PROCEEDING

The 1st INTERNATIONAL SEMINAR on SUSTAINABILITY in the MARINE FISHERIES SECTOR 2017

Establishing Sustainable Marine and Fisheries Sector to Support Food Security within ASEAN Economic Community Framework

16th September 2017
Mokodompit Auditorium UHO & Swiss Bel Hotel
Kendari, Southeast Sulawesi - Indonesia

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Hosted by

Faculty of Fisheries and Marine Sciences
University of Halu Oleo

Published by

Reviewers

La Sara

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Wa Iba

PREFACE

The proceeding of the 1st International Seminar on Sustaninability in the Marine Fisheries Sector (ISSMFS) 2017 with the theme "Establishing Sustainable Marine and Fisheries Sectors to Support Food Security within ASEAN Economic Community Framework" is a collection of selected papers presented at the seminar. The 1st ISSMFS is organised by the Faculty of Fisheries and Marine Science, University of Halu Oleo, as a part of the celebration of the 36th Anniversary of University of Halu Oleo and in conjunction with the Higher Education Leaders Forum for Fisheries and Marine Science (FP2TPKI) which was held at the Mokodompit Auditorium UHO & Swiss Bel Hotel Kendari on 16th September 2017.

The seminar was attended by 131 participants mostly coming from different parts of Indonesia and from several countries including Japan and Malaysia. The scientific presentations cover six topics namely: Aquatic Resources Management, Aquaculture, Marine Science and Technology, Capture Fisheries, Socio-Economic of Fisheries and Processing of Fisheries Product. The Ministry of Marine Affairs and Fisheries, Dr. (HC) Susi Pudjiastuti was the keynote speaker, while Head of Fish Quarantine, Quality Control and Inspection Agency (Dr. Ir. Rina, M.Si), Prof. Kazunori Yamahira from Ryukyus University, Japan and Prof. Dr. Hasjim Djalal (Expert Staff in Maritime Law at Ministry of Marine Affairs and Fisheries) were the invited speakers.

Out of 100 presentations, 38 full papers were submitted to be followed up and processed into the proceeding. The papers submitted were assessed for suitablility of subject matter and overall technical quality by Editorial Board. There are interesting papers presented at the seminar but not included in this proceeding for some reasons.

Finally, we would like to thank everyone who involved in the process of the publication of the proceeding. We hope that this proceeding will bring benefit for all of us.

Prof. Ir. H. La Sara, MS, Ph.D
Editor in Chief

PROGRAM OF ISSMFS 2017

Time	Details	Facilitator
09.00-10.00	Registration	Registration committee
10.00-11.25	Opening Ceremony (Mokodompit Auditorium UHO)	Master of Ceremony
	➢ Welcome Dance	Organizing committee
	➢ Sing the National Anthem, Indonesia Raya and Mars UHO	UHO Choir
	➢ Reciting Prayers	Organizing Committee
	➢ Speech from the Rector of University of Halu Oleo	Prof. Dr. Muhammad Zamrun, M.Si, M.Sc
	➢ Speech from the Governor of Southeast Sulawesi Province	Brigjen Purn H. Muh. Saleh Lasata
	➢ Keynote Speaker : DR (HC) Susi Pudjiastuti (The Minister of Marine Affairs and Fisheries, Republic of Indonesia) and officially open the 1st ISSMF	Prof. Ir. H. La Sara, MS, Ph.D
11.25-11.30	Signing of Inscription of Susi Pudjiastuty's Building	Organizing committee
11.30-11.35	Declaration Towards of Eradication of Destructive Fishing (Bombing and Cyanide used)	Organizing committee
11.35-11.40	The Reading of the Communiques of the Higher Education Leaders Forum for Fisheries and Marine Science	Chair of the FP2TPKI
11.40-11.55	Invited Speaker I : Prof. Ir. R. Sjarief Widjaja, Ph.D., FRINA (Directorate General of Capture Fisheries, KKP RI) Title : The Role of Capture Fisheries to Support Food Security within ASEAN Economic Community Framework	
11.55-12.10	Invited Speaker II : Dr. Ir. Slamet Soebijakto, M.Si (Directorate General of Aquaculture, KKP RI) Title : The Role of Aquaculture to Support Food Security within ASEAN Economic Community Framework	
12.10-12.25	Invited Speaker III : Dr. Ir. Rina, M.Si (Head of Fish Quarantine and Inspection Agency, KKP RI) Title : The Role of Fish Quarantine, Quality Control and Security of Fisheries Products to support Food Security within ASEAN Economic Community Framework	Prof. Ir. H. La Sara, MS, Ph.D
12.25-12.40	Invited Speaker IV: Dr. Sara Beavis (Australian National University, Canberra, Australia) Title : The Impact of Onshore Activities on the Coastal Environment	
12.40-12.55	Invited Speaker V : Prof. Kazunori Yamahira (Ryukyus University, Japan) Title : Diversification of Aquaculture Organisms for the Development of Freshwater Aquaculture	
12.55-13.10	Invited Speaker VI : Prof. Dr. Hasjim Djalal (Expert Staff of Ministry of Marine Affairs and Fisheries of the RI) Title : International Maritime Law	
13.10-13.20	Visiting the Faculty of Fisheries and Marine Science UHO	Organizing committee
13.20-14.30	Break (Lunch and Pray) at Swiss Bel Hotel	Organizing committee
14.30-17.50	Parallel Sessions (Swiss Bel Hotel)	Organizing committee

TABLE OF CONTENT

Topic D: Capture Fisheries

Topic E. Socio-Economic of Fisheries

Topic F: Processing of Fisheries Products

LIST OF PARTICIPANTS

TOPIC A : AQUATIC RESOURCES MANAGEMENT

Study of Phytoplankton Abundance for the Development of Pearl Oyster Culture Area in the North Gorontalo Waters

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Abstract

Kwandang water, Northern Gorontalo is considered as a very potential area for marine aquaculture especially for the pearl oyster cultivation. However, a study of this prospective has not been published. The realization of the pearl oyster farming is affected by several factors. One of the factors that influence the success of oyster farming is the selection of a proper location, which has suitable water quality for marine biota, good water productivy as well asthe abundance of phytoplankton. The aim of this study was to analyze the abundance of phytoplankton as one of the biological parameters for the development of pearl oyster culture in the North Gorontalo area. The research method used was an explorative method by survey. The measurement of physical and chemical parameters was conducted in situ, while the biological parameter (phytoplankton) analysis was carried out in the laboratory. The results showed that the North Gorontalo water is a suitable site for pearl oyster culture based on the abundance of phytoplankton.

Keywords: abundance, phytoplankton, pearl oyster, water quality, North Gorontalo

Introduction

Pearl oysters are one of the potential organisms that can be developed as part of the cultivation industry. The term "pearl oysters" has traditionally been applied to bivalves of the *Pinctada* and *Pteria* genera, including in the family Pteridae and most species of Pteridae are tropical and subtropical, but the distribution of some species extends to higher latitudes (Wada & Têmkin, 2008).

Pearls have been considered as treasured, symbols of wealth, power, and prestige, as well as an object of devotion and respect (Strack, 2008). Currently, the cultivation of pearl oyster is one of the prospect businesses in Indonesia, especially its potential that has not been developed optimally. Potential land for the development of pearl shellfish cultivation and abalone in Indonesia amounted to 62.040 ha (Hamzah, 2007).

Pearl oysters are one of the important commodities with economic potential value of 120 million US$ (Dahuri, 2000). In addition, the territorial waters of eastern Indonesia such as Papua, Arafuru and Sulawesi Islands, have a great potential for pearl oysters. Gorontalo is one of the areas in eastern Indonesia that has a wide coastal and is supposed to have the potential of pearl oyster.

Development of cultivation that currently exists in the North Gorontalo waters is the cultivation of fish in floating cage and seaweed, while the cultivation of pearl oyster has not been established. In establishing a pearl cultivation business, the cultivation location plays an important role for successful pearl oyster production. Good cultivation sites should meet technical requirement such as water quality, water productivitys, fry and host resources, supporting facilities, security, markets and transportation (Fathurrahman *et al*. 2015).

Pearl oyster belongs to the group of herbivores that do not require additional food because they feed phytoplankton that naturally occurs in waters (Matthiessen, 2001; Powell *et al*. 2002, 2004; Fernandez *et al*. 2006). As phytoplankton is the main food, biochemical composition plays key role in nutrition quality in phytoplankton and its function for bivalve (Powell *et al*. 2002, 2004).

This study aims to analyze the abundance of phytoplankton as a biological parameter for the development of pearl cultivation in North Gorontalo waters. This research is expected to provide basic information in the early efforts of developing the research area of a pearl oyster cultivation region in the future especially by promoting the development of pearl oyster cultivation community-based.

Materials and Methods

Time and Location

This research was conducted for two months from July to August 2017 located in the waters of North Gorontalo regency. Primary data collection was carried out at 4 sampling sites (Figure 1).

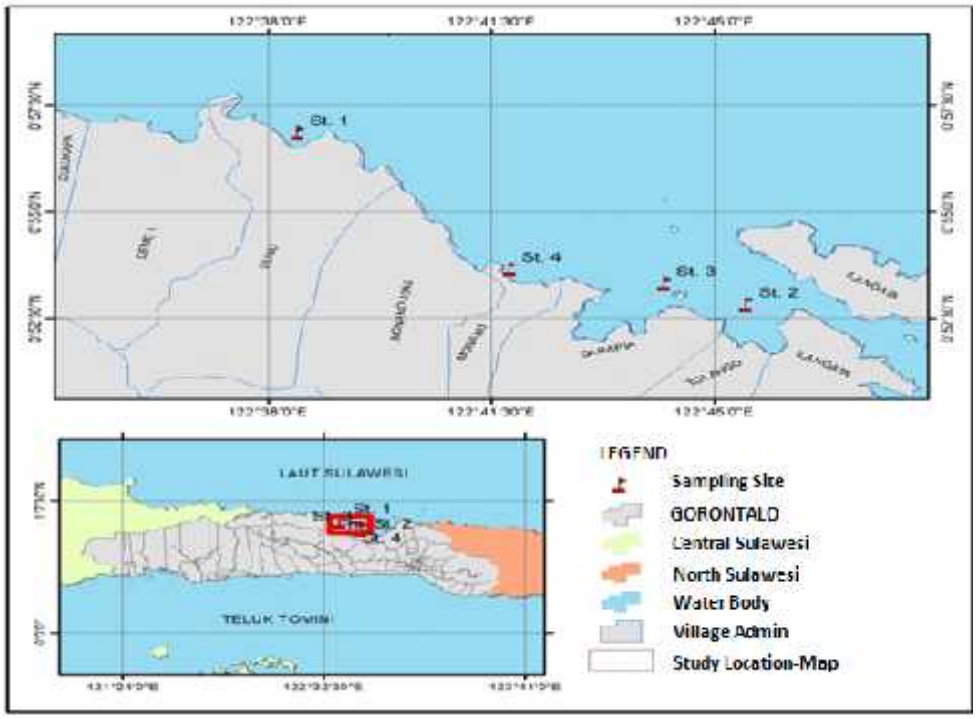

Figure 1. Map of The Study Sites

Phytoplankton Sampling

The main data collected in this research wasthe phytoplankton data as biological parameter and water quality data (physics and chemical) as supporting data. Water sampling for phytoplankton observation used plankton net (size 25µm). Water samples were taken vertically and horizontally. The filtered water sample was preserved by adding 1% Lugol solution. Water quality parameters such as temperature, salinity, pH, and dissolved oxygen were measured directly at the sampling sites.

Data analysis

The abundance of phytoplankton was observed using a sweeping method above the Sedgwick Rafter glass object with individual units per milliliter (ind/ml). The abundance of phytoplankton type was calculated based on equations according to APHA (1980), as follows:

$$N = \frac{oi}{op} x \frac{Vr}{Vo} x \frac{1}{Vr} x \frac{n}{p}$$

where :

N	: phytoplankton abundance (ind/ml)
Oi	: cover-glass area (mm²)
Op	: view area (mm²)
Vr	: filtered water volume (ml)
Vo	: observed water volume (ml)
n	: number of phytoplankton in the entire view area
p	: number of view areas

Results and Discussion

Results

The results of identification and calculation of phytoplankton abundance found in the study sites are presented in Table 1. The phytoplankton found in the study sites comprised of 3 phylum namely Chlorophyta, Crysophyta and Cyanophyta consisting of 22 species of varying number of individuals. The presence of species at each station tends to be varied. The highest number of species was found in the Station 1 and 2 (19 species) followed by Station 3 (18 species) whereas the lowest number of species was found in the Station 4 (16 species). Each phylum has a varying number of species. Chrysophyta has the highest number of species (15 species)followed by Chlorophyta (5 species) and Cyanophyta (2 species). The total abundance of species per phylum showed that Cyanophyta had the highest abundance except at Station 2 in which the Chrysophyta had the highest abundance of the phytoplankton species. Also, the highest total abundance of phyroplankton was found at station 2 (Table 1).

Table 1. Abundance of phytoplankton species in the study sites

No.	Phylum	Species	Station 1	Station 2	Station 3	Station 4
1	Chlorophyta	*Cosmarium sp.*	476.25	317.50	562.24	694.53
2		*Hyalotheca mucosa*	0	1058.33	0	0
3		*Chlorella sp.*	793.75	2381.24	926.04	0
4		*Golenkinia sp.*	330.73	231.51	0	198.44
5		*Pediastrum simplex*	2116.65	529.16	3208.05	3174.98
			3717.37	**4517.73**	**4696.33**	**4067.94**
1	Chrysophyta	*Achnanthes brevipes*	727.60	1587.49	661.45	0
2		*Amphora sp.*	396.87	330.73	694.53	0
3		*Cymbella sp.*	198.44	66.15	330.73	132.29
4		*Chaetoceros affinis*	2116.65	4497.89	1058.33	1587.49
5		*Chaetoceros messanensis*	396.87	0	1852.07	1190.62
6		*Coscinodiscus sp.*	132.29	165.36	0	198.44
7		*Hemiaulus membranaceous*	264.58	396.87	0	1058.33
8		*Rhizosoleniacastracanei*	264.58	1389.05	463.02	396.87
9		*Rhizosolenia imbricate*	264.58	2778.11	297.65	0
10		*Rhizosoleniapungens*	198.44	330.73	350.57	198.44
11		*Surirella sp.*	244.74	562.24	926.04	0
12		*Synedragailonii*	297.65	879.73	727.60	99.22
13		*Synedramontana*	0	1342.75	793.75	132.29
14		*Synedra ulna*	793.75	661.45	416.72	661.45
15		*Nitzschiasp*	628.38	482.86	19.84	992.18
			6925.43	**15471.42**	**8592.29**	**6647.62**
1	Chyanophyta	*Anabaena sp.*	6482.25	0	3571.85	8995.78
2		*Oscilatoria sp.*	5688.51	9524.94	8863.49	2381.24
			12170.76	**9524.94**	**12435.34**	**11377.02**
	Total Abundance (cell/L)		22813.56	29514.10	25723.96	22092.58

More details of the composition of each species are presented in Figure 2. As shown in Figure 2, *Oscilatoria* sp. and *Anabaena* sp. had the highest abundance compared to the abundance of the other species. The existence of phytoplankton is certainly influenced by environmental factors.

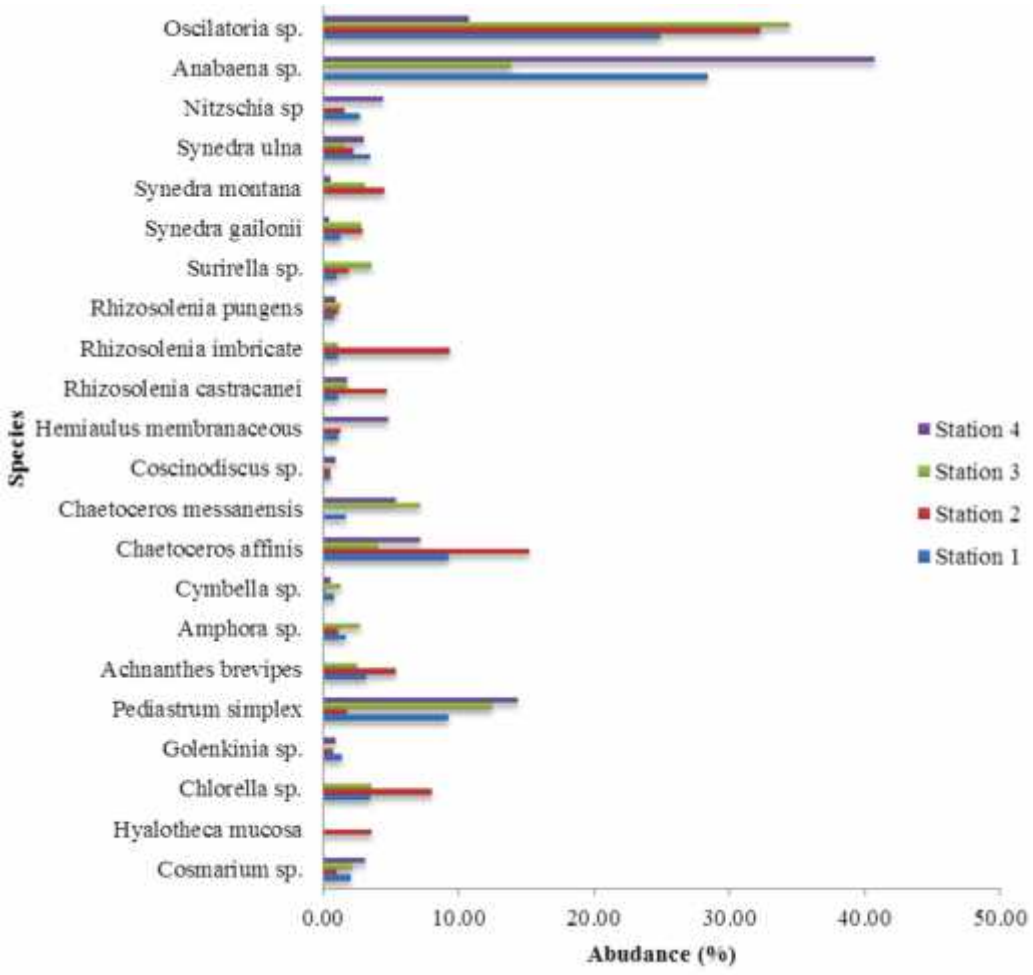

Figure 2. Abundance of phytoplankton in north Gorontalo waters

The measurement results of several environmental parameters are presented in Table 2.

Table 2. Results of physical-chemical and biological parameter measurements at the study sites

No.	Parameter	Station 1	Station 2	Station 3	Station 4
1	TDS (mg/l)	88,6	88,1	87,55	87,8
2	SPM (mg/L)	176	287	323	181
3	BOD_5 (mg/l)	24	27,5	30,5	57.5
4	COD (mg/l)	>1500	>1500	>1500	>1500
5	Conductivity (mS/cm)	50,8	50,4	50,5	55,6
6	Current (m/s)	0.085	0,165	0,1	0,09
7	DO (ppm)	4,16	4,46	4,71	4,73
8	Temperature (^{0}C)	29,6	29,5	29,8	30,1
9	Salinity (‰)	33,3	32,9	33,1	33,4
10	pH	6,89	6,92	6,99	7,34
11	Nitrate (mg/l)	UD*	UD*	UD*	UD*
12	Phosphate (mg/L)	0,0088	0,0071	0,0021	0,0118
13	Transparency (m)	16	6	7	5
14	Depth (m)	16	6	7	5
15	Substrate condition	Gritty-sand	Sandy-corals	Sand	Sandy-corals
16	Weather condition	sunny	sunny	Sunny	Sunny
17	Chlorophyll-a (mg/m3)	0,7872	1.0152	0,9844	0,9504
18	Phytoplankton abundance (cell/L)	22814	29514	25724	22093

*UD: undetected

The biological index values were also calculated to determine the level of environmental stability. The results of the biological index calculations including the diversity index,, the dominance index and the uniformity index are presented in Table 3.

Table 3. Results of Phytoplankton Biology Index score in the Research Sites

No.	Biological Index	Station 1	Station 2	Station 3	Station4
1	Diversity Index (H')	1.8924	2.2691	2.2098	1.8422
2	Dominance Index (D)	0.2464	0.1578	0.1715	0.2336
3	Similarity Index (S)	0.6908	0.7853	0.7888	0.7422

Table 3 shows that the Diversity Index value ranged from 1.8422 - 2.2691, the Dominance Index ranged from 0.1578 to 0.2464 and the Similarity Index value ranged from 0.6908 - 0.7888. Station 2 had the highest diversity Index value with the lowest dominance Index value.

Discussion

Development of pearl oyster cultivation requires waters withgood productivity. Like most other bivalve, pearl oystesr are filter or suspension feeders throughout the free-living stages of their lifecycle. They filter fine suspended particles, seston, from the water around them (Lucas, 2008; Dunphy *et al.*, 2006). Phytoplankton play key role for pearl farming (Faturrahman, *et al.*, 2015).

Phytoplankton is one organism that has a very important role in the life cycle in the water. Phytoplankton can be used as a study material to determine the quality and productivity of aquatic ecosystem that is required to support the exploitation of coastal and marine resources. Five major phytoplankton groups that live in waters are Cyanophyta (blue algae), Chlorophyta (green algae), Chrysophyta (yellow algae), Pyrrophyta and Euglenophyta (Widyastuti *et al*., 2001; Yuliana, 2012).

The phytoplankton found consisted of 3 phylum namely Chlorophyta, Chrysophyta and Cyanophyta. Moreover, the number of phytoplankon types which are found in this research mainly from Chrysophyta phylumconsisted of Xantophyceae, Chrysophyceae and Bacillariophyceae (diatomae) classes (Widyastuti *et al*., 2001). Brahmana (2001) explains that Chrysophyta algae are slightly heterogeneous, containing chlorophyll-a and chlorophyll-c, beta carotene and xantophyll fucoxantin. In addition, the most important group of Chrysophyta is diatoms which are energy recyclers in natural waters and are often declared as the main primary producers in the ocean. Nybakken (1992) stated that composition of phytoplankton in the sea is dominated by Bacillariophyceae.

The abundance of phytoplankton in the waters was quite variedwith relatively large numbers species (22 species). Microalgae differ in their nutritional value for larvae and a mixture of several species is commonly used to provide a better balance of nutrients for larvae development (Southgate, 2008). Two dominant species are *Oscillatoria* sp. and *Anabaena* sp.in which both are from Chyanophyta group. Unlike most of the study, the phytoplankton in the waters was dominated by the Cyanophyta. In most of studies, Bacillariophyceae (diatoms) is the dominant species of phytoplankton in marine waters as in West Halmahera Jailolo waters, in marine waters of Riau, in the waters of Gilimanuk Bay TNBB, and in Berau (Yuliana, 2015; Ariana *et al*.,, 2014; Thoha, 2007; Aryawati & Thoha, 2011). Similar results have been reported by Radiarta (2013) who found that the phytoplankton in the Alas Strait of Sumbawa regency of NTB was dominated by 5 species namely *Oscillatoria* sp. (Chyanophyceae), *Chaetoceros* sp., *Thallasionema* sp., *Melosira* sp., and *Skeletonema* sp (Bacillariophyceae) with an abundance of 446 ind / L, 203 ind / L, 55 ind / L, 32 ind / L, and 25 ind / L, respectively.

Pearl oysters in natural environments are affected by various environmental factors. Food is almost being the major environmental factor (Lucas, 2008). The growth rates of pearl oyster are particularly influenced by the food availability (Saucedo & Southgate, 2008). Pearl oyster feeds on suspended particulate matter (SPM), consisting mainly of bacteria, microalgae, suspended organic matter, and inorganic particles. Quantity of food is also a major factor in the physiological condition, metabolic function, growth, and survival of the pearl oyster. Optimum densities of microalgae are in the range of 10-100x10^3 cell / ml (Lucas, 2008). The results showed that the total abundance of phytoplankton in the study sites was still within the optimum condition with the values ranging from 22093 - 29514 cells / L. The density and composition of phytoplankton are some of the important factors that determine the farming location (Fathurrahman, *et al*., 2015).

The development of pearl cultivation is not only influenced by the biological factors (food availability) but also influenced by the physical and chemical conditions of the waters. According to Lucas (2008), as in all Poikilotherms, ambient temperature profoundly influences pearl oyster through its effects on MR and related processes, such as respiration and feeding rates. The measured temperature at the time of the study ranged from 29.5 to 30.1° C (Table 2). This temperature range is still within the optimum for the growth of marine biota. The surface water temperature in the tropics is between 20-30^{0}C (Nybakken, 1992).

Current velocity is an important parameter related to phytoplankton distribution. Lucas (2008) mentioned that water current is very important in bringing food and oxygen to pearl oyster and carrying away their wastes; however, strong currents may be deleterious by increasing suspended inorganic matter, interfering with filtering and preingestive processes. In this study, the velocity of 0.085-0.165 m / s was categorized as low. Radiarta (2013) also reported that measured current velocity during the Alas Straits research was 0 - 0.27 m / s.

Nitrate concentration wasundetectable and the phosphate concentration was low. This is in line with the results reported by Yuliana (2015) that at Idamdehe station, nitrate was undetectable and the phosphate concentration was 0.004 mg/L. This concentration was at a very low state and can be a limiting factor. Although the nutrient content was low, the abundance of phytoplankton at the study sites was still in good condition. This may be caused by other environmental parameters that are still within the optimum condition. According to Yuliana (2015), no detection of nitrate and low phosphate content suspected due to of the both nutrients have been exploited by phytoplankton for growing purpose.

The condition of Kwandang, North Gorontalo water can be categorized as good condition based on the biological index values. These results can be used to test the level of environmental stability. The diversity index value in the waters of North Gorontalo showed the criteria for medium diversity. This is supported by Odum (1996) that the diversity index value 1-3 indicate medium diversity and moderate community stability. The results of evenness analysis indicated that environmental conditions in the study sites were in balance condition. Gustiarisane (2011) in Liwutang, *et al* (2013) pointed out that if the equilibrium is greater than 0.5 and almost 1, the similarity of the organism is balance and there is no competition for both place and food. The results of the index analysis of dominance also showed a low value meaning that there was no dominant species.

According to Subagja *et al* (2001), in term of water pollution, indirect monitoring is carried out through several major environmental parameter tests such as COD, BOD, suspended particles. Furthermore, based on oxygen content, a particular water body has not been stated contaminated if its COD is higher than the BOD value. The results of this study suggest that the waters at the study sites has not been contaminated.

Acknowledgments

The authors would like to thank the Rector of UNG who facilitated the funding in this project and also the Dean of the Faculty of Fisheries and Marine Sciences who provided an opportunity for the team to conduct this research

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The Growth Parameters of Snakehead Fish (*Channa striata*) in Aopa Watumohai Swamp Waters Pewutaa Village Angata Sub-District South Konawe Regency

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Abstract

The aim of this study was to analyze the growth parameters of snakehead fish (*Channa striata*) in Aopa Watumohai Swamp Waters Pewutaa Village Angata Sub-District South Konawe Regency. This study was conducted for three months from November 2016 to January 2017. The sampling method was done randomly with the total sample of 673 individuals. The male snakehead fish had the highest frequency (36%) at the class length of 268–290 mm in January, whereas female snakehead fish had the highest frequency (32%) at the class length of 268–290 mm also in January. The length and weight relationships of male snakehead fish were positive allometric (r = 0.91–0.95; R^2 = 0.82–0.91) in November and December and negative allometric (r = 0.85; R^2 = 0,72) in January, whereas the length and weight relathionships of the female were positive allometric (r = 96; R^2 = 0.92) in December and negative allometric (r = 0.81–0.86; R^2 = 0.65–0.74) in November and January. The condition factor of male and female snakehead ranged from 0.09–2.05 and 0.11–2.17, respectively. The male snakehead had the maximum total length (L∞) of 765 mm with growth rate of 0.43 per year and female snakehead fish had the maximum total length (L∞) of 705.5 mm with growth rate of 0.42 per year.

Keywords: Snakehead fish, Growth parameters, Aopa Watumohai Swamp Waters.

Introduction

The fishing activity of the snakehead fish in Aopa Watumohai Swamp is one of livelihoods of the community which affects the existence of the snakehead fish population in the waters such as the low number of individuals and the smaller size and weight of snakehead fish caught. Growth parameters studies of fishes have been done by many researchers including the growth of *Mungil dussumierf* in Ujung Pangkah Waters, East Java (Sulistiono *et al*. 2001), studies on the growth aspects of fishes in East Kutai waters (Syahrir 2013), and growth and survival rate of *Channa striata* (Yulisman *et al*. 2011). However, study on the growth parameters of the snakehead fish in Aopa Watumohai Swamp Waters has not been done yet. Study on the growth parameters of the fish is important to be carried out to provide basic information for the sustainable management of the snakehead fish (Firdaus *et al*., 2013). Therefore, the aim of this study was to determine the growth parameters of snakehead fish (*C. striata*) in Aopa Watumohai Swamp Waters, Pewutaa Village, Angata Sub-district, South Konawe Regency. The results of this study will provide basic information for further studies and as a reference for all of stakeholders in the management of the snakehead fish sustainably.

Materials and Methods

Study site and Fish sampling

This study was conducted for three months from November 2016 to January 2017 in Aopa Watumohai Swamp Waters, Pewutaa Village, Angata Sub-district, South Konawe Regency (Figure 1).

The Snakehead fish was caught by three kinds of fishing gears namely fish traps at different mesh size (1.5 inch; 2 inch; and 2.5 inch), gillnets mesh size 1.5 inch; 2 inch; and 2.5 inch, as well as hooks (number 11 and 12). The fishes were collected and then the total lengths from the tip of snout to the tip of the longest ray in caudal fin were measured by ruler (scale 1 mm). Their body weight were weighted using a digital scale 0.1 g. The fish was then identified using an identification book (Iqbal 2011).

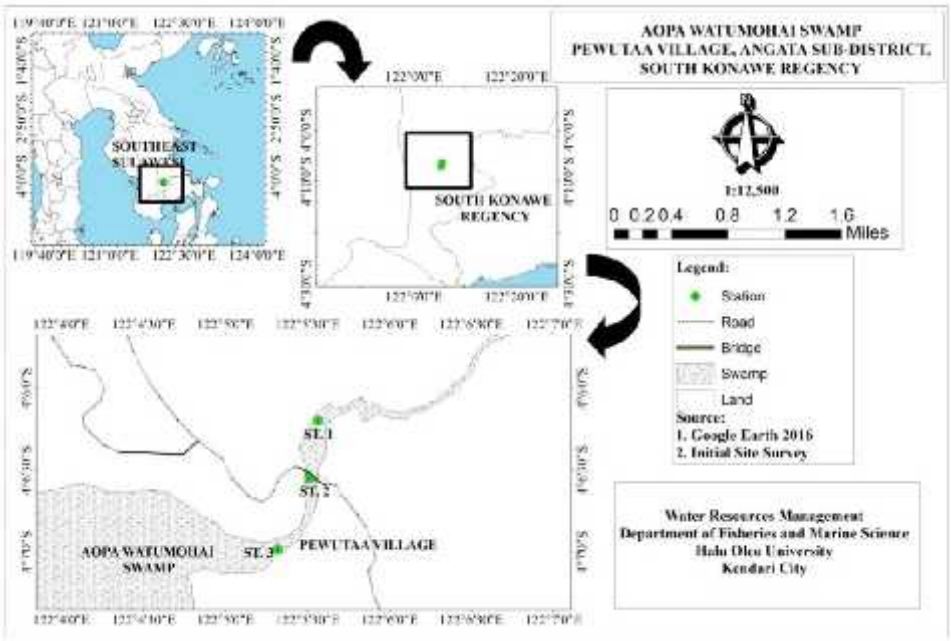

Figure 1. Map of study site

Data analysis

Length-Weight data of snakehead fish was analyzed by using length-weight relationship equation (Effendie, 1997):

$$W = aL^b \quad \text{.....(1)}$$

Where :
W : Total body weight (g)
L : Total length of fish (mm)
a and b : Coefficients of the regression functional between W and L

The growth of fish is isometric if b is equal 3 (b = 3). The condition factor of the fish can be determined using the following formula (Effendie, 1997) if the b=3 or isometric (length and weight increase proportionally) (Morey *et al*., 2003)

$$K = \frac{10^5 W}{L^3} \quad \text{..... (2)}$$

Where:
K : Condition factor
W : Total body weight (g)
L : Total length of fish (mm)

If the growth of fish is allometric (b ≠ 3), then the condition factor can be determined by formula as follows (Effendi, 1997):

$$K = \frac{W}{aL^b} \quad \text{..... (3)}$$

where:
K : Condition factor
W : Total body weight (g)
L : Total length of fish (mm)
a : a constant being the initial growth index
b : Growth coefficient
when:
b < 3 : Negative allometric (length increases faster than weight)
b > 3 : Positive allometric (weight increases faster than length) (Morey *et al*., 2003).

The growth parameters can be estimated by Von Bertalanffy formula (Pauly, 1983):

$$L_t = L\infty\,(1 - \exp^{-k(t-t_0)}) \quad \text{..... (4)}$$

where:

Lt : The length at age t (mm)

L_∞ : The mean length the fish would reach if they were to grow to a very old age (mm)

K : Growth coefficient

t_0 : The "age" the fish would have had at length at zero (year)

Results and Discussion

Results

Length Frequency Distribution

There were total sample of 673 individuals, comprised of 357 males and 316 females. The total length and weight of the male fish ranged from 211–469 mm and 21–888 g, respectively, whereas the total length and weight of the female fish ranged from 216–454 mm and 38,6–867 g, respectively. The length frequency distribution of the snakehead fish is shown on the Figure 2.

Length-Weight Relationship

Length and weight relationship of male and female are shown on the Figure 3. The results of analyze showed that the growth patterns of male and female during this study were positive allometric (b>3) and negative allometric (b<3).

Condition Factor

The condition factors of the fish during the study are shown in the Table 1.

Table 1. Condition factor of the Snakehead fish

Month	Condition Factor			
	Male		Female	
	Range	Average	Range	Average
November	0,09–2,05	1,02	0,35–1,77	1,02
December	0,87–1,17	1,00	0,86–1,19	1,00
January	0,47–2,02	1,05	0,11–2,17	1,03

Growth Parameters

The growth parameters of the male fish had the maximum total length (L∞) of 765 mm and the growth rate of 0.43 per year, whereas the female had the maximum total length (L∞) of 705,5 mm and the growth rate of 0.42 per year.

Discussion

The length frequency distribution of the Snakehead fish was different each month. The male fish was dominated by the class length of 268–290 mm and 315–340 mm, whereas the female was dominated by the class length of 315–340 mm and 268–290 mm. The high catch of male and female fish resulted in the much smaller fish with less frequency of catch fish size. According to Makmur (2003), the higher the length size and weight of catch snakehead fish, the lesser the size and the frequency of the catch fish size. This case was influenced by the catch of the snakehead fish before their reach the suitable size so that the fish could not grow to the maximum length.

There was a strong correlation between Length and weight relationship of male snakehead fish (r=0.85–0.95) and female (r=0.81–0.96) with determination coefficients of male (R^2=0.72–0.91) and female (R^2=0.65–0.92). As pointed out by Syahrir (2013), if the value of R^2 from length-weight relationship is closer to 1, it shows that the variety influenced by other variables is small enough and the relationship of length-weight is strong.

According to the results of this study, the growth patterns of male snakehead fish were positive allometric (the weight increased faster than the length) in November and December and negative allometric (the length increased faster than the weight) in January, whereas the growth patterns of female

snakehead fish were positive allometric (weight increased faster than length) in December and negative allometric (length increased faster than weight) in November and January. The differences of the growth patterns between male and female were influenced by the environmental conditions of the study sites. Jennings *et al.* (2001) and Muthmainnah *et al.* (2012) said that generally, the value of b is influenced by the physiological and environmental conditions such as temperature, pH, salinity, geographical location, as well as sampling techniques. Muthmainnah (2013) reported that the differences between the value of b for snakehead fish cultured in Lebak Sekayu Swamp (b=2.81) and the snakehead fish cultured in Lebak Mariana Swamp (b=2.54) were influenced by the water conditions.

The conditions factors of male and female fish were differentt influenced by different water conditions and stage of gonad maturity. As pointed out by Makmur (2003) that the condition factor of snakehead fish was fluctuated each month. This case was influenced by the different age, stage of gonad maturity, environmental conditions, as well as the available of the food in the waters. Prihartini (2006) also said that the value of condition factor is influenced by environmental conditionals, as well as the change of the feeding habits. According to the results of Muthmaimannah (2013), condition factor of snakehead fish cultured in Lebak Mariana Swamp was 0.88 whereas snakehead fish cultured in Lebak Sekayu Swamp was 0.84, indicating that the environmental condition of the fish in Lebak Mariana Swamp was better than environmental condition in Lebak Sekayu Swamp.

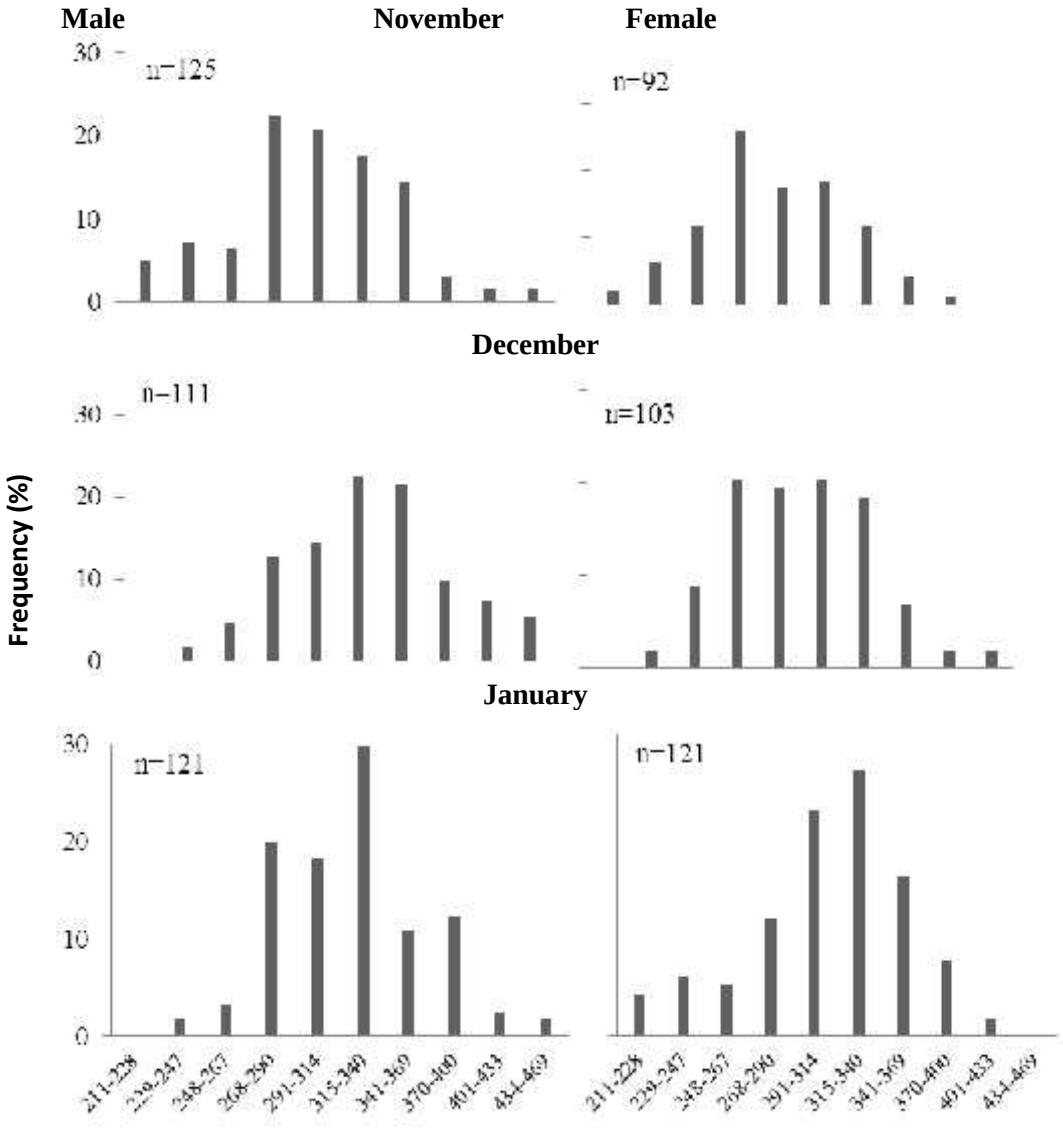

Figure 2. Length frequency distribution of male and female

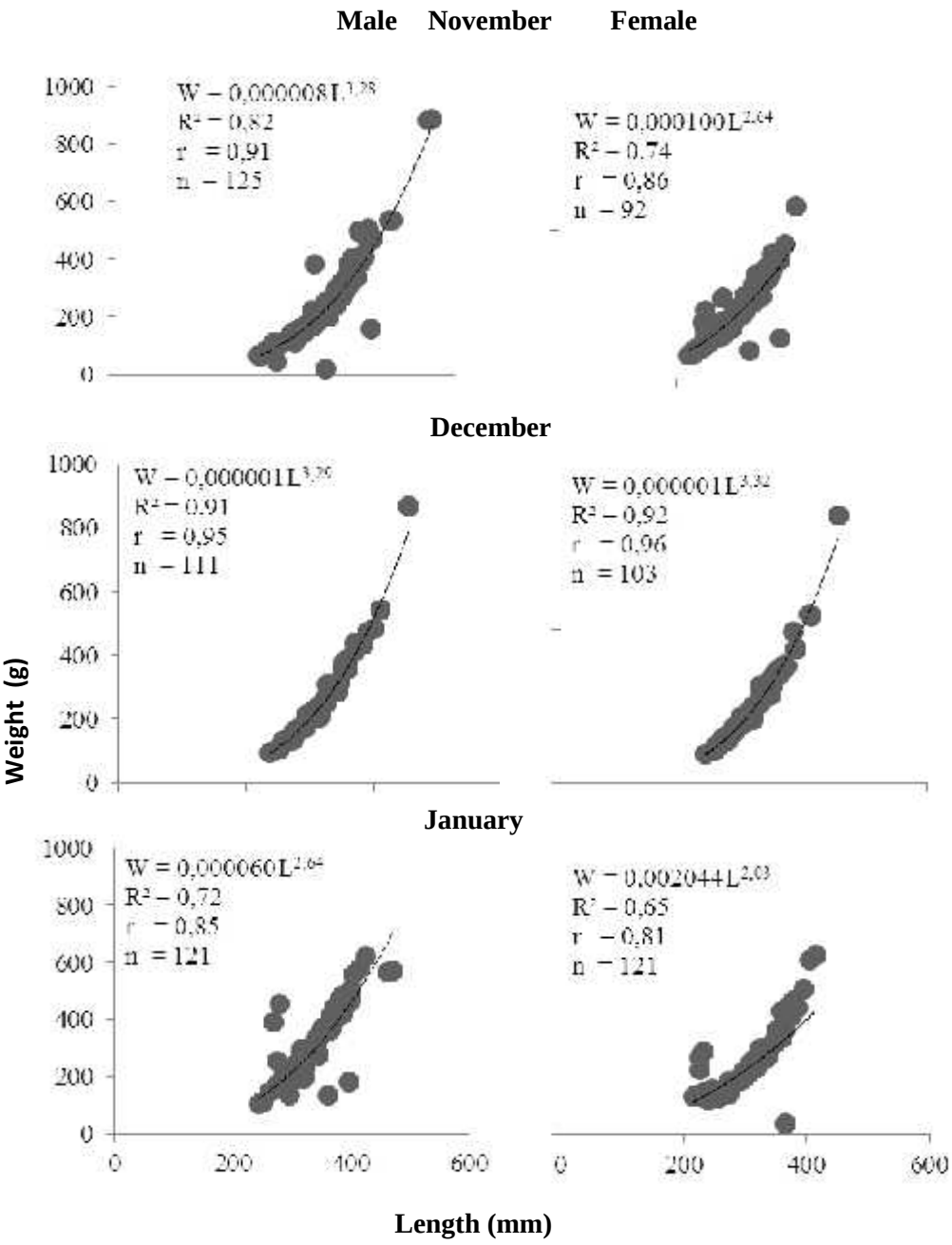

Figure 3. Length-weight relationship of the male and female Snakehead fish

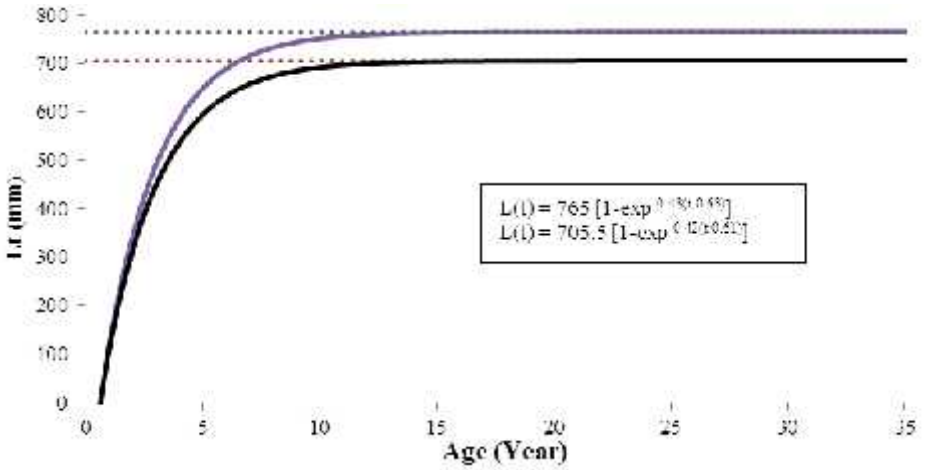

Figure 4. Von Bertalanffy growth curve of the Snakehead fish

The growth parameters of snakehead fish between male and female in Aopa Watumohai Swamp were different. The differences can be attributed to the sex, food, as well as the environmental condition. According to the results of Kartamihardja (1994), the maximum total length of the snakehead fish in Kedungombo Reservoir was 669.3 mm with growth rate of 0.40 per year. Kartamihardja (2000) reported that maximum total length of snakehead fish in Tondano Lake was 457 mm with the growth rate of 1.10 per year. Makmur (2003) reported that maximum total length of snakehead fish in Musi River was 722.8 mm with the growth rate of 1.36 per year. So, there were differences of the value of growth parameters in this study with other studies and that differences could be influenced by the differences of habitat and environmental conditions.

Aknowledgements

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Study on Bycatch Fish of Gillnets in the Lalowaru Coastal Waters of South Konawe

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Abstract

Information concerning by-catch fish of gillnets is urgently needed in an effort to minimize discarded catches and maximize the utilization of by-catch fish for sustainable fisheries management purpose. The present study aimed to analyze and identify the species of by-catch fish caught by gillnets and assessing the level of gillnet friendly used by fishermen in Lalowaru coastal waters towards the sustainability of fish resources. The study was conducted from February to April 2017. The sampling fish was taken biweekly for 3 months. The fish samples were caught using gillnets mesh size of 1 inch, 1½ inch, 1¾ inch, and 2 inch. All fish caught were collected and sorted according to species and then each species counted. The data were analyzed to obtain the proportion of the main catches and by-catch fish (incidental catchanddiscarded catch). The proportion of main catches were 25%, while the proportion of incidental catches and discarded catches were 86% and 14%, respectively. Those data indicate that by-catch fish is over amount than that of the main target of fish. It can be concluded that the gillnet fishing gears used by fishermen constitute non selective fishing gear.

Keywords: By-catch fish, Discarded fish, Gillnets

Introduction

Lalowaru coastal waters is located on the North Moramo. It has coastal and complex ecosystem such as mangrove, seagrass, and coral reefs. The ecological conditions provide the consequences on biodiversity are high enough with the nature and characteristics. Moreover it has the economic potential to be developed. One of the valuable natural resources of marine fisheries is really important, both fish or non-fish resources. This puts the coastal waters are become a source of income for fishermen to fulfill the daily needs of their family and even become a source of income of the area. These coastal waters have been exploited by fishermen as fishing grounds. These activities are carried out continuously by local fishermen with different types of fishing gears such as gill nets. The problem of the use of gillnets is closely related to the design, construction, catchability and mesh size. Normally the coastal waters have a high productivity so that the fishermen may catch a lot of variations of types of fish. The operation of fishing with gillnets in the waters is not only a chance to catch the fish, but also various types of other fish including juvenile stage which is not a target of the catches (by-catch). This situation threatens the biodiversity and productivity of coastal waters. Considering the sustainability of fish populations is highly determined by the survival in any stage of the life cycle of fish, and then it needs to be thought out and designed the gill nets to be selective and environmentally friendly. Selective fishing gear in question had the ability to catch fish only at certain size range fish according to the operating target of fish caught in order to minimize by-catch. To find out the level of selectivity of gillnet catch that it is required data catches as a proportion of the main catch and by-catch.

