyses. To analyze and determine the significant difference in the abundance of mangrove secondary species among the two sampling stations, Analysis of Variance (ANOVA) was used. Kruskal Wallis was used to determine the significant differences in the number of secondary species in the different sampling stations. All analysis were done using Microsoft software, SPSS 17.0.

Results and Discussions

Species of Organisms Identified

There were 15 species found in the study area namely *Ostrea lurida*, *Terebralia sulcata*, *Coenobita sp.*, *T. telescopium*, *C. cingulata*, *Astropecten spinulosus*, *Littorina scabra*, *Ovalipes ocellatus*, *Scylla serrata*, *Mugil cephalus*, *Anodontia alba*, *Isognomona latus*, *Ovalipes catharus*, *Periopthalmus argentilineatus* and *Pomacea canaliculata*. Only two species are not commonly found in each station. Station 1 species that

are not found in station 2 are *C. cingulata* and *T. telescopmium*, based on the actual ocular survey during conduct this species were commonly thrived on a muddy and a mixed species of mangrove in the area. While on station 2 two species that are not found on station 1 are the portunid crabs (*Ovalipes ocellatus* and *Ovalipes catharus*). These

species also thrived in muddy area because they have the ability to burrow on the mud and they were also are a fast swimming crabs and mostly preferred *Rhizophora sp.* Identified species were commonly thrived on mangroves present in the area.

Table 1: The occurrence of species in the PNAP mangrove Area

Species	Station 1	Station 2
Arthropoda		
<i>Coenobita sp.</i>	+	+
<i>Scylla serrate</i>	+	+
<i>Ovalipes ocellatus</i>	-	+
<i>Ovalipes catharus</i>	-	+
Chordata		
<i>Mugil cephalus</i>	+	+
<i>Periophthalmus argentilineatus</i>	+	+
Molluska		
<i>Littoraria scabra</i>	+	+
<i>T. telescopmium</i>	+	-
<i>C. cingulate</i>	+	-
<i>Isognomon alatus</i>	+	+
<i>Anodontia alba</i>	+	+
<i>Pomacea canaliculata</i>	+	+
<i>Ostrea lurida</i>	+	+
Echinodermata		
<i>Astropecten spinulosus</i>	+	+

Legend: + = Represent the presence of species; = Represent the absence of species

Relative Abundance/Dominance

The Relative abundance of secondary productivity revealed that in station 1 the highest abundant species was *Terebralia sulcata* with 29.74 and with the lowest abundant value of 0.416% was *Astropecten spinulosus*. *Terebralia sulcata* was the highest abundant species thrived in the area due to the vast and diversified mangroves present in the area. While in station 2, abundant result of the species revealed that *Ostrea lurida* has the highest value of 27.35% and with the lowest abundant

value of 0.54% is the *Ovalipes ocellatus* (Table 2). It shows that the species of *Ostrea lurida* was the most abundant in station 2 because of the diverse mangrove *Rhizophora sp.*, these species mostly preferred prop roots of *Rhizophora sp.* The relative abundance of the secondary productivity shows that there is no significant difference of species abundance of the two sampling stations (Table 2) due to their distribution within the two stations.

Table 2: Relative abundance/dominance (%) of secondary species

Species	Station 1	Station 2
<i>Ostrea lurida</i>	4.162	27.346
<i>Terebralia sulcata</i>	29.736	23.324
<i>Coenobita sp.</i>	2.579	1.072
<i>T. Telescopmium</i>	6.243	0.000
<i>C. Cingulata</i>	3.330	0.000
<i>Astropecten spinulosus</i>	0.416	1.340
<i>Littorina scabra</i>	16.876	26.273
<i>Ovalipes catharus</i>	0.000	0.536
<i>Scylla serrata</i>	0.832	1.072
<i>Mugil cephalus</i>	1.665	2.145
<i>Anodontia alba</i>	2.112	1.340
<i>Isognomon alatus</i>	4.162	1.072
<i>Ovalipes ocellatus</i>	0.000	1.072
<i>Periophthalmus argentilineatus</i>	6.243	2.681
<i>Pomacea canaliculata</i>	3.330	9.651
TOTAL	100.00	100.00

Diversity and Evenness Indices

Diversity of secondary productivity species shows that the station 2 has the highest index value of 3.741 and station 1 has

the lowest value of 3.723. Station 1 has the highest evenness value of 0.303 while station 2 has the lowest evenness value of 0.207. The diversity of mangrove area can be considered

low if the species are few. Higher diversity, then, means longer food chains and more cases of symbiosis and greater possibilities for negative feedback control, which reduces oscillations and hence increase in stability (Odum, 1971) ^[6].