Materials and Methods

Location of the Study

The study was carried out from February to April 2017 which included survey, data collection, data processing and analysis, and preparation of study results. Sampling was carried out in the Lalowaru coastal waters, North Moramo of , South Konawe (Figure 1).

Sampling Method

The samples of fish were taken biweekly for 3 months. The fish samples were caught using gillnet with mesh size of 1 inch, 1½ inch, 1¾ inch, and 2 inch. Operation of gillnets was carried out during low tide at water depth of 1.0 - 1.5 m. Sampling of fish followed the custom of fishermen that is carried out when the evening following the phases of the moon (the moon dark and the moon light). All fish caught were collected and sorted according to species and then each species counted. Every individual was measured using the total length of the slide with a precision of 1 mm, while the total weight measured using digital scales with accuracy of 0.1 g. Total length of the data was used to classify the catch fish on stadia juvenile and adult. Each type of fish catches was pictured and then identified based on manual Kuiter and Tanozuka (2001) and White *et al*. (2013).

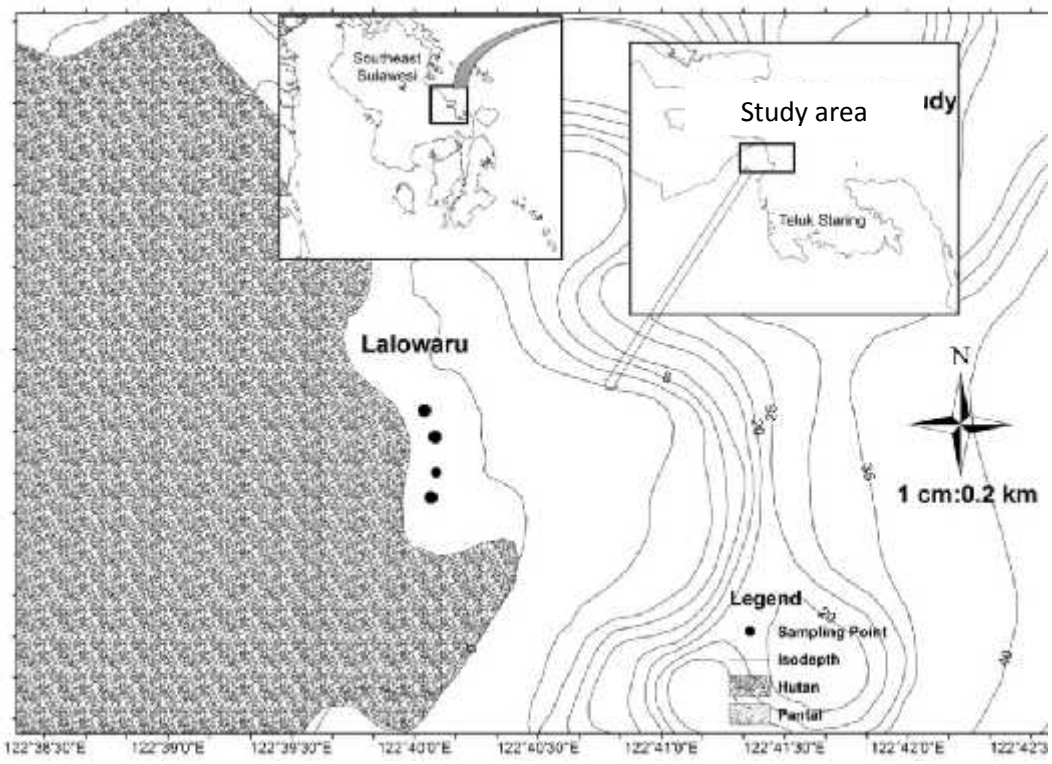

Figure 1. Location of study in North Moramo of South Konawe

Data Analysis

The composition of the different types of fish are calculated using the formula of Odum (1996):

$$Pi = \frac{ni}{N} \times 100\%$$

where:
P_i : Composition of species (%); i = 1, 2, 3,. . . n
n_i : Number of species (ind); i = 1, 2, 3,. . . n
N : Total number of species (ind)

The level of by-catch was calculated with the following formula (Akiyama, 1997):

$$The\ level\ of\ By-catch = \frac{\sum by-catch}{\text{Total catch}} \times 100\%$$

where:
Σby-catch : The number of individual by-catch (in addition to the target fish)
Total catch : The number of individuals of all types of fish (total number of individuals each sampling

Result and Discussion

Result

Fish Catch Composition

The total catch of fish identified were 45 species which classified into 27 families. Of 45 species, there were 40 species of fish, 1 species of mollusk and 4 species crustacean (Table 1). From the data in Table 1 showed that 43 species of fish including bycatch fish. There are several species of fish caught were still in the juvenile stage.

The composition of fish catches during the moon's dark and light on all mesh sizes (Tables 2 and 3) showed differences. The highest composition of family of fish during dark moon using gillnet mesh size of 1 inch, 1½-inch, 1¾-inch, and 2 inch were Mugilidae of 36.76%, the Portunidae of 24.77%, the Toxotidae of 41.18%; and the Toxotidae of 69.88%, respectively. It was relatively different with the highest composition of family of fish during light moon with only 2 dominant families were caught namely the Mugilidae and the Toxotidae. The Mugilidae dominant caught using gillnet with mesh size of 1 inch and 1½-inch were 47.41% and 34.97%, respectively, while the Toxotidae dominant caught using gillnet with mesh size of 1 inch and 1½-inch were 36.23%, and 49.58%, respectively.

Table 1. Size and weight of bycatch fish caught in Lalowaru coastal waters, North Moramo of South Konawe

No	Local Name	Spesies	Size Distribution		L_m (cm)	Information
			TL (cm)	Weight (g)		
1.	Serinding	*Apogonichthyoidesmelas*	12,1	25,3	-	DC
2.	Serinding	*Archamiableekeri*	7-15,1	5-60	-	DC
3.	Grobokan	*Atherinomoruslacunosus*	7	5	-	DC
4.	Peperek	*Aurigequulafasciata*	5,5-12,7	2,6-22	-	IC
5.	Kuwe	*Caranxtille*	5,6-21,2	3-112	11	IC
6.	Bandeng	*Chanoschanos*	26	123	68	IC
7.	Kapas-kapas	*Gerresfilamentosus*	6,2-13,1	5-147,85	-	IC
8.	Kwee	*Gnathanodonspeciosus*	15,2	48	32,5	IC
9.	TambakPasir	*Gymnocraniusgrandoculis*	9,5	11	-	IC
10.	Julung-julung	*Hyporhamphusbalinensis*	15,3-18,5	9-20	8	IC
11.	Julung-julung	*H. dussumieri*	15,3-34,4	9-67	10	IC
12.	Julung-julung	*H. quoyi*	26,2	62	13	IC
13.	Paut-paut	*Inegocia japonica*	18-27,3	46-123	-	DC
14.	KakapPutih	*Latescalcarifer*	12-24,7	24-129	29	IC
15.	Lencam	*Lethrinusgenivittatus*	10,4	14	16	IC
16.	Lencam	*L. lentjan*	15,2-17	51-78	18	IC
17.	Cumi-cumi	*Loligo*sp.	9,3-14,7	36-115	-	IC
18.	Kakap, EkorKuning	*Lutjanuscarponotatus*	9,6-13,7	10-35	18,6	IC
19.	Tambangan	*L. johnii*	17,8	87	39	IC
20.	Gebal	*Monodactylus argenteus*	11,7	17	13	IC
21.	Petek	*Nuchequula gerreoides*	10,5-19,6	12-37	9,2	IC
22.	Gabus malas	*Ophiocara porocephala*	11,3-16,1	15-274,1	-	DC
23.	Pogo	*Paramonacanthus japonicas*	14,3	46	-	DC
24.	Udang windu	*Penaeus monodon*	6,9-27,3	2-142	-	IC
25.	Sembilang	*Plotosus canius*	18,2-20	41-60	-	DC
26.	Sembilang	*P. lineatus*	11,7-20,6	8,65-58	14,0	DC
27.	Rajungan	*Portunus pelagicus*	5,6	337,5	-	IC

Table 1. (continued)

28.	Kepiting	*Thalamita cooperi*	2,5-4,4	8-49	-	IC
29.	Bidang	*Scatophagus argus*	13,6	28	-	IC
30.	Baronang	*Siganus canaliculatus*	11,5-13,4	18-42	11,6	IC
31.	Baronang	*S. guttatus*	10,5-21,7	13-171	18,1	IC
32.	Baracuda	*Sphyraena putnamae*	17,7-35,5	26-260	-	IC
33.	Apogon	*Sphaeramia orbicularis*	8,3-9,9	7-15	-	DC
34.	Loncong	*Strongylura marina*	31-40,5	41-101	-	IC
35.	Loncong	*S. strongylura*	29,3-39,4	36-98	-	IC
36.	Kambing	*Sufflamen chrysopterum*	12,6	28	-	DC
37.	Kepiting batu	*Thalamita sima*	6,2	33	-	DC
38.	Kerong-kerong	*Terapon jarbua*	8,5-17,5	6,99-83	13	IC
39.	Timbaloah	*Tylosurus crocodiles*	51	164	-	IC
40.	Sumpit	*Toxotes jaculatrix*	8,2-13,6	9-244	-	IC
41.	DayahJenggot	*Upeneus vittatus*	11,3-17,3	14,22-56	-	IC
42.	Loncong	*Xenentodon cancila*	31,3-33,6	54-59	-	IC
43.	Apogon	*Zoramia leptacantha*	7,3-10,7	5-15	-	DC

where: TL = Total Length; Lm = Length Maturity; IC = incidental catch; DC = discarded catch; - = unknown

Table 2. The composition of fish caught using several gillnet mesh size during moon dark in Lalowaru coastal waters, North Moramo of South Konawe

No	Family	1 inch	1½ inch	1¾ inch	2 inch
1.	Apogonidae	7.35	0.92	0	1.81
2.	Atherinidae	1.47	0	0	0
3.	Belonidae	25.00	0.92	0	0.60
4.	Carangidae	1.47	2.75	0	1.81
5.	Chanidae	0	0.92	0	0
6.	Eleotridae	1.47	0	0	3.61
7.	Geridae	5.88	7.34	0	3.61
8.	Hemiramphidae	13.24	0	0	0
9.	Leiognathidae	0	0	0	0.60
10.	Lethrinidae	0	0	0	0.60
11.	Loliginidae	1.47	0.92	0	0
12.	Monacanthidae	0	0.92	0	0
13.	Mugilidae	36.76	23.85	5.88	6.02
14.	Mullidae	0	1.83	0	0
15.	Platycephalidae	0	4.59	5.88	0
16.	Plotosidae	0	0.92	5.88	1.81
17.	Penaeidae	0	0	11.76	0.60
18.	Portunidae	0	24.77	23.53	6.63
19.	Scatophagidae	0	0.92	0	0
20.	Siganidae	0	3.67	5.88	1.81
21.	Sphyraenidae	4.41	0.92	0	0
22.	Terapontidae	1. 47	0.92	0	0.60
23.	Toxotidae	0	22.94	41.18	69.88

Table 3. The composition of fish caught using several gillnet mesh size during light moon in Lalowaru coastal waters, North Moramo of South Konawe

No	Famili	1 inch	1½ inch	1¾ inch	2 inch
1.	Apogonidae	12.07	2.10	1.45	1.68
2.	Balistidae	0	0	0	0.84
3.	Belonidae	9.91	2.10	0	0
4.	Carangidae	1.72	11.89	8.70	6.72
5.	Eleotridae	0	0	4.35	1.68
6.	Geridae	6.47	0.70	1.45	2.52
7.	Hemiramphidae	9.05	0	0	0
8.	Latidae	0	2.10	0	0.
9.	Leiognathidae	1.29	4.20	2.90	0.84
10.	Lethrinidae	0.43	0.	0	1.68
11.	Lutjanidae	0.43	1.40	0.	0.
12.	Monodactylidae	0.43	0	0	0
13.	Mugilidae	47.41	34.97	14.49	6.72
14.	Mullidae	1.29	2.10	0	0
15.	Platycephalidae	0	3.50	0	0
16.	Plotosidae	1.29	0	1.45	5.88
17.	Penaeidae	0.86	0.70	0	0
18.	Portunidae	1.72	14.69	24.64	15.97
19.	Siganidae	0	2.80	2.90	2.52
20.	Sphyraenidae	4.74	2.10	1.45	0.84
21.	Terapontidae	0.43	0	0	1.68
22.	Toxotidae	0.43	14.69	36.23	49.58

The Proportion of Main Catch and Bycatch

The catch data tabulated indicated that the proportion of main catches were 25%, while the proportion of incidental catches and discarded catches were 86% and 14%, respectively (Figure 2). Among 45 species of fish catches obtained were belongs to the stadia juveniles and adults (Figure 3). Total catches of juveniles stage of 49 individuals consisted of 11 families, while adults stage of 336 individuals consisted of 8 families and as many 568 could not be classified as juvenile or adult. Those total catches were only small amount used for other purposes, while others were discarded do the sea. The proportion of total catches used and discarded to the sea during dark and light moon were showed in Figure 4. It was similar differences to the proportion of total catches according to each mesh size of gillnet between dark moon and light moon were showed in Figure 5.

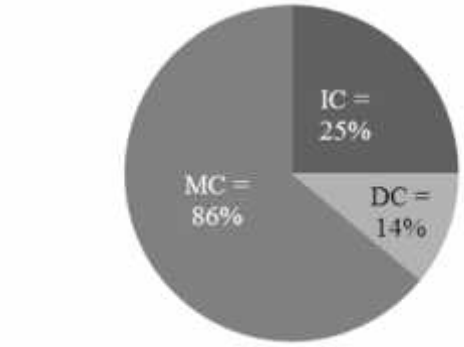

Figure 2. Proportion of main catch, incidental catch and discarded fish caught in Lalowaru coastal waters, North Moramo of South Konawe (MC = main catch; IC = incidental catch; DC = discarded catch)

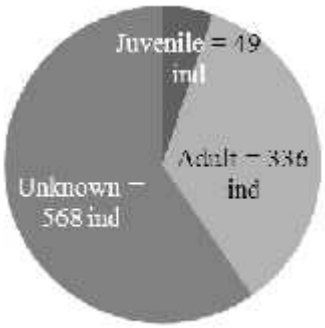

Figure 3. The number of stadia juveniles, adults and unknown (unidentified) fish caught in Lalowaru coastal waters, North Moramo of South Konawe

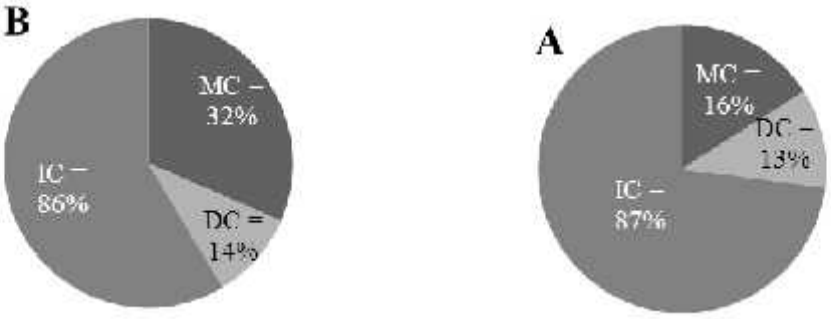

Figure 4. The proportion of gillnets catches fish during dark moon (A) and light moon (B) in Lalowaru coastal waters, North Moramo of South Konawe (MC = Main catch, IC = Incidental catch, DC = Discarded catch)

Discussion

Composition of Species

The fish catches during the study showed that fish resources in the coastal waters of the study areas are diverse enough (Table 3). There is a difference in the number of species of catches during dark and light moons namely 388 individuals and 565 individuals, respectively. The difference catches is due to the differences mesh size of gillnet used, the phases of the moon which affect tides, and scattering of light of the moon in the water column.

The moon phases are affected by the gravitational force of the earth resulting in the presence of tidal circulation of sea. During light moon particularly full moon causes very high tide, while during dark moon will cause low tide. Such phenomenon of high tide causes the fish in the water column distribute in a wide range of coastal waters and several fish heading to coastal ecosystem foraging primarily on seagrass and mangrove. Rakhmadevi (2004) stated that during light moon (full moon) caused the highest tides and water currents which affect fish behavior in foraging and migration. Tiku (2000) stated that high tides may cause a tidal current so that coastal and inshore fish migrate to the intertidal areas and estuary which in turn may affect catches as its shown by the fish composition of the highest species of catches during light moon is the family of Apogonidae, Mugilidae, Toxotidae, Portunidae, Hemiramphidae and Lethrinidae. Adrim (2006) explained that there was some families of fish commonly feed in the seagrass namely family of Apogonidae, Belonidae, Geriidae, Gobiidae, Hemiramphidae, Labridae, Lethrinidae, Monacanthidae, Syngnathoidea, Siganidea, and Scaridae. Other studies conducted at different location using similar fishing gear showed a relatively similar results (Table 4).

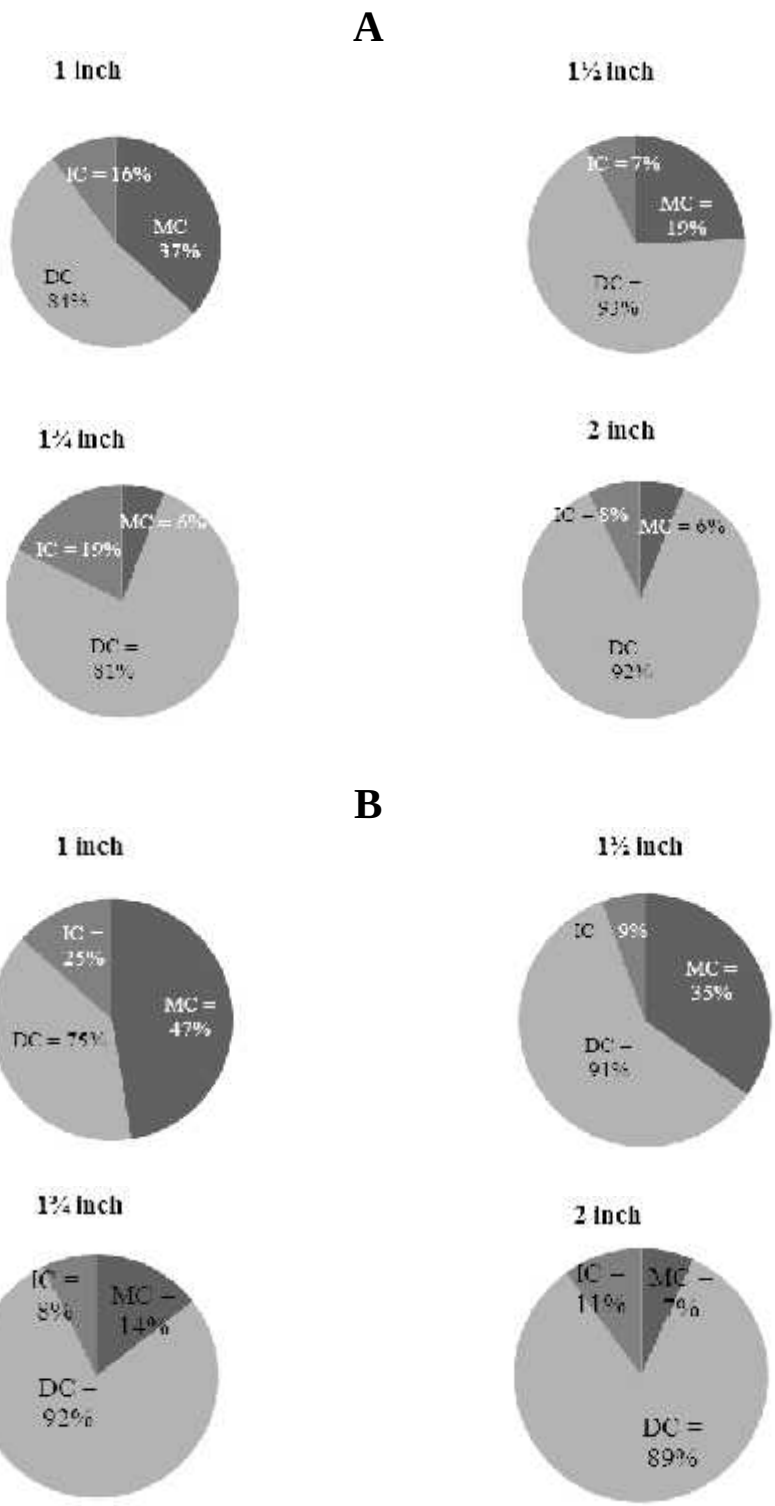

Figure 5. The proportion main catch, incidental catch and discarded fish caught by gill net according to each mesh size during dark moon (A) and light moon (B) in Lalowaru coastal waters, North Moramo of South Konawe.

The difference of catch composition of the gillnet from different locations may be caused by the different condition of each coastal ecosystem, geographical condition, type of fishing gears used, catchability of fishing gears (mesh size) and time of catch. However, most of the fish caught are quite similar. It means that those fish occupy coastal waters.

Table 4. The fish composition caught using gillnet from different locations

Location	Type of Fish Caught	Source
Pacitan Bay	*Eleutheronema tetradactylum, Congretox talabon, Caranx sexfasciatus* and *Thryssa hamiltonii*	Setyono, 1983
Indramayu waters	*Scomberomorus commersoni, Chirocentrus dorab, Leiognathus* sp., *Rastrelliger* sp., *Megalaspis cordyla, Arius thalassinus, Formioniger, Tylosurus* sp., *Lutjanus* sp., *Therapon theraps, Trichiurus* sp., *Selaroides leptolepis,Sardinella fimbriata, Hemirhamphus far, Scylla serrata* and *Scylaroides squamasus*	Ramdhan, 2008
Bojonegara waters, Serang, Banten	*Auxisthazard, Decapterus russelli, Sardinella fimbriata* and *Selaroides leptolepis*	Aprilia, 2011

Proportion of Main Catch and Bycatch

Total fish catches during the study were 45 species of 27 families. The fish caught are belongs to the juvenile and adult stages. There are 11 families consisting of 40 juvenile individuals, while the other 7 families consisting of 351 adult individuals. All those juveniles and adults are belongs to vertebrate. Fish composition of total catches during dark moon and light moon showed a relatively large differences (Figure 4) which bycatch fish during dark and light moons are higher that of the main catches. The main catches and bycatch during the dark moon were 16% and 84%, respectively. It was relatively different with the total composition catches during the light moon namely the main catches of 31% and bycatch of 69%.

Generally fish will be forage during high tide when light moon so the opportunity of the proportion of main catch fish caught is higher than that of proportion of main catch fish during low tide when dark moon. The proportion percentage of discarded fish from bycatch during dark moon was 16% and it is relatively different during light moon as many 32%. Among those bycatch fish during dark moon and light moon, there were fish still used it for other purposes which totaled of 87% and 86%, respectively, while the rest were discarded as many 13% and 14%, respectively. Those discarded fish caught are lower than that of discarded fish caught by other fishing gears. Shrimp trawl operated in the Arafura Sea had caught bycatch fish was 19 over than that of main catch of shrimp. As many 95% of bycatch fish were discarded to the sea and only 5% was used for other purpose (Nasution, 1997). Other study of Alverson showed tuna long line had bycatch fish of 1.13 – 1.58 over amount than that of main catch of tuna (Arimoto, 1995). Shrimp fisheries in Kuwait showed that 98% of bycatch was discarded to the sea (Ye and Mohammed, 2000). Study on beach seining fishing gears operated in Botany Bay of Australia showed that 44% of individual fish and 38% of total weight were discarded to the sea (Gray *et al*. 2001). Another study proved that more than 350 species in tropical waters of Australia included bycatch fish (Stobutzki *et al.* 2001). It suggests that bycatch fish of gillnet in the present study is lower compare to other fishing gears.

Generally, bycatch fish of all fishing gears discarded are juveniles and immature adult stages which are not economically important. It may affect the structure trophic level and biodiversity of marine and coastal ecosystems to be low (Alverson and Hughes. 1996) and the fish stock decrease significantly (Alverson *et al*., 1996). Those discarded fish are dead fish and will decompose on the bottom of the sea. It becomes organic waste and may contribute to water quality decreasing. However, those organism wastes in the not excessive amount may contribute to the dissolved nutrient concentration in the sea (Hall, 1999).

Fisheries Resources Management

The fish resources in Lalowaru waters of South Konawe is to be an income source of fishermen to fulfill their families and local government. Fisheries management of the coastal waters is urgently needed because the coastal waters was declared as “the coastal waters conservation area”. It is a nursery and feeding ground of many species, but also as fishing ground and migration lane by endangered and endemic species.

The problem of fisheries management up to the present is fishermen catch fish are using gillnets which constitute as fishing gears unselective. Several studies showed that gillnets are still contribute a lot of bycatch fish of juveniles and uneconomically fish which most of those are discarded to sea (Alverson *et al*., 1996). The present study may be used to have information of several fish species and their size composition caught by gillnet. An alternative of mesh size of gillnet should be find out or those gillnet

have to be replaced with other selective fishing gears. Other management effort is local government providing “the local government regulation” based on coastal zone (spatial) and season of fish juvenile and immature abundance (temporal). Marine Work Group and Friend of the Irish Environment had been stated that some countries had applied the use of big mesh size of gillnet and separation tools or filtering tools of fish caught (Odum, 1996) which are attached in the codend of trawl for example to minimize bycatch or discarded fish caught.

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Clam (*Polymesoda* sp.) Density at Various Habitats of Mangrove Forest in Kendari bay Southeast Sulawesi

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Abstract

Clams are bivalves that have been associated with mangrove forest in Kendari Bay for decades. These clams have experienced ecological pressures as their exploitation is increasingand degradation of mangrove forest occurred extensively. This research was conducted from November 2013 to October 2014 in mangrove area of Kendari Bay to determine its density in various habitat conditions of the mangrove forest. Three sampling stations were chosen based upon the mangrove density, namely station I was a thick density of mangrove, station II was located in areas with low density of mangrove, and station III was a medium density of mangrove with intensive clam exploitation. The clam and substrate sampling as well as measurement of mangrove density were done using quadratic transects that were taken perpendicular to the sea during low tide. The clam density was analyzed using standard formula, whereas the suitability of clam habitat was analyzed using principal component analysis and cluster analysis on multivariate statistical packages program. The result showed that the clam density was found higher at station I (13.65±3.74 ind.m^{-2}) than station II and III that was 6.62 ± 2.46 ind.$m^{-2}$and 5.72±1.53ind.m^{-2}, respectively. The high density of clam at station I is characterized by the high mangrove density of each category of seedlings (3,200 ind.ha^{-1}), saplings (2,960 ind.ha^{-1}) and trees (180 ind.ha^{-1}).At station I, there was higher silt fraction (3.454) and soil organic matter content compared to other sampling stations, suggesting that those factors contributed to the high density of clams.

Key words: Clam, density, mangrove, Kendari Bay

Introduction

Mangrove is a source of nutrients in coastal areas and provide a convenient place for the growth and development of various macrobenthos biota (Nagelkerken *et al*., 2008; Nordhaus *et al*., 2009) including clams (*Polymesoda erosa*) (Ingole *et al*., 2002). Like other bivalves, clams are filter feeder organism whose play an important role in the ecosystem including deposit the organic material into dissolved inorganic in the water column and the bottom waters directly (Allen and Vaughn, 2011) and be used as bioindicators in heavy metals polluted water (Dsikowitzky *et al*., 2011). The clams are capable to decompose organic matter that strongly associated with mangrove habitat.Therefore, if the mangrove degradation as habitat of clams occurred, it will be followed by the decline and even loss of this organism.

In general, bivalves extinction may be caused by two condition: habitat degradation and exploitation of bivalves itself (Lydeard *et al*., 2004). Based on data of mangrove forest in Kendari Bay, there has been significant loss that was estimated around 300 ha in the 1990s to 10 ha in 2012 (Alwi, 2012). Rapid conversion of the forest into land function to public facilities was suggested to contribute to the loss of decent living habitat for these bivalves. On the other hand, uncontrolled activities such as illegal logging, littering and other public activities in the upper land and around Kendari Bay are expected to accelerate decrease of clams population in mangrove habitat. Clams from the genus *Polymesoda* are known for their delicious meat that drawn a high consumer demand. Some species of *Polymesoda* have been massively exploited due to their high economic value (Clemente & Ingole, 2011) such as: *P. solida* and *P. arctata* (Severeyn *et al*., 1994). The increasing demand from the regional and local marketis other factor contributing to the decrease of clam's population in Kendari Bay (unpublished data, 2014). Based upon the ecologically and economically important roles of clams in mangrove area, research on clam density in various conditions of the mangrove habitat of Kendari Bay becomes critical. This aim of research was to determine the density of clams in various habitat conditions of the mangrove forest. The results of this study are expected to provide basic information for the management of clam resources in Kendari Bay and in other mangrove areas in Indonesia with similar condition.

Materials and Method

Sampling and data collection

This study was conducted for one year from November 2013 to October 2014 at the mangrove forest of Kendari Bay, Southeast Sulawesi. The stations were determined by purposive random sampling which were based on mangrove density: station I was an area with considerably thick density of mangrove, station II was located in areas with low density of mangrove, and station III was an area with medium density of mangrove and intensive utilization of clam by local community (Figure 1). There were three sub-stations at each station, located at the beginning, middle and end of the line transect in a perpendicular position toward the coast. The clam samples were collected using quadratic transect (5x5 m^2) with 3 replicates at each sub-station which were done on monthly basis. Sampling of mangrove density was categorized by tree, sapling and seedling (10x10 m^2, 5x5 m^2 and 1x1m^2), respectively, taken in the same area as clams station. The number stands of tree, sapling, and seedlings in each quadratic transect was recorded. The substrate sampling was taken approximately at 15 cm deep and then put them into labeled plastic bag. Subsequently, texture and substrate organic material were analyzed at Texting Laboratory of University of Halu Oleo. Substrate texture was divided into 7 parts i.e.: very coarse sand(PSK), coarse sand (PK), medium sand (PS), fine sand (PH), very fine sand (PSH), clay (Le) and dust (Li) (Sousa *et al*., 2008).

Figure 1. Map of clam sampling at mangrove forest of Kendari Bay. Sampling stations are marked in black dots

Data Analysis

The density of clams was as a function of the sampling area occupied by the clams (ind.m^{-2}), whereas the mean density was analyzed using Mann-Whitney (U) test (Ocana, 2015). The relationship between environmental quality and clams density in each station was analyzed using Principal Component Analysis (PCA) (Musin *et al*., 2015) and Cluster Analysis (CA) on Multivariate Statistical Package Program (MVSP).

Results and Discussion

Results

The result of Mann-Whitney (U) test showed that mean density of clams in station I was different from station II dan station III. The highest density of clams was found at station 1 with a value of 13.65±3.74 ind.m^{-2}, whereas in stations II and III, the density wasfound to be relatively unequal with values of 6.62±2.46 and 5.72±1.53 ind.m^{-2} respectively (Figure 2).

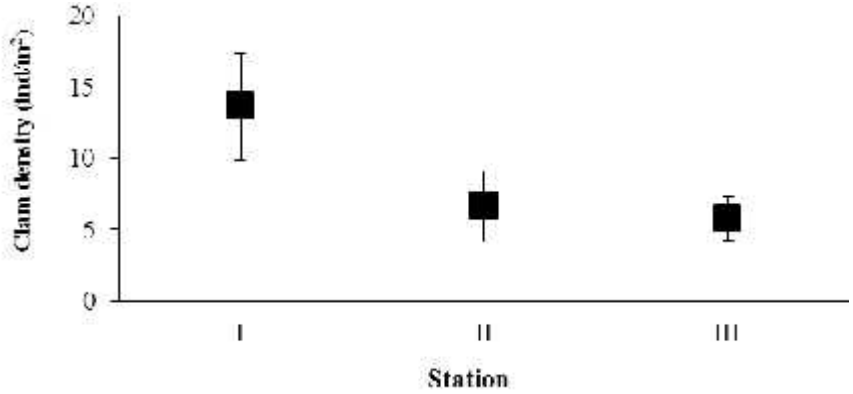

Figure 2. Density of clams in mangrove forest of Kendari Bay

The highest mangrove density of each category (seedlings, saplings, and trees) were found in station I, respectively by 32,000, 2,960, and 180 ind.ha^{-1}. Furthermore, at station III, it was found that each category of seedlings, saplings, and trees was 14,000, 2,400, and 160 ind.ha^{-1}. Lower mangrove densities were found in station II by 6,000, 1,040, and 40 ind.ha^{-1}. Among all categories, seedlings were the densest that were found in all stations (Figure 3).

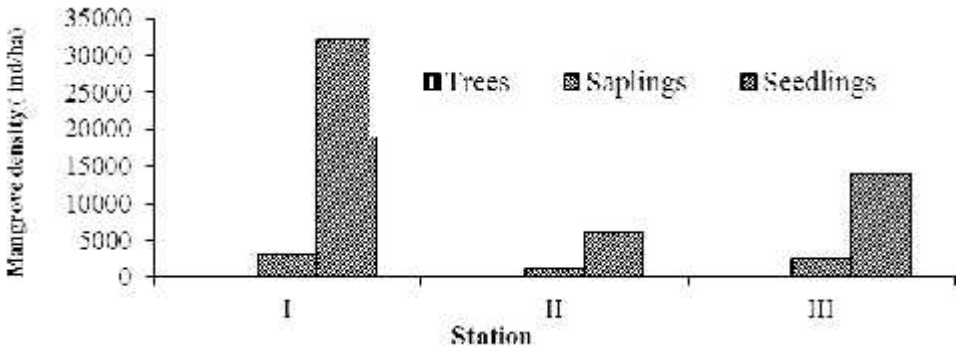

Figure 3. Density of mangroves at each station of Kendari Bay

The mangroves species found in Kendari Bay were belongs to 4 species consisting of *Soneratia alba, Rhizophora* sp., *Xylocarpus* sp., and *Avicennia* sp. In general, the 2 most dominant species found were *Rhizophora* sp. and *S. alba*. It was found that *Rhizophora* sp. and *S. alba*in station I had higher density than other stations. Three species was found in station II with dominant speciesbeing *S. alba* and *Xylocarpus* sp., whereas low density species was*Rhizophora* sp. Similarly, in station III 3 species werefound that wasdominated by *Rhizophora* sp., *Avicennia* sp. and *S. alba* (Figure 4).

The results of the PCA showed that the Eigenvalue was explained by 99% of the axis I and axis 2, by 83% and 16%, respectively. The large contributing parameters to the axis 1 was dust and clay, with values respectively by 4,197 and 2,294. Subsequently, some variables contributed in small amounts and distributed evenly across the stations namely medium sand (-0.554), fine (-0.454), and coarse sand (-0.098). The large contributing parameters to the axis 2 was dust (3,454), medium sand (1,543) and clay (-1.091), whereas the small contributing parameters was coarse sand (-0.556) and fine sand (-0.299) (Figure 5). Stations I and II contributed to the 2 axis and station III contributed to the 1 axis.

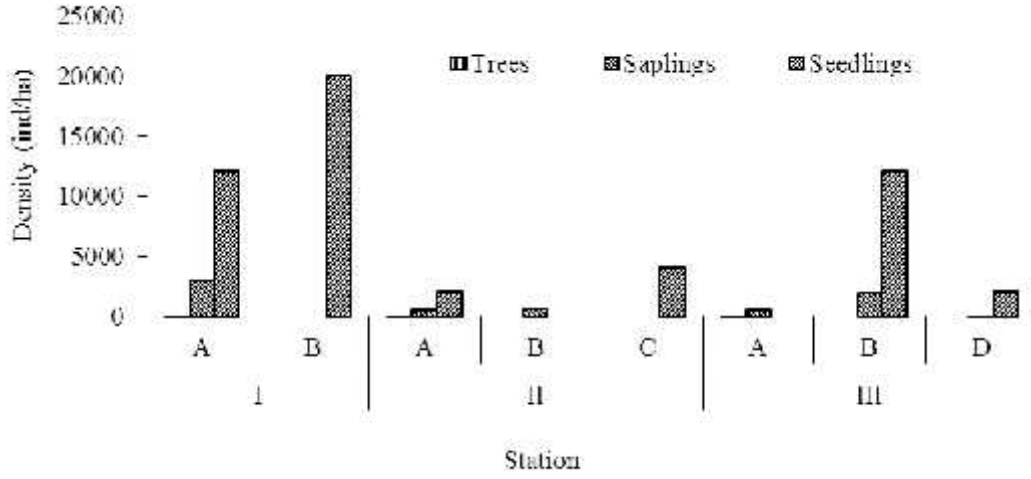

Figure 4. Density of mangrove species at each station in Kendari Bay. A = *Soneratia alba*, B = *Rhizophora* sp., C = *Xylocarpus* sp, and D = *Avicennia* sp.

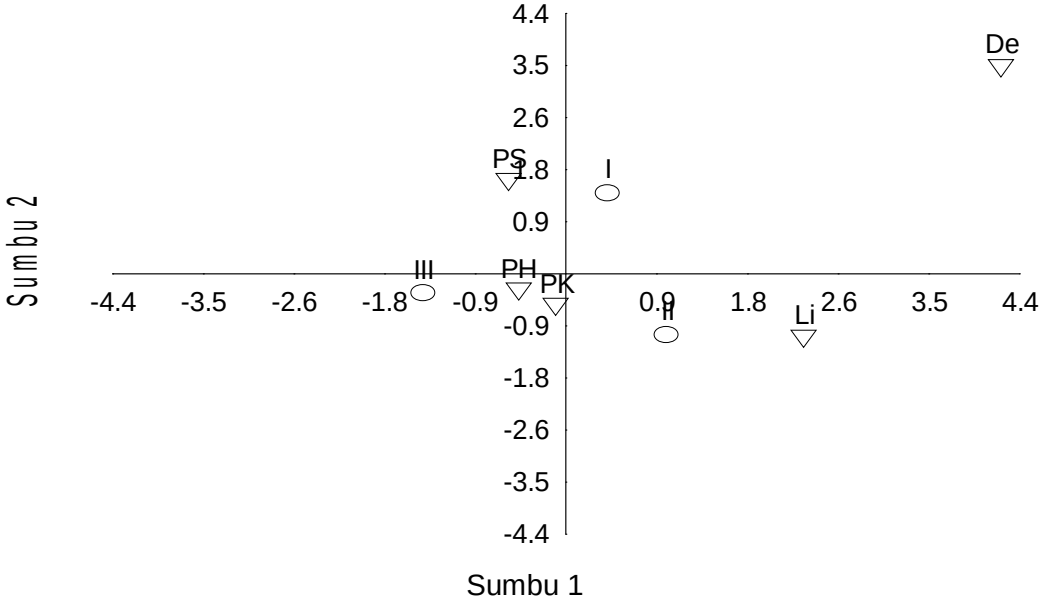

Figure 5. Principal component analysis on water texture at each station in Kendari Bay

Furthermore, the values of substrate texture variables and stations were grouped by Cluster Analysis which were divided into 3 groups. Group I (station 1) was characterized by a fraction of dust, group 2 (station II) was characterized by clay fraction, andGroup 3 (station III) was characterized by moderate sand (Figure 6). The clams densities increasedwith the amount of mangrove density and soil organic matter. Station I had thehighest mangrove densities of seedlings and trees categories compared to other stations. Similarly, soil organic matter in this station showed a higher value and higher density of clams compared to other stations (Figures 7 and 8).

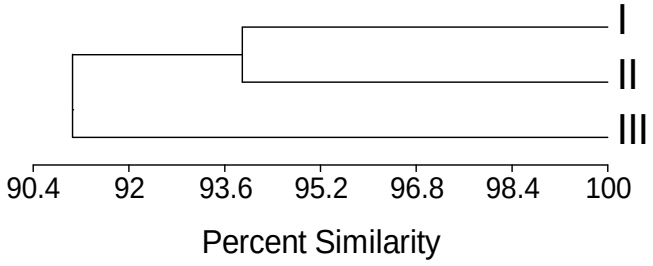

Figure 6. Cluster analysis on water texture at each station in Kendari Bay

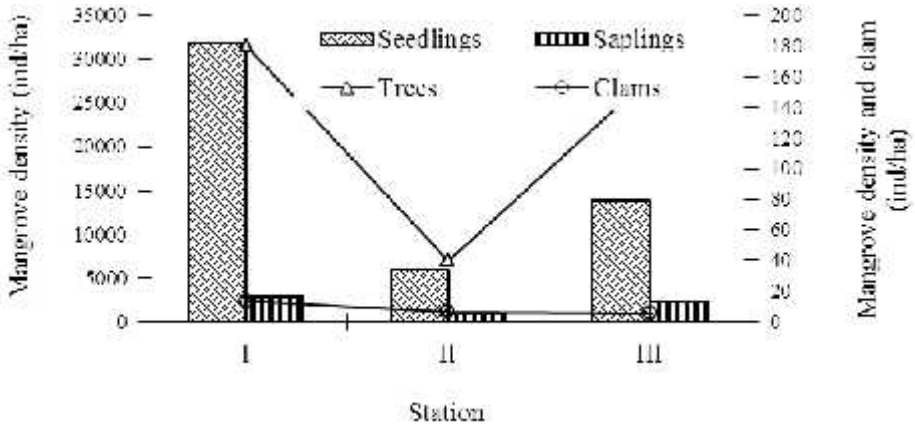

Figure 7. Relation of clam density and mangrove density in Kendari Bay

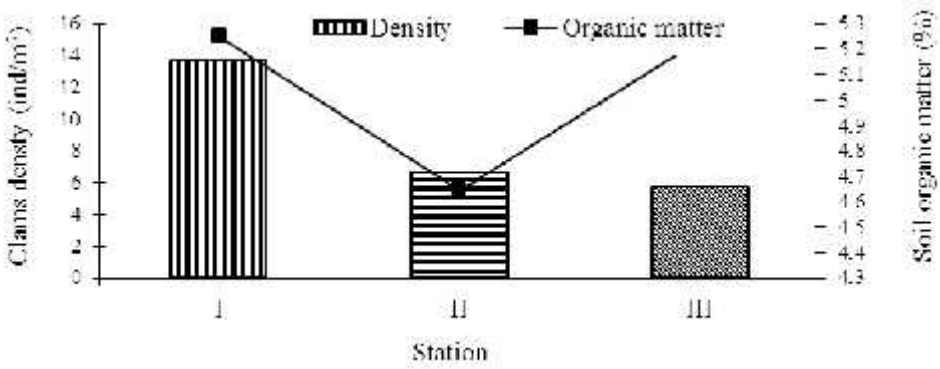

Figure 8. The relation of clam density and organic matter in Kendari Bay

Discussion

Sediment type is an important factor for the existence of benthic communities (Van Hoey *et al*., 2004). This study showed that clams are found to be abundantin mangrovehabitat with substrate texture dominated by dust. Habitat with high dustwill provide stability to clamsfor digging during burial period (Lyimo *et al*., 2002) and it is also provide the clams to breathe in air during the protruding phase for a long time compared to clay and sand substrates. Substrate that supports respiration in air will provide higher clam density and play an important role in their distribution thanin substrates which inhibit its activity (Clemente and Ingole, 2011). In addition, this texture will make it easier to bind the organic matter needed by clam (Lopez & Levinton, 1987) compared to other textures. Through the mechanism of the pedal feeder, clams sweep all the food contained in the ground floor of mangroves. According to Box and William's (2000) substrate textures greatly determine bivalve density, which provides sediment stability and the presence of organic matter (food) for bivalves.

Ecologically, substrate size determines the density of some bivalves. *P. erosa* was also found at high density in fine mud substrate but not inhabitant of high sand content (Clemente & Ingole, 2011). Preferences of certain substrates was also found in some species of freshwaterbivalves such as *Dreissena polymorpha*whichfavored of sand and clay fraction, whereas *D. bugensis* favored of clay fraction (Jones & Ricciardi, 2005) and *Corbicula fluminea*was found abundant in the sand fraction (rough and medium sand) (Sousa *et al*., 2008). It is known that the substrate provides a strong attachment point in the denser surface hence making it as a suitable ecosystem for biological activity of the clams,thuscolonization of adult bivalves (Vaughn *et al*., 2008). However, the sediment is not always directly related to habitat preferences of theclams, given that some other environment quality variables also affect theirpresence. For example, the large grains of sand content in sediment are associated with food availability, stronger currents associated with increasing phytoplankton abundance and small grain but slow current associated with benthic algae density (Snelgrove & Butman, 1994).

The highest density of *Polymesoda* sp. was found in thick mangrove areas of seedlings, saplings and trees. It is suggested that the thick mangrove area has a high productivity characterized by the high

organic materials that produce food for the organisms associated with it. In addition, clamsare taking plankton as food and filtering the detritus from mangrove leaves decomposition. The lower density of clams at mangrove habitatcan be caused by several factors: 1) lowdensity of mangrove only provides relativelysmall/limited food in the ground, 2) direct exposure to the sunlight making clams must adapt to high temperature in thin mangrove areas (Paschoal, 2015); and 3) over harvesting of clams by local communities contributed greatly to the decreasing of clams density, although the environmental quality of the area was favorable for its growth such as in in station III where low density of clams was observed although mangrove density was at medium level.

The clams densities were found to be higher in mangroves where *Rhizophora* sp. and *S. alba*were dominant. Although this finding is not in agreement with Skilleter and Warren (2000) who discoveredthe densities of *Polymesoda* sp. were higher in *Avicenia* sp. habitat but Capehart & Hackney (1989) stated that theunique root systemof *Rhizophora* sp. and *S. alba*, their rhizome and rootstock may provide a comfortable environment structure for the survival of *Polymesoda* sp. Some studies showed that *Avicenia* sp. had the ability to oxidize sulfides higher than other mangrove species (Lyimo *et al*., 2002; Thibodeau & Nickerson, 1986); 2) Also, pneumatophores structure in *Avicenia* sp. makes the substrate denser to support the mechanism of resuspension filter and they also provide higher supply of organic materials. Chapman, 1998; Skilleter & Warren , 2000). In contrast, in the present study, it was found that in station III where *Avicenia* sp. was dominant with lowerclams density. Therefore, it can be concluded that the low density of clamsin this station was not due to unfavorable environmental condition but because of the high harvesting in this area.

The clams density in the present study was relatively not much different with those of *P. erosa* (Clemente & Ingole, 2011), but was significantly different from *P. caroliniana* (Duobinis, *et al*., 1982). Also, this study showed a much lower clamsdensity compared to freshwater clams from lakes and rivers (Table 1).

Table 1. Densities of clams species in various types of waters

Location	Species	Density (ind/m^2)	Reference
Cermin Bay, Riau	*Anadara* sp	2.07	Suwondo, *et al*., 2012
	Pharus sp	2.75	
	Geloina sp	2.53	
	Pernaviridis	2.32	
Irupe Lake	*Limno pernafortunei*	2,765	Musin *et al*., 2015
Mini Lake		981	
Missisipi Estuary	*P. caroliniana*	126 - 136	Duobinis *et al*., 1982
Chorao Island, India	*P. erosa*	7 - 12	Clemente and Ingole, 2011

The high density of freshwater clams can be attributed to continuous distribution of organic materials as food for clams. This food is directly absorbed by freshwater clams through filter feeder mechanism resulting in higher productivity of freshwater clamscompared to marine and brackish water clams (Musin *et al*., 2015; Suwondo, *et al*., 2012).

Conclusions

Clams density in mangrove forest of Kendari Bay was found to be in medium category due to high harvesting by local people. Habitats preferences of clams in the present study were in high density of mangrove (seedlings and trees), with dominant dust fraction and high organic matter in the sediment.

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Abundance and Distribution of Plankton to Support a Sustainable Fishing Ground in Staring Bay

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Abstract

Plankton is an important factor in aquatic ecosystem because it serves as main food reserve for aquatic animals. The purpose of the present study was to investigate the abundance and composition of plankton to support a sustainable fishing ground in Staring Bay, North Moramo. Purposive sampling method was used by placing eight stations around the bay. Sampling was collected every month from January to March 2017. Results showed that the abundance of plankton in Staring Bay consisted of 73 genus of phytoplankton and 9 genus of Zooplankton. The mean value of phytoplankton abundance was found highest in the class of Bacillariophyceae (9,674 individuals/L) with the most abundant genus was *Chaetoceros* sp. Meanwhile, the mean value of zooplankton abundance was found highest in the class of crustacea (2,423 individuals/L), with the most abundant genus was copepod. Planktons were equally distributed in every station.

Keywords: abundance, plankton, fishing ground, Staring Bay

Introduction

Staring Bay is one of valuable resources in South Konawe Regency, Southeast Sulawesi, and it lies between 4°02'40" - 4°08'53" S latitude and 122° 40' 03" - 122° 48' 2" E longitude. The bay is important for people living around the area, as it has high natural resources, such as coral reefs, sea grass, mangrove, small islands, pelagic and coral fish. Furthermore, the bay has ecological functions where traditional fishermen used for fishing, and it also provides feeding and reproduction ground for marine fish.

The presence of such complete ecosystem in Staring Bay is supported by the fertility of the water. Water fertility contributes to the abundance of fish around the bay. One of the ways to measure water fertility in fishing ground areas is through the assessment of abundance and composition of plankton. Plankton is a microscopic aquatic organism floating in the sea or fresh water with limited movement, consisting mainly of phytoplankton and zooplankton. It is a start of biological component from which higher organism obtain energy through food chain (Levinton, 1982; Arinardi *et al.* 1995; Castro & Huber, 2007).

Phytoplankton, as an aquatic plant, contain a chlorophyll pigment and belongs to the autotrophic components of the plankton community which capable of producing an organic material from water and carbon dioxide with the assistance of sunlight and essential minerals. Phytoplankton makes a significant contribution in primary productivity of the oceans (Kingsford, 2000). There are many biotic and abiotic processes affecting the variability of plankton, and the intensity and frequency of these processes can lead to unequal dynamic and increase biodiversity of the plankton (Chalar, 2009).

The purpose of the present study was to investigate the abundance and composition of plankton to support a sustainable fishing ground area in Staring Bay.

Materials and Methods

Study Sites

The study was a collaboration research between Institution for Research and Community Service (LP2M) University of Halu Oleo and US-AID. The study was conducted from January to March 2017 in Staring Bay located in South Konawe Regency, Southeast Sulawesi.

Plankton samples were collected from 8 sampling stations (Fig.2). The sampling stations were divided into four groups according to their positions. The first group was Puasana Village (station 1 and 2), Lalowaru Village (station 3 and 4), Tanjung Tiram Village (station 5 and 6) and Wawatu Village (station 7 and 8).

Sample Collection

Samples were collected by filtering 100 L seawater using planktonet with a diameter of 30 cm and mesh size of 60 µm. The filtered water was transferred to a 150 mL bottle and preserved using 3-4 liters 10% formalin for a couple weeks and stored in laboratory prior to qualitative analysis.

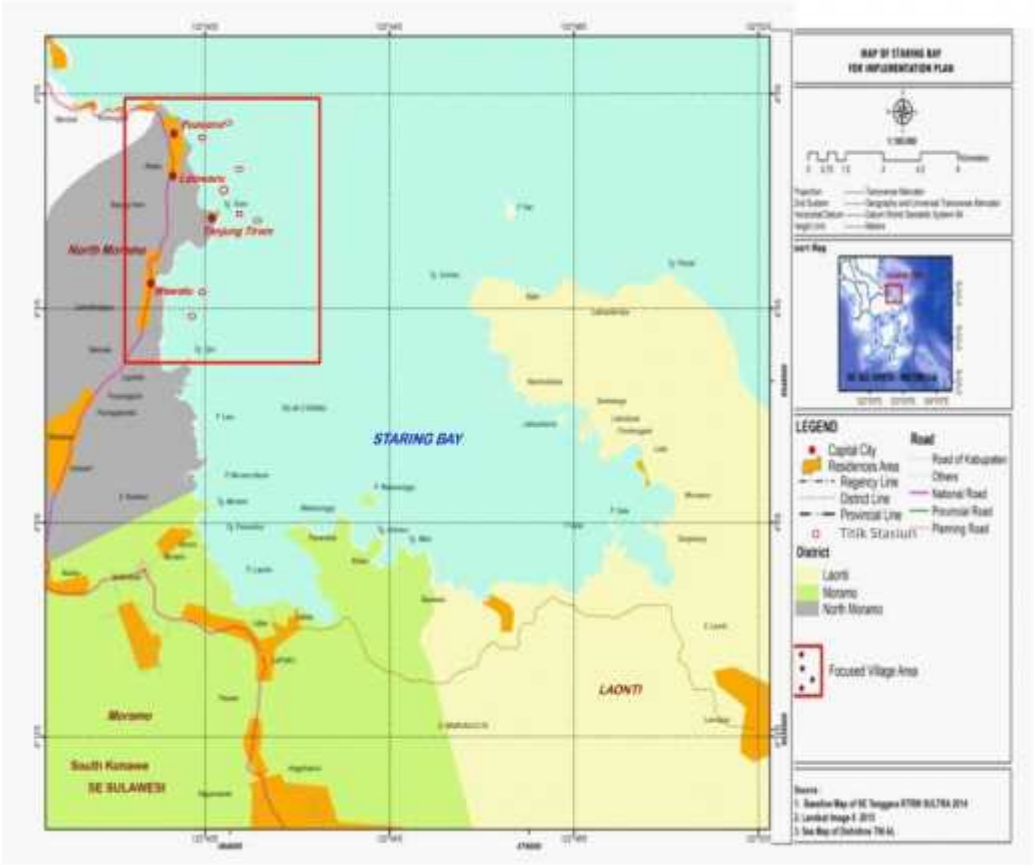

Figure 1. Sampling locations in Staring Bay

Counting cell method was used to calculate plankton sample collected from every station, and the results were expressed in cell L^{-1}. Plankton were observed using a biological microscope under a magnification of 10 x 10. The observed plankton was identified using an identification book by Sachlan (1982), Darwis (1995) and Perry (2003).

Results and Discussion

Results

Composition and Abundance of Plankton

The abundance of phytoplankton for three months in each sampling station was presented in Table 1. The number of phytoplankton was higher consisting of 59 genus and 70 species compared to the number of zooplankton which comprised of 20 genus and 23 species. Four different taxonomic groups of plankton were identified: Bacillariophyceae, Dinophyceae, Cyanophyceae and Euglenophyceae (Fig.2), and eight different taxonomic groups of zooplankton: Crustacea, Cyclopoida, Ostracoda, Arachnida, maxillopoda, heterotrihaeta, Ciliata and Pseudodiaptomidae (Fig.3).

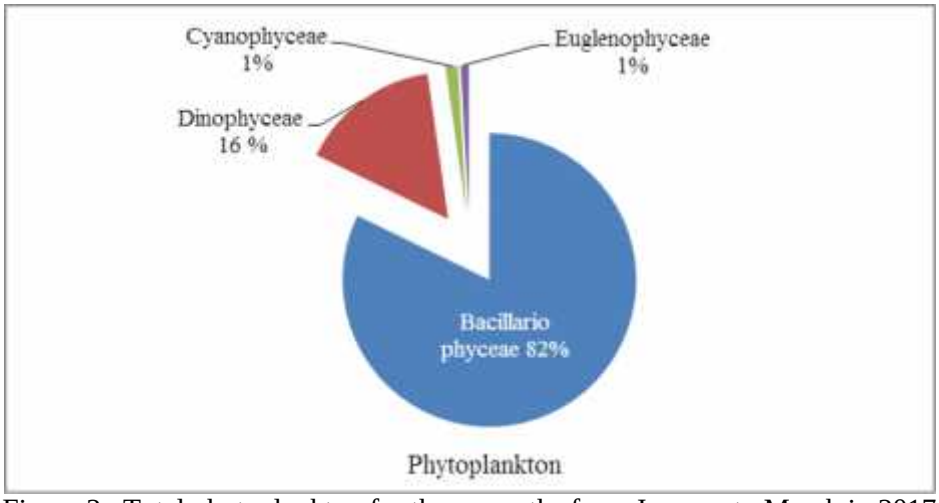

Figure 2. Total phytoplankton for three months from January to March in 2017

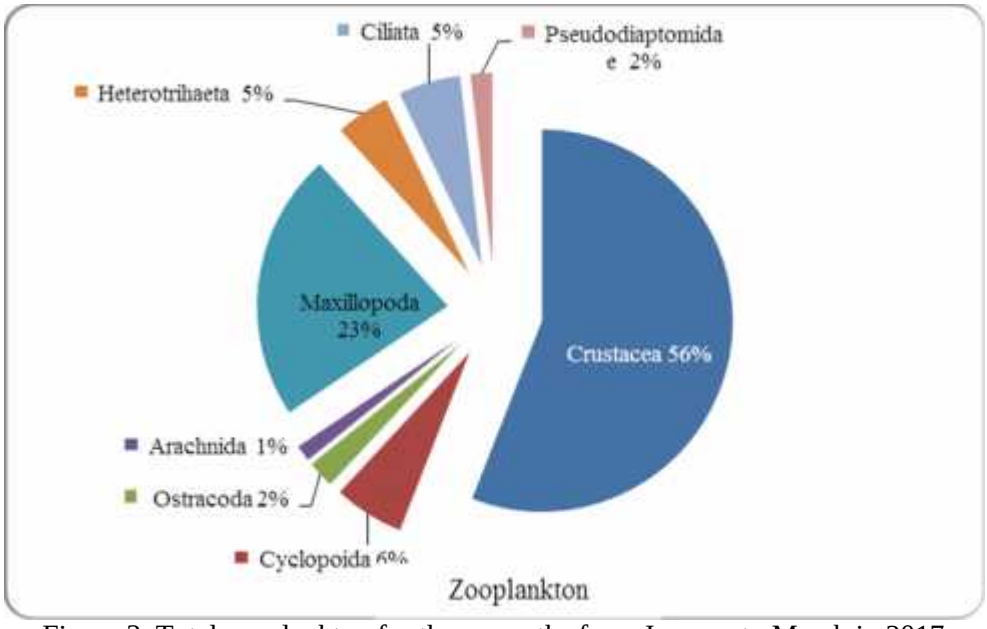

Figure 3. Total zooplankton for three months from January to March in 2017

The present study found that phytoplankton count was mainly dominated by *Chaetoceros* sp., ranged from 13.50-75 ind/L, and the most abundant genus was Chaetoceros distributed in all stations. Meanwhile, *Mysis* sp., was the most dominant species from zooplankton ranging from 7.5-34.5- ind/L. The species identified during the study and their abundance is shown in table 1.

Tabel 1. The abundance of phytoplankton and zooplankton in Puasana, Lalowaru, Tanjung Tiram and Wawatu

No	Phytoplankton species	Puasana		Lalowaru		Tanjung Tiram		Wawatu	
		1	2	1	2	1	2	1	2
1	*Alexandrium* sp.	---	1.5	---	---	---	---	---	---
2	*Anabaena*sp.	---	---	1.5	3	1.5	6	---	---
3	*Asterionellopsis glacialis*	---	---			3	7.5	---	---
4	*Bacteriastrum* sp.	---	---	1.5	3	---	---	---	---
5	*Bidullphia* sp.	3	3	---	---	---	---	4.5	9
6	*Centropyxis* sp.	3	0	---	---	---	---		
7	*Ceratium horridum*			---	---	---	---	0.13	3
8	*Ceratium sp*	10.5	6	---	---	---	---		
9	*Chaetoceros affinis*	---	---	3	1.5	---	---	0.13	3
10	*Chaetoceros sp*	37.5	13.5	---	---	---	---	30	75
11	*Chaetocores difficle*	---	---	7.5	7.5	---	---	---	---
12	*Chaetocores lorenzianus*	---	---	3	13.5	3	9	---	---

Table 1. (continued)

13	*Climacodium frauenfeldianum*	---	---			9	16.5	---	---
14	*Climacosphenia sp*	---	---	13.5	0	1.5	6	---	---
15	*Cocconeis sp*	---	---	7.5	3	1.5	9	4.5	9
16	*Coscinodiscus grani*	---	---	6	4.5	---	---	37.5	28.5
17	*coscinodiscus radiatus*	15	12	15	7.5	15	3	---	---
18	*Coscinodiscus stellaris*	---	---	3	1.5	7.5	6	---	---
19	*Cyclotella sp*	---	---	---	---	4.5	7.5	1.5	6
20	*Cymbella sp*	---	---	3	1.5	---	---	---	---
21	*Diatoma sp*	6	7.5	7.5	12	---	---	9	27
22	*Dinophysis caudata*	---	---	3	4.5	---	---	---	---
23	*Dinophysis sp*	---	7.5	---	---	7.5	3	1.5	4.5
24	*Ditylum brightwellii*	12,00	1,50	---	---	---	---	---	---
25	*Entomomoneis sp*	3	3	---	---	6	9	7.5	---
26	*Euglena sp*	4.5	1.5	---	---	---	---	---	---
27	*Eunotia sp*	15	18	6	---	---	---	3	7.5
28	*Fragilidium sp.*	---	---	1.5	3	---	---	3	3
29	*Fragillaria sp*	---	10.5	7.5	4.5	---	---	---	---
30	*Fragiolariopsis sp*	---	---	---	---	3	0	1.5	---
31	*Gomphonema sp*	---	---	0	4.5			---	1.5
32	*Gymnodinium sp.*	---	---	---	---	3,00	12,00	---	
33	*Gyrosigma sp*	---	---	9	3	---	---	---	4.5
34	*Hemiaulus sinensis*	---	7.5	---	---	---	4.5	---	
35	*Lauderia annulata*	3	---	---	---	---	---	1.5	---
36	*Leptocylindrus minimum*	---	---	10.5	3	---	---	---	---
37	*Licmophora sp*	4.5	7.5	---	---	4.5	12	---	---
38	*Meridion sp*	4.5	3	---	---	---	---	---	---
39	*Navicula sp*	10.5	12	1.5	---	---	6	6	3
40	*Nitzschia longisima*	---	---	7.5	---	---	---	3	---
41	*Nitzschia sigma*	9	6	1.5	3	7.5	13.5	---	---
42	*Odontella mobillensis*	---	---	1.5	3	---	---	---	7.5
43	*Ornitho thurnicercus*	---	---	3	7.5	---	1.5	---	---
44	*Oscillatoria anguta*	---	---	3	1.5	---	---	---	---
45	*Oscillatoria sp*	12	15	---	---	7.5	9	---	---
46	*Peridinium sp*	4.5	4.5	---	1.5	---	---	3	6
47	*Phacus sp*	3	6	---	---	---	---	---	---
48	*Pinnularia sp*	---	---	3	---	---	---	1.5	---
49	*Plagiodiscus sp.*	---	---	---	---	4.5	3	---	---
50	*Planktoniella sp*	10.5	---	---	---	---	---	---	---
51	*Pleurosigma elongatum*	---	---	1.5	0	---	3	---	---
52	*Preperidinium meunieri*	3	---	6	0	---	---	---	---
53	*Prorocentrum micans*	---	---	3	3	1.5	1.5	---	---
54	*Prorocontrum belizearum*	---	---	1.5	3	---	---	---	---
55	*Protoperidinium depressum*	---	---	---	---	3	---	---	---
56	*Protoperidinium sp*	9	9	---	---	---	---	---	---
57	*Protopredinium micans*	---	---	---	9	---	---	3	1.5
58	*Pseudo-Nitzschia sp*	6	3	3	1.5	---	---	---	---
59	*Pyrophacus horologicum*	---	---	3	4.5	1.5	1.5	---	---
60	*Rhizosolenia cakar*	1.5	6	---	---	---	---	3	---
61	*Rhizosolenia sp.*	---	---	6	3	---	---	---	---
62	*Stephanopysis turris*	1.5	---	---	---	1.5	---	---	---
63	*Streptotheca sp*	---	---	4.5	6	---	---	---	---
64	*Striatella limpunctata*	---	---	6	0	---	---	---	---
65	*Surirella sp*	1.5	3	---	---	7.5	---	1.5	3
66	*Synedra sp*	16.5	15	---	---	3	6	4.5	4.5
67	*Tabellaria sp*	0	6	9	1.5	3	6		
68	*Thallassionema nitzshiodes*	---	---	---	---	4.5	1.5	3	7.5
69	*Triceratium sp*	---	---	4.5	3	---	---	---	---
70	*Urosolenia sp*	---	3	---	---	---	---	1.5	1.5

Table 1. (continued)

	Zooplankton species								
1	*Acarina sp*	---	---	0	3	---	---	3	3
2	*Acartia longiremis*	---	---	---	---	---	---	10.5	6
3	*Apocyclopas sp*	4.5	13.5	---	---	---	---	12	9
4	*Apocyclops loyi*	---	---	---	---	1.5	9	---	---
5	*Balanus sp*	---	---	3	7.5	9	3	7.5	3
6	*Branchionus sp*	---	---	4.5	4.5	6	6	4.5	4.5
17	*Calanoid sp*	---	---	7.5	10.5	---	---	19.5	24
7	*Capepoda sp*	---	---	---	---	21	4.5	---	---
8	*Centropages hamatus*	---	---	---	---	3	4.5	6	9
9	*Centropages sp*	---	---	1.5	3	---	---		
10	*Colurella sp*	---	---	---	---	---	---	4.5	1.5
11	*Euplotas sp*	---	---	1.5	3	---	---	1.5	3
12	*Favella sp*	12	13.5	---	---	---	---	---	---
13	*Labidocera sp*	---	---	---	---	---	---	3	3
14	*Moina micrura*	---	---	4.5	0	---	---	3	4.5
15	*Moina sp*	6	4.5	---	---	---	---	---	---
16	*Mysis sp*	---	---	24	7.5	---	---	33	34.5
18	*Oithona sp*	---	---	3	7.5	3	7.5	12	0
19	*Ostracoda sp*	---	---	3	0	3	6	---	---
20	*Polychaeta sp*	7.5	9	---	---	---	---	---	---
21	*Schmackeria sp*	6	6	---	---	---	---	---	---
22	*Shrimp larvae*	24	22.5	4.5	9	4.5	12	6	3
23	*Temora sp*	---	---	1.5	16.5	---	---	21	16.5

** The highest number of plankton during the study
*The lowest number of plankton during the study

Environmental conditions

Hydro-chemical parameters measured in the study were water temperature, water current, light intensity, DO, pH, nitrate, and phosphate. The average values of hydro-chemical parameters are presented in table 2.

Table 2. Hydro-chemical parameters in Staring Bay

Parameters	Range	Average
Temperature (^{o}C)	25 – 31	30,5
Light intensity (%)	51 – 100	84,26
Water current (cm/s)	0,082 – 0,22	0,147
Salinity (ppt)	25 – 35	29,5
pH	6 – 7,35	6,6
DO (mg/L)	3,5 – 6,6	4,95
Nitrat (mg/L)	0,0145 – 0,0152	0,0344
Phosphate (mg/L)	0,0027 – 0,0069	0,00474

Discussion

It was identified in the present study that there were 93 genus of plankton identified from 8 stations in Staring Bay. The genus consisted of 70 types (59 genus) of phytoplankton and 23 types (20 genu) of zooplankton (table 1). The composition phytoplankton was dominated by Bacillariophyceae (82%), followed by Dinophyceae (16%) and Cyanophyceae and Euglenophyceae (1%) (Fig.2). Meanwhile, the composition of zooplankton comprised crustacea (56%), Maxillapoda (32%), Cyclopoida (6%), Cilliata (5%), followed by Ostracoda (1%) dan Pseudodiaptomidae (1%) (Fig. 3).

The composition of phytoplankton was found higher than zooplankton due to the collection of sample was conducted in the day light. Phytoplanktons are more active in the day and tend to be in the surface of the water as it relates to the activity of photosythesis (Sirait, 2011).

In the present study, the most dominant phytoplankton was from Bacillariophyceae. This may be caused by their higher tolerance to environmental changes compared to other classes. Furthermore, it is generally accepted that Bacillariophyceae is the most frequently obtained species when filtering by using planktonet (Nybakken, 2000). Ecologically, diatom is one of the most important group in algae, and it is estimated that the group could generate 40-45% primary production in the ocean (Mann, 1999). In addition, diatoms are widely distributed in all aquatic environment (Round *et al*., 1990). Odum (1996) found that the high dominance of diatom, specifically Bacillariophyceae could be caused by the ability to adapt to environment, cosmopolite, resisten to extreme environmental conditions and high reproduction rate. Meanwhile, the most dominant class in zooplankton was crustacea. The dominance could be caused by the prey activities of the zooplankton. Odum (1996) reported that crustace depends their life on organic materials, such as phytoplankton and detritus.

Other findings showed that diatom and dinoflagellata dominated the composition of phytoplankton in the water of South Kalimantan as reported by Thoha & Amri (2010), in Ambon Bay (Kurawal, 2015), East Nusa Tenggara, Bonerate Island, is identified 80 genus of phytoplankton consisting of 52 genus of diatom, 21 genus of dinoflagellata and 7 genus of chyanophyceae (Febrine, 2005). In Manado, it is found that diatom and dinoflagellata is more dominant than other species (Liwutang, *et al*., 2013). Wanggai (2007) reported that 22 genus of diatom, 6 genus of dinoflagellata, 3 genus of cyanophyta, and 3 genus of clorophya in Manado. Other study by Panda et al (2012) found that there are 95 species of phytoplankton comparising Bacillariphycea (84%), Dinophyceae (12.5%), Chyanophyceae (5%) and Haptophycea (1%). Meanwhile, Kiteresi *et al*. (2012) identified in Kenya that there are 52 taxon of diatom, 23 taxon of dinoflagellate, and 4 taxon of flagellates. Another finding indicated that in lagoon crustacea dominates the composition of zooplankton (Madinawati, 2010).

There was a variation in the dominance of plankton identified in every station. The most equally distributed species in all stations from phytoplankton and zooplankton was Bacillariophyceae and Crustacea, respectively (table 1). Bacillariophyceae is mostly found in marine, specifically lagoon. The most abudant phytoplankton was from *Chaetoceros* sp reaching between 0.13-75 ind/L (Table 1) and distributed in all stations. Meanwhile, the distribution of zooplankton was from crustacea and the most dominant genus was Mysis sp attaining between 7.5-34.5 ind/L (Table 1).

The most dominant genus of phytoplankton in the present study was *Chaetoceros*. This could be attributed to the morphology of the genus. *Chaetoceros* forms chine-like structure and has chaeta making the genus tend to be in the water coloumn. Moreover, the genus is less preferred by herbivorous fish. The most dominant species found in the marine is *Chaetoceros, Bacteriastrum, Rhizosolenia,* and *Biddulphia* (Nontji, 2007). The similar finding was also recorded in Ambon Bay where Chaetoceros is the most dominant species (Haumahu, 2004).

The most abundant genus of zooplankton identified in the study was *Mysis* sp and shrimp larva. The abundance of eggs and larvae of Maxillopoda in the bay was an indicator that the area could be used for a spawning, nursery and feeding ground. In fact, larvae of fish and muscle were also found in the sampling area. Nontji (2007) explained that larvae of Maxillopoda are mostly found in coastal area. Romimohtarto and Juwana (2004) further added that information on the presence of Maxillopoda larvae is essential in order to know the breeding season of muscles. Moreover, Asriyana and Yuliana (2012) found that fish larvae in the first phase of their growth tend to migrate to coastal areas to seek for protection and feeding ground. The larvae found in the coastal areas might make active movement or be washed away by water tides.

Physical parameters observed in the present study were temperature, light intensity, water current, and pH (table 2). Temperature is an important factor affecting the life and distribution of aquatic organism, photosynthesis rate and growth rate of algae. The results of measurement showed that temperature ranged from 25-31^{o}C, with the average value was 30.5^{o}C (table 2). The value remained favorable for the growth of phytoplankton. Light intensity in the study area reached 84.26% (table 2). The high value of light intensity was important for phytoplankton to carry out photosynthesis. Low light intensity affected the distribution and abundance of phytoplankton. Abida (2010) reported that the distribution of phytoplankton in estuary of Porong River, Sidoarjo is fairly low due to high suspension. Water current ranged between 0.082-0.22 m/s (table 2). The current was low and could affect the distribution of plankton.

Chemical parameters measured were salinity, dissolved oxygen (DO), nitrate, and phosphate. The salinity level in the present study ranged from 25-31 ppt. The range remained favorable to support the growth of plankton. The DO values varied between 3.5 and 6.6 mg/L. Nitrate and phosphate are essential nutrients for water fertility. The high level of the nutrients in the current study could be due to the

discharges of pollutant through domestic or agricultural wastes. Water close to residential area generally contains high level of nitrate, ammonia, and phosphate (Nontji, 2008). The mean values of nitrate and phosphate recorded in the study were 0.0344 mg/L and 0.00474 mg/L.

In conclusion, the most abudant plankton identified in Staring Bay consisted of 59 genus of phytoplankton (65 species) and 20 genus of zooplankton (23 species). The domiance of phytoplankton was higher than zooplankton. The abudance of phytoplankton was dominated by Bacillariophyceae reaching 1107 ind/L with the most dominant species was chaetoceros. Meanwhile, zooplankton was dominated by crustacea attaining 366 ind/L with the most dominant species was Mysis. Water quality in Staring Bay remained favorable for the growth of plankton.

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Mound Characteristics of Mud Lobster *Thalassina Anomala* (Herbst 1804) in Coastal Area of Tanjung Tiram, South Konawe - Southeast Sulawesi

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Abstract

This research aimed to analysis mounds characteristics, density and distribution pattern of mounds of mud lobster *T. anomala* (Herbst, 1804) at mangrove ecosystem. The research area was located in Tanjung Tiram, North Moramo, South Konawe, Southeast Sulawesi. The research station was classified based on substrate type: mangrove ecosystem area with sand substrate (station 1), mangrove ecosystem area with the sand muddy substrate (station 2) and mangrove ecosystem area with combination substrate (mud, sand and pebble) (station 3). The density and mounds distribution every research station were measured using transect quadratic of 10 m x 10 m. The mounds characteristics measured were base diameter of mound, height of mound, slope of mound, slope of hole, diameters of outer hole, depth of burrow, inclination of burrow, the temperature and humidity. The substrate of mounds was analyzed. Distribution of mound in this research was random, and the highest density was found at stasion 2 (4.5 ind/m^2) with the sand muddy substrate. The highest average of mound height and the largest diameter of outer hole were found at stasion 2 (7,94 ± 2,64 and 3,96 ± 0,94). There was significant correlation between carapace width and diameter of outer hole ($p < 0,01$)).

Keywords : Distribution pattern, density, mound characteristics, *Thalassina anomala*

Introduction

A coastal area of South Konawe reach about 9,368 km^2 or 61,85% of its land area and the coastal line reach ± 200 km (BPS Kabupaten Konawe Selatan, 2014). One of coastal area that has wide mangrove ecosystem is Tanjung Tiram in North Moramo. This location is one of target villages of FPIK UHO, and it becomes education and tourism destination (research, exploration, and marine tourism). One of its potentials is the existence of mud lobster *Thalassina anomala* as unique fauna in mangrove ecosystem that has not been well reported. Local community call it as shrimp scorpion because of mud lobster structural morphology resembles scorpion, while in Jambi, it is called as soil shrimp (Kartika and Patria, 2013) and in Terengganu, Malaysia was named ketam busut, udang ketak, mud lobster and ghost shrimp (Hassan *et al.*, 2015). *T. anomala* is classified into burrowing crustacea because it has a habit of digging the soil to make a burrow/crab hole at the bottom substrate of mangrove ecosystem which has function as mound (Moh and Chong, 2009; Ngoc Ho and de Saint Laurent, 2009).

A nest of mud lobster *T. anomala* consists of mound and burrow connected and composed by sand and mud particles. Burrow formed by *Thalassina* can reach up to 2 m of depth or even more with vertical burrow direction or to the waters (Teo *et al.*, 2008). Moh and Chong, 2009) explained that *T. anoma* species is found far enough under surface of the bottom, while *Thalassina* kelanang showed high salinity tolerance. Mound is formed by mud filtered which is exavated from substrate surface using a couple peleopod. Mud lobster *Thalassina* ingests organic matter when it excavates into the ground to find food (Voris and Murphy, 2002). Kartika and Patria (2012) found that burrow of mud lobster *T. anomala* has a form like I, L and Y letters, while other Thalassinidae are reported to have burrow type like U, Y and I letters (Mukai and Koike, 1984; Kinoshita, 2002). The burrow of *T. anomala* found in Setiu, Terengganu, Malaysia, has form like U and Y letters. Kinoshita (2002) concluded that the burrow form of *Thalassina* is strongly related to foraging activity. Mud lobster *T. anomala* constructs its mound and burrow at night and it will be seen many new mounds in the morning (Hassan *et al.*, 2015).

Teo *et al.*, (2008) mentioned that the nest existence made by *T. anomala* activity can be benefited as habitat for other mangrove biota such as crabs, worm, snake and mud skippers (*Periophthalmus* sp.). Furthermore, these fauna groups can interact and perform its function in mangrove ecosystem. Ashton and Macintosh (2002) stated that the role of *T. anomala* in mangrove ecosystems consisted of nutrient utilization of mounds resulted by *T. anomala.*

Because of mound formed by this fauna, it can change environmental condition of mangrove ecosystem. Abiotic factors such as soil humidity, pH and acid oxidation in the soil are factors which influence distribution and density vegetation especially mangrove which will be rehabilitated (Macintosh *et al.*, 2002). Ecologically, the existence of Thalassinidae family is important macrofauna component because this activity can restore the nutrient cycle on sedimentation area (Kartika and Patria, 2012). In some areas, it can become areal indicator with FeS_2 oxidated and resulting sulfat acid (Ashton and Macisntosh, 2002; Teo *et al.*, 2008). The information about the nest existence (mound and burrow) of mud lobster *T. anomala* in Southeast Sulawesi especially South Konawe is not available, therefore this research become important to be conducted to describe nest characteristics, density and mound distribution pattern formed by *T. anomala* in mangrove ecosystem. The results is expected to give ecological information of *T. anomala* especially related to nest characteristics (mound and burrow) and its role in aquatic biota at mangrove ecosystem.

Materials and Methods

Time and Location

This research was conducted from January to March 2016. The research consisted of two steps which were field sampling (physics and chemical parameters) which taken in Tanjung Tiram (Figure 1) and laboratory analysis water quality analysis conducted in Texting Laboratory of Faculty of Fishery and Marine Science, University of Halu Oleo.

Materials

The materials were pH indicator, thermometer, hygrometer, soil tester, GPS Garmin 60, scaled stick, pipe, digital camera, shovel, calipers (mm), stopwatch, protractor, compass, kite current, secchi disc, paper label, plastic sample, transect, quadrant plot 1 x 1m^2, plastic bucket diameter of 30 cm, other materials and chemical compounds .

Research Procedure

Research station was determined using purposive random sampling method (station interpretation determined based on location or area that has mound and burrow of *T. anomala* at every observation station). Quadrant plot size of 10 m x 10 m was made and the distance between the nearest quadrant plots was 10 m. At every sampling point, the number of burrows or mounds made was counted. Each mound was measured its upper part, base diameter, height, burrow depth, slope and burrow direction.

Water quality parameters at each statin were measured such as temperature, transparency, current velocity, pH of water and sediment, dissolved oxygen, total suspended solid and total organic matter. Humidity of air and burrow were measured and sediment sampling was taken from a burrow of each quadrant plot. Organic content and texture fraction of the sediment was analyzed at laboratory.

Data analysis

Mound density formed by mud lobster *T. anomala* was calculated based on density equation (Soegianto, 1994), while mound distribution pattern used spread index formula by Marisita (Brower *et al.*, 1990). The results of mound measurement and the correlation between burrow diameter and carapace width of mud lobster were analyzed using nonparametric analysis of Spearmen test.

Results and Discussion

Results

Density and Mound Distribution

The results of research showed that the highest density was 4.5 ind/m^2 at station 2 (S: 4^o 2' 8,84" and E: 122^o 40'18,83") with a muddy sand substrate, followed by 2.9 ind/m^2 at station 1 (S: 4 ^{o} 2'12,99" and E: 122 ^{o} 40'18,84") with sand substrate and 1.5 ind/m^2 at station 3 (S: 5 ^{o} 6'15,75" and E: 122 ^{o} 11'28,88") with combination substrate of sludge, sand and gravel, respectively. The density of mound varied according to station, while mound distribution pattern at each research station was the same (Table 1).

Table 1. Density and mound distribution pattern of *T. anomala*

Station	Density (ind/m^2)	Morisita Index (*Id*)	Dispersion Pattern
1	2.9	1.00	random
2	4.5	1.00	random
3	1.5	1.00	random

Those data in Table 1 showed the mound distribution pattern formed by *T. anomala*. Distribution pattern of those mounds at each station following random distribution pattern (*Id* = 1). The density and the distribution of mounds of *T. anomala* were clearly seen on the surface of land. Station 2 had the highest number of mounds of 4.5 ind/m^2. The nearest distance between mounds was 6.7 cm, while the farthest was 227 cm with the average of 58.24 cm.

All water quality and texture substrate (including organic matter) measured at each station were quite similar (Table 2). According to Spearmen test between humidity and temperature, and salinity and substrate pH showed significantly correlation ($p < 0.01$) (Table 4). It means that those limiting factors had close correlation with substrate humidity parameter of burrow.

Table 2. Water and substrate quality of the mound of *T. anomala* measured

Parameters	Average ± Standard Deviation		
	Station 1	Station 2	Station 3
Temperature	25.75 ± 0.45	25.33 ± 0.65	25.92 ± 0.51
Salinity	30.5 ± 0.52	29.75 ± 0.62	30.58 ± 0.51
pH substrate	6.31 ± 0.19	5.35 ± 0.19	6.72 ± 0.17
pH water	7.5 ± 0.52	7.5 ± 0.52	7.5 ± 0.52
Humidity of burro substrate	7.26 ± 0.29	17.86 ± 0.57	6.54 ± 0.32
DO	4.1 ± 0.40	4.53 ± 1.20	4.3 ± 1.25
Total suspended solid	0.35 ± 0.25	0.42 ± 0.26	0.33 ± 0.11
Total organic matter	25.44 ± 0.98	43.53 ± 9.43	42.65 ± 11.37

Table 3. Texture Substrate and Organic Matter of the mound of *T. anomala* measured

Station	Percentage (%)				
	Dust	Clay	Sand	Class	BO
1	6.8849	0.2758	92.8393	Sand	2.2
2	2.4562	8.553	88.9908	Sand	6.5
3	5.881	0.1709	94.6104	Sand	4.9

Table 4. Correlation between substrate humidity of burrow and temperature, salinity, and substrate pH

Parameters	Substrate Humidity of Burrow (%)
Temperature (^{o}C)	0.0001**
Salinity (ppt)	0.0001**
Substrate pH	0.0001**

**Significantly difference ($p < 0.01$)

Mound Characteristic of *T. anomala*

Some mound architectural parameters showed no much different, although the depth of mound was different between station 2 and station 1 and 3 (Figure 2 and Figure 3).

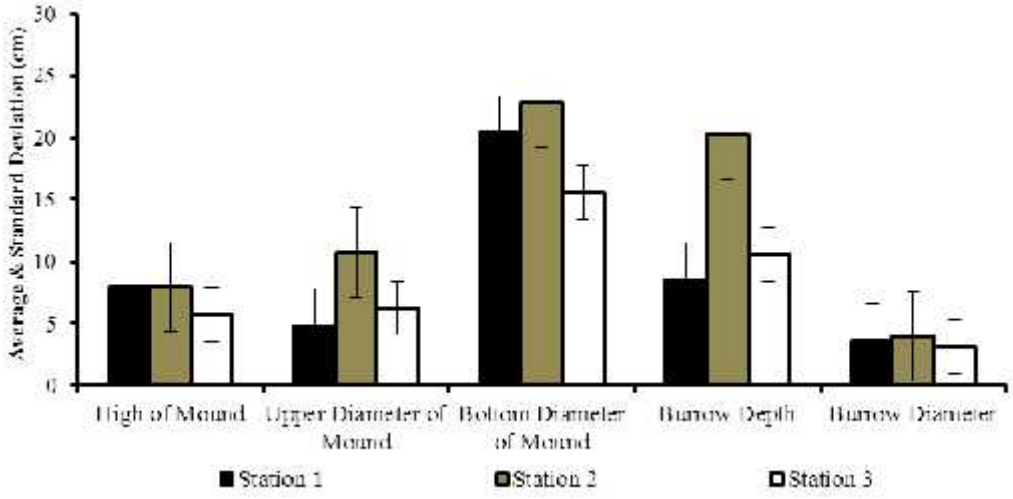

Figure 2. Average and standard deviation of high mound, upper and bottom diameter of the mound, burrow depth and burrow diameter formed by *T. anomala* on each station

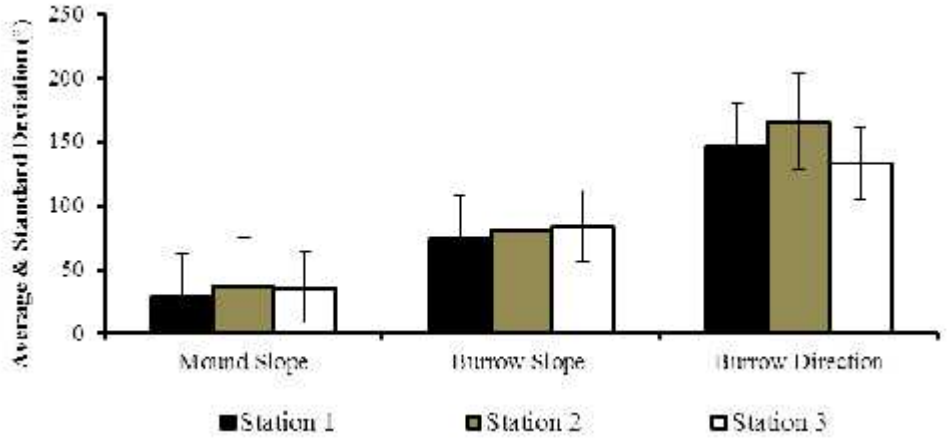

Figure 3. Average and standard deviation of mound slope, burrow slope and burrow direction formed by *T. anomala* on each station.

Those mound architectural parameters (mound height, mound upper and bottom diameter, burrow depth, mound and burrow slope, and burrow direction) clearly showed that they had relatively the same value at each station, except burrow depth which had much different between station 2 and station 1 and 3. The average of burrow depth was 28.14 ± 11.82 at station 2, while the values were relative similar 16.4 ± 2.01 and 16.26 ± 3.21 at station 1 and 3, respectively. Based on correlation analysis between mound height and burrow depth at each station showed significantly correlation (95%) which it is showed by probability rate in spearmen correlation test of 0.026 less ($p < 0.05$).

Among these parameters, the mound height and the mound bottom diameter, and the mound height and burrow depth had significantly correlation ($p < 0.01$) It suggests that the higher mound made by lobster, the deeper burrow the higher mound, and the wider bottom diameter of mound architecture produced by mound lobster.

Table 5. Mound architectural correlation of *T. anomala* at all station

Parameters	Mound Height	Mound Slope	Mound Upper Diameter	Burrow Slope	Burrow Depth
Mound Bottom Diameter	0.005**		0.043*		
Mound Height			0.043*		0.026*
Mound Slope	0.041*			0.417^{ns}	

** significantly different at $p < 0,01$); * significantly different at $p < 0,05$) and ns = not significantly different

The results of burrow diameter measured and the correlation between burrow diameter and carapace width (CW) size are presented in Table 6. Based on Spearman correlation test, data in Table 6 showed empirically CW and burrow diameter had significantly correlation $p < 0.01$). It indicates that mound of *T. anomala* exited and entered the burrow from a mound connected to 2 - 5 secondary tunnels which lead out the burrow (outside burrow of the mound).

Table 6. Carapace width measured (cm) and the burrow diameter of mound

No	Station	Carapace Width (CW) (mm)	Burrow Diameter (cm)
1	1	2.1	4.2
		1.6	3.4
		1.6	3.4
		2	3.9
		1.3	2.9
2	2	2.3	5.4
		2.1	4.4
		1.7	3.6
		1.6	3.3
		1.5	3.1
3	3	1.9	3.8
		1.9	3.8
		0.8	2.1
		1.7	3.5
		0.9	2.5
Average and Sd		**1.67 ± 0.424**	**3.55 ± 0.791**
Correlation		**0.0001 (significantly different, $p < 0.01$)**	

Discussion

Mound Density and Distribution

This study showed that the highest density was 4.5 ind/m^2 at station 2 with muddy sand substrate. Visually the density rate formed by *T. anomala* could be clearly seen based on the measurement of the distance between mounds of mud lobster. The closest distance between mounds was 6.7 cm at station 2, while the furthest was 227 cm. The average distance between distances between

the mounds was 58.24 cm, and 193.94 cm and 453.7 cm at station 1 and 3, respectively. This proved empirically that mound density at station 2 was higher than that of two other stations (station 1 and 3). This study also presented that an individual *T. anomala* could form more than one mounds adjacent and connected to one another. This was identified when the mound architectural measurement (opening of the cross section of the mound) showed that burrows were connected by 1 - 5 tunnels and interconnected among them. Those channels connect each other at outside of the burrow as inlet access of mud lobster *T. anomala*. Those mound have a function as a camouflage to cover the main burrow which protecting *T. anomala* from competitors and predators. It is in accordance with description of Mukai and Koike (1984; Kinoshita, 2002) that other species of *thalassina* such as *Upogebia* and *Callianassa* had typical mound form resembling letters of U, Y and I. Those burrow shapes associate with the feeding activity. For instance, letter of Y is a typical form of crustacean class (burrowing crustacean) used to obtain suspended particles in water and to ingest the substances deposited inside the burrow.

The percentage of mounds found at each station, particularly station 2 that have the largest number of 45 mounds. Those mounds tended to distribute between mangrove vegetation and its association. *T. anomala* interaction with mangrove vegetation was dominantly at *Rhyzopora* and *Sonneratia* vegetations. Those niche characteristics indicates that each nest or mound formed by mud lobster was accessible to water source and those were strongly affected by tidal dynamics. Several studies had stated that mounds formed by *T. anomala* always interacted with mangrove vegetation such as *Bruguiera* sp., *Rhyzopora* sp., *Xylocarpus* sp., and other mangrove plants located in the interior forest (Sasekumar, 1974); Ashton and Macintosh, 2002). Teo *et al.*, (2008) stated that burrow characteristics shaped by *T. anomala* was made to branch and towards water sources. The distribution pattern of mounds was random. It is an indication that *T. anomala* activity in making mound was no depending on certain environmental conditions.

The results of some water quality measured showed relative similar values Random distribution pattern usually occurs in a group of solitary organisms with a specific characteristic (Brower *et al*., 1990). Johnson (1961) and Sasekumar (1974) revealed that macrofauna groups of random distribution pattern tend not to have difficulty in finding food and adapting to their environments. Such conditions cause *T. anomala* widely spread in mangrove ecosystem (Kartika and Patria, 2013). The correlation of humidity substrate among temperature, salinity and soil pH was significant correlation ($p < 0.01$). It indicates that when temperature increase that salinity also increase and the burrow humidity decrease and vice versa. Furthermore, the temperature and texture of burrow clay also has significant correlation. The clay texture tends to bind large amount of water because it has a smaller pore space and high surface pressure (Colemen *et al*., 2004; Ruiz *et al*., 2008). Due to clay texture that muddy sand substrate has the highest density of *T. anomala* mound. It indicates that the muddy substrate is one among environmental parameters which is suitable for habitat preferred by mud lobster.

The average pH of substrates at all stations ranged 5.35 – 6.71. Sasekumar (1974) stated that the substrates derived from *T. anomala*'s nest will be acid. Thus, the presence of *T. anomala* can be a bioindicator of acid sulphate soil (Ashton and Macintosh, 2002; Teo *et al*., 2008; Kartika and Patria, 2013). The highest level of soil organic matter (BO) was obtained 6.5% at station 2, followed by 4.9% and 2.2% at station 3 and station 1, respectively. The percentage of BO content on burrow substrate is strongly influenced by the presence of clay texture, as one of clay characteristics which tends to a bind large amount of water. The present study proves that the amount of organic matter at station 2 has significant correlation to the clay texture which was higher percentage of 8.553% compared to station 1 of 0.2578% and station 3 of 0.1709%. One of *T. anomala*'s role as burrow crustacean is producing organic materials in the sediment with low toxicity. Kristensen (2008) stated that the increase of aeration in the soil due to burrow formed by the excavations of decapoda groups may affect the anoxic properties in mangrove substrates. These fauna groups are also able to change the physical properties of substrates because burrow and mound made by them and is also related to physical transport processes (materials, liquids and gases) as well as chemical reactions.

Characteristic of *T. anomala's* Nest

The mound architectural parameters of mud lobster nest were mound height, upper and bottom mound diameter, burrow depth, burrow diameter, mound and burrow slope, and burrow direction. The correlation of these parameters was significant ($p < 0.05$), except burrow slope was not significantly correlation ($p > 0.05$). The deeper burrow of *T. anomala* and the higher mound of excavation activity of *T. anomala*, the wider the bottom burrow mound diameter. Kartika and Patria (2013) stated that the soil

substrates released to the surface by *T. anomala* form like a chimney on the ground. Kinoshita (2012) stated that *Upogebia* sp. and *Callianasa* sp. tended to differ with their excavation activity. Both these Thalassinidae groups show the nests in the form of burrow and remaining substrates (pellets) around the burrow without making stacks or forming chimneys. Kartika and Patria (2013) stated that mound formed by *T. anomala* is clearly seen and unique in mangrove ecosystem. The size and amount of nest is also formed continuously. The existence of nest *T. anomala* will change the topography and landscape of substrate and also create a microhabitat for other species associated with mangrove ecosystem (Ashton and Macintosh, 2002; Teo *et al.* 2008). It was observed that during 12 hours (20.00 – 08.00 WITA) and 08.00 – 20.00) of mud lobster *T. anomala* was a solitary and nocturnal organism. Mud lobster *T. anomala* is usually caught at night using net. The latest observation at study area showed that the burrows formed a letter of L, where the upper part of the letter is the mouth of the burrow covered by the mound, and the bottom end of the letter of L or tunnel is a tunnel connected to the outside of *T. anomala* burrow. Nowadays, some nests found in the several studies were in the form of U, Y and I. (Mukai and Koike, 1984; Kinosita, 2002) which indicated that individual of *T. anomala* has build more than one mound.

Conclusion

The mound formed by *T. anomala* show a random distribution pattern at each station. The highest density was found 45 mounds at station 2 with muddy substrate, while the lowest density was 15 mounds at station 3 with a substrates mix of mud, sand and gravel. A significant correlation was found between the burrow diameter and the carapace width of *T. anomala*.

Acknowledgment

The authors would like to thank to the Directorate of Research and Community Service, Ministry of Research, Technology and Higher Education of the Republic of Indonesia who has financed this research.

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Spatial Changes and Management of Estuarine Water Quality at the Rawa Aopa Watumohai National Park (RAWNP), Southeast Sulawesi, Indonesia

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Abstract

This study was carried out with the aim to evaluate the spatial variation of water quality in the Roraya and Lanowulu River estuary at RAWN Park coastal zone. Water quality in seven stations along the estuary were monitored in February 2014 including, temperature, salinity, turbidity, dissolved oxygen (DO), chlorophyll-*a* and nutrients (NO_2, NO_3, NH_4, PO_4). This study was analyzed by Surfer 11 software using interpolation method and Principal Component Analysis (PCA) for elucidation the spatial dynamics of physic-chemical qualities of two rivers estuary. The results showed that the spatial classification of water quality decline due to freshwater flow at low tide and input of sea water at high tide. The levels of DO, turbidity, chlorophyll-a, NO_2, NO_3 and NH_4 of the Roraya River estuary were higher as compared with Lanowulu River estuary. The existence of natural mangrove in the Lanowulu river estuary plays an important role in maintaining water quality. The spatial characterization of the Roraya River estuary showed that changing in water quality indicators was due to seawater influx and the effect of land use because of regional development. Human activities around the Roraya River such as mining, agriculture, fishery and household waste activities were the main responsible factors for spatial variation of the monitored variables. Spatial management of estuarine water quality in the RAWN Park areas should be done with ecosystem-based approaches.