Table 3: Diversity and evenness indices of the species.

Station	H'	E
1	3.723	0.303
2	3.741	0.207

Index of Similarity

A similarity test of the two stations on mangrove secondary productivity species was observed. It appeared that it has a similarity of 50% in which based on the actual ocular survey the result shows that station 1 and 2 have the same similarity index due to the distribution of species between the two stations.

General Discussion

Based on the result, there were 15 species serves as part of the secondary productivity in PNAP Mangrove Rehabilitation Area and commonly belongs to Phylum Mollusca, Arthropoda, Chordata and Echinodermata. A total of 613 species individuals were identified. These species were commonly inhabited in the area which has diverse mangroves, hence, Mangroves create unique ecological environments that host rich assemblages of species. The muddy or sandy Sediments of the mangal are home to a variety of epibenthic, infaunal, and meiofaunal invertebrates, it also support communities of phytoplankton, zooplankton, and fish (Pinto And Punchihewa, 1996) ^[9]. The diversification of mangrove species leads the diversity and abundance of the species in the area, the diversity of mangrove area can be considered low if the species are few. Higher diversity, then, means longer food chains and more cases of symbiosis and greater possibilities for negative feedback control, which reduces oscillations and hence increase in stability (Odum, 1971) ^[6]. Secondary production estimates could therefore be an especially useful tool in scenarios where diversity or community-based metrics do not detect an anthropogenic effect, but where a secondary production of fish communities' ecosystem-level effect is nonetheless suspected (e.g., Hoyle and Harborne 2005). In a broader context, it is often assumed that diversity change reduces species richness regardless of particular species or functional groups (Micheli 1999, Ceballos *et al.* 2005, Cardinale *et al.* 2006) ^[5, 2, 1].

Conclusions

There were 613 individuals belongs to 15 species found in the study area. Majority of these species belongs to Arthropoda, Molluska, Echinodermata and Chordata. Results for relative abundance showed *Terebralia sulcata* as the species with highest abundant with 29.74% (Station 1), while 27.35% for Station 2 (*Ostrea lurida*). Furthermore, indices results revealed Station 2 with highest index value of 3.741, and highest evenness value was recorded in Station1 (0.303).

There was no significant difference between the species diversity and abundance of mangrove secondary productivity in PNAP area. It only implies that all stations were

comparable.

References

1. Cardinale BJ, Srivastava DS, Duffy JE, Wright JP, Downing AI, Sankaran M, Jouseau C. Effects of biodiversity on the functioning of trophic groups and ecosystems. *Nature*. 2006; 443:989-992. [Http://dx.doi.org/10.1038/nature05202](http://dx.doi.org/10.1038/nature05202)
2. Ceballos G, Ehrlich PR, Soberon J, Salazar I, Fay JP. Global mammal conservation: what must we manage? *Science*. 2005; 309:603-607.
3. English S, Wilkinson C, Baker V. Survey for Tropical Marine Resources. National Library of Australia Catataguing, 1994, 368.
4. Generalao I, Fuentes A, Llamag M, Elimino M, Avenido P, Lubat G, *et al.* Aquasilviculture: A coastal conservation and livelihood project in Davao del Sur. Paper presented during the 4th Biennial Convention of the Philippines Association of Extension Program Implementors Inc. (PAEPI) at Mindanao University of Science and Technology (MUST), Claro M. Avenue, Cagayan de Oro City, Philippines on, 2014, 27-29.
5. Micheli F. Eutrophication, fisheries, and consumer-resource dynamics in marine pelagic ecosystems. *Science*. 1999; 285:1396-1398. <http://dx.doi.org/10.1126/science.285.5432.1396>
6. Odum WE. *Fundamentals of Ecology*, 1971, 10.
7. Odum WE, Heald EJ. The detritus based food web of an estuarine mangrove community. In *Estuarine research*. L. Cronin(ed). Academic press, NY, 1975, 265-286.
8. Pacyao JPR, Llamag MB. Success Indicators of the Philippine National Aquasilviculture Program (PNAP) - Mangrove Rehabilitation Project in Davao del Sur, Southern Philippines. *Open Science Journal*. 2018; 3(1).
9. Pinto L, Punchihewa NN. Utilization of mangroves and seagrasses by fishes in the Negombo Estuary, Sri Lanka. *Marine Biology*. 1996; 126(2):333-345. <https://www.fishbase.de/>