Keywords: Spatial water quality, estuarine system, RAWN Park.

Introduction

Estuaries are defined as restricted bodies of water in which the seawater is diluted, in a measurable way, by the fresh water (Pritchard 1967). These environments are generally located in places with high population densities and, as a result, they have been extensively exploited and destroyed, although they still remain one of the most resilient environments on Earth (Elliot and McLusky 2002). Estuaries and coasts, the interfaces between land and the ocean are among the most productive of the earth's aquatic systems because their physical, chemical and biological characteristics provide a favorable setting for a diverse flora and fauna (Ryther, 1969; Odum, 1971). Particles and dissolved material, as well as the biota itself, are transported from the fresh water to the salt water over relatively short distances. Those comprise important ecological services including trapping and cycling of nutrients, the processing of pollutants, sediment stabilization and wave attenuation, and they play a key role in shoreline stabilization (Costanza *et al*., 1997; UNEP, 2006). Moreover, estuaries support many important ecosystem functions: biogeochemical cycling and movement of nutrients, purification of water, mitigation of floods, maintenance of biodiversity, biological production (nursery grounds for several commercial fish and crustacean species) etc. (Daily *et al*., 1997; De Groot, 1997; Meire *et al*., 2005). An estimate of the economic value of these ecosystem functions (goods and services) indicated that estuaries are among the most valuable ecosystems in the world (Costanza *et al*., 1997).

The estuary and coastal areas have a complex and dynamic water environment (Morris *et al*., 1995). A large number of physical and chemical processes occured when river water mixes with seawater, which can affect water quality (Anitha and Kumar, 2013). Water quality in the estuary is decreasing due to rapid industrialization and agriculture practices along the river. These activities increased excess nutrients from industrial and municipal waste and from forest and agricultural products (Ball, 1992). Water quality varies both spatially and temporally. Spatial variations in water quality usually occurs in the converted areas along the river. The concentration of discharge and pollution in water bodies varied with temporal variations of precipitation, surface run off, interflow currents and groundwater flow (Vega *et al*., 1998).

Therefore, seasonal changes in surface water quality are used to interpret spatial and temporal variations in river pollution caused by natural or anthropogenic input from point and non-points sources (Ouyang *et al.*, 2006; Fan *et al*., 2012).

Estuarine water quality is very critical issue due to anthropogenic influence as well as natural processes (changes in precipitation inputs, erosion, weathering of crustal materials) that degrades surface water and impairs use for drinking, industrial, agricultural, recreation and other purposes (Simeonov *et al*., 2003). Human pressure and thus their impact on estuaries are very high, as most of the urbanization is concentrated in the coastal zone (Meire *et al*., 2005). Estuaries constitute a major interface between land and the ocean and have been regarded as one of the most important aquatic system. The sewage from urban areas and industrial wastages contribute a constant source of pollutants, in which the surface run off is a seasonal phenomenon largely affects by climate in the basin. The urban inputs, agricultural runoff and industrial inputs play a vital role in nutrient cycling and water quality in estuarine and near shore ecosystems. Apart from this, fishing activities near the estuary also influence the water quality parameters (Blaber *et al*., 2000). The coastal zone of Southeast (SE) Sulawesi including the Rawa Aopa Watumohai National (RAWN) Park especially Lanowulu estuary is largely dominated by mangrove (Analuddin *et al*., 2013). Lanowulu and Roraya River are the largest rivers in RAWNP. The growth of industrialization and land use in the upstream and estuarine region of Roraya is putting unique pressure on estuarine and coastal resources in the area and therefore is a threat to the health of the river estuary in RAWNP.

In this context, the purpose of this study was to determine the dynamics of spatial water quality changes along the river estuaries of Lanowulu and Roraya River in RAWN Park, where mix tidal and anthropogenic effects on the water quality occurred in the river mouth.

Materials and Methods

Study site

The present study was carried out at seven sites along Lanowulu and Roraya River estuary at RAWNP, SE Sulawesi (Fig. 1). Coordinate of each station was determined using GPS as follows:

1. Station 1 (S: 04^{o}29’08.25” - E: 122^{o}06’24.48”),
2. Station 2 (S: 04^{o}30’10.77” - E: 122^{o}06’40.10”)
3. Station 3 (S: 04^{o}32’12.19” - E: 122^{o}06’84.05”)
4. Station 4 (S: 04^{o}28’30.48” - E: 122^{o}08’55.52”)
5. Station 5 (S: 04^{o}29’27.81” - E: 122^{o}08’02.70”)
6. Station 6 (S: 04^{o}31’10.81” - E: 122^{o}10’02.70”)
7. Station 7 (S: 04^{o}30’14.28” - E: 122^{o}09’49.33”).

Analysis of NO_2, NO_3, NH_4, PO_4 concentration in water samples was performed at the Ecology and Forensic Laboratory of Faculty of Mathematics and Natural Sciences, University of Halu Oleo, Kendari SE Sulawesi.

Sampling Methods and Data Collection

The estuarine water quality data was obtained from onsite water-physicochemical measurement, including temperature, salinity, turbidity, DO and chlorophyll-a using Chlorotec Probe (AAQ1183 Alec Electronic). Water nutrient parameters including NO_2, NO_3, NH_4 and PO_4 were analyzed in the Laboratory using Spectrophotometer.

Data analysis

Spatial distribution pattern to determine the distribution of water quality parameters at Lanowulu and Roraya River estuaries was analyzed by Surfer 11 software using interpolation method. Geostatistical gridding method produces visual maps from irregular data connecting from coastal areas to offshore areas (Yang *et al*., 2013). Furthermore, to determine the distribution and correlation between estuary water quality parameters of Lanowulu and Roraya River estuaries, Principal Component Analysis (PCA) were used.

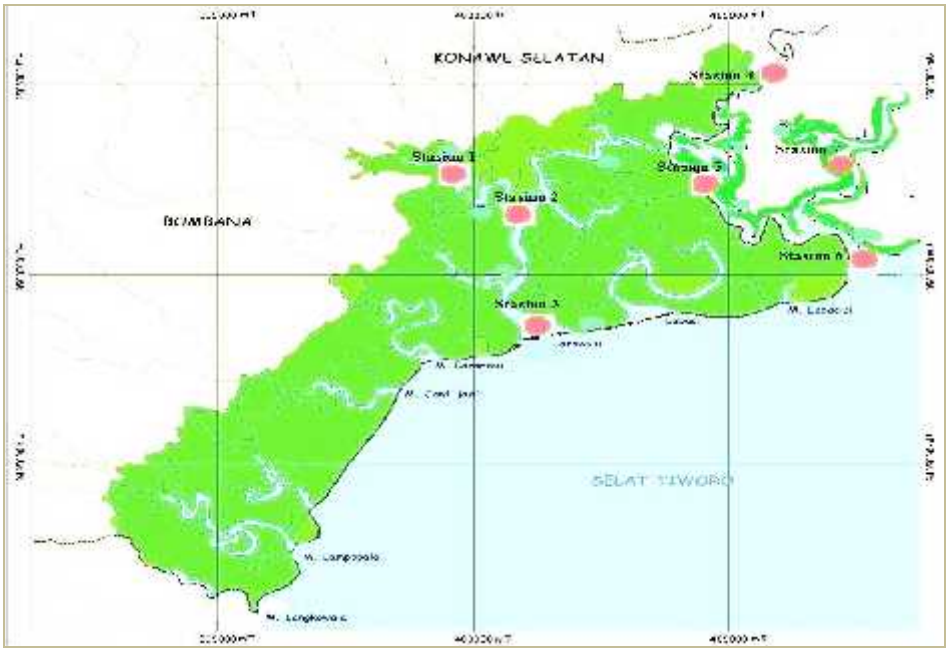


Figure 1. Sampling stations (red color) in the study site at the RAWNP

Results and Discussion

Spatial changes of physics-chemical of estuarine water quality

The results of physics-chemical water quality measurements obtained at the sampling stations during the study period are shown in tables 1a and 1b (high tide and low tide, respectively). Spatial variability of physics-chemical of water quality reflected the influence of river flow and marine processes in the estuary.

Table 1. Summary of average water quality parameters at the sampling stations at high tide in the Lanowulu and Roraya River estuary

Station	Temperature (^oC)	Salinity ($^o/_{oo}$)	Turbidity (NTU)	DO (mg/l)	Chlorophyll-a (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)	NH_4 (mg/l)	PO_4 (mg/l)
1	29.66	25.99	28.26	2.53	2.35	0.024	0.0125	0.155	0.026
2	29.53	28.85	13.93	3.58	1.81	0.009	0.004	0.087	0.006
3	30.24	31.04	13.17	3.36	1.82	0.002	0.0009	0.047	0.008
4	30.4	8.07	29.28	4.78	3.85	0.061	0.1321	0.341	0.019
5	30.81	29.16	15.71	5.25	2.03	0.018	0.0133	0.249	0.015
6	30.51	31.96	8.77	5.71	1.52	0.007	0.0046	0.082	0.01
7	31.08	30.31	11.05	5.6	2.04	0.015	0.0132	0.171	0.018

Table 2. Summary of the average results at the sampling stations at low tide in the Lanowulu and Roraya river estuary

Station	Temperature (^oC)	Salinity ($^o/_{oo}$)	Turbidity (NTU)	DO (mg/l)	Chlorophyll-a (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)	NH_4 (mg/l)	PO_4 (mg/l)
1	28.91	20.7	24.07	2.9	2.71	0.035	0.037	0.292	0.013
2	29.34	28.26	11.38	3.35	1.9	0.02	0.012	0.149	0.006
3	29.52	28.38	23.79	3.37	1.82	0.018	0.008	0.125	0.007
4	30.27	0.15	64.79	6.35	4.48	0.087	0.18	0.368	0.03
5	29.67	4.01	70.96	5.95	4.75	0.064	0.148	0.327	0.025
6	29.8	25.3	26.44	3.18	2.75	0.032	0.029	0.528	0.016
7	29.63	24.65	16.06	3.37	3.41	0.035	0.02	0.617	0.018

The temperature characteristics of estuary waters during the study at high and low tide showed normal conditions within a range of temperatures common to waters in the tropics which was from 28.91 – 31.08°C (Figure 2). There was an increase of temperature at station 7 at the mouth of the Roraya River with an average of 31.08°C. The rise in temperature at this particular sites was probably caused by human activities include mangrove ceniversion into aquaculture ponds. In the aquatic ecosystem, the temperature is influenced by various factors such as the intensity of sunlight, the exchange of heat between the water and the surrounding air, the geographic height and also by the canopy factor of the growing trees which prevents the water body to be exposed to direct sunlight. Temperature is a critical physical factor, affecting the chemical and biological reactions in water and controls the rate of photosynthesis in aquatic ecosystems. Also, temperature variation was influenced by rainfall (Fatema *et al*., 2014). In a tropical estuary, temperature is always inversely correlated with salinity and water transparency. Transparency decreased more during the wet season than during the dry season due to flooding from adjacent catchment areas (Simier *et al.*, 2006). Mansor *et al.* (2012) also observed an increase in temperature during heavy rains and the reverse effect during the dry season.

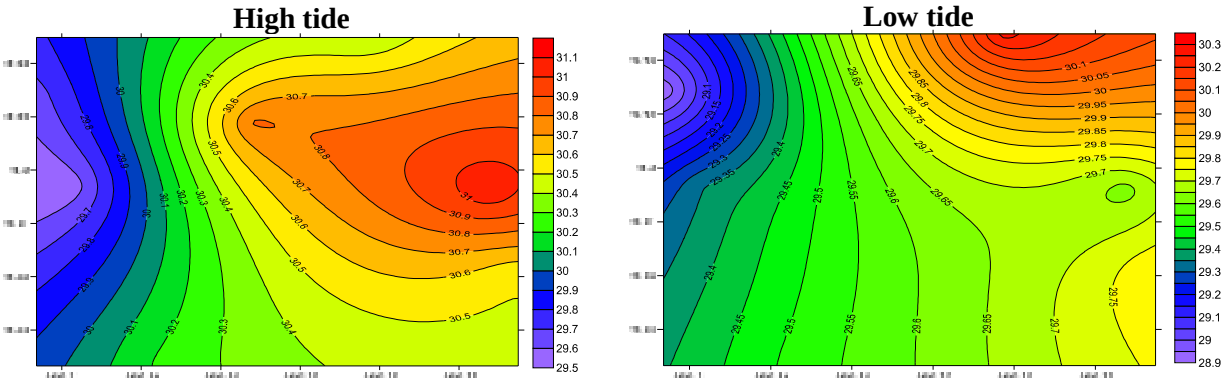


Figure 2. Spatial variation of temperature in the fluvial-estuarine system of Lanowulu and Roraya River.

Water salinity measurement during high tide and low tide (Figure 3) showed a salinity ranged from 0.15 to 31.96 $^{o}/_{oo}$ (Figure 3). Average water salinity at the Lanowulu and Roraya river estuary was from 8.07- 31.96 $^{o}/_{oo}$ at high tide and 0.15 – 28.38 $^{o}/_{oo}$ at low tide. There was a decrease of salinity at low tide at station 4 and 5 of Roraya river estuary and station 1 of Lanowulu river estuary because of high input of freshwater from river stream. The distribution of salinity in estuary is known to be influenced by various factors such as patterns of water circulation, evaporation, and rainfall as well as river flow. Water body that received high rainfall and river flow would have low salinity whereas high evaporative waters will subsequently have high water salinity (Riyadi *et al*., 2005). The salinity conditions at the estuary were spatially altered at low tide due to high amount of fresh water came through the stream. Significant changes occurred at station 5 where the salinity at high tide was 29.16 $^{o}/_{oo}$ and decreased drastically at low tide to 4.01 $^{o}/_{oo}$. Similarly at stations 3, 6 and 7 showed high salinity conditions at high tide of 30.31 - 31.96 $^{o}/_{oo}$ while at low tide the salinity decreased. Stations 3, 6 and 7 were near the mouth of the river with salinity values ranging from 24 and 31 $^{o}/_{oo.}$ Values below this range resulted from dilution by groundwater (Hays, 2005) and therefore indicated proximity to a groundwater seep. The influence of the seawater on the distribution of nutrients and organic matter in estuarine and coastal systems generally resulted in a decrease in the concentrations of these compounds as the salinity increased (Gago *et al*. 2005, Cabeçadas *et al*. 1999, Morris *et al*. 1995). The non-passive use of the land such as agriculture and urbanization in the areas near the water bodies resulted in increasing of particulate entry and dissolved matter to the system and, therefore, in the decrease of water quality in the water body (Basnyat *et al*., 1999).

Average water turbidity on high and low tides (Figure 4) was from 8.77 to 70.96 NTU. The highest turbidity was occurred during low tide at the stations 4 (64.79 NTU) and 5 (70.96 NTU) of the Roraya river estuary. High turbidity of Roraya river estuary may be attributed to the activity of land clearing and mining activities in the upper part of the Roraya River and mangrove forest conversion into aquaculture ponds. These activities increased sedimentation into the estuary carried by the river. In addition, the turbidity of the Roraya River may also due to sediment inputs resulting from erosion. Persistent and relatively high turbidity levels in estuary systems may be an indicator of human impact (Ward *et al*., 1998). Uncles *et al*. (2002) stated that turbidity levels can vary considerably due to the daily cycle of high

and low tides. It is mainly controlled by tidal processes in macro tidal or hyper tidal estuaries, although it may migrate in response to changes in freshwater inflow. In micro tidal estuaries it usually occurs during sporadic river freshets. There was a tendency for long, macro tidal estuaries to have higher suspended sediment concentrations (in the high turbidity zones) than shorter systems with comparable tidal ranges. Long micro tidal estuaries may also have naturally high turbidity levels.

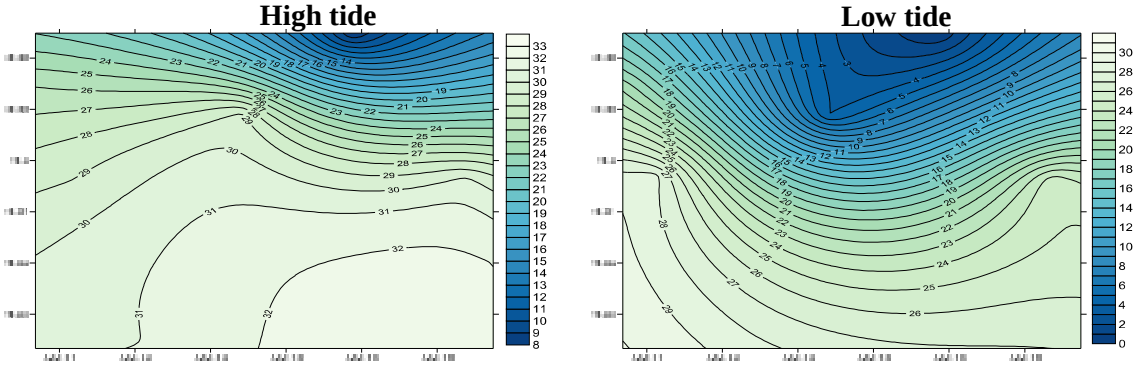


Figure 3. Spatial variation of salinity in the fluvial-estuarine system of Lanowulu and Roraya River.

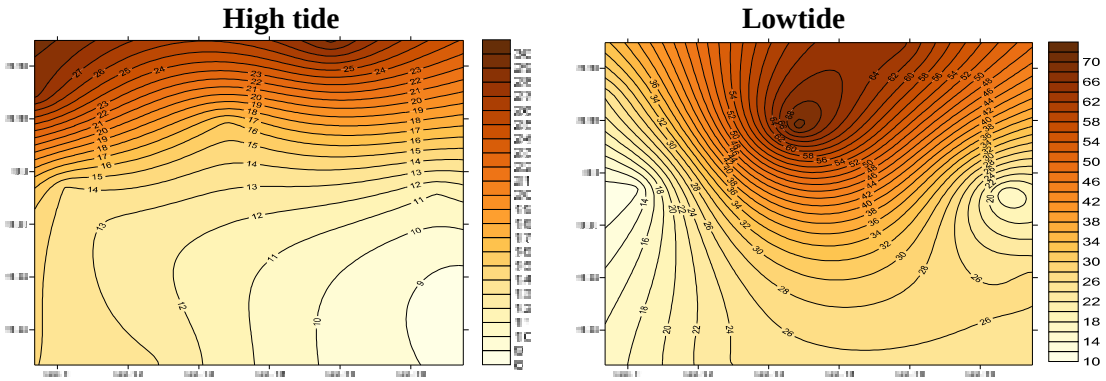


Figure 4. Spatial variation of turbidity in the fluvial-estuarine system of Lanowulu and Roraya River

DO measurements on high and low tides (Figure 5) showed the average DO ranged from 2.53 to 6.35 mg/l. The highest DO value was at low tide occurred at station 4 (6.35 mg/l) at the Roraya river estuary. High DO in this station maybe due to the large number of organic inputs from the mainland carried along the river due to mining activities and mangrove. In addition, high chlorophyll-*a* concentration at station 4 during low tide contributed to high DO level. During measurement, considerable high water temperature was occurred resulting in high producing of oxygen from photosynthesis by phytoplankton as suggested by Dunn *et al*. (2007) and Prabhahar *et al*. (2011) who reported that higher concentration of chlorophyll-*a* during the dry/summer compared to wet/rainy season.

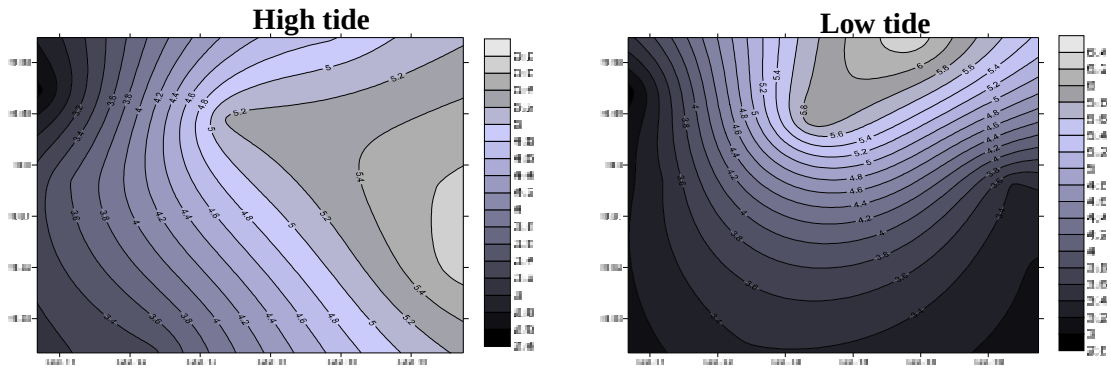


Figure 5. Spatial variation of DO in the fluvial-estuarine system of Lanowulu and Roraya river.

Average chlorophyll-a measurements during high and low tides (Figure 6) was from 1.52 to 4.75 mg/l. The highest value of chlorophyll-*a* was at low tide in station 4 and 5 of Roraya river estuary. Generally, the distribution of chlorophyll-*a* in coastal waters is a result of nutrient supply originating from the mainland through river runoff. Chlorophyll-*a* tends to be low in offshore areas in contrast to estuary. The high chlorophyll-*a* of the Roraya river estuary may be attributed to the large amount of nutrient input from the land carried along the river to the mouth of the Roraya River. Chlorophyll *a* concentrations may increase after rainfall when the rain flushed nutrients into the water. Increased chlorophyll-*a* concentration is also common during the summer months when water temperatures and light intensity increased. Monbet (1992) argued that tidal regime was an important control on algal biomass. Strong tidal mixing decreased chlorophyll-*a* concentrations because the residence time of algae in the photic zone was reduced. Tidal mixing also caused fine sediment to emerge and elevated turbidity levels that in turn will reduce the amount of light available for photosynthesis.

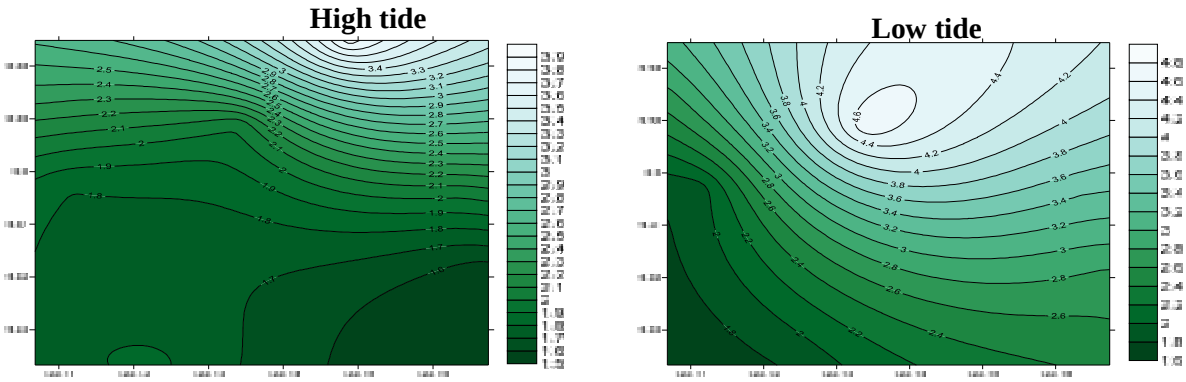


Figure 6. Spatial variation of chlorofil-a in the fluvial-estuarine system of Lanowulu and Roraya river

The results of nitrite measurements on high and low tide (Figure 7) showed that NO_2 concentration ranged from 0.002 to 0.06 mg/l at high tide and from 0.02 to 0.087 mg/l at low tide. The highest of NO_2 value was recorded at station 4 (0.087 mg/l) at low tide in Roraya river estuary. The high concentration of nitrite when low tide was due to the large number of freshwater input from the river. The source of nitrite can be from industrial and domestic waste. Usually, the concentration of nitrite in waters was relatively low because it is immediately oxidized to nitrate. The high NO_2 at Roraya river estuary may be due to the large amount of organic input from the land carried along the river to the mouth of the Roraya River. Variations in the excretion of phytoplankton, ammonia oxidation, and nitrate reduction are likely to contribute to these findings, in addition to nitrogen recycling and bacterial decomposition from planktonic detraction and denitrification as also found by Prabu *et al*. (2008).

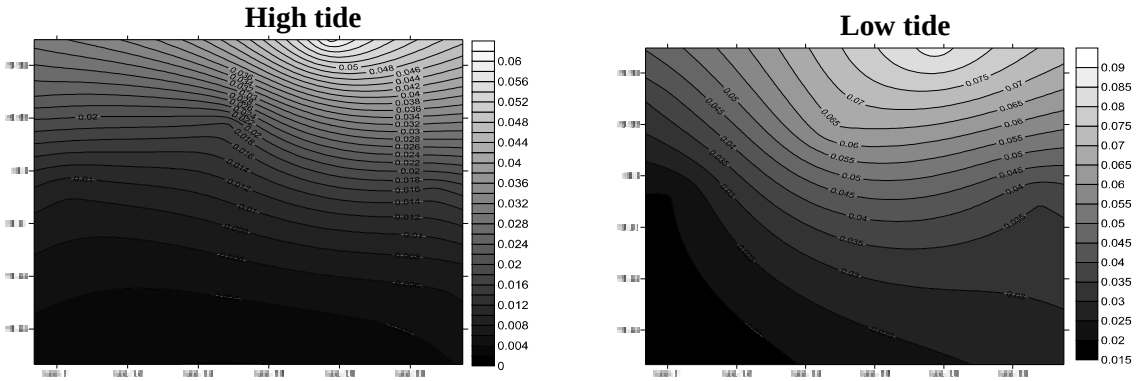


Figure 7. Spatial variation of nitrite in the fluvial-estuarine system of Lanowulu and Roraya river.

Nitrate measurements during high and low tide (Figure 8) showed that average NO_3 concentration ranging from 0.0009 to 0.132 mg/l at high tide and from 0.008 to 0.181 mg/l at low tide. The highest of NO_3 value was found at station 4 (0.1818 mg/l) during low tide at the Roraya river estuary. The high NO_3 at this station can be attributed to large amount of nutrient input from in form of weathering of rocks, fertilizers, household and urban sewage, and freshwater flow. The decomposition of organic matter led to

an increase in nitrate value was also found in mangrove waters with an average nitrate value of 0.11 ± 0.06 mg/l (Selvam *et al*., 1994).

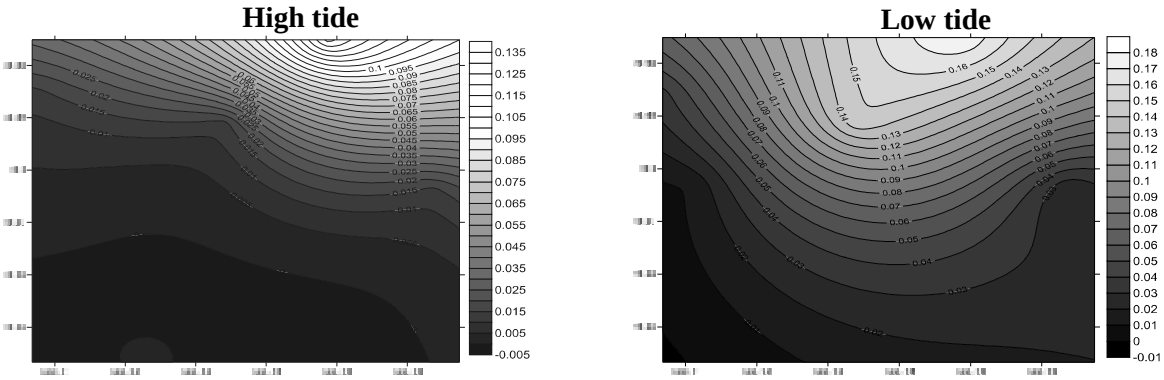


Figure 8. Spatial variation of nitrate in the fluvial-estuarine system of Lanowulu and Roraya River

The results of ammonium measurements on high and low tide (Figure 9) showed that average NH_4 concentration was from 0.047 to 0.341 mg/l at high tide and from 0.125 to 0.617 mg/l at low tide. The highest NH_4 concentration was recorded at station 7 (0.617 mg/l) during low tide at the Roraya river estuary. The high NH_4 at the station might be due to high input of waste from household activities that discharged directly to the river. Seasonal variation has been reported to affect ammonium concentration in water. We measured water quality parameters including ammonia during dry season when low precipitation thus less rainwater dilution occurred, therefore prevent the reduction ammonium concentration in the estuary (Damotharan *et al*., 2010).

Phosphate concentration during high and low tide (Figure 10) showed that in average, PO_4 ranged from 0.006 to 0.026 mg/l at high tide and from 0.006 to 0.03 mg/l at low tide. High PO_4 value was found at station 4 (0.03 mg/l) at low tide at the Roraya river estuary. This high concentration of phosphate at station 4 might be due to the large amount of freshwater input from the Roraya River that carried fertilizer particles from upstream agricultural and aquaculture activities as well as high diffusion of phosphates from the sediments. Fertilizers from agricultural land are a source of phosphates that contribute to increased levels of phosphate in estuary (Ajithkumar *et al*, 2006). The phosphate compounds bonded in the sediments can be decomposed with the aid of bacteria as well as through the abiotic process resulting in soluble phosphate compounds which can undergo diffusion back into the water column (Paytan and McLaughlin, 2007).

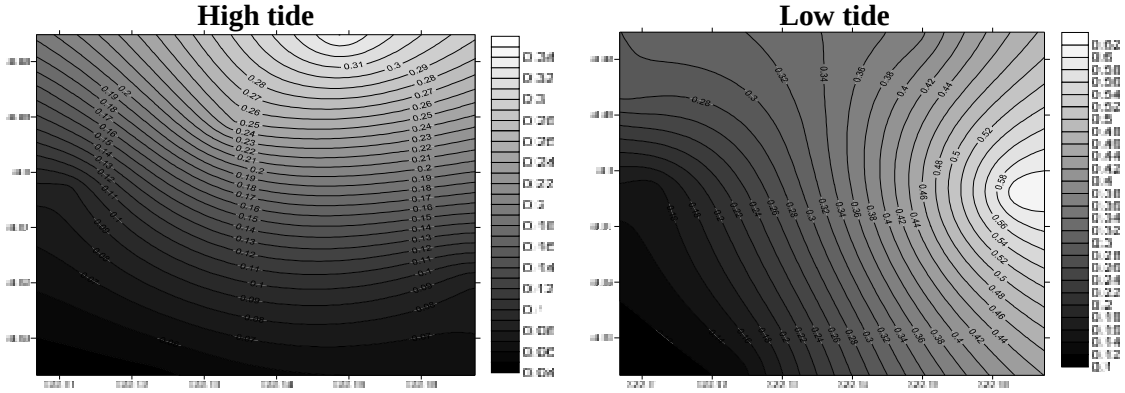


Figure 9. Spatial variation of ammonium in the fluvial-estuarine system of Lanowulu and Roraya River.

The principal components analysis (PCA) was applied in the data matrix of water quality parameters. The factorial axes were calculated based on Pearson's r correlation matrix among the variables (Figure 11).

Principal component analysis (PCA) is used to extract key factors. The component loading is a linear combination for each major component, and they express the correlation between the original variable and the newly formed component. The component loading is used to determine the relative importance of the variable compared to the other variables on the main component. An eigenvalue greater

than 1 is used to determine the number of factors. The first two main components have an eigenvalue greater than 1 and explain about 92.73% of the total variance in the original dataset for high tide. For low tide, the first 2 main components have an eigenvalue greater than 1 and explain about 84.24% of the total variance in the original dataset (Figure 11). During high tide, Factor 1 (F1) describes 57.00% of the total variance, indicating strong positive loading for temperature, turbidity, dissolved oxygen, chlorophyll-a, nitrite, nitrate, ammonium, phosphate but strong negative loading for salinity . This difference may be due to physical-chemical factors between parameters and freshwater input at the estuary. Factor 2 (F2) describes 75.73% of the total variance and has strong positive loading for temperature, salinity, dissolved oxygen, nitrate, ammonium, phosphate but strong negative loading for turbidity, chlorophyll-a, nitrite. This difference may be due to the intrusion of seawater at the mouth of the river and a reflection of the biological interactions between parameters. At low tide, Factor 1 (F1) describes 69.22% of the total variant and has a strong positive loading for temperature, turbidity, dissolved oxygen, chlorophyll-a, nitrite, nitrate, ammonium, phosphate but strong negative loading for salinity. These results can be attributed to the inclusion of fresh water at the mouth of the river. Factor 2 (F2) describes 15.02% of the total variance and has strong positive loading for chlorophyll-a, nitrite, nitrate, ammonium but strong negative loading for temperature, salinity, turbidity, dissolved oxygen, phosphate. This result may be due to the large number of freshwater inputs originating from the mainland and carrying nutrients to the estuary. It was also suggested that rapid conversion of mangrove to brackish pond at the mouth of Roraya River, greatly affected the quality of water particularly in increasing temperature, DO, turbidity and nutrients concentration. Some anthropogenic activities with the large potential impacts, such as agricultural development was concentrated primarily on the banks of the Roraya river estuary.

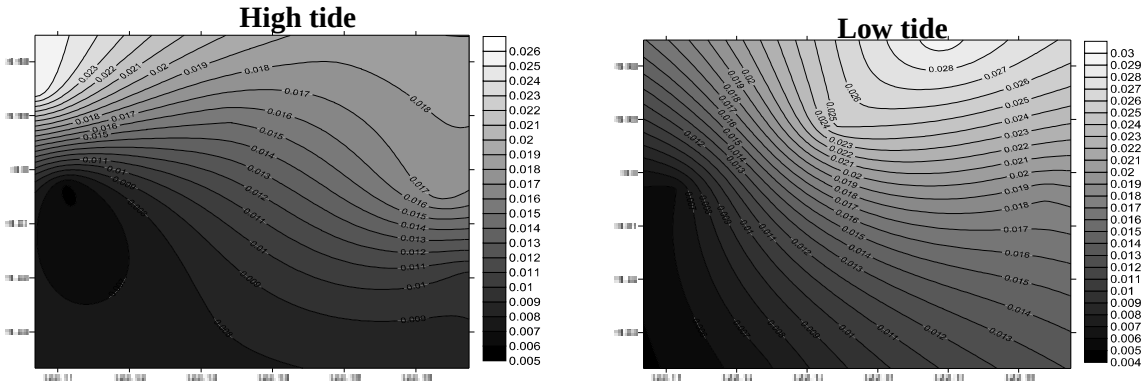


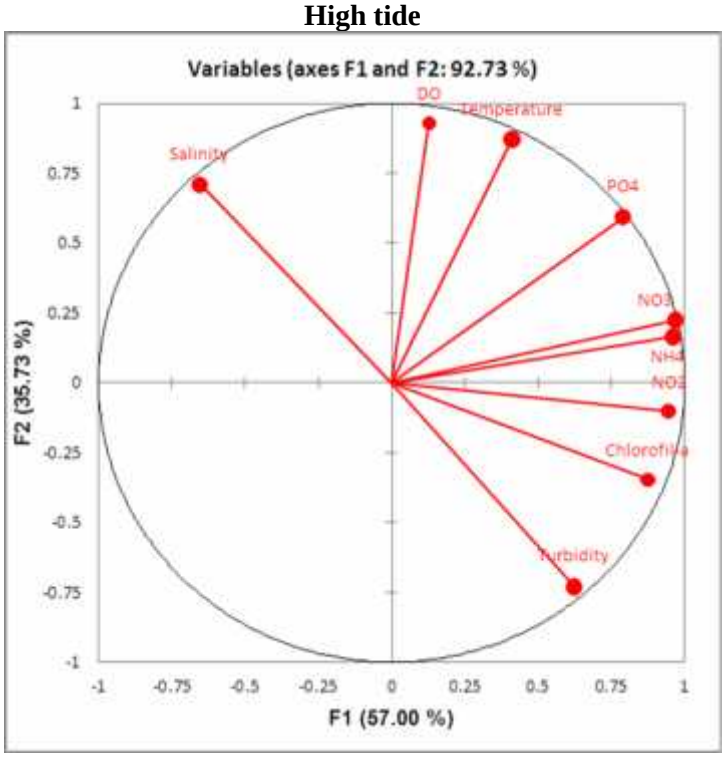
Figure 10. Spatial variation of phospate in the fluvial-estuarine system of Lanowulu and Roraya river.

According to Pejman *et al*. (2009), water quality parameters which showed a strong correlation coefficient (> 75%), are considered as significant parameters for water quality monitoring. Important water quality parameters that should be used to measure spatial variation in Lanowulu and Roraya estuaries are listed in Table 2. Temperature, salinity, turbidity, chlorophyll-a, DO, NO_2, PO_4 were the most significant parameters that determine water quality in the estuary of Lanowulu and Roraya River. The patterns of physical concentration (temperature, salinity, turbidity) were the effects of anthropogenic impacts and erosion around the estuary. The pattern of biochemical concentrations (chlorophyll-a, DO, NO_2 and PO_4) as a result of pollution sources could be attributed to domestic wastewater discharged from upstream community settlements, whereas nonpoint pollutant sources entered the estuary from farming and livestock (Madramootoo *et al*. 1997; Kaniz *et al*. 2012).

Table 2. Critical water quality parameters in the Lanowulu dan Roraya river estuary.

Spatial	Positively influenced parameters	Negatively influenced parameters
High tide	Temperature, DO, NO_3, NH_4, PO_4	Salinity, Turbidity, Chlorofil-a, NO_2
Low tide	Chlorofil-a, NO_2, NO_3, NH_4	Temperature, Salinity, Turbidity, DO, PO_4

High tide



Low tide

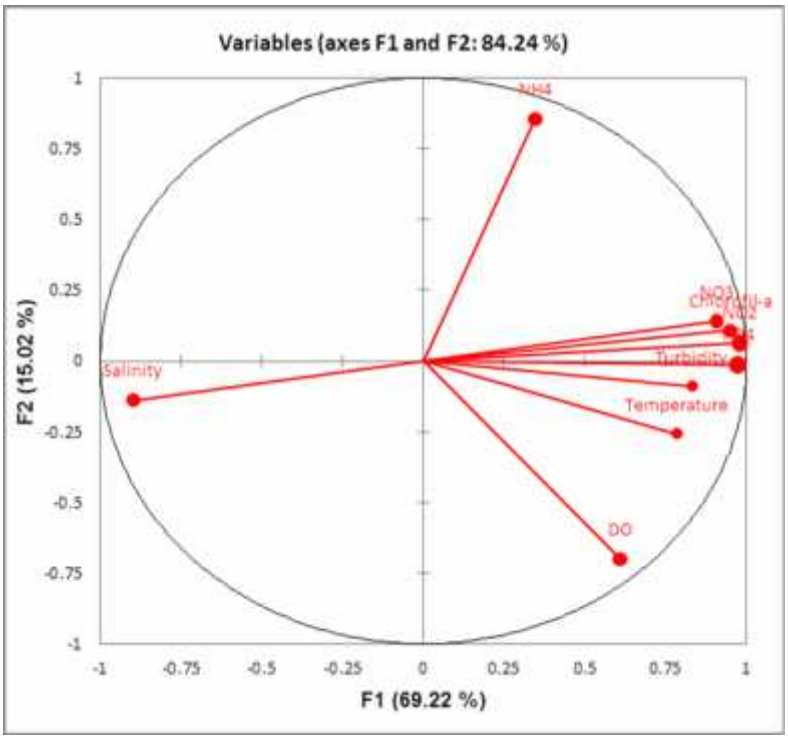


Figure 11. Plane formed by axes of the PCA carried out on the spatial averages, showing the variables (mode R)

Spatial management of estuarine water quality

Spatial management for an estuarine area describes what is to be protected and the level of protection needed. They need to be developed in a way that they can become key objectives for achievement through management plans and other regulatory tools and they should be related to environmental parameters that can be measured. Spatial management of estuarine water quality need to reflect the specific problems and threats, the desired levels of protection for coastal ecosystems and the attributes of the resources that are to be protected or the beneficial use. Management goals often

encompass a dynamic approach, recognizing that a series of progressive targets across time may be required and that these would be addressed through implementation of strategies aimed to sequentially attain higher environmental quality targets and metrics for water quality.

The setting of management goals for a defined area requires consideration of the array of marine and coastal resources and water characteristics, biodiversity and biological processes, the socio-economic status and potential for the area, the desires of stakeholders and national resource and water quality policies. Determination of water quality issues and objectives are part of the overall process of determining management goals. This approach presumes the need for water quality monitoring as a vital part of assessing the performance and effectiveness of the overall management strategy and actions in the attainment of the management goals (which may including goals of amelioration or diminution of pollution as opposed to goals of maintenance of existing environmental and water quality status).

In general, the spatial management of the estuaries in RAWNP particularly the estuary of the Roraya River should reflect the issues and actions that need to be taken to address pressures on water quality from catchment areas, anthropogenic activities and inputs of marine materials including natural and human pollutants and extraction water and resources. Cross-border issues need to be recognized and considered in the development of management goals and water quality targets, particularly those related to material transport and flux within the domains of the atmosphere and oceans. Here, ecosystem-based management is urgently needed to restore the river mouth, especially at the Roraya estuary.

Conclusion

Physic-chemical parameters showed a spatial water quality changes in the Lanowulu and Roraya estuaries. Concentrations of temperature, turbidity, DO, chlorophyll-a, nitrate, nitrite, and ammonia increased at stations 4, 5, 6 and 7 in the Roraya estuary, indicated the effect of nutrient inputs from the river flow and mangrove conversion to fish ponds as well as mining, agriculture and household activities around the Roraya River. Furthermore, the results of statistical analysis showed the evidence of spatial variation on observed water quality parameters and strong correlations between those parameters. Correlation and factor analysis confirmed that temperature, salinity, turbidity, chlorofil-a, DO, NO_2, PO_4 served as critical parameters of Roraya estuarine water quality. Spatial management of estuarine water quality in the RAWN Park areas is need to be done within ecosystem-based approaches.

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The Study of Forest Functions in the Posalu Watershed to Water Potensial and Availability of Pelagic Fish Resources in the Wangi-Wangi Island of Wakatobi Regency

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Abstract

Wangi - Wangi District is the capital region of Wakatobi Regency with a dense population and dynamic and intensive land use for the fulfillment of development needs. Thus, the use of forest land is essential in maintaining the hydrological system and the availability of water within its watershed. Increasing the potency of clean water is deemed necessary to do with the effort to restore the function of forest to balance the ecosystem. Therefore, a research study was conducted. There are two main objectives in this study. The first objective is to analyze the function and role of forest in Posalu micro-Watershed to water potential through estimation of groundwater potency for daily need consumption of community in Wangi – Wangi. The second is to determine the availability of pelagic fish in the Wangi-Wangi Island.The research used survey method ofthe forest area that has decided as observation area. The results showed the forest area in Posalu Watershed Wangi – Wangi District has been damage because of cut down forest (illegal logging) and land use change which were resulted in the reduction of forest area from 269.2 ha (13.1%) in the year of 2009 to 155,6 ha (7,6 %) in 2016 particularly in theupstream of Posalu watershed. In addition, based on quantitative criteriagroundwater potentials were low to medium level (<0.2 l/s and 2.0 l/s - 10 l/s). Then the decreased forest area affects the loss a number of pelagic fish in the Wanci, Mola and Numana Lagoons. Multiple fish population are decreased such as Bali sardinella (*Sardinella lemuru)*, yellow stripescad (*Selaroides leptolepis*), short mackerel (*Rastelliger* spp), rainbow runner (*Elagatis bipinnulata*) and Largeheadhairtai (*Trichiurus lepturus*).

Keywords: Watershed, land use change, forest, waterpotential, lagoon, pelagic fish

Introduction

Wangi-Wangi Island is a small island with a dense population. It has a dynamic and an intensive land use for the fulfillment of development needs. Utilization of forest land is very important in hydrological and air behavior systems within the watershed or small islands (Alwi and Marwah 2011). Water Resources is one of the solutions in the development plan of small islands (Sumawijaya, Suherman, 2005). Forests are one of the buffer zones and ecological balancers that play an important role in the balance of watershed ecosystems. Indonesia is a country which has a high biodiversity of tropical forests with a forest area of 95,628,800 ha (FWI, 2001). Forest area needs to be ascertained at least 30% of land area (30% of watershed area) from each region so that its function and role as a buffer and other functions can be optimal (Spatial Planning Act, 2007). Human activities by encroaching forests or converting the land use may lead to the damage of hydrological cycle causing disruption of the hydrological cycle itself characterized by the lack of water from the source (e.g. wells and river discharge) and an indicator of damage to forest ecosystems and watersheds.

The Posalumicro watershed of 2,056 ha on Wangi-Wangi island which is the capital of Wakatobi Regency has a population of 43,671 people (BPS, 2003) with a land area of 44,800 ha. In this area, there is primary forest area of 4,639 ha (10.35%) and secondary forest is 997 ha (2.22%) ofthe Wangi-Wangi land area (Biphut, 2004). The secondary forest is in the micro-watershed of Posalu covering 431.5 ha (21%) of the watershed area in 2005 and 269.2 ha (13.1%) in 2009. Decreased forest area in the watershed was caused by increased development activities, public facilities etc. It led to an increase in the need for clean water for household, agriculture, industry, tourism, and other needs.

Forest area with dense vegetation provide an important role in the hydrological cycle. Together with local geological factors, it forms a recharge area which provides flow in the soil (interflow) to the river body and/or into the ground (base flow) into water reserves for the surrounding area. This is one of the roles of forests as water providers, water regulators, and buffer zones (Alwi, 2011 *et al*.). The forest is a water regulator because the leaves are dense to keep rainwater which fell indirectly to the soil, so there

is no mud causing erosion or landslides, rooting trees absorb and rainwater infiltrated then infiltrated into the ground partly form the flow of interflow and part into groundwater (base flow or groundwater) and at a certain place can come out as a spring. Forests also serve to prevent floods and drought, maintaining soil fertility in both forest areas and areas around the forest so that people have to maintain the sustainability of the forest area (Hardjowigeno and Widiatmaka, 2001). In addition, forest biomass affects soils in regulating groundwater supplies and can improve soil structure through the humification process (Junus, 1986). In general, forest lands tend to have high infiltration rates due to litter deposits on the forest floor, root penetration into the soil, higher soil organism activities (such as worms) and rarely freezing temperatures (Seyhan, 1995).

Groundwater is water that fills the soil pores or rock gaps, which after rainwater will be infiltrated downward through the aeration zone. The amount of water circulating in the soil or retained by the capillary forces in the upper layers of the aeration zone is known as the soil moisture (Linsley, 1990). Groundwater comes from infiltrated precipitation into the soil and unconsolidated gravels and large spaces between rock shards (Lee 1990). Groundwater is the largest source of water on the planet Earth, covering approximately 10.5 million km3 (30%) of total freshwater obtained from open wells, wells, springs, or horizontal wells. Groundwater is water that occupies cavities in a geologic layer or rock. The soil layer located below the groundwater surface is called the saturated zone, while the area is not saturated until the soil surface is called the unsaturated zone (Soemarto, 1986). Soils in the catchment areas that groundwater filling from rainwater entering the free aquifer zone will result in higher groundwater levels (Asdak, 2007).

Implementation of a wellbore technology using pumps and without engine pumps in meeting the need for water often creates serious problems that can reduce the availability of groundwater to a much deeper layer. Increasing the potency of clean water is considered necessary to restore the function of forest to balance the ecosystem especially the hydrological cycle in the watershed. It may increase the volume and groundwater availability or the recharge area.

The purpose of this study is to study the role of forest to the potential of groundwater for the consumptive needs of the community in Wangi-Wangi District and to determine its effect on the availability of pelagic fish in Wangi-Wangi Lagoon.

Materials and Methods

This research was conducted in Wakatobi Regency from August to December 20016 and is a continuation of the results of research in 2006. Analysis of soil and water samples conducted in Soil Science Laboratory Faculty of Agriculture and Laboratory PPLH IPB. The materials used in this study include 1: 50,000 scale of worksheet maps, 1: 50,000 scale of earth maps, 1: 250.000 land rePPProt system, BPN administration map, hydrogeological scale 1: 250,000, rainfall data of 10 years period, soil samples, water samples, water preservatives (H_2SO_4), bottles, plastic bags, labels, and chemicals for analyzing samples at the Laboratory. The tools used notebook computer book, ArcGIS 10.3 and Microsoft Office Excel software, machetes, hoe, GPS, pH meter, permeameter, roller meter, stationery and digital camera.

Data were obtained through primary and secondary data. Primary data were obtained from the results of air portrait interpellation, field observations / measurements including: Analysis of forest vegetation (density and criticality of the area), groundwater in quantity (well depth, well diameter, well water depth and groundwater level) and quality (TSS and pH), soil texture and infiltration rate. The secondary data were data that came from the documentation obtained from related institutions such as Earth map scale 1: 50.000, Land system RePPProt scale 1: 250.000, BPN Administration map, Hydrogeology scale 1: 250.000, the last 10-year rainfall data, etc.

Survey method was used in this study by exploring the forest areas that have been designated as observation sites. The location of the observation is determined purposively with consideration: the forest area is a catchment area in the Wangi – Wangi island. Field observations for water sources were conducted using a transect method adjusted to the field conditions and obtained sampling points at 0.25 km (W1), 1.25 km (W2), 2.0 km (W3), 3, 0 km (W4), and 4.2 km (W5) from the beach. Sampling of water, soil and vegetation observation was done as follows: 1) predicted water potential at water sampling points based on Hydrogeology map and measurement of well depth, water level, groundwater level and well diameter; 2) conducted three stages of water sampling at each observation point, i.e.: Stage I, sampling water at the bottom of the well and in the spring, Stage II, sampling water at well depth in a mid- water level, and stage III, sampling surfacewater of well water. Thereafter, the water samples of

each stages were inserted into the bottle and preserved to prevent contamination and ensure the purity of the sample; 3) soil sampling was conducted around wells, where water sampling took place. Soil sampling was carried out at a depth of 0 - 30 cm and or 30 - 60 cm for the determination of the texture in a manner determined in the field and Laboratory; 4) observed the forest vegetation (density), made plot size 20 m x 20 m for tree level, 10 m x 10 m for pole, 4 m x 4 m for stakes and seedlings. The plot was randomly assigned to 3 plots. Further data on pelagic fish availability were observed in three ecosystems which were Wanci, Mola and Numana lagoons as well as interviewingthe fishermen in the three areas.

For the water analysis, pH calculations were obtained from a pH meter and the determination of soil texture using the pipette method. Similarly, the analysis of sea water samples was the measurement of TSS, salinity (salinity) and sea water temperature.

Results and Discussion

Forest Vegetation

Field observations indicated that based on their function the forest in the Posalu micro-watershed area of 431.5 ha (21%) were classified as a protected forest and limited production forest of 206.02 ha (10.0%) and 225.5 ha (11%) respectively. The density level of protected forest vegetation in Wangi-Wangi district in 2006 and 2016 is presented in Table 1.

Table 1. The levels of vegetation density of protected forest in Posalu watershed

Structure of Vegetation	Average density (tree/ha)		Relative density (%)	
	Year of 2006	Year of 2016	Year of 2006	Year of 2016
Seedlings	2.214	2.114	36,8	37,2
Pole-stage trees	2.247	2.147	37,3	37,8
Pillar-stage trees	1.081	1.062	17,9	18,8
Trees	481	354	8,0	6,2
Total	**6.023**	**5.677**	**100,0**	**100,0**

Table 1 shows that the density of tree as one of vegetation structures in the protected forest is very low at 481 trees/ha^{-1} (8.0%) in 2006 and 354 trees/ha^{-1} (6.2%) in 2016. It means the forest vegetation has a low ability to withstand and absorbs rainfall from year to year, so the role of a forest as a regulator of the water system is also very low. This condition is closely related to the critical level of forest area. Lee (1990) pointed out that the disruption to the forest ecosystem; changes in use for tourism, settlement, agriculture and even timber harvesting or looting greatly affect the water quantity and quality. Changes in the use of forest land for agriculture or other upstream watersheds will affect the waterflow in the downstream areas (Alwi, 2016). Further damage in the upstream will cause flooding, erosion, sedimentation, and degradation of water quality downstream of the watershed (Sinukaban, 2008).

The Critical Level of Forest Area

The critical level of protected forest areas in Posalu watershed in 2006 is presented in Table 2.

Table 2. The critical level of Protected Forest Area at Wangi-Wangi District from 2006 to 2016 (Director General Decree-RLPS N0, 167 / V-SET / 2004)

No.	Valuing factors	Class categories	Score	Weight	Score x Weight
1.	Land cover	Bad	2	50	100
2.	Downhill	Very steep	1	20	20
3.	Erosion	Very bad	3	20	60
4.	Management	Bad	1	10	10
Total					**190**

Criteria of the critical level of forest area (181 – 270) = critical

Table 2 shows that the critical level of protected forest area in Posalu watershed in Wangi-Wangi District is classified as critical (score x weight) = 190 (criteria of SK Dirjen-RLPS No. 167 / V-SET-2004, i.e. value (score x weight) = 181 - 270 pertained critically).

Forest Vegetation Cover

The survey results show that the forest in the Wangi-Wangi Posalu watershed is about 269.2 ha (13.1%) consisting of 143.9 ha (7%) of limited production forest in Wungka village with various vegetations such as Bitti (*Vitex cofassus)*, Bayam (*Amaranthus* spp) and saffron (*Crocus sativus)*, and 125.4 ha (6.1%) of protected forest in Tindoi village with vegetations such as *Canarium*, *livistona*, Bitti, *Ficus* spp and other local woods and seedlings are 285.8 ha (13.9%), Mixed Garden 1,187.6 ha (57.8%) and Settlement 313.4 ha (15.2%) (Table 3)

Table 3. Types of land use in the Posalu Watershed in Wangi-Wangi District 2006-2016

No.	Landuse	Area (ha)		Percentage (%)		Δ (%)/10 years
		Year of 2006	Year of 2016	Year of 2006	Year of 2016	2006-2016
1	Secondary forest	269,2	155,6	13,1	7,6	-5,5
2	Seedling	285,8	255,8	13,9	12,4	-1,5
3	Mixed garden	1.187,6	1.297,6	57,8	63,1	5,3
4	Settlement	313,4	347,0	15,2	16,7	1,7
	Total	**2.056,0**	**2.056,0**	**100,0**	**100,0**	

Sources: field surveydata, 2009& 2016, Information: Δ = shifting area

The secondary forest area in Posalu watershed was decreased from 269.2 ha (13.1%) in 2006 to 155.6 ha (7.6%) in 2016, with 5.5% (<30% area of watershed) of area reduction (Table 3). According to RI Law no.26 in 2007 on Spatial Structuring and RI Law. 7 in 2004 on Water Resources states that the area of the watershed is at least 30% of the watershed area. In addition, the forest has a low density as a cover vegetation for lowland. Then it is classified as a critical forest with score of 240 (criteria SK Dirjen-RLPS No. 167 / V-SET-2004, i.e. value (weight x score) = 181 - 270 pertained critically) Posalu watershed (Table 4).

Table 4. The result of vegetation survey in Posalu watershed in Wangi-Wangi District

No	Criteria (% of weight)	Class	Description	Score	Information	Score
1.	Land cover: 50	Bad	21- 40 %	3	Based on canopy cover %	150
2.	Slope: 20	Very steep	> 40 %	1		20
3.	Erosion: 20	Very bad	Soil (deep solum) > 75 % top soil loss Soil (superficial soil), 50-75 % top soilloss	3		60
4.	Management: 10	Bad	-	1	there is no regional boundary	10
			Total			**240**
The critical level of the area			181- 270 = Critical			

Vegetation density in the Posalu watershed were classified into three observations of vegetation diversity which are: seedlings, pole-stage plants, pillar-stage plants, and trees (Table 5). Furthermore, based on Table 4 and Table 5, the results indicate that the low level of vegetation as a land cover (50% weight and bad class), very steep slopes, heavy erosion (very bad) and poor management (bad). Hence, the forest vegetation area is classified as critical area (scoring 270) due to the area of protected forest is not balanced with the area of forest in the Posalu watershed.

Table 5. The result of vegetation survey in Posalu watershed in Wangi-Wangi District

Observation	*Species*	*Density (individual ha^{-1})*	*Relative density (%)*	*Frequency (%)*
I	*Seedling*	2,750	33.6	100
	Pole	4,250	52.0	100
	Pillar	900	11.0	100
	Tree	275	3.4	100
II	*Seedling*	1,900	37.6	100
	Pole	1,400	27.7	100
	Pillar	1,050	20.8	100
	Tree	700	13.9	100
III	*Seedling*	2,325	44.7	100
	Pole	1,125	21.3	100
	Pillar	1,325	25.1	100
	Tree	500	9.5	100

Source: Field survey data, 2016

Groundwater Condition

The results of groundwater measurements at 0.25, 1.25, 2, 3, and 4.2 km from the coast (W1, W2, W3, W4, and W5) downstream of Posalu watershed in 2006 are available on Table 6a and in 2016 on Table 6b.

Table 6a. Groundwater condition in the observed wells of Posalu Watershedin Wangi-Wangi District in 2006

Sample codes (Village/sub-district)	**Distance from the coastline (km)**	**Height of area (m.asl)**	**Well depth (m)**	**groundwater level (m)**	**water table depth (m)**	**Well diameter (m)**
W1(Wanci)	0,25	4	4,93	0,72	4,18	0,87
W2(Pongo)	1,25	6	8,98	0,87	7,18	1,14
W3(Pongo)	2,0	15	8,18	1,24	6,98	0,89
W4(Padajambu)	3,0	80	8,88	**1,15**	**7,73**	0,79
W5(Wakalara)	4,2	134	2,84	**1,36**	**1,48**	1,70

Source: Field survey data, 2006; information: asl = above sea level

The groundwater condition indicates that the depth of groundwater level at Wangi-Wangi has increased towards the mainland especially to the south, except at W5 wells which show the difference because W5 (Wakalara) is near forest area and has a different geological formation with other wells (Table 6a). The impact of secondary forest stands on the W5 sample. Itstrongly affects the groundwater level of 1.36 m and water table depth of1.48 m throughincreased infiltration capacity by rooting influence and geological formation as the recharge area, although it is located at an altitude of 134 m asl. and higher than other wells. Furthermore, Table 6b f shows W5 area hasa decrease ofwater level in which the groundwater level and water table depthshifted from 1.36 m and 1.48 m respectively in 2006 to 1.21 m and 1.63 m in 2016. In the W4 sample showsthe same pattern, a high decrease of water levelin which the groundwater level and water table depth shifted from 1.15 m and 7.73 m in 2006 respectively to 1.05 m and 7.83 m in 2016. Hence, there is a decrease of groundwater level about 10 cm in W4 area and 15 cm in W5 area.

Table 6b. Groundwater condition in the observed wells of Posalu Watershed in Wangi-Wangi District in 2016

Sample codes (Village/sub-district)	**Distance from the coastline (km)**	**Height of area (m.asl)**	**Well depth (m)**	**groundwater level (m)**	**Water table depth (m)**	**Well diameter (m)**
W1(Wanci)	0,25	4	4,93	0,72	4,18	0,87
W2(Pongo)	1,25	6	8,98	0,87	7,18	1,14
W3(Pongo)	2,0	15	8,18	1,24	6,98	0,89
W4(Padajambu)	3,0	80	8,88	**1,05**	**7,83**	0,79
W5(Wakalara)	4,2	134	2,84	**1,21**	**1,63**	1,70

Source: Field survey data, 2016; information: asl = above sea level

The decrease of groundwater level and increase of groundwater depth were caused by the decrease of forest area and subsequently resulted in a decrease of potential forest interception, soil infiltration capacity and increased water evaporation inPosalu watershed. This is consistent with the results of the

studies (Marwah and Alwi, 2014 and Alwi, 2016) which expressed a function of forest by increasing potential interception, infiltration capacity, erosion prevention and flood removal and conserving water resources within the watershed.

The groundwater potential of Posalu watershed in Wangi-Wangi district for its development was based on quantitative criteria (Table 7). The estimation of groundwater potential was calculated based on 1: 250,000 Hydrogeological Map in the Tukang Besi Archipelago, by estimating the water flow with aquifer parameters in two geological formations i.e. Qpl 2.0 - 10.0 l/s and Tmpl less than 2.0 l/s.

Table 7. The estimation of groundwater potential through quantitative criteria

Quantity	Class	Geological formation (Symbol)	Year 2006	Year 2016
Debit Optimum >10 l/s	High	-		
Debit Optimum = 2,0-10 l/s	Medium	Qpl	Medium level	
Debit Optimum < 2,0 l/s	Low	Tmpl		Low level

Source: Tirtomihardjo, 2003

Based on Table 7 in 2006, the estimation of groundwater potential shows the geological formation Qpl is in optimum discharge of 2.0 - 10.0 L/s with medium class, so that the development of forest area is needed to increase the optimum discharge of groundwater. It couldincrease thegroundwater potential in the watershed area. Furthermore, in 2016 the Tmpl has a debit of less than 2.0 L/s with low class especially in September and October each year, so that forest and watersheds management are urgently needed.

Soil Texture and Infiltration Rate

Based on the soil texture analysis showed the soil coming from the research site was sandyand clay with infiltration rate ranging from fast to medium (Table 8). The table shows that the rougher the soil texture the faster the rate of soil infiltration. It was stated by Arsyad (2010) and Chang (2002) that many factors determined infiltration rate such as organic matter, structure, size, and arrangement of large pores. The rougher the soil texture the bigger the pore so that the aircame out and replaced by water into the soil. The table also shows that the closer the coastline 0.25 km the rougher the texture of the soil and the faster the infiltration rate of 181.4 mm/h (W1). The further away from the coastline 4.2 km, the finer the soil texture and the less the rate infiltration 29.2 mm/h (W5).

Table 8. Infiltration rate measurements and soil texture

Sample codes	Distance from the coastline (km)	Soil texture		Infiltration rate		Criteria
		Year of 2006	Year of 2016	2006 (mm/h)	2016 (mm/h)	
W_1	0,25	Sandy	Sandy	181,4	181,5	Very fast
W_2	1,25	Sandy	Sandy	154,2	154,4	Very fast
W3	2,00	Sandy	Sandy	123,8	123,8	Very fast
W4	3,00	Sandy clay	Sandy clay	62,4	62,5	Fast
W5	4,20	Clay	Clay	29,2	29,3	Medium

Sources: field surveydata, 2009 & 2016

Forest Area, coastal waters, and Pelagic Fish in Laguna

The forest area has a strong linkage in determining the condition of the coastal ecosystem and the lagoon condition (Lagoon) which determines the availability of the pelagic fish or other fish in the lagoon area. Forests function as a water regulator in the watershed area by draining water to the shore and making the brackish water around the coast. Freshwater from the river can reduce the salinity around the river mouth because of the dilution process. The waters of Wangi-Wangi beach have a steep and sloping coastal morphology. The steep coast happens because of the abrasion of seawater that runs from time to time. While the sloping beach occurs because of a weak coastal abrasion that occurs similar to the formation of land.

The condition of coastal waters in Wangi-Wangi Lagoon (Laguna Wanci, Mola and Numana) is influenced by the sea water tide with the substrate of the seabed in the form of coarse sand, fine, silt-grayish white mud and overgrown with seagrass, coral, and splinter coral in the certain places. Such ecosystems are suitable for living and breeding of pelagic fish and other types of fish. This, as stated by Mustafa *et al*. (1995) that the tides of seawater influence the morphology of the sloping white sandy beaches. Generally, the substrate of the seabed is in the form of fine sand, smooth and smoother with the rise of the sea of dust 0.02 mμ. In addition,at a certain depth, there are seagrass and coral which are very suitable for ecosystems of various types of pelagic fish, demersal, lobsters, shrimps, and crabs.

Table 9. The relation between forest area and water quality in Wangi-Wangi Lagoon

No.	Lagoon	**Luas hutan (ha) di DAS Posalu dan Kualitas air laut di Laguna***					
		269,2			**155,6**		
		Year of 2006			**Year of 2016**		
		TSS (mg/l)	**salinity (ppt)**	**Temperature^{0}C**	**TSS (mg/l)**	**Salinity (ppt)**	**Temperature^{0}C**
1	Wanci	19,5	31	27	19,7	34,5	31
2	Mola	15,0	32	28	15	35,0	32
3	Numana	11,0	32	28	11,2	35,0	33
Based on the decree of Environmental Ministry No. 51 in 2004		≤ 20	33 – 34	28 – 30	≤ 20	33 – 34	28 – 30

Information: measurement conducted from August to October

Table 9 shows the results of water quality analysis in the Wanci, Mola and Numana lagoon in 2006. The total dissolved solids (TSS) are ranging from 11.0 mg/l - 19.5 mg/l, salinity $Cl^-$from 31 to 32 ppt and temperature from 27 to 28 ^{0}C which are categorized as suitable for pelagic fish habitat. While the 2016 measurements such as TSS are ranged from 11.2 mg/l - 19.7 mg/l, salinity $Cl^-$from 34 to 35 ppt and sea temperature from 30 to 31 ^{0}C which are in the category of non-standard quality for marine biota because salinity and sea water temperature has exceeded the required limit of salinity which is between 32 ppt and 33 ppt and temperature 26- 28 ^{0}C. However, the TSS is still suitable i.e. ≤ 20 mg/l (The decree of Environmental Ministryof RI No. 51 in 2004 on the Standard of Sea Water Quality). The high salinity and sea temperatures are caused by freshwater volumes coming from the Posalu watershed or underground river or base flow are getting smaller. This is due to the decrease of forest area, so that the function of receiving, storing, and flowing water is getting smaller. Furthermore, water reached the coast is also smaller. The smaller the freshwater reaches the coastal area (August - November),the higher salinity in the lagoondue to the small number of seawater dilution. Evaporation rate in that period is also high because of dryseason, so that it causes high salinity and temperatures.

There is a strong relation between forest area and pelagic fish population. Dense population of fish such as *Sardinella lemuru*, *Selaroidesleptolepis*, *Restrelinger*spp, *Elagatisbipinnulata* and *Trichiuruslepterus* were found in the Wanci, Mola and Numana Lagoons in the period of 1992 with a forest area of 1,109 ha (Table 10). Subsequently, the population declined to a moderate population inWanci and Numana Lagoon, and a smallpopulation in Mola Lagoon in 2006 with a forest area of 269.2 ha.

Table 10. The relation between forest area and pelagic fish in Wangi-Wangi Lagoon

No.	Laguna	**Forest area (ha) in Posalu watershed and presence frequency of Pelagic fish in Wangi-Wangi Lagoon**		
		Year of 1992*	**Year of 2006****	**Year of 2016****
		1.109	**269,2**	**155,6**
1	Wanci	Dense population	moderate population	Very small population***
2	Mola	Dense population	small population	Very small population***
3	Numana	Dense population	moderate population	Very small population***
Watershed area		2.056,0	2.056,0	2.056,0

Information: * Interview record with fishermen, ** field survey data, *** in the transition period of West season and east season (September – Oktober)

In 2016, the population became very small with a forest area of 155.6 ha and was only found in the rainy season (around December - May) in the three lagoons. The decline in pelagic fish populations from 1992 to 2016 was closely related to the decrease in forest cover in upstream and downstream areas of Posalu watershed. The decreasing number of forest areas declined freshwater volumes coming from poorly stored or preserved rainwater in the Posalu watershed and flowing from the downstream as Surfaces flow, subsurface flows and base flows into the sea. The decrease of freshwater volumes in coastal waters of Wangi-Wangi caused increasing salinity and water temperatures beyond the tolerance limit of suitable ecosystem for various pelagic fish.Hence, the Wanci, Mola, and Numana lagoons become the unsuitable ecosystems for the pelagic fish.

That is relevant to Dahuri study (2003) which stated salinity may be a limiting factor for certain species with high adaptation mechanism. If the availability of freshwater supply is not sufficient it will cause the salt content in soil and water reaching extreme conditions. As a result, the viability of multiple mangrove ecosystem species and other coastal species will be threatened. In addition, reduced nutrition on freshwater from river flow (surface run off or base flow) can affect migration of pelagic fish, especially those are migrating in groups (schooling) toward suitable habitats during the dryseason.

In Wangi-Wangi island,multiple caves are found with freshwater flows on them. The freshwater flows into the sea and spills on the shores of tens or even hundreds at a distance of 0 - 300 m from the shoreline. Furthermore, the water is also found out of the three mentioned lagoons and the cliff walls at a depth of 3 - 10 m above sea level. The areas aremagnificently beautiful withnumerous colorful coral. Various types of fish are living very comfortable because the area has a suitable temperature due to the compound between freshwater from land and seawater. It causes Wakatobi particularly Wangi-Wangi district to be a center of the world's attention for its marine ecotourism.

Conclusions

Forest destruction and reduced forest area from 1992 to 2016 sequentially from 1,106 ha to 155.6 ha in Posalu Watershed in Wangi-Wangi District affected the water system and decreased the water quantity from 2.0 - 10 l/s to <2,0 l/s with a decrease of groundwater level about 10 cm in W4 area and 15 cm in W5 area; Measured groundwater potentials based on quantitative criteria are low to medium level(<0.2 l/s and 2.0 l/s - 10 l/s); Damage and decline in forest cover in the Posalu (upstream-downstream) watershed in 1992, 2006 and 2016 resulted in a decrease of freshwater volume compounded by seawater causing the increase of coastal water salinity and temperature; The decline of forest cover in Posalu watershed also caused a dramatic decrease in pelagic fish populations from dense populations to very less populations particularly speciesof *Sardinela lemuru*, *Selaroides leptolepis*, *Restrelinger* spp, *Elagatis bipinnulata* and *Trichiurus lepturus* at Wanci, Mola and Numana Lagoon.

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Length Frequency, Cohort and Growth of Beloso Fish (*Glossogobius* sp) in the Waters of Lake Tempe South Sulawesi

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Abstract

Beloso Fish (*Glossogobius* sp) is one of the native fish in the Lake Tempe that has not been cultivated. The existence of these fish in the waters of the Lake Tempe is very important, ecologically and economically. However, the fish has been experiencing a decline in production and the size nowdays. The size of the Beloso fish commonly found today only ranges from 100 mm to 140 mm. Formely the fish size could reach 375 mm. The genetic diversity of the fish was very low. If this condition continues without proper management, the size and production of the Beloso fish will continue to decrease and will be threatened to extinction. This study was conducted in order to preserve this fish in the Lake Tempe and to provide basic information for cultivation of the Beloso fish cultivate. This study aims to determine the frequency distribution of the length, the cohort as well as the growth of the Beloso Fish. Total length frequency of the Beloso fish was collected from five locations in Tempe lake waters using fishing gear bubu step, a passive trap and timpo. Determination of the age group of Beloso fish was analyzed by Bhattacharya method and Infiniti length (L_∞) measurement using Fisat II program (version 1.2.2). The theoretical age of the Beloso fish when the fish length is equal to zero (t_o) was determined using empirical equation of Pauly (1983). Growth curve models were created by applying the growth parameters into the formula Von Bertalanffy growth equation. Total length size distribution of the Beloso fish caught during the study was 82 mm to 231 mm. The cohort obtained at each sampling locations consisted of three cohorts. Similarly, the combined population of the cohort and the cohort males consisted of three age groups, whereas the cohort females only consisted of two age groups. Infinity length (L∞) of the Beloso Fish was 325 mm, t_o was -0.1595 and the growth coefficient was 0.53

Keywords: Beloso Fish, Length Frequency, Cohort, Lake Tempe

Introduction

Beloso Fish is one of the fish species with high economic value and favoured by the people which has a special flavor and a distinctive thick flesh and a bit of bones. It consumes as fresh or dried form. The Beloso Fish (*Glossogobius* sp) is one of the native fish in Tempe Lake that has not been cultivated. The size of the Beloso fish that are commonly found currently only ranges from 100 mm to 140 mm.Formerly, the size of the fish could reach 375 mm (Tamsil, 2000). The genetic diversity of fish was very low (Hadijah, 2011 and Hadijah *et al*, 2014). If this condition is left unchecked, then the fish Beloso will decrease in size and production and will lead to the extinction..

Various community activities around the Lake Tempe potentially damage the Beloso fish habitat and other fish species which in turn led tothe reduction in the size of fish and decrease / loss of population and the diversity of fish in these waters (Nasution, *et al*, 1995 and Tamsil, 2000). Cultivation and introduction of other fish (*Cyprinus carpio* and *Tilapia*) to the waters of Tempe Lake pose a threat to the existence of the Beloso fish in the lake. This activity could cause significant pressure on the endemic/native species through predation and competition (Wijeyaratne and Perera 2001). Leyse *et al*. (2003) suggested that non-native fish species will cause a decline in the population of endemic species.

The intensive use of Beloso fish resources could threaten its sustainability. Therefore, the Beloso fish utilization need to be managed so that the fish can be used continuously. Information about length frequency distribution, age groups as well as the growth of Beloso fish in the waters of Tempe Lake will provide basic information for its management.

Materials and Methods

Study Sites

There were 5 sampling sites/stations of the Beloso Fish in the waters of Lake Tempe, South Sulawesi. Site 1 was in a fishing area in the central area of Lake Tempe (119°57 706' EL and 4° 6.674'

SL). Site 2 was in the area of water from the Bila river (119°57'19.47'EL and 4°3'56.22' SL). Site 3 was in the area of water from the River Walanae (120 ° 1.220 'EL and 4 ° 8097' SL). Site 4 was in the discharge of water into the River Cenranaee, (120° 1.678 'EL and 4° 8.118' SL). Site 5 was Batu-batu areas of Soppeng (119°55.168' EL and 4°7502' SL).

Fish Sampling

The samples were collected using gear bubu step, a passive trap and timpo (a type of fishing gear from bamboo, one end remains closed and the other end open). The amount of the fish caught was calculated and then measured the total length (from the tip of the mouth to the tail end of the last section)

Data Analysis

The length frequency distribution of the Beloso fish was determined by grouping the length frequency of the total length data obtained during the study. Determination of the cohort of Beloso fish was analyzed by Bhattacharya method and the Infinity length (L_∞) was measured using Fisat II program (version 1.2.2). The analysis of the theoretical age Beloso fish when the fish length is equal to zero (t_o) was determined using empirical equation developed by Pauly (1983). Growth model was estimated by Von Bertalanffy equation; using Fisat II program (version 1.2.2):

Results and Discussion

Length Frequency Distribution of Beloso Fish

The length frequency of Beloso fish caught during the study ranged from 82 - 231 mm (Figure 1). The Beloso fish populations structure in each location indicated that the fish were small with the middle value of the total length was 88 mm found in all sampling locations except in the Batu-batu location. A study done by Tamsil (2000) obtained a total length ranged from 43 to 375 mm. The largest size obtained in the present study was 231 mm which is much smaller than the size obtained by Tamsil (2000).

The Cohort of the Beloso Fish

The smallest Beloso fish obtained in this study was 82 mm found February, March and April. The existence of small-sized fish in a group showed that there was an addition of new individuals. The largest fish size was 231 mm found in July. The presence of the large fish in the waters indicated that these fish were able to survive in conditions of the water environment. The size distribution of the fish was varied indicating the relationship between the new additions to the waters and the fishing mortality.

Determination of the age group / size of fish Beloso in this study were analyzed by using the method of Bhattacharya. Beloso fish age group in each sampling sites can be seen in Figure 2. The average length of the first group (I), is between 116.63 mm to 132.69 mm and the average size of the fish captured at each location was within the size of the first group except in Walanae and Batu-batu River locations. The most numerous group caught falled within the size of the second group (II) with the average length of 150.58 and 165.29 mm. The group size of the fish mostly captured in this study was greater than the fish caught by Tamsil (2000), who obtained the group fish size between 100 mm to 119 mm. But the largest size group of fish in this study was much smaller in size (207.60 mm) compared to that obtained byTamsil (2000) with the largest group of fish size was 360 mm to 380 mm. The longest fish caught in this study was 231 mm (1 fish). Whereas Mamangkey (2010) reported that average length of the majority of the Butini fish (*Glossogobius matanensis*) caught was 28.08 cm and the least caught was 40.50 cm. This indicates that the length of the fish Beloso in the waters of Lake Tempe is now very small.

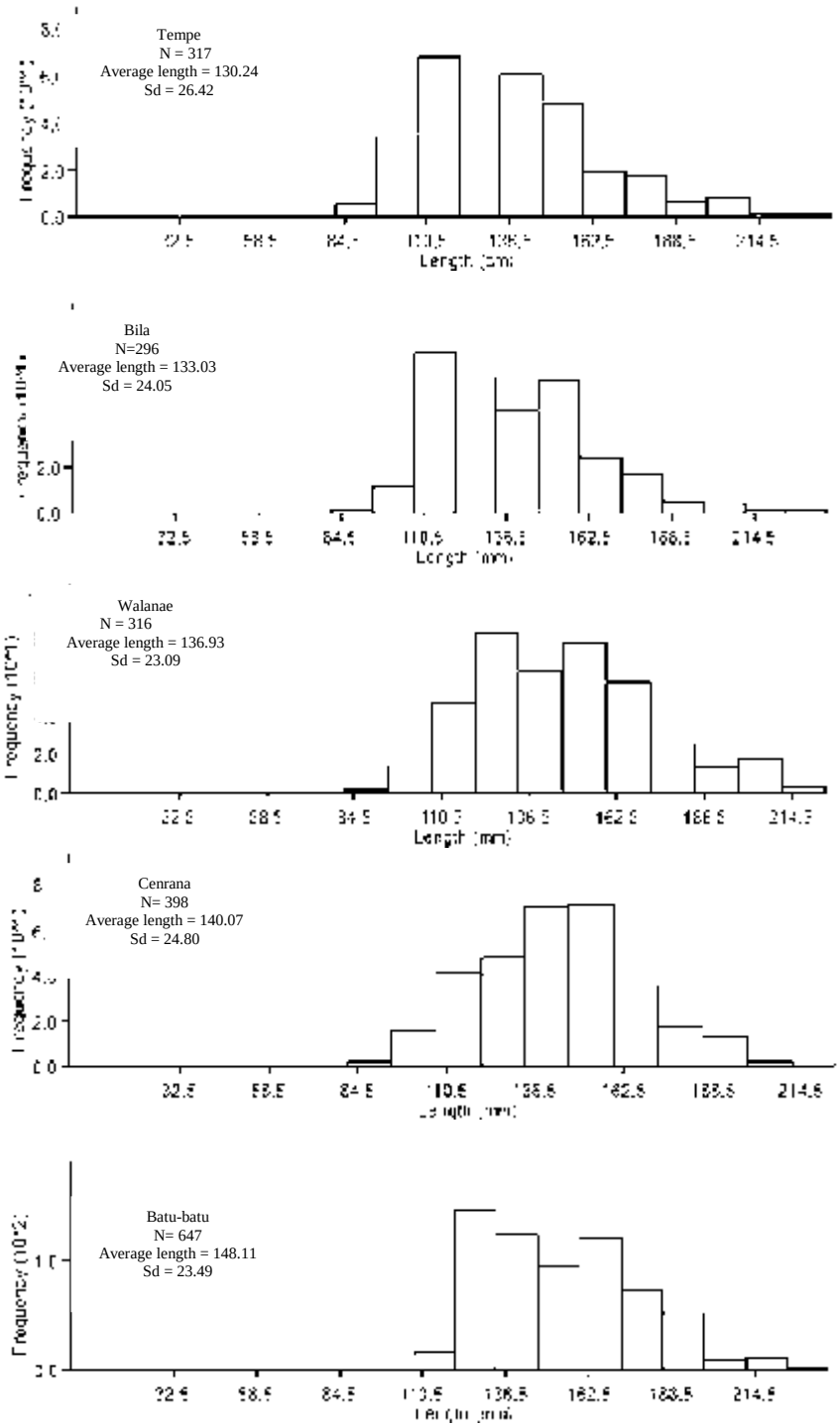

Figure 1. Length frequency distribution of the Beloso fish by location in Tempe Lake

In general, the cohorts of the Beloso fish were very low/small. The analysis showed that there are three (3) cohorts of the Beloso fish at each sampling location in the waters of Lake Tempe. The normal population has a range of cohorts between 5-7 (Mallawa, 1986) The majority of the age group caughtper month was mostly two cohorts. This indicates that the fish population in the waters of Lake Tempe Beloso is under pressure.

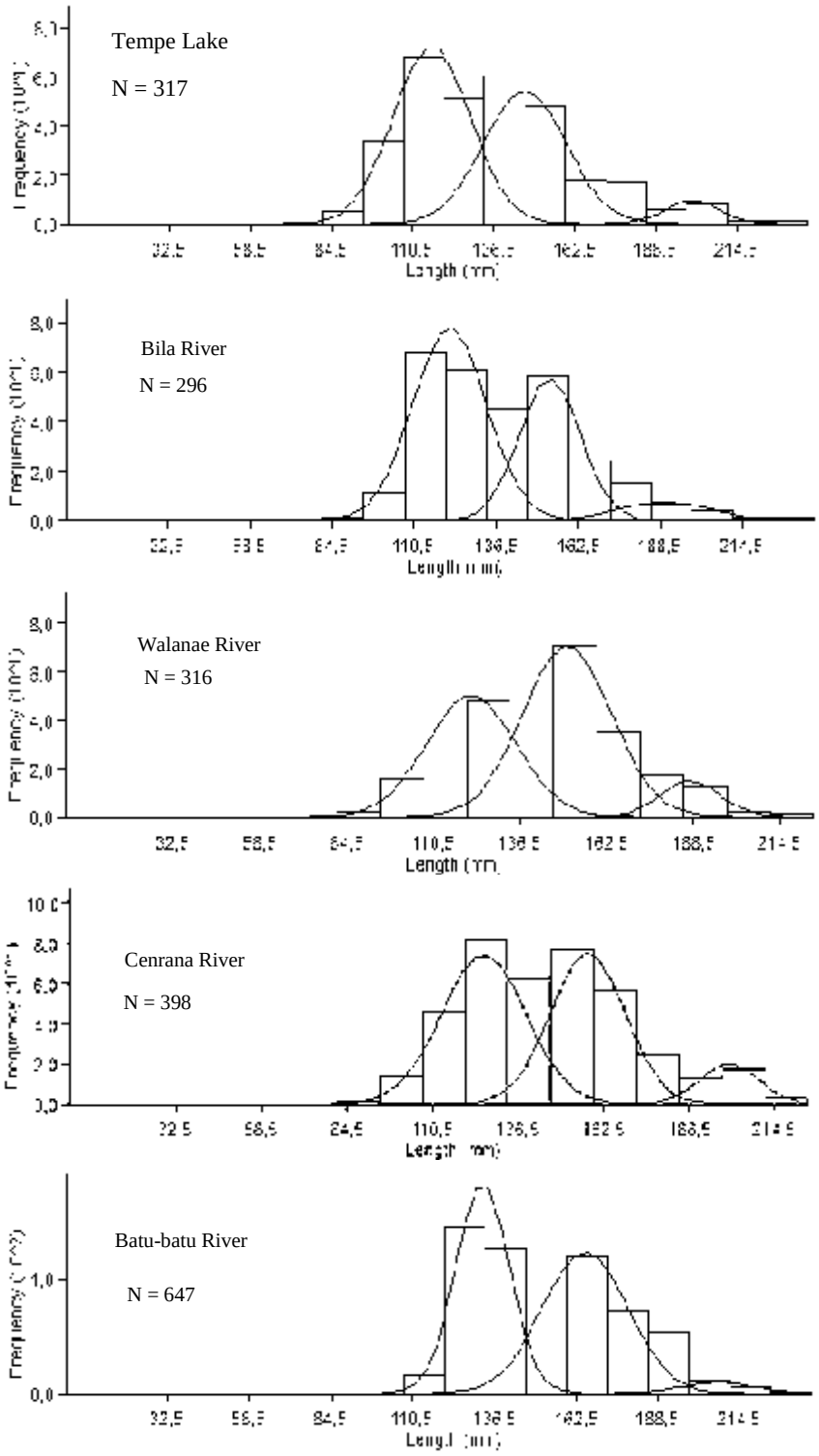

Figure 2. Cohort of Beloso Fish by location in Tempe Lake

The growth of Beloso Fish

Length infinity (L∞), Growth coefficient (K) and size at t_o at each sampling location can be seen in Table 1.

Table 1. Parameters of growth (fish Beloso) each study site location

Location	Invinity Length (L∞) (mm)	Growth coefficient (K)	t_o
Tempe Lake	303	0.68	-0.1255
Bila River	285	0.52	-0.1757
Walanae River	302	0.7	-0.1219

Table 1. (continued)

Cenrana River	290	0.6	-0.1447
Batu-batu River	292	0.72	-0.1195

The highest growth coefficient (K) (0.72/year) was obtained in the Batu-batu location and the lowest was in the Bila River (0.52/year). Higher growth coefficient in the Batu-batu location indicated that growth of the Beloso fish in that location was faster than other locations. Infinity length (L∞) obtained in this study was relatively much lower when compared to the invinity length (L∞) of the Butini fish (*G. matanensis*) (46.62 cm of total length) reported by Mamangkey (2010) and infinity length (L∞) (515.81 mm) obtained by Tamsil (2000). This study suggests that the size of the Beloso fish in the waters of the Tempe Lake is now very small.

Conclusion

The length size distribution of the Beloso fish was very small (82 to 231 mm) with three cohorts.The population of fish in the waters of Lake Tempe Beloso is under pressure. The the Infinity length (L∞) of the Beloso fish was 285-302 mm and the coeffisien growth was 0.52 - 0.72.

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Sustainability Blue Swimming Crab *Portunus Pelagicus* Fisheries Management Using Fish Capture Control Approach in Southeast Sulawesi Waters, Indonesia

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Abstract

Blue swimming crab (BSC = *Portunus pelagicus*) in this region was exploited since last 3 decades and just last 2 decades BSC fishery was to be commercial due to development of mini plants of crab meat processing in Buton (Central Buton), Muna (West Muna), South Konawe and Bombana. The mini plants process crab meat to be exported mainly to America, Europe, Japan and Singapore with premium price. This phenomenon stimulates BSC exploitation intensively using unselective crab pots, gillnets and mini trawls. It is possible that fishing gears used by fishermen are more than that of actual population. In the last 5 years, the evaluation results of BSC population status had indicated an over exploitation as shown by exploitation level (E) of > 0.5. It was supported by CPUE of 2 -3 kgs/trip, BSC carapace width of < 6 cm, small biomass of 10 – 20 ind/kg, spawning potential rasio of 13 - 14% and fishing ground moving further afield. This fact suggestes that the present fishing gears of crab pots and gillnets should be reduced and operated in the water depth of > 30 m, and crab pots should be equipped with vent size of 5,0 cm x 3,5 cm or using cover net of 3 inch mesh size in order those fishing gears catch only BSC of > 10 cm. To sustain recruitment to fihing ground that berried females should be prohibited to be caught. It is also needed to formulate closed seasons and closed areas for BSC exploitation.

Keywords: *Portunus pelagicus*, over-exploited, crab pots, gillnets

Introduction

BSC fishery in the present constitutes commercial fisheries which are found in the several Indo-Pacific regions such as in the entire of Australia coastal waters (except Tasmania and Victoria) (Queensland Government, 2010), Indonesia and Philippines. BSC fihery in Australia is not only as commercial fiherery which increased during the last 20 years (de Lestang, *et al*. 2003), but also as recreation fishery which is delighted by people (Kailola *et al*. 1993; Kangas, 2000; de Lastang *et al*. 2003). The BSC fishery in Indonesia is limited to fulfill local consumption and commercial.

In Southeast Sulawesi, BSC fishery had been exploited traditionally by fishermen since last 3 decades. In the past, BSC exploitation was to fulfill family consumption only, but around last decade BSC was to be commercial commodity with premium price when several exporters joined together in the Indonesia Blue Swimming Crab Managament built mini plants closed to fishing ground of BSC such as in Baubau, Lasongko Bay, West Muna, South Konawe, etc. This phenomenon positioned BSC resources having a huge contribution to social and economy of local community and local government.

The bussines chain of BSC fishery in Southeast Sulawesi has been making available of ± 3,500 fishermen labor and around 1,500 pickers. It is very helpful overcoming job availability problems of coastal community. The BSC production in 2005 was about 2,000 tons increasing to be about 4,000 tons in 2012 (La Sara *et al*., 2016a). It will continously increase following domestic and international consumen demand. It rises a new apprehensive about the BSC population sustainability due to BSC fisheries is exploited intensively by fishermen (La Sara *et al*., 2016a; 2016b).

High intensity of BSC exploitation in Southeast Sulawesi is mainly found in Tiworo Strait and Lasongko Bay namely about 16% of Indonesia BSC total production. It is quite similar with the BSC production of Lampung waters. The BSC production in other coastal waters such as in western and southern Sumatera were about 7% and 5%, respectively.

Collapsible crap pots and bottom gillnets are common fishing gears used by fishermen which have serious impact. High intensity exploitation are characterized by (1) the carapace width of BSC getting small (2 – 5 cm), (2) CPUE ranging 2 – 3 kg/trip (1 trip = 1 – 2 days) (La Sara, *et al*. 2014-2016; La Sara *et al*. 2016b), (3) fishing grounds moving further afield, (4) SPR of 13 – 14% (La Sara and Astuti, 2011, La Sara 2014; La Sara *et al*. 2014; 2016b; 2016c; 2016d), and (5) very rare and even already diaspeared in several coastal waters (La Sara *et al* 2014-2016, 2015; 2016a, 2016b; 2016c). The depletion of the

population is increasingly much higher because its habitat such as mangrove area, seagrass and coral reef have been experiencing damage which its natural functions as feeding ground and shelter for juvenile have disappeared (La Sara *et al*., 2016b). Similar condition had been found in Lampung waters and coastal waters of northern part of Java (southern part of Java sea).

Threatened in BSC population sustainability in those waters could give problems to the food chain and trophic level structure in the waters ecosystem. Anothers negative impact are social, economy and environment, such as loss job availability for fishermen and coastal community (pickers in the mini plants), decreasing fishermen income, loss of animal protein source, loss of local government revenue, giving new critical social problems (such as urbanisation), exploitation of mangrove forest and coral reefs, illegal fishing (using bom and cyanide) (La Sara *et al*., 2014 – 2016). People who loss their jobs and income source will cause low quality of human resources in those regions. Therefore, the problems in the BSC fisheries are not only impacted to the fishermen and local coastal community, but also impacted to local and national government, industries (mini plants and exporters of crab meat), and international consumen supply (USA, Europe, Japan, Singapore, etc). It was sugested using selective crab pot attached with escape vents in both sides (La Sara *et al*. 2016c). La Sara et al (2014 – 2016) formulated "management design of blue swimming crab (*Portunus pelagicus*) to sustain its population and to increase fishermen income in Southeast Sulawesi, "mapping fishing ground of blue swimming crab (*P. pelagicus*) in Tiworo Strait, Southeast Sulawesi (Muskita *et al*. 2015), and "sustainability blue swimming crab management using harvest control and knowledge of aquatic ecosystem" (La Sara *et al*. 2017a).

BSC Fishing Gears

Consumen demand of BSC is high enough, particularly from USA and Europe countries. Indonesia BSC production exported to USA reached 50% of total production, while BSC from Southeast Sulawesi contributed around 12%. Therefore, those high demand lead to high exploitation intensity using crab pots, bottom gillnets, mini trawls, and some fishermen using hand picking and fish line. The first and second fishing gears are stationary gears which common used by fishermen. Inside crab pot (Figure 1) is put with baits which are usually operated in relatively shallow coastal waters (< 5 m), while bottom gillnets (Figure 2) is operated in the deep waters of > 10 m parallel to coastal line. Mini trawl is a dynamic fishing gear and destructive due to the gear is hauled by a motor boath. This gear is usually operated in the water depth of > 10 m covering width area of coastal waters. All those fishing gears are unselective (La Sara *et al*. 2016b; 2016c; 2017b). There are fishermen are using fish line, but the numbers are very small. The data of fishing gears used by fishermen in Southeast Sulawesi had been reprted by USAID (2014) (Table 1).

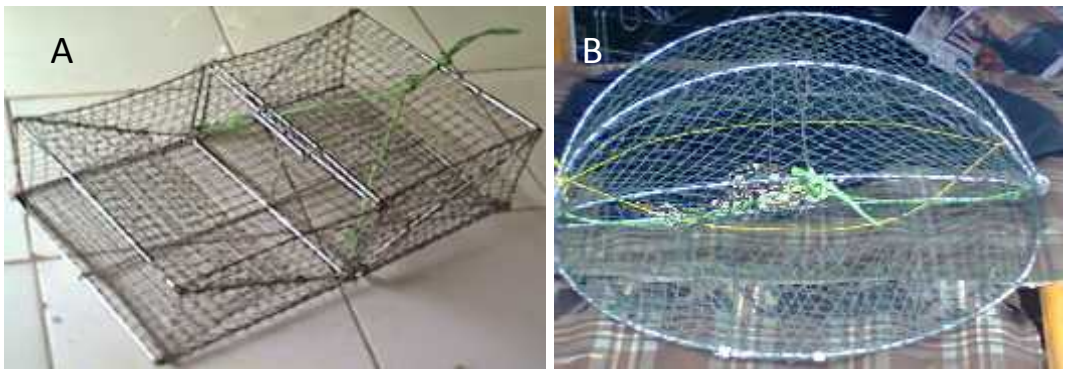

Figure 1. Collapsible Crab Pot Commonly Used by Fishermen in Southeast Sulawesi Waters (A. Rectangular Crab Pot; B. Circular Crab Pot)

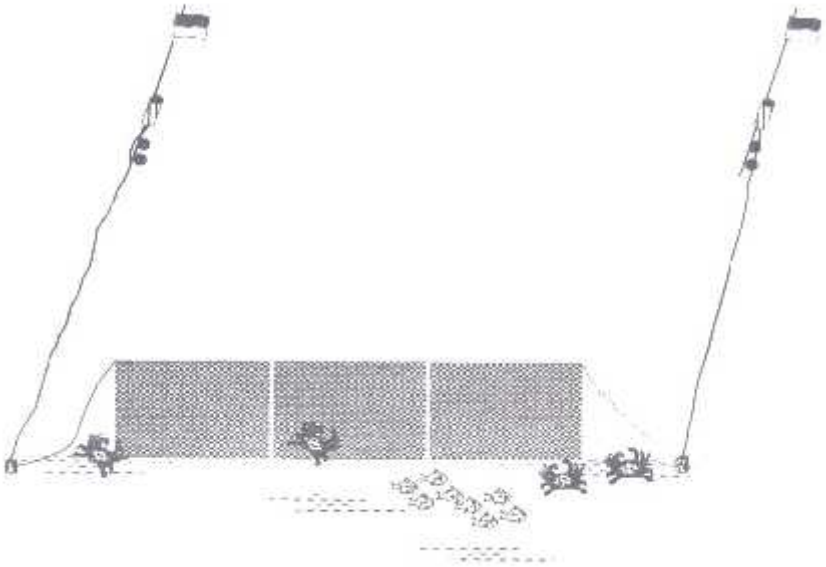

Figure 2. Bottom Gillnet Used by Fishermen Southeast Sulawesi

Table 1. Type of Fishing Gears and BSC Fishermen in Southeast Sulawesi Waters (USAID, 2014)

No.	Fishing gear	Water Depth Operated (m)	Total Fishermen	Fishermen Persentage (%)
1.	Fish line	2 – 5	280	3
2.	Bottom gillnet	> 5 – 30	1.250	46
3.	Collapsible crab pot	1 – 5	3.500	50
4.	Others	2 – 5	< 100	1

Boats used to catch BSC are without machine and boats with outer machine (< 1 GT). Those boats without machine in 2013 – 2014 are around 1,300 units, while those boath with outer machine are 975 units. There are boats of 100 units using machine (< 5 GT) operated by fishermen in the deep waters for bottom gillnet.

Efforts in Harvest Rule of BSC

When the BSC population goes down that the catch of fishermen may be predicted its number is also small. Its implication is the owners of mini plant of crab meat processing have to reduce its production and even several of them have to completely shutdown. It impacts to pickers and the fishermen loss their job and shift to very difficult others job opportunities. The effort of regulating fishing capture of BSC and protecting its habitat are facing big constraints particularly the data of BSC potential and its distribution are not available. To overcome those problems have to do some efforts particularly researches which support the sustainability of BSC regulation.

Minimum Legal Size (MLS) and Fishing Gear Selectivity

The first effort to be conducted is identifying the gonad growth according to its carapace width sizes of both sexes to find out what size of carapace width achieve the first gonad maturity. Our study showed that BSCs have spawned minimum once are BSCs with carapace width of ≥ 10 cm (La Sara *et al*., 2016c). This biological scientific reason is to be a base to constitute the MLS. Aside this scientific reason there are several economic reasons namely this MLS is the minimum size of "jumbo lump", the meat of each BSC is much bigger when attain higher carapace width, and the meat processing at mini plant is much faster and low cost for labor (La Sara, 2014; La Sara and Astuti, 2015; La Sara *et al*., 2016b).

The MLS of ≥ 10 cm is used to design a selective fishing gear for BSCs where carapace width smaller than the MLS (< 10 CM) will have opportunity to escape from the gears to the sea. The result showed that the collapsible pot equipped with escape vent of 3.5 cm X 5.0 cm in both sides was high percentage of BSC of > 10 cm caught (± 85% from total caught) (La Sara *et al*., 2016 – ecape vent). Prior to Indonesia, Philippines had decided MLS of carapace width of BSC of 10.16 cm. In Queensland,

Australia, the MLS of BSC allowed to be caught was 11,5 cm (Queensland Government, 2010), while in Vietnam stated MLS of BSC of 10 cm, but no law enforcement implementation yet (La Sara *et al*., 2016b; 2016c).

In 2015 – 2016, we had conducted a study to find out a selective fishing gear of BSC which much practical and easy to be operated by fishermen. There were four treatments of 1.5 inch, 2.0 inch, and 3.0 inch mesh size net that covering main frame of collapsible pot and the collapsible pot using escape vent (Heldawati, 2016; La Sara *et al*., 2016b). The result showed that BSC catches into collapsible crab pot using mesh size of 3.0 inch of covered net on main frame was much selective. The BSC retained in the crab pot was only 1.54%, while the BSC retained in the crab pot with escape vent was 9.29% (La Sara *et al*., 2016b).

Returning Berried Female

Socialization to all fishermen around Tiworo Strait and others in order not to catch berried females was continuously conducted since 2012. They have to be returned to the sea in order they have opportunity to spawn, minimum once along their life. This effort is objected to sustain its population and in accordance with the Regulation of the Minister of Marine Affairs and Fisheries No.1/2015 (La Sara and Astuti, 2015; La Sara *et al*., 2014 – 2016; La Sara *et al*., 2016b).

Commitment of APRI and the Government

In 2014 the local government officially established an organisation named "Data Management Committee of BSC" (La Sara *et al*., 2016b). There were studies had been conducted with the conclusion of MLS of BSC to be caught is ≥ 10 cm of carapace width (La Sara *et al* (2016c; 2016d). In February 2014, APRI had agreed and stated to implement to all its members and related mini plant processors that MLS of BSC is ≥ 10 cm (APRI, 2014). The agreement was signed by 12 members (exporters) of APRI. According to APRI that implementation of MLS of ≥ 10 cm carapace width actually has maintained: (1) the BSC population sustainability, (2) job opportunity for fishermen and pickers in the mini plants, and (3) marketing system (export) of BSC meat (La Sara *et al*., 2016b). The national government has been declared the Regulation of Minister of Marine Affairs and Fisheries No.1/2015 rergarding banning catching BSC of < 10 cm carapace width and berried females.

Mapping Fishing Ground and Nursery Ground

Several researchers tried to map fishing ground and nursery ground of BSC particularly in Tiworo Strait (Muskita *et al*., 2015). Stock assessment at each fishing ground had been conducted to regulate its fishing effort based on spatial and temporal distribution (La Sara *et al*., 2014 – 2016; 2017b). Location of each nursery ground which generally found in intertidal zone closed to mangrove area was decided to be a MPA of BSC (Muskita *et al*., 2015; La Sara *et al*., 2016b). Its management scope was formulated together with local community in a focus group discussion (FGD) forum. The regulation of MPA consisted of (1) fishing efforts of BSCs or other related activities are not allowed in the MPA, (2) The objective of MPA management is to give opportunity of BSC juveniles to grow up to become mature sizes, and (3) the mature sizes of BSC in the MPA will split over to around MPA waters and it is allowed to be caught by fishermen (La Sara *et al*., 2014 – 2016; La Sara *et al*., 2016b).

Action Research to Sustain BSC Population

Up to the present, sistematically efforts to sustain BSC population in this region are still limited. Exploitation of BSC is not yet formulated well, particularly about catchabiliy and catch composition of fishing gear used. Selective and practical fishing gears are not yet implemented so BSC small carapace width still also are caught. The urgent action to be done ir order BSC population sustain is collecting data of catch, composition and aquatic ecosystem condition based on spatial and temporal to formulate a policy or regulation which prohibit "when" and "where": (1) catch of BSC juvenile, (2) catch of berried females, (3) catch at certain close habitats and close seasons, and (4) operation of mini trawl.

Limitation of number of crab pot and length, height and mesh size of bottom gillnets should be regulated and fishermen operated those fishing gears should get a licence from local government. After BSC of < 10 cm carapace widt prohibited to be caught that it is time to think about total allowable catch (TAC) of BSC at eacg fishing ground. The must distinct prohibition catch of BSC is at the nursery ground.

The other studies are production and propagation of the BSC seeds produced from hatchery. The seeds will be maintained up to juvenile in hatchery.The juvenile will be restocked to the BSC fishing ground which its population has been over exploited. Also those juveniles produced in hatchery will be cultivated in fence cages. Those efforts are to provide BSC source not only from fishing but also from cultivation. Therefore, the BSC population in the sea will be stable and sustainable to be exploited (La Sara *et al*., 2016b).

Conclusion

To maintain sustainability of BSC population can be achieved with maintain its habitat, prohibited illegal fishing, and respect of regulations. Among regulations respected are not to catch BSC of < 10 cm carapace width, not to catch berried females, and not to catch BSC at nursery ground. In order only BSC of > 10 cm carapace width caught that fishermen must use crab pots with escape vent of 3.5 cm x 5.0 cm attached in both sides. The berried females caught without intentional must be returned to the sea to grow and spawn in the sea.

The others action recommended to sustain BSC population are formulating catchability of fishing gears, dimension and numbers of fishing gears used, data collection of catch production based on spatial and temporal to formulate sustainability management policy. A hatchery fro seeds production constiutes an urgent action for restocking and for BSC cultivation in the fence cages. Therefore, BSC population in the sea will be stable and sustainable to be exploited.

Acknowledgment

This paper is part of a grand topic of research on “Fishing Ground and BSC Fisheries Resources Characteristics in Tiworo Strait, Southeast Sulawesi” which was funded by MP3EI 2015 – 2017 through the Ministry of Research, Technology and Higher Education. We would like to thank to alumnies of Department of Aquatic Resources Management who involved during data collection and fishermen who helped and gave very useful information of blue swimming crab during this study conducted.

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TOPIC B : AQUACULTURE

Effect of different initial weight on the growth of *Gracilaria verrucosa* cultured with vertical rope method in brackish water pond

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Abstract

This study aims are to determine the growth of the seaweed *Gracilaria verrucosa* with different initial seed weight using vertical rope method in brackish water ponds. Research was conducted for 42 days in the brackish water fishpond at Malili District, East Luwu Regency South Sulawesi Province, Indonesia. The experiment was designed with Complete Randomized Design with 3 treatments of initial seed weight at 50 g, 100 g and 150 g in triplicates. Growth measurements was performed weekly. Different initial seed weight significantly affected *G. verrucosa* growth. The results showed that the highest daily growth rate (16.66% day^{-1}) obtained at lowest initial weight (50g), followed by initial seed weight of 100g (6.71% day^{-1}), and the lowest growth rate (3.05% day^{-1}) was obtained at highest initial seed weight (150g). The water quality parameters in the culture pond were still optimal for growth of *G. verrucosa*. Water pH and light intensity range were 6.5 – 8.5 and 2956-4104 lux, respectively. Average nitrate, ammonium, and phosphate concentrations were 0.026 $mg.L^{-1}$, 0.225 $mg.L^{-1}$, and 0.032 $mg.L^{-1}$, respectively.

Keywords : growth, *Gracilaria verrucosa*, seed weight, verticulture, water quality

Introduction

Seaweed is one of important aquaculture commodity in Indonesia. Currently, land potential for seaweed culture in Indonesia is around 1.2 million ha, however it was only about 26,700 ha (2.2%) of the area is utilized for seaweed culture with production of 410,570 tons of wet weight. Seaweed culture could be easily done by applying simple technology, low investment, absorbing lots of labor, and generating sufficient income. *Gracilaria verrucosa* is among the important and commonly cultivated seaweed species in South Sulawesi Province with highly prospective market both at local and international level, and play role in preserving natural resources.

Culture technique is one of the problems faced in *G. verrucosa* production in the brackish water pond. The common method used was by simply spreading the seaweed seeds on the bottom of pond. This practice is suspected to be the main factor in low production and quality of this seaweed species due to occurrence of silt particles and some mollusk covered the thallus surface. Low production could also be caused by loss of some of seaweed thallus in the mud during harvesting. Another factor which may cause the low production level of this seaweed was the initial weight of seed planted was not optimal to support maximal growth rate and quality of seaweed through absorbing light and nutrients.

As nickel mining area, continuous sedimentation has been increased water turbidity and could have influence growth of cultured *G. verrucosa* at East Luwu Regency, South Sulawesi, Indonesia. One alternative solution that can be done is to implement a seaweed cultivation method using a vertical rope method in the pond so that the seaweed is not directly exposed to the mud in ponds and facilitate the harvesting. Therefore, the objective of this present study is to determine the initial weight of *G. verrucosa* seed which can contribute to high growth rate thus production and quality of the seaweed by applying the vertical rope method. The study outcome will be beneficial to increase income of the seaweed farmers and in turn increase the local economy.

Materials and Method

Vertical rope framed with bamboo (Figure 1) was applied to culture the seaweed. Seaweed seeds was tied at mono line rope positioned at 40 cm distance. Three different seed-weight were cultured as treatment, namely 50g (treatment A), 100g (treatment B), and 150g (treatment C), with with 3 replicates for each treatment. The experiment was designed with Complete Randomized Design. The seaweeds

were sampled weekly for growth measurement. The experiment was terminated after six weeks of culture.

The growth rate was determined using the formula from Hurtado *et.al*., (2001):

$$DGR = (\ln W_t - \ln W_0)t^{-1} \times 100\%$$

where:
DGR is daily growth rate (%),
Wt is weight at t week
W_0 is weight at previous week.

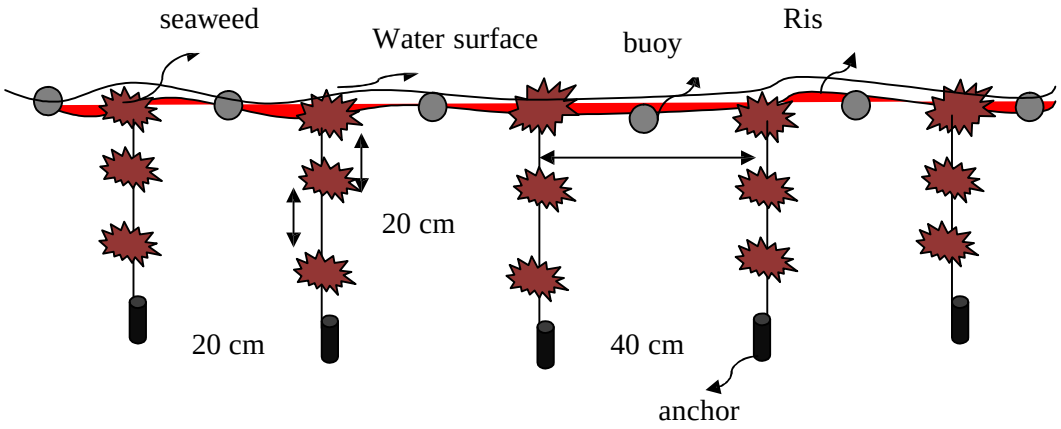

Figure 1. Vertical Rope Method of *G. verrucosa* in brackish water pond (Frontage viewed)

Water temperature, salinity, pH, and light intensity, as well as nitrate, ammonia, phosphate, were monitored daily using thermometer, hand refractometer, spectrophotometer, and titration, respectively. Growth rate was analyzed using Analysis of Variance (ANOVA) continued with Least Significant Difference (LSD).

Results and Discussion

Results

Growth Rate

Daily growth recorded in this study was relatively higher compared to growth rate of *Gracilaria* sp recorded at Kalianda Waters, South Lampung Province, Indonesia reported by Novyandi *et.al.* (2011) which was 4.25% day^{-1} cultured at 30 cm from surface water and by Putra *et al*. (2011) which was 4.445 % day^{-1}, cultured in long line.

Analysis of variance showed that differences in initial seed weight affected the growth rate of *G. verrucosa* in vertical culture method. LSD test indicated that highest growth rate (16.66% day^{-1}) occurred at lowest initial weight (50 g), followed by initial seed weight of 100g (6.71% day^{-1}), and the lowest growth rate (3.05% day^{-1}) was obtained with highest initial seed weight (150 g). Higher growth rate of *G. verrucosa* with initial seed weight of 50 g compared to 100g and 150 g was also recorded by Widiastuti (2011) and Hasan *et.al.* (2015).

Water Quality Parameters

During the study period, recorded water temperature was 28 –31ºC whereas salinity was 18–26 ppt and pH was 6.5–8.5. Light intensity range was 2956 - 4104 lux and average nitrate, ammonium, and phosphate concentrations were 0.026 mg L^{-1}, 0.225 mg L^{-1}, and 0.032 mg L^{-1}, respectively.

Discussion

Growth Rate

Several environmental factors affected *Gracilaria* growth include light, nutrients, cultivation depth, and water movement (Yang *et al*., 2015). Optimal light intensity obtained by the thallus cultivated with vertical rope method, although *G. verrucosa* could also probably be classified as shade-adapted seaweed because it has high chlorophyll a and phycobilins content, similar to *G. chilensis* (Carnicas *et al*., 1999).

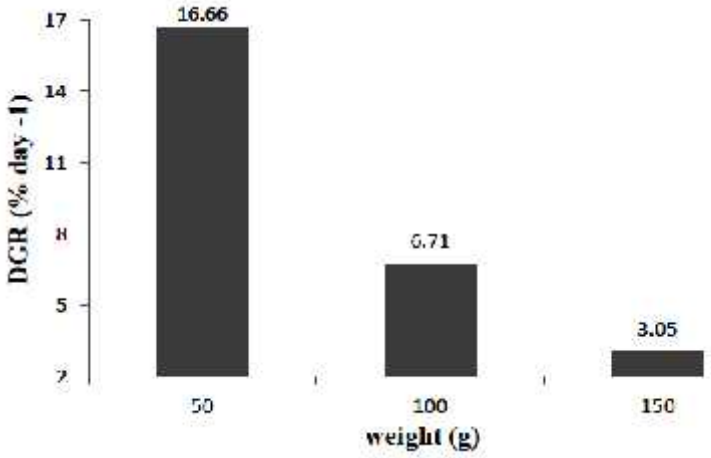

Figure 1. Daily grouth rate seaweed *G. verrucosa* during the study with vertical rope method in brackishwater pond.

Considerably high growth rate at the low initial seed weight (50g) could be attributed to better water movement surround the seaweed clamps which diffused more dissolve nutrients into the thallus of the seaweeds. High growth rate of *Kappaphycus alvarezii* with low initial weight of seed was also by obtained Mondoringin *et.al.* (2013), who argued that high growth rate of the seaweed at low initial weight was due to less competition in absorbing nutrients. High growth rate at 30 cm water depth in the study by Novyandi *et al.* (2011) and in long line method culture trial by Putra *et al.* (2011) was due to more water movement, less silt particles and optimal light intensity absorbed by the seaweed thallus. According to Ryder *et al.* (2004), lack of water movement significantly decreased growth rates of *G. parvispora* in ponds. Better water movement caused less amount of silt particles on the thallus surface allowed absorption of light and nutrition increased thus more light energy exposed to the thallus surface, therefore more nutrients diffused into the seaweed thallus resulting in high growth rate.

Growth rate of the plant positively correlated with light intensity. Light intensity and quality (Wedchaparn *et al*. 2015) affected the rate of photosynthesis which stimulate cell division and enlargement as well as nutrient uptake of seaweed thallus which ultimately made seaweed to grow well (Stockenreiter et al. 2013 in Juneja *et al*. 2013). Growth rate was affected by different light intensities under both low and high nutrient concentrations (Wedchaparn *et al*., 2015). However, light also stimulated nutrient absorption of thallus (Stockenreiter *et al*., 2013 in Juneja et al., 2013).

The uptake rate of NO_3^-N and PO_4^-P by *G.asiatica* under low and high concentrations were affected by light intensity (Wedchaparn *et al*., 2015). Beside nitrogen, carbon absorption by *Gracilaria* was also stimulated by light (Yang *et al*., 2015; Novyandi *et al*, 2011). Moreover, Putra *et al*. (2011) stated that low growth rate of *Gracilaria* sp. in the brackish water pond was caused by silt particles as well as very slow water movement at certain point. Mamang (2008) in Novyandi *et al.* (2011) explained that optimal water movement prevent silt accumulation and stimulate nutrient absorption by seaweed.

Water Quality Parameters

According to Yang *et al*. (2015), several key environmental factors have been identified to affect *Gracilaria* cultivation, include light, temperature, salinity, nutrients, cultivation depth, and water movement. Water temperature range of 28 – 31ºC was considered suitable for the growth and development of *G. verrucosa* as stated by Poncomulyo (2006) that *G. verrucosa* grew well at water

temperature of 27 – 31 ºC. Water salinity range of 18–26 ppt was suitable for *G. verrucosa* growth as stated by Ahda *et al.* (2005). Water pH of 6.5-8.5 was in the optimal range for growth and development of *G. verrucosa* as found by Ahda *et.al.* 2005 which was in the range of 6.0–9.0.

Table 1. water quality during the study with vertical rope method in brackishwater pond

Parameter	Range
Temperature (^oC)	28 –31ºC
Salinity (ppt)	18–26
Water pH	6.5–8.5
Light Intensity (lux)	2956 – 4104
Nitrate (mgL^{-1})	0.026
Ammonium (mgL^{-1})	0.225
Phosphate (mgL^{-1})	0.032

Light intensity recorded during the study which was in range of 2956 – 4104 lux might attribute to variation of *G. verrucosa* growth at several initial weight seed. The proper light intensity that could stimulate the seaweed growth should not exceed 12000 lux (Isnansetyo and Kurniastuty, 1995). The growth rate of *Gracilaria* increased when light intensity increased. However, in nature *Gracilaria* did not live under very high light intensity (Gomez *et al*., 2005). Under both high and low nutrient concentrations, the high growth rate 18.87% day^{-1} and 10.56% day^{-1} respectively of *G. asiatica* were observed by Wedchaparn *et al*. (2015) at the light intensity of 4860±1080 lux.

Nitrogen is highly important in determine the productivity of algae (Prescott, 1968). Nitrogen is essential for seaweed growth, cell division and protoplasm construction. In photosynthesis, nitrogen may function in pigment (chlorophyll-a) construction (Prescott, 1968; Lawlor, 1993; Sutedjo, 2008). Nitrate was limiting factor for the seaweed growth in the brackish pond at study site. Recorded nitrate concentrations (0.026 mg L^{-1}) was below concentration required for optimal seaweed growth as suggested by Kapraun (1978) and Andarias (1992). Nitrate concentration in the water for optimum rowth of seaweed ranged from 0.9–3.50 $mg.L^{-1}$ (Andarias, 1992) and 1.0–3.5 $mg.L^{-1}$ (Kapraun, 1978). However, 0,01– 3,50 ppm was suitable for seaweed culture (Zatnika, 2009). *K. alvarezii* was grow well at coastal waters of Salemo Island, Pangkep Regency, South Sulawesi cultured in 0,30–0,76 $mg.L^{-1}$ of nitrate concentration (Kune, 2007).

Ammonium is another form of nitrogen ion which was recorded with concentrations of 0.225 $mg.L^{-1}$ during the study period. This concentration was in the range suitable for seaweed growth according to Kapraun (1978) and Andarias (1992). Ammonia is the form in which nitrogen enters the metabolic process. Nitrate is reduced to ammonia before being incorporated into organic compounds (Syrett, 1962).

Average phosphate concentrations of 0.032 $mg.L^{-1}$ recorded in this study was low and suggested as the limiting factor for the cultured *G. verrucosa* in the study site. The range of 0.09-1.80 $mg.L^{-1}$ (Andarias, 1992) or 0.1–3.5 $mg.L^{-1}$ (Kapraun, 1978) was the optimal phosphate concentration for seaweed growth.

Conclusion

Based on our results and discussion, some conclusions can be drawn from this study as follows: Initial weight affected the growth of *G. verrucosa* cultured with vertical method in brackish ponds; Higher growth rate was obtained at low initial seed weight (50 g) compared to other initial seed weight of 100 g and 150 g tested in this study; nitrate and phosphate concentration at brackish ponds recorded during the study period suggested that those nutrients were limiting factors in cultured seaweed.

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Analysis of Water Quality Parameters for Suitability of Seaweed Cultivation in Campalagi Waters, Mallari Vilage, Bone Regency

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Abstract

The research was conducted from May until August 2017 at Campalagi Waters, Mallari Village, Bone Regency. Sampling was carried out at twelve sampling stations representing water condition. Samples were collected within two weeks interval with three replicates. Analysis of soil and water samples was carried out at Water and Soil Laboratory, Polytechnic of Marine and Aquaculture Bone. Analysis of the suitability of waters condition was performed by feasibility standard analysis for seaweed aquaculture operation. The waters conditions were subjected to certain value depend on the criteria and condition of physical and chemical parameters, and also based on the standard of live of marine organisms issued by Ministry of Environment Decree No. 51 in 2004. The results showed that every station had unique characteristic which determine the physical and chemical parameters. Chemical parameters of every observed station were considered suitable for seaweed aquaculture, except the station near the ponds outlet. The distinctive features that determine the feasibility of every station was obtained from physical factors, namely water depth, water current, turbidity and transparency. The Campalagi waters are still suitable for seaweed aquaculture operation, particularly around the location of the present seaweed aquaculture. Observed stations surrounding estuarine, ponds and settlement are unsuitable for seaweed cultivation sites.

Keywords: Suitability, environmental, physical-chemistry and seaweed aquaculture

Introduction

Marine aquaculture, particularly the cultivation of the seaweed *Euchema cottoni* is one of the fishery aquaculture sector developed by fishermen and coastal communities. The use of culture method developed recently is a way to increase production, to create new job opportunities, to improve coastal people's welfare and to conserve marine environment. Indonesian coastal waters has great prospects for the development of seaweed cultivation. With the application of good technology and adequate funding support, the development of seaweed cultivation in Indonesia will be achieved.

Seaweed culture is strongly influenced by environmental factors including physical, chemical, and biological factors. Some environmental factors also include water quality, coastal topography, oceanography physics, climate and weather and socio-economic conditions of surrounding communities.

Campalagi waters, in Mallari Village, Bone District, is an area that has the potential for seaweed cultivation development. The local communities and outsider have carried out seaweed cultivation business in the area in recent years. This is possible because of the availability of suitable seaweed seeds growing in these waters as well as the increasing demand for large markets at reasonable prices.

The growing public interest in this effort needs to be supported by a comprehensive knowledge of the environmental conditions of the waters. Currently, there are about ten seaweed aquaculturist in the area. The Campalangi waters is located only a few kilometers from the town of Watampone meaning that the community activities will affect the coastal environmental and the carrying capacity of aquaculture activities. The waters located on the East Coast of South Sulawesi also have specific climatic and oseanographic conditions which are varied according to the seasons. This is the reason for the importance of knowledge about the dominant environmental factors that support this marine culture business. The aim of this study was to determine the water quality (physical and chemical factors) of the Campalagi Waters, Malari, Bone, South Sulawesi and to assess the technical feasibility of Seaweed aquaculture in the Campalagi Waters.

Materials and Methods

Study Sites

The research was conducted from May to August 2017 in Campalagi, Mallari, Bone, on the East Coast of South Sulawesi, approximately 15 km North of Watampone City. There are 12 observation stations in this study. Determination of the location of the station is based on: (1) environmental conditions and the use of materials around water bodies; (2) distance from shoreline; (3) accesibility. The position of each station was determined using Global Position System (GPS). The location of each observation station is presented in Table 1.

Table 1 Location and state of observation stations

Station	Location of The Research		The Condition of Area
	S	N	
A1	04◦ 06’ 31,4”	119◦ 36’ 31,5”	Seaweed aquaculture belongs to fishermen
A2	04◦ 06’ 32,2”	119◦ 36’ 46,9”	Seaweed aquaculture belongs to fishermen
A3	04◦ 06 ’35,5”	119◦ 36’ 54,9”	Seaweed aquaculture belongs to fishermen
B1	04◦ 05’ 31,3”	119◦ 36’ 39,2”	Estuary S. Bulu
B2	04◦ 07 ’25,4”	119◦ 37’ 03,2”	Estuary S. Campalagi
B3	04◦ 07’ 13,8”	119◦ 37’ 02,1”	Near the Pier
CI	04◦ 05’ 41,8”	119◦ 36’ 35,6”	Near the ponds
C2	04◦ 05’ 58,8”	119◦ 36’ 24,6”	Near the ponds
C3	04◦ 06’ 17,0”	119◦ 36’ 23,2”	Drainage ditch
D1	04◦ 06’ 31,2”	119◦ 36’ 33,4”	Near the mangrove forest
D2	04◦ 06’ 23,0”	119◦ 36’ 24,9”	Near the mangrove forest
D3	04◦ 06’ 22,9”	119◦ 36’ 45,3”	Near the pile of sand

Water Quality Measurements

Several parameters were measured insitu while others were measured in the Laboratory of Fisheries and Aquaculture Studies Program Polytechnic of Fisheries Bone (Table 2). There are two main components that become the object of observation of water quality that is physical parameters (physical oceanography), and chemical parameters.

The physical and chemical parameters of waters observed can be seen in Table 2.

Table 2. Parameters of physical-chemical quality of waters observed

No	Parameters	Method	Analysis Place
1	Temperature	Thermometer	Insitu
2	Turbid	Turbiditymeter	Laboratory
3	Bright	Secchidisk	Insitu
4	Speed of Flow	Current Meter	Insitu
5	Tide	BMG Data & Measuring Board	Insitu
6	Wave	Data BMG	Insitu
7	Depth	Meter pita dan tali dan Kayu	Insitu
8	pH	Outomatic (pH-meter)	Insitu
9	Salinity	Refractometer	Insitu
10	Oxygen (DO)	Outomatic (DO-meter) dan Metode Winkler	Insitu
11	Ammonia (N-NH3)	Spektrophotometri	Laboratory
12	Nitrat (NO3)	Spektrophotometer	Laboratory
13	Fosfat (PO4)	Spektrophotometer	Laboratory

Data Analysis

To assess the suitability of the environment for seaweed cultivation, the water quality parameters of the each location/station were then compared with the several references such as Pong- Masak, P.R and Nelly Hidayanti Sarira (2015), Rahmansyah (2004) and Ministry of Environment Decree No 51 Tahun 2004. This suitability analysis is carried out descriptively in which all parameters measured must meet eligibility or excellent criteria. If there is one parameter that does not meet the requirements, the station is considered not suitable for seaweed cultivation. After knowing the feasibility of each station, it is then classified from the best to the least.

To sort, assess and compare the appropriate environment for seaweed cultivation between observation stations, each parameter measured is given a weight of ten (10). Parameters that are toxic if in the content required but still subject to change by treatment or time are given weights (5). While the parameters in water depend on the other parameters above or their value is relatively stable in seawater given a value of three (3) or one (1).

Table 3. Assessment criteria of water quality parameters for marine aquaculture in Mallari waters

No	Parameter	Assessment Criteria		
		Enough (Score 0)	Good (Score 6)	Very Good (Score 9)
1	Salinity (ppt)	<20,>35	21 - 29	30-35
2	Brighness (meter)	<3	3,1 -4,9	5<
4	Turbidity (NTU)	>100	10-100	<10
5	Depth (meter)	5,9>	6 – 9,9	10<
6	Tidal (cm)	>200	<100	100-200
7	Mean Wave heigth (cm)	>50	<25,>50	25-50
8	Current (cm /s)	>60	<40	40 -60
9	Temperature (◦C)	30<	<26	26 – 30
11	DO (ppm)	<3	3-4	>4
12	NH_3 (ppm)	>0,1	0,02-0,1	<0,02
13	NO_3 (ppm)	>3,5 mg /L	0,95 mg/l >	0,95 – 3,5 mg/l
14	NO_2 (ppm)	>0,1	0,015 -0,1	<0,001
15	PO_4 (ppm)	> 1	0,02 >	0,02 – 1 mg/L
16	pH	< 6,5	6,5 <7,2	7,3-8,2

The environmental suitability for Seaweed Cultivation at a location (station) is calculated by accumulating the values of all measured criteria (parameters) based on their respective weights. The equation is:

$$N= (x.n)$$

Where, x = value of each parameter and n = weight of each parameter.

To determine if the waters is suitable or unsuitable for seaweed aquaculture, the accumulation value is used.
Value 800 < = Suitable
Value 800 > = Unsuitable

Results and Discussion

Results

The result of water quality parameters measurement (physical and chemical parameters) of Campalagi waters, Mallari Village, Awangpone Subdistrict, Bone Regency can be seen in the following table.

Table 4. Mean of physical and chemical measurements of Campalagi waters, Mallari.

No	Parameter	Station A (Seaweed Cultivation)			Station B (estuary)			Station C (pond)			Station D (Mangrove)		
		A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
		Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average
							Physics						
1	Temperature	28,0	28,1	28,2	28,6	28,5	28,9	29,5	28,5	29,2	29,0	29,0	29,0
2	Turbidity	1,07	0,92	0,86	3,02	2,68	2,79	0,50	0,64	1,36	1,02	0,76	1,04
3	Brightness	8,67	7,70	8,33	2,97	3,07	5,83	8,30	7,40	7,17	7,00	7,23	8,27
4	Speed of Flow	50,07	50,57	60,	80,87	75,87	50,97	57,77	56,90	43,23	58,33	49,87	57,17
5	Tide (Cm)	150	150	150	150	150	150	150	150	150	150	150	150
6	Wave height (cm)	40	40	40	50	50	40	40	40	40	40	40	40
7	Depth	7,5	8,5	7	10	9	8	4,6	4,5	5,5	6,8	7,2	7,4
							Chemistry						
8	pH	7,6	7,4	7,4	7,4	7,4	7,4	7,5	7,4	7,1	7,5	7,4	8,0
9	Salinity	30,0	30,0	30,0	21,7	24,3	27,0	30,7	31,0	31,7	32,0	32,0	33,0
10	Oxygen	6,6	6,3	6,0	5,7	5,4	5,4	5,5	4,6	3,5	4,6	5,5	5,2
11	Ammonia	0,012	0,00577	0,00357	0,00393	0,00473	0,01993	0,00113	0,00030	0,00500	0,00387	0,00170	0,00567
12	Nitrat	0,0135	0,06920	0,05280	0,17690	0,05120	0,01530	0,54810	0,56920	0,18710	0,03580	0,01020	0,01280
13	Nitrit	0	0	0	0	0	0	0	0	0	0	0	0
14	Phosphat	0,02387	0,02403	0,03273	0,04432	0,04130	0,05300	0,05000	0,06235	0,05190	0,02900	0,03890	0,01690
							Biology						
15	Vegetation(%) Visual	10,0	10,0	10,0	10,0	10,0	10,0	60,0	60,0	70,0	70,0	70,0	10,0
16	Content of sand (%) base Lab	92,3	93,3	93,7	92,3	92,3	91,0	68,3	68,0	66,3	64,0	64,0	97,0
17	BO Protracted (BOT) (ppm) Lab	7,8	6,8	6,8	4,8	4,5	4,7	4,1	3,6	14,5	5,4	6,3	6,1

The condition of the water bodies of more than 7.7 meters is located at the stations around the cultivation location of the cultivators (Station A1 and A2) and estuaries around the sand dune. The Magnitude of this brightness is very feasible for seaweed cultivation. This condition is also supported by water depths ranging from 6.5 to 10 meters. While the location near the aquaculture, although kecerahaannya still in the range of feasible but not supported by the depth of the waters that must be more than 6 meters for seaweed cultivation activities. Seaweed cultivation requires a minimum depth of 6 meters at low tide to prevent seaweed drought (Pong-Masak, 2015). In addition, the lower depth will increase the occurrence of stirring base waters that can raise organic materials and sediments and disturb the life of seaweed.

The water transparency around the estuary (2.97 meter) is the lowest because the water from the upstream contains many soil particles and rubbish especially after raining. River water into the sea also contains many nutrients that support the growth of plankton causes high levels of low turbidity in the station.

Flow Rate and Wave Height

Current velocity in all stations is good and excellent for seaweed cultivation ranging between 43.23 to 80.87 cm / sec. The current velocity and wave height at the mouth of the river are higher than elsewhere. The currents in these waters are generally created by the movement of water due to the meeting of river water flow with t he tides. The shallow waters make the current that occurs is the surface current. Except near the mouth of the river, the direction and velocity of the current are influenced by the movement of the water mass from the land carried by the Bulu river. River flow discharge is greatly influenced by the season causing the water quality condition of the estuary t o fluctuate following the seasonal changes.

Temperature and Salinity

The mean temperature of the inter-station waters showed a relatively stable value in accordance with the conditions of tropical waters. Measurement time around 10:00 to 13:00 causes the temperature measurement results generally stable and normal in all stations except the location of pond disposals which had relatively high water temperature values compared to other stations. It can also be seen in PCA analysis where temperature factor is the main characteristic around the pond disposal site. While the temperature around seaweed cultivation is lower than other stations (average temperature 28.1^{o}C is very feasible for seaweed farming location), low temperature in seaweed cultivation area allegedly influence from seaweed plant that absorb heat water temperature is relatively lower than in other stations.

The mean salinity of inter-station waters showed that salinity around the estuary has the lowest salinity value of 24.33 ppm on average. The low salinity in the estuary is caused by fresh water flow from upstream of Bulu river and Campalagi river. Moreover, at the time of research the rain intensity in Bone Regency is relatively higher than in other months.

Turbidity

The results of turbidity measurements and TSS indicated that the turbidity of water is still within the range that is feasible for seaweed cultivation. Even in the waters around the ponds and mangrove forests with the lowest turbidity value, the water is still very clear. This is caused by the substrate which generally in the form of sand and coral fragments with sea grass vegetation. The mangrove ecosystem and seagrass beds found around this station act as sediment traps, stabilizing the basic substrate, and purifying the water (Subriharyono 2002).

The highest turbidity of 3.02 NTU was recorded in station B1 caused by high turbidity of river water. The turbidity parameter is one of the principal characteristics of the waters around the river mouth.

Dissolved Oxygen And pH

As open waters, where the incoming and outgoing water circulation is quite smooth, the oxygen content dissolved in water in almost all observation stations is still within the proper range for seaweed cultivation, except around the pond drainage (2.5 ppm) which quite low and less feasible for seaweed cultivation. This low dissolved oxygen content is the result of consumption by cultivated organisms and the process of decomposition of organic materials.

The sea water pH showed a relatively stable value and still within the range of optimum pH for seaweed cultivation. This is because these waters are open water with better water circulation so that the pH will follow the open sea pH value ranging from 7.4 to 8.0. The pH conditions of water do not fluctuate/extreme as they are correspond to high alkalinity values (greater than 40 ppm). High water alkalinity describes the high buffer capacity of water (Alaerts and Santika 1990).

Ammonia, Nitrates and Phosphates

The ammonia measurements showed values that are within a reasonable range for seaweed cultivation. The lowest ammonia level was 0.0003 ppm at around drainage channel and highest was 0,0199 ppm in waters outside estuary of Bulu river. Ammonia is not one of the principal determinant variables of one station whose ammonium content is more prominent.

Although, still within the proper range for seaweed cultivation, high nitrate content is found in the stations around the seaweed cultivation and estuaries of the Bulu River (0,56920 ppm and 0,17690 ppm, respectively). The high nitrate content in the waters surrounding semi-intensive pond discharges is presumably due to the high content of feed residues and the excretion of cultivated organism. Because of the oxidation process of ammonia to nitrite by bacteria, and because nitrite is an unstable compound then with high oxygen and carbon dissolved conditions and assisted by bacteria, nitrite is directly oxidized to nitrate. The low ammonia content of the cultivation site also indicates the high rate of oxidation of ammonia to nitrate. Although the current velocity at this station is sufficient to drain the nitrite content, the current generally is the surface current and the current velocity at the bottom is not yet proportional to the rate of ammonia reshuffle to nitrate.

Nitrite was not found in these waters presumably due to the process of nitrification where ammonia is converted to nitrite and then oxidized to nitrate by nitrobacter bacteria. This process requires a great deal of oxygen and carbon that many seawater contain as a source of energy.

Around the pond drainage, the ammonia and nitrate content is not the highest. The low content of ammonia and nitrate around pond drainage is thought to be due to the ammonia and nitrate contained in pond water discharged already utilized for the growth of phytoplankton, and pond water effluent has undergone dilution by sea water. According to Alaerts and Santika (1990), nitrate is a stable nitrogen compound. Nitrate content in water should not exceed 10 ppm.

Environmental Suitability Analysis For Seaweed Cultivation

Based on the Decree of the Minister of Environment Number 51 Year 2004 regarding Sea Quality Standard for Marine Biota, almost all parameters observed are still within that range. Except in the vicinity of drainage ditches, higher levels of nitrates and phosphates were recorded resulted from aquaculture activities, particularly the use of artificial feed. Similarly, the levels of dissolved oxygen did not meet the standard criteria of seawater quality standards.

Table 5. Results of feasibility assessment of physical-chemical parameters Cempalagi waters for seaweed cultivation based on eligibility criteria from table 1.

No	Parameter	Station A (seaweed cultivation)			Station B (estuary)			Station C (pond)			Station D (Near mangrove forest)		
		A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
Phisic													
1	Temperature	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good
2	Turbidity	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good
3	brightness	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good
4	Current velocaty	Very good	Very good	Very good	Enough	Enough	Very good	Very good	Very good	Very good	Very good	Very good	Very good
5	Tidal (cm)	Very good	Very good	Very good	Very	Very	Very good	Very good	Very good	Very good	Very good	Very good	Very good
	Wave	Very good	Very good	Very good	Very	Very	Very good	Very good	Very good	Very good	Very good	Very good	Very good
7	height	good	good	good	good	Good	good	good	good	good	Good	good	good
	Depth	Good	good	good	Very	Good	good	enough	enough	enough	Good	good	good
Chemist													
9	pH	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	good	Very good	Very	Very good
10	Salinity	Very good	Very good	Very good	Good	Good	good	Very good	Very good	Very good	Very good	Very good	Very
11	DO	Very good	Very good	Very good	Good	Very good	Very good	Very good	Very good	Very good	Very good	Very	Very
12	Ammonia	Very good	Very good	Very good	Good	Very good	Very good	Very good	Very good	Very good	Very good	Very	Very good
13	Nitrat	Very good	good	Very good	Good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good
14	Nitrit	Very good	Very good	Very good	Good	Very good	Very good	Very good	Very good	Very good	Very good	Very	Very good
15	Fosfat	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good	Very good
Result research		**Proper**	**proper**	**proper**	**proper**	**Inproper**	**proper**	**proper**	**proper**	**inproper**	**Proper**	**proper**	**proper**

Table 6. Result of physical-chemical conformity assessment of Campalagi waters, Mallari for seaweed cultivation

Score	Station	Result research	Limitation Factor
911	A3	Proper	Depth
887	A2	Proper	Depth
881	A1	Proper	Depth, pH
830	D10	Proper	Depth
830	D11	Proper	Depth
830	D12	Proper	Depth
815	B4	Proper	Curren, salinity,
815	B6	Proper	Depth, Curren, salinity,
802	C7	Proper	Depth.
801	C8	Proper	Depth
785	B5	inproper	Curren, depth, salinity,NO3
770	C9	inproper	Depth, pH

Conclusion

Environmental suitability for seaweed *E. cottoni* culture in Campalagi waters, Mallari Village, Awangpone Subdistrict, Bone Regency is determined by physical-chemical factor. The environmental condition of Campalagi waters is still suitable for Seaweed culture except the areas around the estuary and the ponds.

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The Level of Parasitic Infestation of *Caligus* sp. in Grouper Transported from Station of Fish Quarantine and Quality Control of Fishery Products (SKIPM) Kendari

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Abstract

Station of Fish Quarantine and Quality Control of Fishery Products (SKIPM) Kendari is a public service unit that runs control functions on fish health assurance system and fishery product quality and safety in Kendari. One of frequently transported marine organisms from SKIPM Kendari is grouper. Groupers were vulnerable to parasites especially *Caligus* sp. The aims of the present study were to determine the level of parasite *Caligus* sp. infestation in groupers imported into, or moved from Kendari. Data was observed for three months (October to December 2016) from five customers. The level of parasite infestation was counted as prevalence and intensity. Parasitological examination of groupers was done by necropsy procedure. Data showed that the highest prevalence was obtained in November, while the lowest prevalence was in October. Furthermore, the observation of parasitic intensity obtained the highest intensity in December, while the lowest intensity number was in October. Considering the danger of parasite infection, it needs tightly supervision of groupers transportation.

Keywords: Parasite, *Caligus* sp., grouper, SKIPM Kendari.

Introduction

The State of Indonesia is a country with abundant natural resources. One of them is fishery resources both freshwater, brackish and marine. Those resources that are exploited with the concept of "Fishery Industryization" certainly can support the increase of foreign exchange of State from non oil and gas sector.

Southeast Sulawesi is also the eastern part of Indonesia which geographically has an area of about 75 percent of marine waters of its total area. The potential of the large marine and fishery sectors allows for development. With the increasing number of centers of aquaculture both marine aquaculture such as seaweed cultivation, floating net for grouper, and pond cultivation for tiger shrimp, milkfish and crab, as well as cultivation of land fisheries such as ponds fish cultivation Mas, Nila and Lele dumbo.

While the increase of catching fisheries sector is marked by the increasing number of fleets of fishing vessels that landed catches in fishery ports in Southeast Sulawesi and the increasing number of fish processing industries such as salted fish, smoked fish, fillets and frozen. The widening gap of the people's economy, especially in the fishery sector, gives optimism for fishery actors to improve socio-economic of fisherman society in particular and society of Southeast Sula wesi in general.

Along with the increase, the traffic activity of fishery commodities will increase as well and do not close the possibility of fish diseases pest can be followed. For that one of the institutions that have duties and functions to prevent the absorption of Quarantine Fish Disease Pest that is the Fish Quarantine Body of Quality Control and Fishery Product Security (BKIPM), in this case for Southeast Sulawesi region is the Fish Quarantine Station of Quality Control and Fishery Products Safety Kendari as a Technical Implementing Unit implementing Quarantine Measures based on Law No. 16 of 1992 and Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia No. Kep.32 / MEN / 2004 Organization and Working Procedures of Fish Quarantine Technical Implementation Unit to carry out Quarantine Measures.

Groupers are economically important species and often transported both in fresh and life. Grouper is one of the important economical marine fish commonly cultivated and often transported good inter-area in the country to become an export commodity. Subyakto and Cahyaningsih (2005) stated that the waters in Indonesia with large grouper population are Sumatera, Java, Sulawesi, Buru, and Ambon. One of the indicators is coral waters, Indonesia has a large enough coral reefs so that the potential of fish resources is very large (Tampubolon and Mulyadi, 1989). But the problem in the cultivation of groupers being the occurrence of disease. Diseases caused by parasites often infect groupers one of them is *Caligus* sp. The

purpose of the present study was to determine the prevalence and intensity of the infection of *Caligus* s.p., parasite in Grouper from October to December 2016.

Materials and Method

The research was conducted for three months from October to December 2016 located in Konawe Regency, Kendari. Data were collected by interviewing and field observation and then laboratory examination.

Interview Method

Interview method is a way of collecting data used to obtain information directly from the source. Interviews have been acknowledged as an important data collection and information technique in the development of information systems. An interview is a direct conversation with specific goals using a planned question and answer format.

Field observation and sampling

Observation is a data collection tool that is done by observing and recording systematically the observed symptoms of fish behavior at the time of swimming. Samples of fish taken for examination are fish in living conditions or in near-death condition so it is still feasible for laboratory examination. Samples of fish were taken randomly, but the sick fish were preferred or have pathological abnormalities, which will then be done by laboratory examination.

Method of Parasite Examination

Fish samples were examined by 2 parts namely external and internal part, where the first examination started from the external part and then continued to the internal organs.

- External Examination
  1. Examined the abnormality of each targeted organ before surgery.
  2. Begin examination of test samples on skin organs, fins, tails, anus, gills, eyes, and nose whether visible parasites and other abnormalities (such as lesions, ulcers or ulcers, haemorrhagic on the skin, cysts).
  3. Take the target organ mucus, place it on the glass object contained sterile water then cover with a glass cover for under the microscope.
  4. Identify parasites by matching observations under a microscope with the morphology of parasitic species.
  5. Calculate the intensity of the parasite found on each target organ.
- Internal Audit

  Put the test sample with the right side facing upward, then cut the posterior portion of the inner cavity carefully not too deep when cutting, starting from the bottom in front of the curved anus following the spinal direction until before the pectoral fin.

  Once open observe abnormal symptoms that occur on the target internal organs (liver, anus, stomach, kidney, limpha) by looking at changes in shape and color.

  Cut with target organ using scissors work carefully to avoid damage and place on petri disk, take target organ slime and located on glass object sterile water then cover with cover glass to be under microscope by using enlargement 4 x 10,10 x 10.

  Identify the parasites found by matching observations under a microscope with the identification books used. Calculate the intensity of the parasite found on each target organ.

Method of Analysis

The examination result of the test sample was analyzed descriptively by using the following calculation;

- Prevalence

$$\text{Prevalence} = \frac{(number\ of\ samples\ infected)}{(number\ of\ samples\ examined)}\ x\ 100$$

) Intensity

$$\text{Intensity} = \frac{(number\ of\ parasite\ found)}{(number\ of\ test\ samples\ infected)}$$

Results and Discussion

Results

Based on data analysis the number of prevalence obtained at the laboratory examination and the amount of intensity of the infecting parasite, total Prevalence and Intensity of *Calas* sp Parasites in October - December 2016 are presented in the following tables and graph:

Table 1.Total prevalence of *Calas* sp parasites in October-Desember 2016

Exporter	October	November	December
Ir. Ramlan	0	9,5	10
M. Fuadzin	0	10,3	12,5
Hengky	0	50	7,7
PT. Global	0	100	5,9
CV. Rudiana	14,2	18,1	5,9

Table 2.Total intensity of Calas sp parasites in October-Desember 2016

Exporter	October	November	December
Ir. Ramlan	0	13,5	12,5
M. Fuadzin	0	8,3	10
Hengky	0	2,3	14
PT. Global	0	3	7
CV. Rudiana	1,5	7	8

P	October	November	December
Prevalence	3,174603	17,3913	8,791209
Intensities	1,5	6,583333	10,5

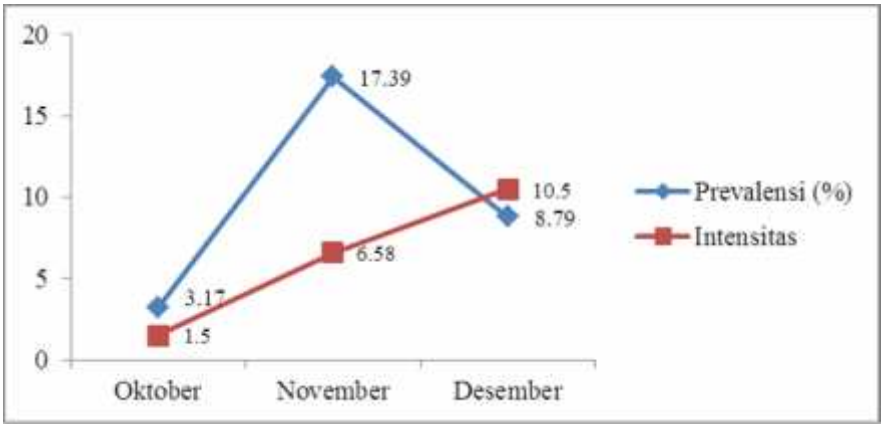

Figure 1. Total prevalence and intensity of *Calas* sp parasites in October-Desember 2016

Discussion

Grouper Taxonomy

Grouper has 15 genera consisting of 159 species. Groupers belong to the Serranidae family,Epinephelinea subfamily, commonly known as groupers, rockcods, hinds, and seabasses. Grouper fish found in Indo-Pacific waters as many as 110 species and the waters of the Philippines and Indonesia

as many as 46 species are included in 7 genera Aethaloperca, Anyperodon, Cephalopholis, Cromileptes, Epinephelus, Plectropomus, and Variola (Marsambuana and Utojo, 2001).
The classification of groupers is as follows:

Klas: Pisces
Subkla: Teleostei
Order: Percomorphi
Sub Order: Percoidea
Division: Perciformis
Family: Serranidea
Sub families: Epinephelinea
Genus: Epinephelus
Species: *Epinephelus fuscoguttatus*

Grouper (*Epinephelus fuscoguttatus*) has beneficial properties to be cultivated due to its rapid growth and mass production, and the market demand for groupers is increasing. because of the changing consumer appetite of dead or frozen fish to live fish, thus encouraging the community to meet the demand of grouper fish market.

Grouper Morphology

The characteristics of grouper morphology are as follows (Wardana, 1994):

- The body shape is flat, ie the body width is smaller than the length and height of the body.
- Upper and lower jaws are equipped with pointed and strong teeth.
- Wide mouth, upward with the lower lip slightly protrudingupper lip.
- Round tail fin, single and elongated dorsal fin wherethe hard-fingered part is more or less the same as the soft fingers.
- The position of the abdominal fin is under the pectoral fin.
- Body covered with small fins are scaled stenoid.

Spreading and Habitat

According to Weber and Beaufort (1931), Indonesian waters, the population of the Sumatra, Java, Sulawesi, Pulau Baru and Ambon are quite large. Juvenile grouper usually inhabit coastal coral waters with a depth of 0.5 - 3 m, and move to deeper waters when reaching adult stage, ie at a depth of 7 - 40 meters. Usually this move takes place in the afternoon. Eggs and grouper larvae are pelagic (located in the water column). When the grouper reach juvenile stage, they become demersal and settle in the bottom of the pond when they mature (Tampubolon and Mulyadi, 1989).

Disease

Fish diseases may be defined as anything that causes a disruption of a function or structure of the body/partial body apparatus, either directly or indirectly caused by the occurrence of irregularities or anatomical abnormalities, the physiology of the body organs and the chemistry of bodily fluids or functions undergoing a change from normal conditions due to internal causes (external) and outside (external).

Fish disease in general is still a constraint that can cause decreased or loss of production and result in economic losses. Because the disease can cause stunt, longer maintenance period, high feed conversion, low density of stocking and death (Ghufran, 2004). In principle, the disease that attacks the fish does not just come, but through the process of relationship between three factors, namely environmental conditions (conditions in the water), host conditions (fish) and the presence of pathogenic bodies (disease). Thus the onset of the disease is an unsuitable interaction between the environment, the fish and the body / disease organism (Handayani, 2005).

Fish diseases can be caused by abiotic factors and biotic factors. Disease by abiotic factors is a disease caused due to decreased water quality, food poisoning and certain vitamin deficiencies in the diet. While the disease by biotic factors is a disease caused by pathogenic organisms both parasites, bacteria, fungi and viruses (Report Monitoring Disease Pest and Disease Map 2014).

Diseases caused by Parasites

Parasites are one of the factors that cause failure in the fisheries sector. Parasites usually attack more farmed fish than fish in the wild, it is because fish culture has a higher density. Parasites are defined as living organisms by extracting food from host organisms so that in general parasites can not live outside the host for long periods (Prayitno, 1996). The statement is in accordance with the opinion of Chong and Chao (1986) that the parasite is an organism that lives in or on the living organism and does not provide benefits to its host.

Agnes et al, (1995) stated that the parasite in fish viewed from the place of life on the fish body is divided into parasites that are ectoparasites and endoparasites. Ectoparasites are parasites that attack the skin, fins and gills. While the endoparasit is a parasite that attacks or lives in the intestines, kidneys, liver, muscles, flesh, brain. Parasites that cause disease in fish consist of parasite groups of animals (zooparasite), fungi or mold (fungi) and groups of algae (algae).

The types of ectoparasites that attack fish include: Argulus sp, Lernea sp, Ergasilus sp, Trichodina sp, Ichthyophthirius multifiliis, Costia sp, Myxosporidia sp, Dactylogyrus sp and Gyrodactylus sp, including Caligus sp. While the types of endoparasites that attack fish include: Pleistophora sp, Nosema sp, Glugea sp, Coccidia (Eimiria sp, Goussia sp), Telohania sp, Henneguya sp, Perkinsus sp, Myxobolus sp, Hexamita sp, Cryptobia (fish blood parasite) -type of the Acanthocephala Nematodes and the types of Crustacean classes (Dana and Alifuddin, 1995).

In principle, the disease that attacks the fish does not just come, but through the process of relationship between three factors, namely environmental conditions (conditions in the water), host conditions (fish) and the presence of pathogenic bodies (disease). Thus the onset of the disease is an unsuitable interaction between the environment, the fish and the body / disease organism (Handayani, 2005).

Caligus sp

Classification ;

Phylum: Arthopoda
Class: Crustaceans
Order: Copepode
Subordo: Siphonostomatoida
Family: Caligidae
Genus: Caligus
Species: Caligus sp

Morphology

The length and width of the cephalotorax are the same, having a back shield as a cover 1.5 - 50 mm long, free swimming, multiply by way of spawning organs. The target organ is the Gills.

Figure 1. *Caligus* sp

Prevalence

From the Prevalence graph above shows that from October obtained prevalence or percentage of attack of Caligus sp parasite is 3.17%, whereas in November increased 17.39% while in December dropped to 10.5%. This shows that the percentage of fish infected with parasites Caligus sp was lower in December compared with November, this parasite was generally found in the gills, it is possible because groupers live in vast ocean waters so density is not too high, besides that these parasites live ectoparasit means living outside the fish host and not too dangerous for grouper life. This is evidenced by groupers sent live through Haluoleo Airport, Southeast Sulawesi, there is no death to reach the destination.

According to the fish farmers, they get grouper from fishermen around the waters of Southeast Sulawesi where, the waters of Southeast Sulawesi are still free from harmful Quarantine Fish Disease pest. In accordance with the statement (Handayani, 2005) the onset of the disease is an unsuitable interaction between the environment, fish and the body / organism of the disease.

Intensity

From the graph above shows that in October the number of parasites *Caligus* sp infecting groupers in averages was 1.5 parasites while in November was 6.58 parasites *Caligus* s.p that infected groupers and in December was 8.79 this intensity is still small and not including harm to fish because fish can still freely breathe freely although parasites does not provide benefits for the fish as its host. Besides, given the vast fish life in the waters and the condition of the free waters with the disease so it is still possible to survive, so also the number of population density is still low so competition in terms of food and oxygen competition is not there.

Conclusions

Southeast Sulawesi is a potential area because it has abundant fish resources, and grouper is an important economic fish. Therefore, it should be maintained and protected for the prosperity of people and specifically in Southeast Sulawesi. Since the waters of Southeast Sulawesi are still free from diseases that are harmful, it needs to be prevented and the outbreak of the disease it is the responsibility for all of us as fishing communities, stakeholders and fisheries and government entrepreneurs.

With the prevalence and intensity of infection of *Caligus* s.p parasite found in Grouper fish is still low, but we remain alert to the entry and spread of pests in the region of Southeast Sulawesi for the welfare and prosperity of the people can still be enjoyed by the community. It is recommended that it is necessary for fish businessmen in Southeast Sulawesi to coordinate and cooperate with related institutions especially quarantine officers for the prevention and treatment of fish diseases andfor fisheries entrepreneurs to use certified seeds in order to avoid spread of diseases originating from the broodstock or seed region.

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Keputusan Menteri Kelautan dan Perikanan No. 80 Tahun 2015 tentang penetapan jenis-jenis hama dan penyakit ikan karantina, golongan, media pembawa dan sebarannya.

TOPIC C : MARINE SCIENCE TECHNOLOGY

Suitability Analysis of Diving Tourism in Seliu Island, Belitung Regency

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Abstract

Coral reef is one of the tourist attraction that attract tourists. The coral reef ecosystem is a very good precedence in opening tourism business activities in the field of diving. To know the suitability of diving tour of islet island, then take the data retrieval of diving tour suitability index and make a map. Methods of data collection is done by purposive sampling and took two types of data that is biotic in the form of coral reef and reef fish, and abiotic in the form of current, depth, and brightness. Coral cover measurements were measured using Line Intercept Transect (LIT) method. The Tourist suitability index analysis is done by scoring and weighting by collecting all parameter data. Based on the research results, there are three spot diving. There are Aik Arak, Aik Bulo dan Marang Bulo. On the three spot the brightness value around 57%. The value of coral cover ranged 51% -59% along with the type of lifeform 9-11 types. The value of reef fish species belongs to category N or not appropriate. Current velocity range from 0.07 cm / s - 0.2 cm / s. Depth ranges from 5 to 7 meters. Based on the parameters above, the three stations namely Aik Bulo, Aik Arak and Marang Bulo have IKW with the value of S2 category is quite appropriate. It means that the selected station can be accomplished as a diving tourism activities. With the S2 category (quite appropriate) the community can open tourism activities in the form of diving to introduce Pulau Seliu as a tourist destination, diving tour map has been created with coordinate points 1) S 03°12'270''- E 107°30'751"; 2) S 03°12'715"- E 107°30'768" 3) S 03°12'174"- E 107°30'807"

Keywords : Tourism, diving, suitability, tour map diving, seliu belitung

Introduction

Seliu Island is an archipelago village that has an area of about 1,530 hectares. Administratively Seliu Island Village entered into the subdistrict of Membalong, Belitung Regency, Bangka Belitung Province. Seliu Island Village has the potential of coastal ecosystem is mangrove ecosystem, seagrass, coral reef, capture fishery, aquaculture fishery and coastal tourism. In addition to the potential of the ecosystem, Seliu Island Village also has products of small business (*UMKM*), customs and socio-culture.

The development and utilization of the potential is not maximized. One of the potential that has a high selling point for the development of marine tourism is the coral reef ecosystem. Coral reefs are good for marine tourism including SCUBA diving or diving and can be used as a spot for snorkeling (surface subs). Diving tourism is a diving activity to enjoy the underwater beauty of biological resources such as coral reefs, reef fish and non-biological resources such as underwater caves, sunken ships and historical sites. However Seliu Island itself has not undertaken the development of underwater tourism so that conducted research on the analysis of tourist suitability index. This study aims to analyze the suitability of Seliu Island to be used as a marine tourism and making a tourism map so that the results can be used as a reference by the community in the management of tourism business in Seliu Island, especially snorkeling and diving tourism.

Methods

This research was conducted in 3 west part of Seliu Island that is Aik Bulo, Aik Arak and Marang Buloh in July 2017. Sampling using purposive sampling method where the selected location is near and easy to reach, besides the condition of east season influence the parameters of water so that data allows to be taken in the western part. Tools and materials used in the form of roll meters, GPS, SCUBA submarine, camera and stationery. Determining the suitability of diving tourism required biotic and abiotic parameters. Biotic parameters include coral reef data and fish data while abiotic parameters including depth data, current velocity and brightness.

Fish data collection using visual census technique which according to English *et al* (1994) taking fish data on lifeform. Line transects are then combined with transect belts, line transects extended

over 50 meters by divers with a viewing width of 2.5 m left and right using SCUBA equipment (English et al, 1994). The line transect is then left for approximately 15 minutes or until the condition of the waters becomes the original one, and the fish hiding during the installation of the outline transect from the hideaway (Dedi, 2012). The measurement of reef fish data is done by recording directly and recording the video from the top of the line transect. Identification of fish using illustrated manuals (Allen, 1999; Kuitler & Tanozuka, 2001).

Measurement of cover coral were measured using the Line Intercep Transect (LIT) method by stretching a 50 meter long Roll meter without intervals with line transect accuracy in centimeters (cm). The data was taken by recording a line transect video up to 50 meters using an underwater camera. Data identified the percent of cover and the number of coral growth forms found (English *et al*., 1994).

Scoring and quality is done by collecting all parameter data. Scoring on the parameter data based on the value of the parameter, While for quality is given on each parameter with the weight value of 1, 3 and 5 which shows the effect of these parameters on the suitability of diving tourism. The greater the influence of these parameters the greater the quality given. Scoring and quality of the Suitability Index of Tourism (IKW) for diving is outlined in Table 1.

Tabel 1. Parameters of diving tour suitability

Parameter	Quality	S1	Score	S2	Score	S3	Score	N	Score
Brightness (%)	5	>80	3	50 - 80	1	50 - <50	1	<20	0
Cover Coral (%)	5	>75	3	>50 - 70	1	25 - 50	1	<25	0
Type of Lifeform	3	>12	3	<7 - 12	1	4 to 7	1	<4	0
Type of Coral Fish	3	>100	3	50 - 100	1	20 - <50	1	<20	0
Current Speed	1	0 - 15	3	>15 - 30	1	>30 - 50	1	>50	0
The Depth of Coral Reef (m)	1	6 to 15	3	>15 - 20	1	>20 - 30	1	>30, <3	0

After all the data collected conducted the analysis of the suitability of tourism using the formula of maritime tourism suitability according to Yulianda (2007) are as follows:

$$IKW = \sum \left[\frac{Ni}{Nmax} \right] x\ 100\%$$

where:

IKW : Suitability Index of Tourism
Ni : Grade of Parameter -I (quality x score)

Results and Discussion

The suitability of dive tourism in Seliu Island waters is determined based on the alculation of Suitability Index of Tourism (IKW). The calculation of Suitability Index of Tourism (IKW) is presented in Table 2.

Table 2. Calculation Result of Dive Tourism Index Rate

Parameter	Quality	Station 1 (aik bulo)			Station 2 (aik arak)			Station 3 (marang bulo)		
		Score	Ni	Nmax	Score	Ni	Nmax	Score	Ni	Nmax
Brightness (%)	5	2	10	15	2	10	15	2	10	15
Cover Coral (%)	5	1	10	15	2	10	15	1	10	15
Amount of Type of Coral	3	0	0	9	0	0	9	0	0	9
Fish (many)	3	2	6	9	2	6	9	2	6	9
Amount of Type of life form (many)	1	3	3	3		3	3	3	3	3

Table 2 (continued)

Parameter	Quality	Station 1 (aik bulo)			Station 2 (aik arak)			Station 3 (marang bulo)		
		Score	Ni	Nmax	Score	Ni	Nmax	Score	Ni	Nmax
Current (cm/s)	1	3	3	3		3	3	3	3	3
Total			32	54		32	54		32	54
IKW (%)			59%			59%			59%	
Category			(S2)			(S2)			(S2)	
Explanation			Suitable Enough			Suitable Enough			Suitable Enough	

Map of diving tourism index in Seliu Island based on 3 research stations at Station 1 that was Aik Arak into Suitable Enough (S2), Station 2 that was Aik Bulo into category Suitable Enough (S2) and Station 3 that Marang Bulo into Suitable Enough categories in accordance (S2) presented in figure 1 and table 2:

Tabel 3. Class of Index Suitable Tourism diving in Seliu Island

Station	IKW	Coordinate point	Category	Suitable
1	59%	S 03°12’270” - E 107°30’751”	S2	Suitable Enough
2	59%	S 03°12’715” - E 107°30’768”	S2	Suitable Enough
3	59%	S 03°13’174” - E 107°30’807’’	S2	Suitable Enough

Sources: data were collected in 2017

Good diving sites is a dive site that meets the category of diving tourism conformity parameter (Table. 2). Adi *et al*., (2013) adds the condition of the diving location that attracts many tourists is the location with clear waters and good coral cover.

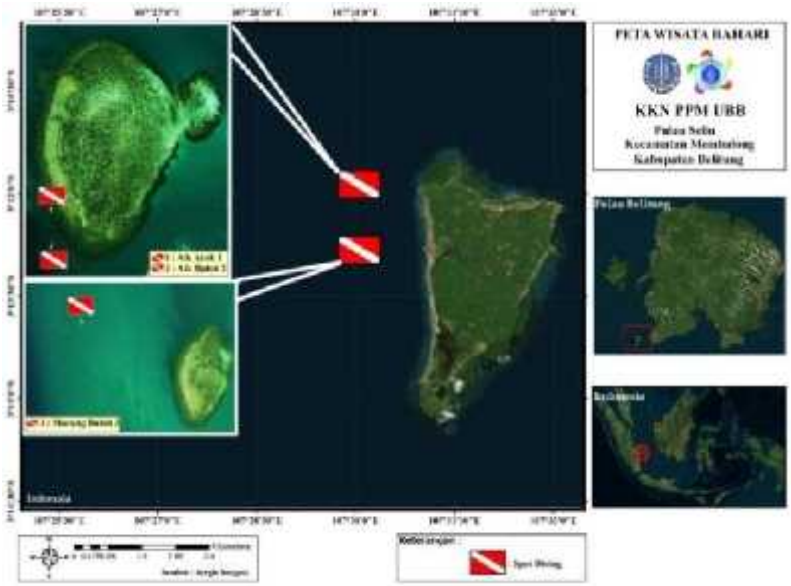


Figure 1. Map of stations and diving tourism

Abiotic Parameter Condition

Aquatic brightness is an important factor in diving activities. Brightness of the waters will affect the visibility of divers when doing diving activities. The higher the brightness value the better the water. Rajab *et al*., (2013) declared a diving tourism area with 80-100% brightness is a suitable location for diving tourism. Based on the research result, the brightness to 3 stations is 57%. The results are affecting the weather that affects the waters of the currents and depth of waters. The brightness value of the 3 station including score category 2. The results of brightness of waters on the island of Seliu is still

categorized both for diving activities with an average visibility> 1 meter. Philips (2012) adds low visibility to dive if horizontal visibility is less than 1 meter.

The optimal current velocity for diving activity is 0-15 cm / s (Yulianda, 2007). Based on current measurements of current velocity at Station 1 ie 0.07 cm / s, this value indicates that at Station 1 goes into category score 3. At station 2 has a current velocity of 0.2 cm / s in the category score 3 and station 3 has value of current velocity 0.10 cm / s and termauk category score 3. Low current velocity value at the 3 stations is because the location of the station in the west is protected when compared with the other direction of the island location.

The overall value of current velocity on Pulau Seliu enters into the category of score 3 when used as a diving touris place and all current velocities of each Station belong to the type of slow current velocity (Yulianda, 2007).

The results showed that the depth of coral reefs 3 stations suitable for diving. The depth of coral reef for the 3 stations is 7 meters. Yulianda (2007) mentioned that the depth of coral reefs suitable for diving activities ranged from 6-15 meters.

Biotic Parameter Condition

The type of coral reefs in Seliu Island can be categorized as fringing reef. Coral reefs are generally located at a short distance from the beach and there is no large lagoon (Suharsono, 2007). Cover of coral reefs at 3 observation stations in Seliu Island as a whole after averaged in good condition that is with average of live coral cover of 56,74%. Percent cover of coral reefs at Station 1, 2 and 3 entered into score category 2. At Station 1 with coral cover 58,54%, Station 2 with coral cover 60,2% and station 3 with coral cover 51,48%. The percent value of the cover that is not much different shows the homogeneity of environmental parameters. Stations 1,2 and 3 are sheltered during the east season, so all stations in this section have values that are not much different.

Source: Data of Based Research (2017) : 1. Coral folliose, 2. Coral massive, 3. Coral encrusting, 4. Acropora encrusting, 5. Acropora branching, 6. Coral branching

The condition of coral reefs at Station 1, 2 and 3 in Seliu Island is a huge potential to continue to be developed. The value of conformity index of diving tourism location based on the coral cover parameters of Seliu Island is included in category 2 score (as conditional) when used as a diving tour.

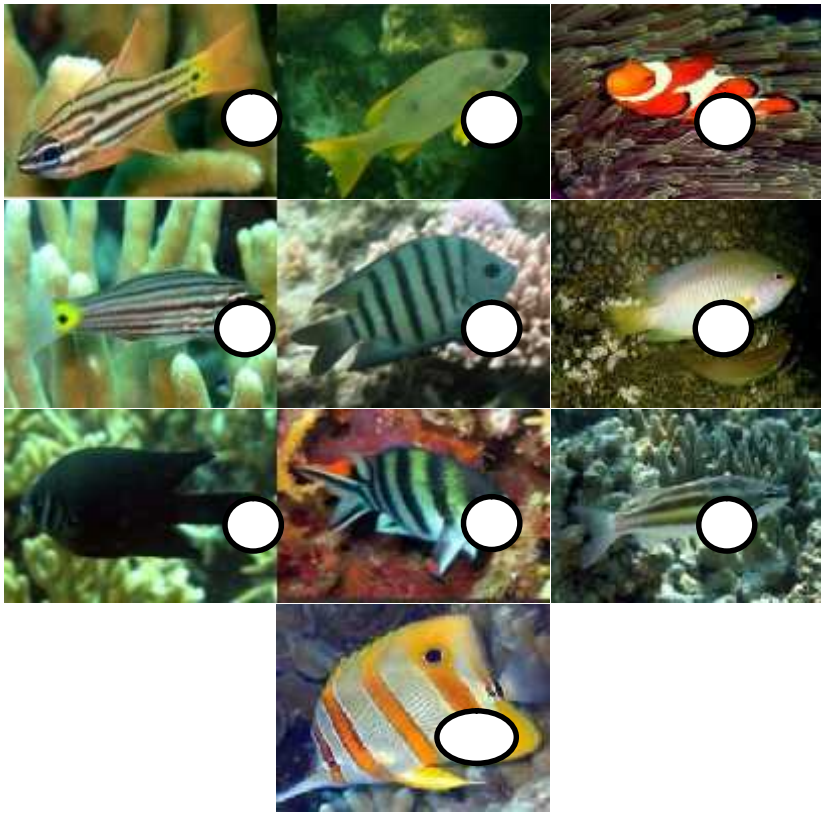
The coral reef growth form found in all of the four stations is 10 types: Acropora Branching, Acropora Encrusting, Coral Branching, Coral Encrusting, Coral Massive, Coral Foliose, Coral Submassive, Coral Masroom Soft Coral, Other. The form of coral reef growth that dominates in each research station is Coral Massive type.

Forms of coral growth or commonly called lifeform contained in the waters of Pulau Seliu get a score of 2 that fall into the category quite appropriate. Yulianda (2007) classifies coral reef growth for the suitability of dive tourism, namely hard coral, soft coral and other biota.

The shape of coral growth in the waters of Seliu Island is categorized as appropriate. The category is quite appropriate to inform that a region is good enough to be used as diving attractions.

Number of reef fish species in Seliu Island is classified into inappropriate category. This is because the number of fish species found at the time of data collection in Pulau Seliu waters is <20 species. The total number of reef fish found in 10 species.

Fish species found in all research stations are Pomacentridae, Apogontidae, Chaetodontidae, Lutjanidae and Nemipteridae family. Pomacentridae fish is also called the major fish groups are generally found abundant, both in the number of individuals and species, and tend to be territorial and fish that are easily found in the area of coral reefs (Kurniawan *et al*., 2015).



Source: Setiawan (2010) 1. *Apogon compressus, 2. Abudefduf sexfasciatus, 3. Cheilodipterus artus, 4. Amphiprion ocellaris, 5. Neoglyphidodon nigroris, 6. Pomacentrus amboinensis, 7. Lutjanus monostigma, 8. Pentapodus trivittatus, 9. Abudefduf bengalensis, 10. Chelmon rostratus*

The value of measuring the number of species of reef fish is low. The low value of coral fish measurements caused by several factors one of which is the observation method used. The method used in this study is a visual census method with a census area of 250 m^2 so that reef fish recorded only in the census area. The method of measuring the number of reef fish species recommended for a narrow area of research is the cruising method in the hope that all reef fish species can be recorded.

Suitability Analysis of Tourism

The determination of the suitability in Seliu Island tourism is a collection of data obtained in the field data obtained through scoring (based on field data collection of abiotic and biotic parameters) which is then described on the map of the suitability of diving tourism location in Seliu Island (Figure 1). Based on the calculation of 6 conformity parameter of diving tourism Seliu Island is included in 3 (three) Class Class category appropriate (S2) with value 59% for 3 Station. This result is the influence of the role of the conformity parameter which gives great influence like brightness and coral cover.

Brightness Station 1, 2 and 3 range 59%, while the value of coral cover of Station 1, 2 and 3 range 51% - 56%. Coral coral cover is associated with the number of coral reef and coral growth forms, although at 3 research stations the value of coral growth and coral fishes is not very different. The next conformity factor which also gives the role is the velocity of current and depth. The current velocity at all stations is classified into the slow currents classified into the class is very appropriate, while the depth to 3 stations into the category suitable for diving activity. Abidin and Mohamed (2014) add dive activities that are too close to coral reefs in advertently diarrhea sediment, so that coral polyps covered with sediment.

Conclusions

Based on the research result, the value of diving tourism diving index of stations 1, 2, and 3 by 59% included in the S2 category is quite appropriate. With the S2 category (quite appropriate) the community can open diving tourism activities introduce Seliu island as one of the underwater tourism destinations. Diving tour map has been made with coordinate point that is station 1 S_03 ° 12'270 " - E 107 ° 30'751 ", station 2 S_ 03 ° 12'715 " - E 107 ° 30'768 " and station 3 S 03 ° 12'174 " - E 107 ° 30'807".

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Coral Cover Evaluation on The Impact of Tin Mining and Conventionally Marine Tourism in Bangka Belitung Archipelago Province

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Abstract

Coral reef ecosystems are the major support for the development of fisheries and marine tourism, as those fields become the leading sector in Bangka Belitung Archipelago Province and some other area in Indonesia. It is necessary to evaluate the impact of tin mining in Bangka and conventionally managed marine tourism in Belitung. This research was conducted in Karang Melantut, district of Sungailiat – Bangka for the impact of tin mining and Lengkuas Island, district of Seliu - Belitung, for the impact on conventionally managed marine tourism. Coral reef data collection was done in 2014 by 50 meter line intercept transect method with centimeter accuracy. The results showed that coral cover at Karang Melantut, Bangka, 0% (whereas the monitoring result in 2008 was 91.62%) and in Lengkuas Island, Belitung was 64.067%. The loss of coral reef was caused by tin mining sedimentation, as the coral covered by silt (Si) and turned into turf algae (TA). The results of conventional marine tourism in Lengkuas Island, Belitung, was surprisingly still able to maintain the good percentage of coral cover. These results indicate that the impact of tin mining is more dangerous compared with conventional marine tourism to the existence of coral reef ecosystems.

Keywords : Coral Cover, Tin Mining, and Tourism.

Introduction

Bangka Belitung Islands Province has wide of land around 16.281 km^2 (19.96% from wide total) and the waters is about 65.301 km^2 (80.04% from total wide). This province has beaches with 2.189,553 km length (longer than beaches in Hawaii where only 1.210 km length) with 950 small islands (Department of Maritime affairs and Fisheries, Bangka Belitung Island Province, 2014). The small islands are about 361 (2007). This condition must present this province plenty of natural capital with sea as main potential. Moreover, the sea condition in Bangka Belitung Island are mostly substrated sands since it is between south china sea and Java sea. This islands are also potential to develop tourism, unfortunately maritime tourism is not developed as well. It is still developed conventionally.

The potential should be a characteristic tourism in Bangka Belitung Island Province, but the sea has been damages by sea tin mining. Tin mining in the sea is not based on environment supports. As example: PT. Timah Tbk has 47 dredgers production in 2014 (as in draft Addendum documents of PT Timah Tbk, 2015). Meanwhile, the operation of dredgers in line with local sea tin mining. The *tailing* (waste of conventional tin mining are about 20 m^3/hours then the tailing of dredgers are about 250 m^3/hours. It means a dredger is equal to 12 conventional tin mining, where there are hundreds of conventional sea mining in the sea of Bangka Belitung. The tailing damages coral reef directly.

The survey has been conducted by exploration of coral reef, University Bangka Belitung from n 2007 – 2013 (published in Bangkapos, October, 15 2013) showed that; from 41 locations of coral reef only 10 locations still have good condition of coral reef. This research is to compare covered coral reef in sea and maritime tourism conventionally in Bangka Belitung Island Province.

Methods

Time and Study Sites

This research was conducted in October 2014 in Karang Melantut, Sungailiat district, Bangka regency by using sample and field survey. On the other hand, the impact of tin mining was in Lengkuas Island, district of Seliu district, Belitung. for the impact on conventionally managed marine tourism. Surveys for the location by swimming then went to spot sites with line intercept

transect. Coral reef data collection by 50 meter line intercept transect method with centimeter accuracy meter (Hill and Wilkinson, 2004).

Data Analysis

1. Percentage life form cover

$$\%\ life\ form\ cover = \frac{Length\ of\ each\ lifeform}{Length\ of\ total\ line} \times 100\%$$

2. Percentage of Life coral cover

$$\%\ life\ coral\ cover = \frac{Length\ of\ life\ coral}{Length\ of\ total\ line} \times 100\%$$

Criteria of coral condition based to decree of the minister of Environment Republic of Indonesia No. 04/2001 about standard criteria of coral reef damages

3. Index of Mortality (IM)

$$IM = \frac{\text{Percent cover (dead coral + ruble + silt}}{\text{Percent cover (dead coral + rubble + silt + life coral}}$$

Results

Melantut Spot – Bangka

Results of coral cover in Melantut spot on October 5th, 2014 with Line Interception Transect generally was covered by algae; Macroalgae, turf algae, corallite algae and *Halimeda*. Coral cover is 0% with coral mortality index is 1. This result showed the condition of coral reef is strongly damaged and in danger. Detail of data community on coral reef is in the Table 1.

Table 1. Result of covered community on coral reef in Melantut – Rebo, 2014

No	Category	Code	Length (cm)	% cover	%LC*	IMK**
1	*Turf Algae*	TA	1094	54.7	0	1
2	*Macroalgae*	MA	137	6.85		
3	*Halimeda*	HA	114	5.7		
4	*Alga Assemblage*	AA	51	2.55		
5	*Dead Coral*	DC	370	18.5		
6	*Silt*	SI	201	10.05		
7	*Coralin Algae*	CA	33	1.65		
	All		2000	100		

Notes : * = Percentage o Life coral
** = coral mortality index
Date : 5 October 2014
Location : 01°56’ 00,5” S dan 106° 12’ 54,8” E

Lengkuas Island - Belitung

Life coral covered in Lengkuas Island is 64,067%. This results was as good criteria condition of coral reef. Value of coral mortality index is 0. This value showed that the condition of coral reef ecosystem is stable, not in dangerous. This estimation based of there are not damaged. There are not dead coral recently, rabble and coral covered by silt. This condition signed that coral reef ecosystem in Lengkuas Island was eternal dan suitable. Detail of data community on coral reef was in the table 2.

Table 2. Result of covered community on coral reef ecosystem in Lengkuas Island

No	Category	Code	Length (cm)	% cover	%LC*	IMK**
1	*Dead Coral Algae*	DCA	592	19.733	64,067	0
2	*Acropora Branching*	ACB	837	27.9		
3	*Acropora Encrusting*	ACE	117	3.9		
4	*Acropora Digitate*	ACD	387	12.9		
5	*Acropora Tabulate*	ACT	412	13.733		
6	*Coral Branching*	CB	21	0.7		
7	*Coral Encrusting*	CE	37	1.233		
8	*Coral Folios*	CF	42	1.4		
9	*Coral Massive*	CM	54	1.8		
10	*Coral Submissive*	CS	15	0.5		
11	*Soft Coral*	SC	143	4.767		
12	*Alga Assemblage*	AA	301	10.033		
13	*Macro algae*	MA	42	1.4		
	All		3000	100		

Notes: * = Percentage of life coral
** = coral mortality index
Date: 17 October 2014
Location 02^{o} 32’ 18.7” S; 107^{o} 37’ 7.4”

Discussions

Melantut Spot - Bangka

Based of analyzed data in table 1, more than a half (54,7%) of o coral covered was changed to be turf algae (TA). Monitoring on 2008 – 2016 showed that was changed of coral community structure from Life coral to be dead coral covered by silt to be turf algae community domination. This condition was showed of sedimentation impacts from tin mining offshores. Melantut location spot about 5.5 km from Rebo Beach, Sungailiat Bangka. Life coral covered in Melantut spot was 91,62% on 2009 (Nurtjahya and Akbar, 2009). After 2010, coral reef begin dead caused silt covered by six cutter suction dredger and tens of floating conventionalist in mining around Melantut Spot.

Lengkuas Island - Belitung

Percentage of Life coral cover in Lengkuas island is 64,067%. This results was the good criteria condition of coral reef. Value o coral mortality index is 0. This value showed that the condition of coral reef ecosystem is stable, not dangerous. This estimation based of there aren’t damaged. There aren’t dead coral recently, rubble and coral covered by silt. The concept of marine tourism in Lengkuas island is conventional, it is because without charring capacity and charring patch based, but the condition of coral reef was healthy.

Conclusions

The research of coral covered on the impact of tin mining and conventionally marine tourism are to indicate that the impact of tin mining is more dangerous compared with conventional marine tourism to the existence of coral reef ecosystems. The loss of coral reef was caused by tin mining sedimentation, as the coral covered by silt (Si) and turned into turf algae (TA) so that very difficult to recovery.

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Preliminary Study on Failure of Seaweed Cultivation at Tablolong - Kupang Bay

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Abstract

Seaweed cultivations in Tablolong – Kupang Bay have recorded failures since 2013. The causes are poorly understood, but probably associated with kinds of wastes polution. Accordingly, observations to discover kinds of wastes have been done recently along the shoreline of Kupang Bay. So far, the study recorded four findings. In the northern shore line, agricultural born waste was dominant. Although mud was the most obvious waste, chemicals such herbicide seems worthy considered. In the middle part of the shoreline, domestic waste, both solid and liquid, were dominant. In the mid-southern part of shoreline however, sea transportation and industry born liquid wastes containing oils were dominant. Parts of solid and liquid wastes floats or dissolve in the underlying water, flowing from north to south and cause turbidity degrees along the shoreline of Kupang Bay; highest turbidity in the northern shoreline and low turbidity in the southern shoreline including in Tablolong and Bolok. Based on these findings, we conclude that the floats and dissolved substances stated above are also responsible for failures of seaweed cultivation in Tablolong and Bolok in the last five years. Further study to find out dissolved substances from wastes responsible for poor growth and failure of seaweed cultivation in the above mentioned area is needed.

Keywords: seaweed, Kupang Bay, domestic waste, agricultural waste, sea transportation.

Introduction

It is widely recognized in Indonesia that the fisheries sector plays an important role not only in producing protein through capture fisheries and aquacultural but also through seaweed farming. In Kupang Bay, attempts have been made in the past to cultivate seaweed and recently effort is being made to integrate seaweed culture into seaweed processing industry in Kupang. At the experimental and field level attempts were made by farmers to farm seaweed *Eucheuma cottonii* by using the rope and raft technique has yielded 541367 tons (wet) in 2015 and 5 times harvests are possible per year. Fluctuation of seaweed production observed so far, mostly affected only by market price. For this reason, the potential exists to develop a small-scale industry based on seaweed.

However unsustainable seaweed culture has been observed recently in Tablolong and Bolok, both in Kupang Bay. According to farmers, gradual failures of seaweed culture have been observed since 2013. The phenomenon of failure seaweed culture in Tablolong and Bolokwhere seaweed were cultivated by off-bottom method was very slow, britle or probably no growth at all in the area has been observed before 2013 but significant economic impact was noticed in april 2013. In the time we collected informations of this problem, allseaweed farmers in these two villages were not cultivating seaweed because they believed that the result is uncertain.

Studies have been undertaken by students and some NGO's to overcome this problem and to strengthen seaweed culture as lifelihood of people in the two villages. Most of experiments were tested of introduced species or seedlings prepared in new ways however, no promising results have been reported.Furthermore, closer look at the testing works done so far, it was clear that the works were undertaken mostly in technical aspects. Considering that for the past five years, seaweed culture in the two villages have failed remarkably on a large-scale, and the trend of seaweed culture failures probably continuously becomes eminent also for the rest of Kupang Bay shoreline, the need to study the phenomenon on ecological ground was therefore necessary.

Methods

This study was conducted to find out kinds of wastes influx to Kupang Bay and then to get insights on its relation to the failure of seaweed culture phenomenon in Tablolong and Bolok - Kupang Bay. The main source of information was the available scientific reading matterials. In addition, broad observations on physical condition along the shore line of Kupang Bay, specifically in Tablolong and Bolok shore line as well as interview of fishers was also carried out.

Results and Discussion.

This study have recorded four sources of wastes which worthy to be considered as main possible causes of the failure in seaweed culture in Tablolong and Bolok, namely agricultural run-offs, domestic waste from Kupang city, port and industrial waste and damages on seagrass beds and corral reefs.

Agricultural run-offs

As reported elsewhere, the recent occurence of seaweed culture failures has been associated with the influx offloating mud from agricultural run-offs. More spesifically, Hartoko and Kangkan (2009) pointed that nitrate and phosphate are possible factors responsible for seaweed growth in Kupang Bay.Current field observations showed that more than 40% of northern shoreline of Kupang Bay was heavilly affected by floating mud from agricultural run-offs during rainy season. As a result,brown colored sea shorebelts and spots were displayed from Pit'ay village seashore area untill Noelbaki seashore area. Interestingly, although the rainy season in this particular area only lasted 4 moths,this brown coloured belts and spots were remained there along the yearbecause continuous wave actions makefloating mud in shallow seawater difficult to settle into the bottom of the sea. Rais (1994) related sea surface and sea bottom dynamics to extreme temperature dynamics in respected atmosfeer.

It seems that some of floating muds eventually flows to the southern part of Kupang Bay along with sea water current and caused relatively high turbidity of sea water just in front of Kupang city (midle part)and also in the southern part of Kupang Bay including Tablolong and Bolok. Corral reefs, seagrass bed and seaweed alongthis seawater currentis probably affected by the floating mud as confirmed by moderate to severa condition of seagrass bedsfound in Tablolong and Bolok(Amtiran *et al*., 2017) as well as corral reef condition in all areas of Kupang Bay (Sine *et al*., 2013).

Effects of influx floating mud from agricultural run-offs on local seaweed in Kupang Bay is poorly understood due to lack of availableinformation. Umar (1999) reported a list of local seaweed along with their seasonal abundance. Those grows and abundant during rainy season were *Acanthophora muscoides, S. spicifera, Anadyomene wrightii, Caulerpa certulariodes, C. racemosa, C. serrulata, Dyctyota cervicornis, Enteromorpha spp., Sargassum spp., Turbinaria ornata, Turbinaria spp., Ulva lactuca* and *Ulva reticulata*. Sato *et al*. (2010) reported that seaweed beds perform the role of fixing carbon dioksideand absorber of nutrients in theseawater and by this way keeping the water clean and preserving the marine environment.The facts of seasonal distribution of local seaweed as described by Umar (1999) and absorbtion of nutrient and carbon diokside as explained by Sato *et al* (2010) explains in part why *E. cotonii* grows well after rainy season until august in Kupang Bay as compared to it's growth after august until november.Recent observation of seaweed culture in Sulamu (northest part of Kupang Bay) between april and august showed that seaweed grows well in low floating mud areas.

It is also widely recogized that herbicide and pesticide were commonly used in agricultural areas, mostly in the low and up land area close to northern part of Kupang Bay. However, noscientific reports have been produced so far. The possible effects ofchemicals used inagricultural practices still a question to be answered in the next future.

Domestic waste loading

The possible significant waste loading from industry and domestic sources was observed along the shorelinejust in front of populated area. Kupang city is located to the seaward side, on the southern coast of the bay. On 2011 population of Kupang city was 349.344 people. Accordingly, potential exists ofhazardous waste loadings from industry and domestic sources as well in forms of solid and liquid waste. Some speculate that domestic and industrial waste loadings are moderate, whereas loading from agricultural sources are relatively high as described above.

The most recognized domestic wasteare food debris from household and solid matterials made of plastic and paper. Observations showed that most of household disposed their waste at community bins and sites followed by the collection of waste by government agencies. In this way public in municipalities and also marine environment of Kupang Bay are prevented and exposed to harmful effects of the waste. Thus, so far this preliminary study recorded no clues to uncover the possible negative effects of domestic waste on marine environment in general and on seaweed culture failures phenomenon in Tablolong and Bolok.

However, some investigator still implicitly pointed human act through unwise domestic and industrial waste disposal has indirect effect on failure phenomenon of seaweed culture in Tablolong and

Bolok.The failure was probably caused by seagrass and corral reef ecosystem function performace, whereas seagrass and corralreef degradation caused directly by human actions. Pirzan and Utojo (2017) reported that there is an association between the growth of seaweed culture in Kupang Bay to seagrass beds and corral reef condition. Similar attitude has been shown by Amtiran *et al* (2017).

Sea transport and port waste

Bolok and Tablolong are considerably close to Tenau and Bolok ports. Accordingly, wastes from ships were susceptible as cause of seaweed culture failure. Characteristic for ship waste is the fact that many different types of waste occur in relativelly small area. Waste from ships were dominated by oily and greasy from engines. Other hazardous waste originated on board including bilge water, paints and varnish. Besides solid and liquid waste, carbon dioxide and other gases are emitted by the vessels engines.

Broad observations around Tenau, Bolok, Namosain and nearby ports gave insights that the shorelinesclose to harbour are dead zones. No mangroves in the beach, no local seaweeds, and no seagrasses. We concluded that the dead zone closer to harbour are most probably caused by greasy and oily substancescome from ships together with bilge water, paints and varnishes.When these substances spilled into the water, they may undergo a variety of weathering phenomena as explained by Prince (1995) including floating,evaporating or dissolve in the underlying water, and some polymerizing. Substances dissolved in the underlying water together with the new formed polymers can be transported by water current far away from harbour and eventually setled in some marine area such as in Tablolong and Bolok and cause damages on seaweed cultures. More studies are needed to know the negative effects of wastes spilled from ships entering Tenau, Bolok, Namosain and nearby ports in order to expand and strengthen the seaweed industry in Kupang Bay, research to find out the causes of seaweed culture failure observed recently in Tablolong and Bolok is considerably important. The causes could be physical, chemical or biological.

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TOPIC D : CAPTURE FISHERIES

Sampo (Sambi-Sambi Pocong), an Environmentally Friendly Octopus Fishing Gear (Case Study: Bulutui Fisherman Village)

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Abstract

Octopus is a mollusk that belongs to Cephalopod class. The octopus has 8 arms (not tentacles) with a vacuum in the form of concave spheres on the arm used for splinting on the seabed to capture its prey. The development of octopus fishing gear has been done by the community of fishermen in Bulutui Village, West Likupang District, North Minahasa, North Sulawesi Province. The purpose of this research are 1) to investigate the level of environmental friendliness of the sampo fishing gear, 2) to determine the best color type to be used in the sampo fishing gear, 3) to determine the best fishing time for octopus using sampo. We concluded that: 1) the environment level of sampo fishing gear used by Bulutui fishermen was fall into very environmentally friendly category, 2) the best cloth color for sampo fishing gear was black without real effect of brown color and 3) The best octopus catch time was between 07.00 - 12.00 am.

Keywords: Sampo (sambi-sambi pocong), Octopus, Bulutui.

Introduction

Prior to be inhabited, Bulutui village was used to be part of Likupang coastal area overgrown by wild water bamboo forest known as "Bulutui". The name of the village of Bulutui itself, in fact, was taken from the name of that bamboo. According to customary leaders in the village, during the colonial era and the *Permesta* rebel, sharpen bamboo was used as a weapon known as "*Bambu Runcing*" in Indonesian. Demographically, Bulutui village is located in West Likupang sub-district, North Minahasa district, North Sulawesi province. The total population of Bulutui was 688 people, the majority of whom work as fishermen. The number of fishermen in Bulutui village was 177 people, with all being Muslim pouplation (Bulutui village data, 2015). The population of Bulutui village is a combination of various ethnics such as Mandar, Bajo, Buton, Ternate, Ambon and Sangir. Although they come from various ethnic background, their customs and cultures merged into one and formed a fishing village in the village of Bulutui. Their livelihood is highly dependent on marine resources and rely on seafood as protein source. The settlement pattern of the fishermen community in the Bulutui village is quite unique. On the left side of the village, the settlement was on the hillside, whereas in the right side the houses were built in the sea.

Fishermen of Bulutui village have been using various fishing gear such as trap, cage culture, nets and fishing rods. Among those fishing gears, the most interesting one to be investigated was "*sambi-sambi Pocong*" or *sampo* that was used to catch octopus. This fishing gear was considered as an environmentally friendly fishing gear based on several criterions such as gear selectivity, harmless to both marine habitats and fishermen as well as consumers, and producing high quality of seafood in term of their freshness. Other criterions such as low by-catch and production and also affordable to be made by the fishermen were fulfilled by this gear. Considering these criterions, therefore, it is necessary to examine the *sampo* octopus fishing gear Bulutui fisherman village to determine the level of environmental friendliness, the best color on the *sampo* gear, and the best catch time.

Material and Methods

The research was conducted in the second week of October until the first week of November 2015, in Bulutui village, West Likupang district, North Minahasa district, North Sulawesi province. The method used in this research was survey method, by doing direct observation in the field as well as conducting interviews and discussions with octopus fishermen. The type and source of data was divided into two categories, primary data obtained directly through observation and direct interview using prepared

questionnaires and secondary data from Polytechnic of Marine and Fisheries Bitung student's field work results in Bulutui Village. The primary data included the color of the cloth for the octopus fishing gear, fishing time and average of octopus catch.

Analysis Anova Single Factor at 0.05 confidence level was used to determine the best color type for *sampo* gear. If Fcount > Fcrit, then H_0 (no difference of catch using different color) is rejected meaning that color used in *sampo* affected the octopus catch and therefore H_1 is accepted.

Data Analysis

Level of Environmental Friendliness of *Sampo*

The level of environmental friendliness of *sampo* fishing gear was conducted against FAO requirement consisted of 9 criterions as follow:

1 The fishing gear must have high selectivity;
2 Fishing gear does not damage the habitat and breeding grounds of fish,
3 No harm to fishermen;
4 Produce good quality fish;
5 Production does not endanger consumer health;
6 By-catches are minimal;
7 The fishing gear has a minimum impact on biodiversity;
8 Not catching fish species that are protected by law or threatened with extinction;
9 Be socially acceptable.

The way of weighting of the 4 sub criteria is to create following scores:

Score 1 for sub criterion D
Score 2 for sub criterion C
Score 3 for sub criterion B
Score 4 for sub criterion A

The maximum value of scores obtained was 36 points, with the category of environmentally friendly fishing gear was divided into 4 categories with a range of values as follows:

1 - 9 = very unfriendly
10 - 18 = not environmentally friendly
19 - 27 = environmentally friendly
28 - 36 = very environmentally friendly

Anova Single Factor Analysis

Our analysis using ANOVA single factor showed that different fabric colors on the *sampo* affected the octopus catch with black being the most desirable color.

Observation of Environmentally Friendly Equipment

Total value obtained for *sampo* gear based on FAO (1995) criteria was 29 (Table 1). The *sampo* fishing gear met all the 9 criterions of environmentally friendly fishing gear with result suggested it was in category of very environmentally friendly gear.

Table 1. Result of observation of environmentally friendly fishing gear.

No.	Criterion of environmentally friendly fishing gear by FAO (1995)	1	2	3	4
1.	The fishing gear must have high selectivity				√
2.	The fishing gear used does not damage habitat, shelter and breed fish and other organisms		√		
3.	No harm to fishermen (octopus catcher)				√
4.	Produce good quality octopus			√	
5.	The product does not endanger the health of consumers				√
6.	The minimum by-catch				√
7.	The fishing gear used should have a minimum impact on the biodiversity		√		
8.	It does not capture the type protected by the law or is threatened with extinction			√	
9.	Accepted socially			√	
	Total				**29**

Materials

Simple materials below were used for making a *sampoo* fishing gear which were easy to get at low prices:

1 Black or brown used fabric
2 2 - 3 kgs of weighing stone
3 Weights made of cement mixture
4 5 - 7 pieces of wire hook replacement
5 String line to fasten the baits

Results and Discussion

Operation Process

Sampo fishing gear was lowered to the 1.5 to 2 meters depths in coral reefs, although sometimes fishermen in Bulutui descended it up to the bottom of the waters depending on the environmental conditions where the octopus located. By the time the gear was lowered, the position of the fisherman's head should be bent to look down and one hand was used to row a boat, and occasionally jerked, to lure the octopus out of hiding. After that when the octopus was finally captured then the fisherman lifted it up onto the surface. The octopus caught was held at the ocular point to kill it and after that the octopus was put into the available bucket in the boat.

Aspects of Environmental Friendliness

The *sampo* fishing gear belongs to wounded type fishing gear, as it catches parts of the body from an octopus caught in *sambi-sambi* or hook. This gear does not harm the aquatic environment or the area around coral reef where the octopus is foraging or hiding. Judging from the 9 criterions consisting of several sub criterions that match the circumstances of the *sampo* gear. This octopus fishing gear catch only one target species with approximately the same size and therefore fulfil the first criteria of selectivity. None or very minimal damage to octopus habitat is another characteristic of this gear making it fulfil the second criteria of harmless to habitat or fish breeding ground. During operation, *sampo* fishing gear is lowered into seawater with distance between octopus hiding place and this gear is about 30-50 cm, therefore no direct contact between fishing gear and coral reefs.

The third criteria of harmless to fishermen is also accomplished by this *sampo* fishing gear. Although there are hooks connected to this gear, very rarely fishermen are injured because this tool because most of fishermen using this gear are skillful and experienced fishermen. The fourth criteria of high quality product is passed by this gear because the caught octopus is directly inserted into the bucket container on the boat. Also, the distance of fishing area to the fishermen house or small harbor is only about 30 minutes by boat, therefore ensure the freshness of octopus condition before they were sold to the collector.

The fifth criteria regarding the consumer safety is perfectly in line with this gear operation to catch octopus. Octopus from Bulutui are either sold to restaurants in Manado or consumed by the fishermen community themselves. The sixth criteria is related to the first criteria which is by catch products from fishing. Operation of this fishing gear is not produce any by product because the fishing gear is only dedicated to catch octopus using bait different from other fishing gear such as nets or other gill nets. Thus, this also fulfils the seventh criteria of minimal damage to biodiversity. Moreover, this gear target is octopus which is not considered protected species by both Indonesian and international laws. Therefore, the eight criteria is also accomplished.

The last criteria of environmentally fishing gear is social acceptance. The *sampo* fishing gear meets 4 items of the following requirements for social acceptance: 1) very low investment cost, 2) economically advantageous, 3) not contradicting culture and custom in Bulutui village, 4) not contradicting existing customary law as well as local law.

The last part of the data is color choice of octopus caught using *sampo* gear. Higher average catches of octopus by Bulutui fishermen was found when they fished at 07.00 to 12.00 am with an average catch of 1.5 to 2.0 kg and 1.5 to 1.8 kg (Table 2). Two fabric colors were used in sampo, brown and black, that were installed using used fabric from household items such as towel, shirts and pants. Single factor anova showed Fcount of 0,248 was smaller than Fcrit 18,512 and P-value was 0,67 > 0.05.

Therefore, it can be concluded that there was a difference in the average number of catches with the use of different fabric colors on the *sampo* fishing gear.

Table 2. The average catch of octopus fishermen Bulutui village

		Time of Catching	
		$07.^{00} – 12.^{00}$	$13.^{00} – 17.^{00}$
Color of Pubric	Black	1,5 – 2,0 Kg	1,0 – 1,5 Kg
	Brown	1,5 – 1,8 Kg	0,8 – 1,0 Kg

Conclusion

Based on the research results and discussion, we can conclude that:

1 The environmental level of the *sampo* gear used by fishermen in Bulutui village is very environmentally friendly.
2 The best fabric color for *sampo* fishing gear was black without real effect of brown color.
3 The best octopus catching time is 07.00 - 12.00 am.

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Analysis on Layang (*Decapterus macrosoma*) Fisheries in Pohuwato, Gorontalo Province

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Abstract

Layang fish (*Decapterus macrosoma*) is one commodity found in the Tomini Bay which have high potential and economic value. Fishermen catch those fish using various types of fishing technology. The purpose of the study was to know if the Layang catches were influenced by extrinsic factors such as fishing zones, water depth, and season and to know revenue per unit effort (RPUE). The data used in the study are primary data, especially data of fish resources were obtained through direct observation and interviewing actors of fisheries (fishermen/crew, ship owners, collectors, TPI officers and other stakeholders), and the option using a list of questions/questionnaire structured in accordance with the purpose of the study. Secondary data were collected through fisheries statistics reports includes statistics data of fishery households (RTP), statistics of fleets and fishing gear, production data from the Marine Affairs and Fisheries of Gorontalo Province, Marine Affairs and Fisheries of Pohuwato, the Central Bureau of Statistics of Gorontalo Province, Regional Planning and Development Board of Gorontalo Province, and Tomini Bay Sustainable Coastal Livelihoods and Management (SUSCLAM). Other data were taken from scientific publications, local publications and other documents. Data were analyzed to determine the allocation of fishing effort and abundance of fish stocks (resource abundance index) using catch data, the number of trips/boat/gear in the time series. The catch per effort (CPUE), analysis of fishing effort allocation namely monthly seasonality index (%) and forecasts of economic benefits using analysis of revenue per unit effort ($RPUE_j$). The results showed that factors fishing gear, depth and seasons have significant effect to catch tuna ($p < 0.05$), while "fishing ground" did not affect the catches of tuna. Based on Monthly Seasonality Index (I_j) showed that the highest Ij in Septembert was 65.83% and decreased in Augustto be 64.37%, while the highest RPUE value occurred in May with value of IDR 52,693,333.

Keywords: CPUE, extrinsic factors, fishing zones, RPUE, fishing season, water depth

Introduction

Pohuwato Regency is located at the western of Gorontalo Province, and is an expansion of Boalemo Regency on 6 April 2003.Geographically,Pohuwato Regency is located between 0^0.22' - 0^0.57' LU and 121^0.23' - 122^0.19' BT. On the northern part of this location is Buol Regency of Central Sulawesi and Sumalata District of North Gorontalo, while in the eastern part is Managgu District of Boalemo. On the southern and the western parts of the location are border on Parigi Moutong and Buol of Central Sulawesi, respectively. It is surrounded by territorial waters covering ± 3,292.71 km^2 with coast line of ± 100 miles (± 160 km). Ten of 13 districts are directly adjacent to the Tomini Bay. The cocentration of fishermen inhabits 40 villages among those districts.

The capture fishery resources potential is dominated by kerapu, beronang, cendana, kuwe, ekor kuning, cakalang, layang, tongkol, selar and tuna. The potential utilized of those fish in 2013 was 34,303 tons (Marine Affairs and Fisheries of Gorontalo Province, 2013) with production was more than 2,820 tons. Among those fish, Layang fish (*D. macrosoma*) is very important pelagic fish caught in Pohuwato waters and lead to be exploited intensively. Layang fish is a stenohaline fish which may tolerate narrow salinity range of 32 – 34 ppt. The fish is a schooling fish in the clear waters and zooplankton feeder. The fish is commonly caught in the waters of 20 – 30 miles away from shoreline (Hardenberg 1937 in Taeran, 2007).

The potential of fisheries resources in Pohuwato waters cannot be optimally exploited due to fishermen in the level of small scale using traditional fishing gears and technology. Fishing fleet of 6 – 7 m length used by fishermen equipped with outboard machine ("katinting"). In 2007, the number of those fleets amounted of 978 units (61% of total number of fishing fleets), while fleets without machine were

31%. There is a traditional fishing activity using local knowledge which they catch fish without fish resources sustainability consideration. It may have an implication of loss resources which in turn may contribute to the loss of fishermen jobs and fishermen income and local government revenue. The fisheries sectors have long been efforted by fishermen but because technology used is traditionally that productivity of the fishermen is still not optimal (Marine Affairs and Fisheries of Pohuwato Regency, 2013). The purpose of the study was to find out whether layang fish catches are affected by extrinsic factors of fishing zone, water depth, and season. It was also to find out the income of catch per unit effort (CPUE).

Materias and Methods

The study was conducted in Pohuwato waters (Figure 1). The survey method was used to collect data including personal interviews using a questionnaires, observations, and data archiving. The location and fisherman samples were chosen purposively, adapted to the research objectives (Adrianto, 2005).

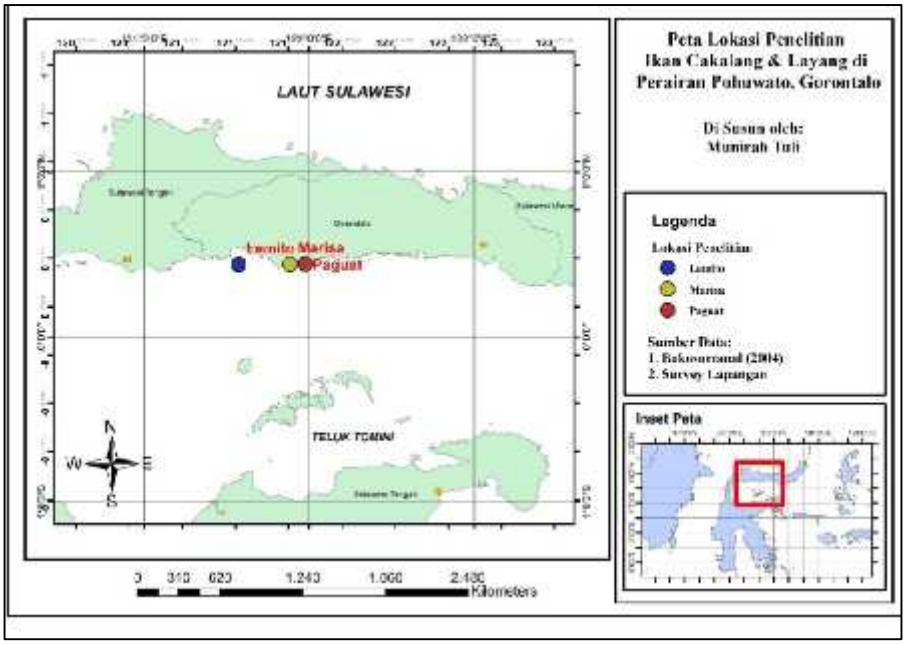

Figure 1. Map of study locations

The tool used in the study was a digital camera which was used to create an object study documentation, GPS (Global Positioning System) for determination of fish landing position, "stationery for writing data and scales for measuring fish weight and fishing boat equipped with an echo-sounder. The data of fish length and weight recorded were fish catches measured in the "fish landing station (TPI)" and on the fishing boat recording about the number of fish caught by each fishing fleet. Water parameters were measured in the same of fishing activities in the sea. Data of daily catches were recorded such as total catches of fishermen, total effort per fisherman, fishing ground, number of fishing gears used, and fish price.

Data were analyzed to know the relationship between total catch and fishing zone, habitat, water depth, season, and allocation of fishing effort. The logistic probability model was used to analyze the relationship between catches and effort, and factors influencing catches (Widarjono, 2010). The purpose of the logistic regression analysis is to obtain the best simplest model which in line with the biological sciences to explain the relationship between the response variables and the independent variable variables (explanatory variables) (Hosmer and Lemeshow, 1989). Allocation of fishing effort data, the fishing gears have to be standardized first.

$$CPUE_s = \frac{Ci}{f_i}$$

$$FPI_s = \frac{CPUE_s}{CPUE_s} = 1$$

$$FPI_i = \frac{CPUE_i}{CPUE_s}$$

Standard effort = = $FPI_i * f_i$

CPUEs : catch per effort of fishing gear standardized
$CPUE_i$: catch per unit effort of fishing gear to i
C_s : number of catch types of fishing gear standardized to i
C_i : number of catch types of fishing gear to i
f_s : number of effort of fishing gear standardized types
f_i : number of effort of fishing gear type to i
FPI_s : capture factor of the fishing gear standardized
FPI_i : capture factor of fishing gear type to i

The binary logistic regression is a method of data analysis used to find out the relationship between binary or dichotomous response (y) variables with predictor variables (x) that are polychotomous (Hosmer and Lemeshow. 1989) such as relationship of catch and fishing zone, habitat, water depth, and season.

$$\mathbf{g(m)_{ijkl} = \mu + fishing\ zone_i + habitat_j + water\ depth_k + season_l + \varepsilon_{ijklm}}$$

Fishing zone : influence of the zone i(1-3)
Habitat : influence of the habitat j (1-2)
Water depth : influence of the depth k(1-4)
Season : influence of the season l(1-3),
εijkl : error

The allocation of fishing effort was analyzed by reviewing the Monthly Seasonal Index (Ij), while the economic profit forecast used Revenue per Unit Effort (RPUE). Seasonal monthly index (Ij) (%) was used to find out the fluctuations of abundance in each month. The value of Ij was obtained using the Makridakis et.al (1983 in Bene and Tewfik, 2000) equation:

$$I_j = 100X \frac{1}{K} \sum_{k=0}^{K} \frac{x_{j+8k}}{T_{j+8k}}$$

I_j : Monthly Seasonal Index of j (j=8months)
K : {0, ... K-1} is the number of seasons (capture time) for the entire time series (8months)
$x_j + 8k$: catch data in the month of j + 8k
$T_j + 8k$: the trend value related to the average of the catch in the month of j + 8k

The Catch per Unit Effort (CPUE) and Revenue per Unit Effort (RPUE)

The CPUE was amount or weight of the catch obtained from one unit of fishing gear over a period of time, which was the abundance index or abundance of a fish stock in kg per ha.

$$CPUE_i = \frac{Ci}{f_i}$$

C_i : the number of catch types to i
F_i : the number of effort of fishing gear to i

The economic profit forecasted from RPUE analysis were used to determine the feasibility of investment using the calculation of bioeconomic of income CPUE or RPUE analysis (Bene and Tewfik, 2000):

$$RPUE_{ij} = CPUE_{ij} \times p_{ij}$$

$CPUE_{ij}$: $CPUE_{ij}$ value the stock to i in month to j (assumption to reflect the availability or abundance of stock average in month to j)

p_i : the stock price to i for month to j (reflecting the targeted economic incentives)

Results and Discussion

Relationship Between Catch and Fishing Zone, Water Depth, and Season

There were fishing gears of purse seine, gillnet, hand line and boat lift net operated for fishing activities of fishermen. The number of catches and fishing effort were standardized based on fishing gear of hand line standardization in the period of 2005 – 2013. According to "the wald test", it was obtained that type of fishing gears has significant effect on catch number ($p < 0.05$), while other factors of fishing zone, water depth, and season have no significant effect on total catch (Table 1).

Table 1. Wald test of layang fish

Variable	b	S.E.	Wald	df	Sig.	exp(b)
Fishing gear:			68.587	3	0.000	
Gill net	2.489	1.503	2.743	1	0.098	12.053
Boat lift net	4.817	0.697	47.790	1	0.000	123.613
Purse seine	7.665	1.176	42.505	1	0.000	2133
Fishing Zone:			1.743	2	0.418	
Bathial zone	0.961	2.169	0.196	1	0.658	2.614
Litoral zone	1.777	2.197	0.655	1	0.418	5.914
Water depth of 51-100 m	-1.853	1.126	2.708	1	0.100	0.157
Season:			1.778	2	0.411	
transition season	0.701	0.876	0.641	1	0.423	2.016
productive season	-0.240	0.842	0.081	1	0.776	0.787
Constanta	-4.689	2.257	4.316	1	0.038	0.009

R^2 = 0.84 means the Y diversity that can be explained by the model of 84.4% while the remaining 15.6% is explained by other factors outside the model

The total catch of boat lift netand purse seineare significantly different compared to the hand line, while total catch of gill net is not significantly different compared to hand line. The boat lift net has an odds ratio of 123.61. It means that the chance of catching layang fish by boat lift net is higher 123.61 times compared to hand line fishing gear, while the odds ratio of purse seine catching was 2,133 means the chance of catching layang fish using purse seine was 2,133 times higher than using hand line. Logistic regression model of layang fish is

Logit (Y) = - 4.689 + 7.665 purse seine + 4.817 boat lift net
(Y is variable of fish catch)

Based on Spearman correlation between catch effort and total catch showed weak correlation of 0.2 which means production of layang fish is not influenced by fishing effort. Generally, the highest total catch increased in the middle of the year and reaching peak of total catch was in September (Table 4 and Figure 2). It is due to weather condition from July to October in Tomini Bay is calm allowing fishing activities of fishermen. The Anova test showed that total catch was affected by type of fishing gears, fishing zone, and water depth of fishing ground, while season was not significantly affect total catch (Table 2).

Analysis on CPUE and Revenue per Unit Effort (RPUE)

Monthly Seasonal Index (I_j)

The result of analysis showed that the highest seasonal index (Ij) of layang fish was August namely 65.83% and decreased gradually to be 64.37% in September (Table 3). Fluctuation of Ij is presented in

Figure 2. To find out if the capture of fisherman responded to any period of fish abundance, the data was computed to be the Ij data and effort (Figure 3).

Data in Figure 4 showed that fishermen always responded to the every fish abundance season, although its respond was relatively similar every month. Total effort increased parallel to increasing fishing effort. The information of fishing seasons will help fishermen to do planning in term of fishing activities efficiency. Fishermen may catch fish efficiently and arrange the number of fishing fleets and fishing seasons. However, the government policy through the Fisheries and Marine Affairs Office to regulate the number of fishing fleets in order to prevent overfishing.

Table 2. ANOVA test on parameters affecting fishing effort of laying fish

Variable	Rataan	SD	p-value
Type of Fishing Gear			
õ Boat lift net	1.61^{bc}	0.85	0.000**
õ Gill net	1.00^{c}	0.00	
õ Hand line	4.85^{a}	3.73	
õ Purse seine	2.55^{b}	1.50	
Water depth			
õ 51 – 100 m	2.00^{b}	1.38	0.024*
õ > 100 m	3.62^{a}	3.29	
Season			
õ Less productive	3.11^{a}	3.31	0.594^{ns}
õ Transition season	3.27^{a}	2.86	
õ Productive season	3.08^{a}	2.91	
Fishing Zone			
õ Bathial zone	5.15^{a}	4.17	0.000**
õ Litoral zone	2.38^{b}	1.50	
õ **Neritic**	**1.25^{b}**	**0.46**	

Note: ** = significantly at α = 0.01; * = significantly at α = 0.05; ns = not significantly different; number with different characters = significantly different

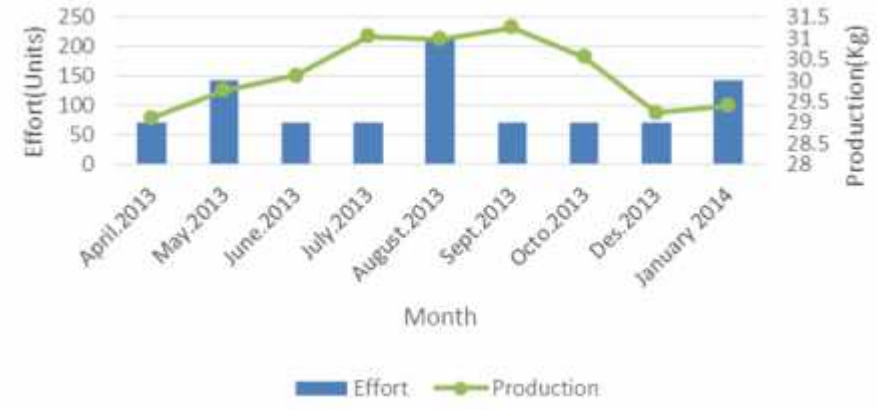

Figure 2. The relation between fishing effort and production of layang fish

Table 3. Seasonal monthly index (I_j)

Period of observation	Seasonal Monthly Index (%)	Total Effort (unit)
Apr-13	22.58	29
May-13	37.06	30
Jun-13	42.91	29
Jul-13	61.44	29

Table 3. (continued)

Aug-13	64.37	31
Sep-13	65.83	30
Oct-13	51.69	29
Dec-13	24.87	29
Jan-14	29.26	30

Figure 3. Monthly Seasonal Index and Effort of Fishing

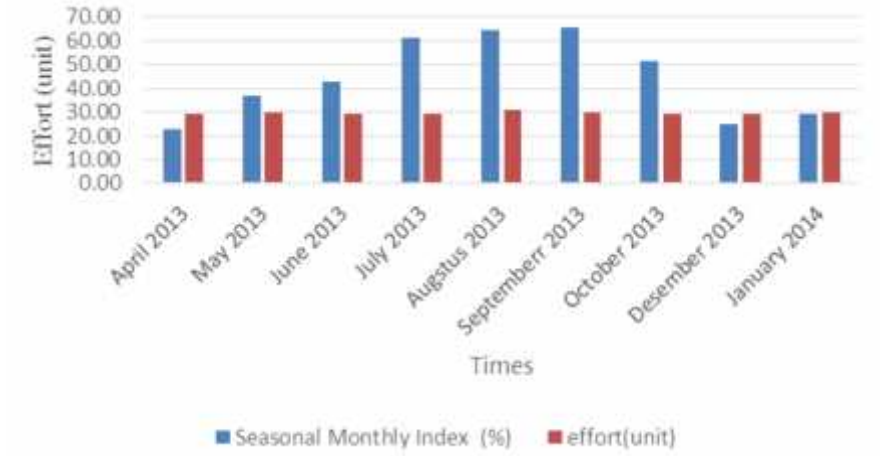

Figure 4. Fluctuations of Monthly Seasonal Index and Fishing Effort of Layang fish

Estimation of the Revenue per Unit Effort (RPUE)

Understanding of dynamics of both fish stock and fishermen have to be understood about population dynamics of fish which integrated with the analysis on fishermen behavior and fishing fleet dynamics (Opaluch and Bockstael, 1984; Hilborn, 1985; Allen and Mc Glade 1986; Hilborn and Walters, 1992 in Bene and Tewfik, 2000). One of them is the analysis on allocation of fishing effort and fisherman behavior using system approach based on RPUE. It is used to calculate the quantity of catch compared with the quantity of unit effort. The highest RPUE value of IDR 52.693.333 happened when reaching the highest fish production which occurred in May (Table 4 and Figure 5).

Relationship Between CPUE and RPUE

CPUE is defined as the number of catches of a type of fishing gear that is most commonly used in exploiting resources. It means decreasing in number of CPUE revealing fish population is not able to

support the fishing effort level. Otherwise the increase in CPUE indicates fish stocks have improved and require an increase in number of fishing efforts. Generally, the trend of fish catch will sharply increase in the middle of the year and reaching a peak in September. It is due to weather condition in surrounding of Tomini Bay from July to October is calm and save for fishing. Fluctuation of CPUE constitutes a reflecting on aquatic resources to external effect, where fishing activities could be assumed as the main effect. However, to maximize the fish production has to have ability on precise prediction of fish abundance to be a base of fisheries management (Kaurnauskas *et al*. 2010).

The purpose of analyzing data on fish stocks, including the relative abundance trend of CPUE data is to provide management advice. Fisheries management can have many goals, including conservation, political, social, and economic (Maunder *et al*. 2006). According to Adrianto *et al*. (2005), a sustainability evaluation of fish resources management policy should be conducted on ecological, social, economic, ethical and institutional aspects in order to formulate an objective management in order to maintain food availability in the present or in the future.

Table 4. Revenue per Unit Effort (RPUE) of Layang Fish

Time (Month)	Total Effort	Production (kg)	Price (IDR)	CPUE	RPUE
April 2013	29	2,315	411,000	80	32,809,138
May 2013	30	3,800	416,000	127	52,693,333
June 2013	29	4,400	113,500	152	17,220,690
July 2013	29	6,300	100,000	217	21,724,138
August 2013	31	6,600	123,000	213	26,187,097
Table 4. (continued)					
Sept 2013	29	6,750	100,000	233	23,275,862
Oct 2013.	29	5,300	138,000	183	25,220,690
Des 2013.	29	2,550	126,000	88	11,079,310
Jan 2014.	30	3,000	157,000	100	15,700,000
	Total	41,015			
	Average (Tj+8k)	5,126.88			

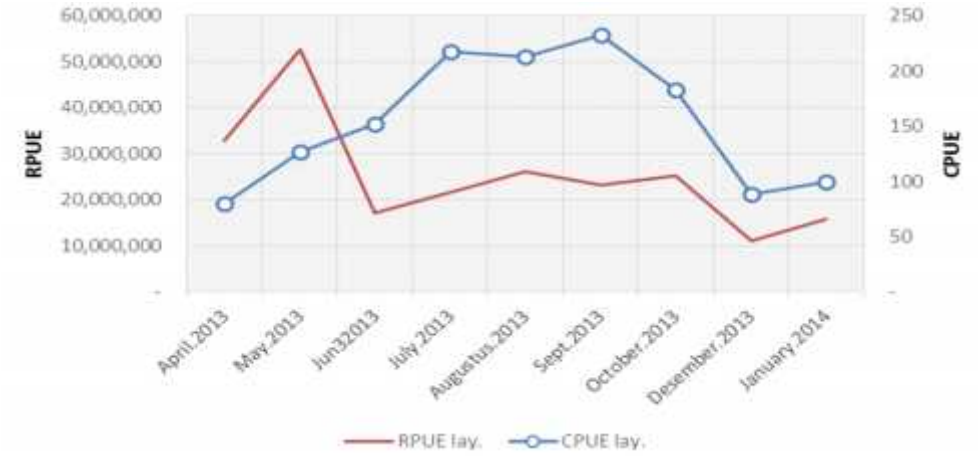

Figure 5. The Fluctuation of CPUE and RPUE of Layang Fish

Conclusion

The present study shows that type of fishing gear, water depth and season factors are significantly affecting catch production of layang fish ($p < 0.05$), while fishing zone is not significantly affecting catch production of layang fish ($p > 0.05$). Analysis on Monthly Seasonality Index (I_j) shows that MSI of 65.83% in September is the highest and then followed MSI of 64.37% in August. However, the highest of Revenue per Unit Effort (RPUE) of IDR 52,693,333 occurred in May.

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Selectivity of Fishing Gear and Capture Feasibility of Blue Swimmer Crab (*Portunus pelagicus*) in Pomalaa Waters

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Abstract

Gillnet, locally known as Pukat Rajungan, is the most widely fishing gear used by local fishermen in Pomala to catch blue swimmer crabs (*Portunus pelagicus*). The objective of the present study was to understand the characteristics of these fishing gears in the Gulf of Bone. Species selectivity was determined using the Shannon Index (*H'*) and crab-based capture was performed using *t–test* based on carapace width (*CW*) and body weight (*BW*) referring to the regulation made by the Minister of Marine Affairs and Fisheries of Indonesia No. 56 of 2016. The results showed that the amount of diversity of gillnet species varied from 0.00 to 0.64 or 0.28 on average. These results indicated that the gillnet had low selectivity to target species. The result of *t-test* showed that crabs the results of the gillnet caught are suitable to be caught ($CW \geq 100$ mm, $BW \geq 60$ gram).

Keywords: Gillnet, Blue Swimming Crabs *(Portunus pelagicus)*, Pomalaa

Introduction

Blue swimming crab (*Portunus pelagicus*) is an economically important fishery commodity in Indonesia. The potential of crab is abundant and distributed in all the waters of Indonesia (Syahrir, 2013; Ningrum *et al.*, 2015). It is estimated that the total potential of crab in Indonesia at 7.2 million tons/year (Sulistiono, 2009). Crabs have long been fished by the public both domestically and abroad. Crabs have been exported to various countries in the form of fresh or processed including Singapore, Malaysia, Japan, Hongkong, Taiwan and the United States (Adam *et al.*, 2006; Ningrum *et al.*, 2015).

The Ministry of Marine and Fisheries of the Republic of Indonesia (2011) recorded the export value of crab in 2007 ranks third after shrimp and tuna of 21.510 tons with a value of 170 million US dollars. Meanwhile, in 2011 the export increased 23.661 tons and reached the value of 250 million US dollars. In 2010, fisheries statistical shows a crab production in Indonesia about 43,002 tons. BPBAP Takalar (2015) reported in 2012, export of crabs and blue swimming crab reach 28.211 tons with a value of US$ 329.7 million, increased to 34.172 tones with a value of US $ 359.3 million in year 2013. Preliminary data in 2014, the volume of exports of blue swimming crab attains 28.090 tons with value of U.S. $ 414.3 million.

Blue swimming crabs, locally known as "*bukkang suji*", is one of high value economic commodities, such as shrimp and other types of fisheries in coastal waters and sea Pomalaa (Syahrir, 2011). This commodity has been utilized by local people to increase income and fulfill animal protein (Syahrir, 2014). Pomalaa is the coastal area and one of regencies in Kolaka that has potential fisheries, it is supported by the condition of the waters of the region bordering the Gulf of Bone that is rich in diverse natural resources, including the potential of natural resources fisheries catch amounted to 144.320 ton/year (La Hatta, 2007). The Bone Gulf and the surrounding area is the second largest contributor (21%) after the coast of North Java (28%) of the total production of blue swimming crab throughout Indonesia from 2001 until 2008 (Surjadi, 2009). The value of maximum sustainable yield (*MSY*) blue swimming crab resource in Kolaka is 129.997 kg with total allowable catch (*TAC*) of 103,998 kg (Syahrir, 2013).

The fishing gear used by fishermen in Pomalaa to catch crab (*P. pelagicus*) in the sea is a "pukat rajungan or *gillnet*". Pukat rajungan is a passive fishing gear that is static and quite effective to catch the blue swimming crab. The fishing gear in principle can be classified into the bottom gill net because it is placed in the bottom of the waters (Syahrir, 2013). In General, the pukat rajungan or gillnet consists of a webbing body, float line, float, sinker line and sinker. This fishing gear is specifically designed to catch the crabs, but (by-caches species are also caught allegedly due to the similarity of habitat between

the target and non target fish species. It is related to the condition of the waters which are the tropical waters and multi species, which have a very high level of water resources diversity.

The dependence of crab production from wild capture resulted in a decrease in the number of crab populations. This encourages the publication of Regulations by the Minister of Marine and Fisheries No. 56/PERMEN-KP/2016 on the prohibition on the catching and/or spending of *Panulirus* spp., *Scylla* spp., and *Portunus* spp. from the territory of the country the Republic of Indonesia. Article 4 paragraph 1 regulates that the catch and/or spending of *Portunus* spp. (with the Harmonized System Code 0306.29.10.00) from the territory of the Republic of Indonesia can only be done in conditions where the crabs are not in spawning season and the size of the carapace width over 10 cm or body weight of above 60 g per individual.

The purpose of this research was to know the level of selectivity of bottom gillnet to the catch species and the feasibility of catching crab the catch fishermen refer to Regulations of Number 56/PERMEN-KP/2016. This information will hopefully provide information about the characteristics of the blue swimming crab resources, so that it can be used as base information in the management of fisheries resources.

Materials and Methods

Survey method was used in the present study and explained descriptively (Hasan, 2002). Field sampling was done by directly following fishing operation with fishermen in fishing ground area of crabs in Bone Gulf area especially Pomalaa District, Kolaka Regency. Objects studied included the fishing gear units, fishing operations, and the captured crab. The tools used in this research were: gillnet, weights, calipers, cameras, and stationery. Field sampling was conducted during the east season from May to August. Nontji (1993) reported that the eastern monsoon season occurs between June and August (sometimes until September).

Blue swimming crab (*Portunus pelagicus*) is a prime target for bottom gillnet operated by fishermen in the study area. The composition of catch based on the type of commodities that are caught, observed and recorded to determine the diversity of the gillnet catches, a comparison between target and by-catch species. The measurement of crab biological parameters of the catches included the carapaceous width (*CW*) measured straight from both ends of the last anterolateral teeth using calipers with the accuracy of 0.05 mm, and the body weights (*BW*) of crab were weighted individually by using digital scales with the accuracy of 0.01 g (Figure 1).

Figure 1. Description of Measurement of the Crab Body Dimension of the Pukat Rajungan Catches. (Source: Ministry of Maritime Affairs and Fisheries of RI No. 56 in 2016, and research private documentation)

The analysis of the selectivity of gillnet were described through the Shannon diversity index. Wiyono *et al*. (2006) described that Shannon Index (*H'*) is an index used to explain the selectivity of fishing gear against the landed catches. The high diversity index values indicate that the fishing gear has a low level of selectivity rate, whereas low index values indicate that fishing gear has a high level of selectivity rate. Shannon's index is calculated by the formula:

$$H' = -\sum_{i=1}^{s} pi \ln pi;\ pi = \frac{ni}{N}$$

where: *H'*= Shannon diversity index; *pi*= Proportion of species caught; *ni*= number of individuals of the species caught; *N*= total number of species caught; *S*= number of species types) (Maguran, 1988).

Shannon's diversity index value criterion (Wiyono *et al*. 2006): *H'≈0* = low diversity, high selectivity of fishing gear; *H'>0.1* = high diversity, low selectivity of fishing gear.

An analysis of the feasibility of catching crabs of gillnet of fishermen in terms of biological aspects is based on the size of the carapace width (*CW*) and body weight (*BW*). This refers to the Regulation of the Minister of Marine and Fisheries No. 56 of 2016, that $CW \geq 100$ mm, $BW \geq 60$ g. Statistical tests were applied according to the *t-Test* is a Steel and Torrie (1993).

Results and Discussion

Results

Marine and coastal waters Pomalaa is one of the central activities of fishing crabs bordering with Gulf of Bone. The characteristics of the aquatic environment fishing ground blue swimming crab as existed in the Pomalaa waters, is a suitable habitat for crab. This is in accordance with the statement that some clan of Portunus inhibits diverse habitats, such as sandy bottom waters, muddy sand, sandy mud, coarse sand with dead coral fragments, especially in seaweeds of *Thalassia* sp. (Moosa *et al.*, 1980; CIESM, 2000; Sea-ex, 2001; Chande and Mgaya, 2003; de Lestang *et al*., 2003; Susanto *et al.*, 2004; Syahrir, 2013). The presence of crabs in aquatic waters is influenced by the nature of the crab resources, either in the form of behavior, habitat and its spread. Crab behaviors are influenced by several factors, among which are the natural progression of life, feeding habits, the influence of the Moon cycle and reproduction (Kumar *et al*., 2003).

Crab fishing operations conducted by Pomalaa fishermen are influenced by seasons. Generally, local fishermen recognize 3 (three) seasons, namely: southwest monsoon season (*peak season*) occurs from December to May with the catch ranged between 5-15 kg; transition season (*medium*) occurs from October to November with the results the catch ranged between 2-10 kg; northeast monsoon season (*off season*) takes place between June and September with the catch ranged between 1-5 kg (Syahrir, 2013). Nontji (1993) reported that the northeast monsoon season occurs between June and August (sometimes until September) that the wind blows from the east and southeast that is dry and relatively quick. Southwest season occurs between December to March from the west and northwest with a relatively high speed and it is the rainy season.

Activities catching crab in the region of study to take place throughout the year. The fishing gear used namely "pukat rajungan or bottom gillnet", this fishing gear is made specifically to catch the crab. The construction of the bottom gillnet is not so difficult because of the simple construction and materials is easily available in the market. In principle, these fishing gear can be classified into *bottom gillnet* because it is a gill net whose way of operation is placed in the bottom of the waters. The naming of these nets can be different according to the region or the naming is tailored to the name of the fish to be targeted by the catch.

The number of individual crabs (*Portunus pelagicus*) caught during the study ranged between 21-49 tail per trip or an average of 36.2 individuals per trip, while the weight crabs caught on each trip ranged from 2.61-4.70 kg or an average of 3.73 kg per trip (Figure 2). The
highest number was found in station II (Dawi-dawi) while the highest weight was found at station V (Hakatutobu). The fisherman catches belongs still profitable (Syahrir, 2014).

Low catches of blue swimming crab during the present study might be because the time when the study was conducted coincided with the northeast monsoon seasons from June to September (Nontji, 1993). At those times fishermen crab in the study area also experienced periods of famine with the catch is also relatively low ranging between 1–5 kg (*personal communication with fishermen*). It is expected that in that season the crabs in the study area are migrating.

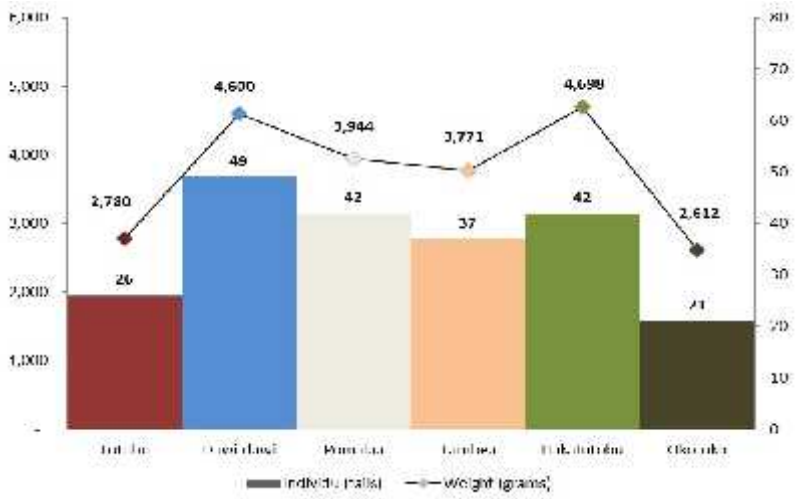

Figure 2. The catch of Blue swimming crab (*Portunus pelagicus*)

Selectivity of bottom gillnet

The catch is that to become a prime target for gillnet operated by fishermen in the study area of Blue swimming crab (*Portunus pelagicus*), but in fact participated also caught some kind of other marine organisms. Species composition of gillnet catches based on target and non-target species is presented in Figure 3. Target species found in all stations of the observations. Non-target species are found in 4 stations, i.e. the station I (20%), II (20%), IV (40%), VI (20%). The presence of by-catch might be due to the similarity of habitat between the target and non target species. It is related to the condition of the waters which are the tropical waters and multispecies, which have a level of waters resource diversity that are very high.

The composition of the gillnet catches operated by fishermen in the study area was used to describe the level of selectivity of the fishing gear. The selectivity level of fishing gear was obtained based on the results of the analysis of diversity index. McClanahan and Magi (2004) and Wiyono *et al*. (2006) described that type of diversity Shannon index can be used to conduct a fishing unit selection based on the type of species that were captured. The recommended fishing gear is a type of fishing gear that has high selectivity to the catches and had a high of size.

The results showed that the value of *H'* ranged between 0. 00 and 0.64 or an average of 0.28 (Figure 4). The lowest diversity index is obtained at the station III and V, while the highest diversity occurred in the station IV. Based on that, it was known that the bottom gillnet used by fishermen in Pomalaa had a low level of selectivity (*H'>0.1*) to the catch. These results indicated that Pomalaa crab fishermen have a low preference for a targeted catch. For the purpose of sustainable management of crab fishery resources, the mesh size of the the gillnet needs to be arranged in order that the species caught as expected, as well as the necessary awareness of fishermen to release the non-target species back to the wild. The main goal of sustainable resource management was the achievement of maximum profitability, while maintaining the sustainability of resource availability, as well as sustainable development goals of development to meet the needs of mankind today, without losing or destroying the ability of future generations to meet their needs (Dahuri, 2002; Bengen, 2005).

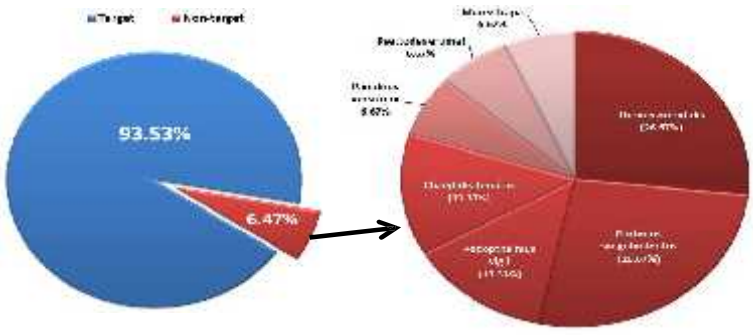

Figure 3. The compositions of the bottom gillnet catch.

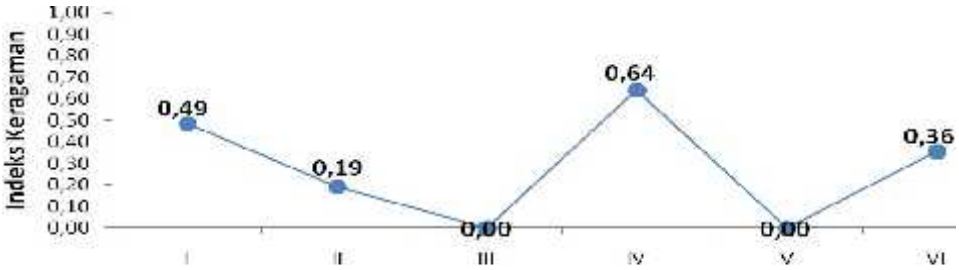

Figure 4. Index of diversity of catches at each station.

Capture Feasibility of blue swimming crab

The issue of the basic problems in the management of the crab resources needs to be quickly followed up with a resolution which is still a large number of crab caught under the minimum size. In this study, the feasibility of catching blue swimming crab of biological aspects is based on the size of a crab. Blue swimming crab size limitations that serve as a reference in determining the crab a decent catch and not worth is based on the size of carapace width (*CW*) and body weight (*BW*). This refers to the regulation of the Minister of Marine and Fisheries No. 56 of 2016. In the regulation stated that the existence and the availability of Blue swimming crab (*P. pelagicus*) have experienced a decline in population, so that needs to restrict its catching.

Article 4 paragraph 1 regulates that the catching and/or expenditure *Portunus* spp. (the Harmonized System Code 0306.29.10.00), of the territory of the Republic of Indonesia can only be done when crabs are not in spawning season and the size of the carapace width attains 10 cm or body weight above 60 g per individual. Based on the regulation in the study established the feasibility of blue swimming crab catch based on the carapace width and body weight size, i.e. *CW<100* mm and *BW<60* gram (*unfeasible catch*); CW> 100 mm and BW> 60 g (*feasible catch*).

The observations was found that crabs both feasible and unfeasible catch is presented in Fig 5. The *t-test* result at the real level of 0.05 indicates that the crabs fishing catches of gillnet during research are feasible to be caught (*CW>100* mm and *BW>60* g). However, this is contradictory to Syahrir (2013) which refers to the regulations the Government of Kolaka Regency No. 419 in 2004 about a ban on catching blue swimming crab under a commodity standard size economically, i.e. carapace size below 8 cm (*CW<80* mm = *unfeasible catch* and *CW≥80* mm = *feasible catch*).

Figure 5 The composition of the catch crab based on the size of a crab (*feasible and unfeasible catch*)

Rukminasari *et al*. (2000) who conduct research in the waters of the Salemo islands, Pangkep Regency, South Sulawesi, found that crab of males and females reached gonad maturity when the carapace width 87 and 85 mm, respectively. Hermanto (2004) reported that in the waters of Mayangan, Subang Regency, West Java, the size of a blue swimming crab first ripe gonads is 81–91 mm. Meanwhile, this research also showed that female crabs that lay eggs were found sized *CW*=103–150 mm. Hooper (2004) explained that legal crabs to be caught in Australian waters are of the same size or larger than 110 mm (CW ≥ 110 mm).

Based on this, the determination of the minimum size standard feasibility of catching crab as stated in Regulation of the Minister of marine and fisheries RI No. 56 in 2016 need to be socialized massively to all stakeholders of crab fishery up to fisherman level. In addition, the decision of the Kolaka Regency is proposed to be revoked because it does not support the sustainability aspects of crab

resources. This is particularly needed for the sake of keeping the blue swimming crab resources sustainable by allowing to reproduce at least one time during his lifetime.

Conclusion

The results of this study revealed that the fishing gear used by fishermen in Pomalaa has a low level of selectivity to the type of catch species. Blue swimming crab (*Portunus pelagicus*) catches fisherman Pomalaa belongs feasible to be caught. Regulation of the Minister of Maritime Affairs and Fisheries RI No.56 in 2016 needs to be massively socialized and the decision of the Kolaka Regency No. 419 in 2004 were revoked because it doesn't support the sustainability aspects of crab resources.

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Fish Species and Size Distribution of Siganidae Family Caught on Sero Fish Trap at Tondonggeu Coastal Area

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Abstract

Fish traps known as *sero* are popular fishing gear used by many fisherman in the shallow coastal areas. Some species from the siganidae family are in high demand, therefore many fisherman are targeting to catch the fish using fish trap including the fishermean in Tondonggeu coastal areas. The purpose of this research was to determine the species, size distribution and fish composition at first maturity of the siganidae family caught on fish trap. The data were divided based on the time and location of the catch. This research was conducted from April to June 2016 by surveying fish trap operations. Sampling was done montly at quarter, third a quarter and full moon following the fish operation time and collection. Samples were recorded from the fish traps location close to mangrove areas, seaggrass beds and coral reef. The results showed that there were six species of siganidae family caught using fish traps including *Siganus canaliculatus, S.guttatus, S.doliatus. S. stellatus, S. javus,* and *S. virgatus* species. Total number of *Siganus* species caught during the study period was 1,099 individuals with size ranging from 3.6 to 26 cm of total length. *S. canaliculatus* was the highest number of individuals caught around 93.54%, followed by *S.guttatus* 5.64% and the other four species composed between 0.16 to 0.78% of the total caught individuals. *S canaliculatus* and *S.guttatus* were found in every caught time. *S canaliculatus* was caught only on fish traps close to the seaggrass beds and coral reefs, whereas *S.guttatus* was found in every fishing ground.

Keywords: Siganidae Family, fish traps, *Sero*, Tondonggeu coastal area

Introduction

Siganidae is a family of fish belonging to the demersal fish group. These fish have a very wide distribution. Fish species in this siganidae family can be found along the Indo-Pacific waters. Almost all fish species in siganidae family have high selling value or economic value. Therefore, fish in the siganidae family are much hunted and serve as target fish in some fishing activities. Several types of fishing gear are used to catch fish in siganidae family such as gillnet, handline, bottom long line, pots and trap (*sero*).

Sero trap is one of the fishing gear that many fishermen use to catch fish, especially in coastal ecosystem. *Sero* trap is a fishing tool that consists of several parts such as leader net, wings, crib/cod end. Sudirman and Mallawa (2004) explain that *sero* (guiding barrier) is usually known as tidal trap because the catching principle is to block the direction of movement of fish migrating at high tide to coastal area. Various types of demersal fish in coastal ecosystems such as snapper, siganids, carangidae and gerreidae, were found caught on the fishing gear.

In Southeast Sulawesi, fishing activities using *sero* can be found in almost all coastal waters, such as those found in Tondonggeu Waters, Kendari City. In these waters, *sero* becomes a common fishing tool used to catch fish. Fishing in Tondonggeu Waters using this fishing gear is carried out throughout the year in all tidal areas. Arami and Nurgayah (2016) found that there are 72 species of fish caught in *sero* fishing gear operated in Tondonggeu waters, consisting of 69 species of fish and 3 species of molluscs and crustaceans with a length of 3.6 - 95cm total length. Species *Siganus canaliculatus* and *Gerres oyena* were dominant fish caught with 41.02% and 26.25% compositions, respectively. Bubun *et al* (2015) found 17 species of fish caught on the *sero* in the waters of Tapulaga Village, Kendari City. Pertiwi (2011) found the types of fish caught with *sero* fishing gear and trawling in Palopo waters during the study were 29 species of fish. Sudarno (2014) who conducted research on *Siganus* sp fish in Tondonggeu Waters found that fish in the species were caught in the 70-190mm size range. Based on the size, the caught fish are to small to be caught as the size less than the length at first maturity. Arami and Nurgayah

(2016) also found that the composition of allowable catch for the *S. canaliculatus* in Tondonggeu waters by 4.1%. A very worrying number when compared with an allowable number of 95.9%.

Preliminary survey results on *sero* activity in Tondonggeu noted that there were differences in size and number of fish, especially siganidae family in different lunar phase. However, it is unclear how the distribution of species and size of family siganidae fish in each phase of the month and the location of *sero*. Therefore, the aim of this study was to determine the species, size distribution and the composition of allowable fish caught in *sero* in Tondonggeu Waters, Kendari City.

Materials and Methods

Time and Location

The study was conducted from April to June 2016 in Tondonggeu waters, Kendari City. Map of the study sites as shown in Figure 1.

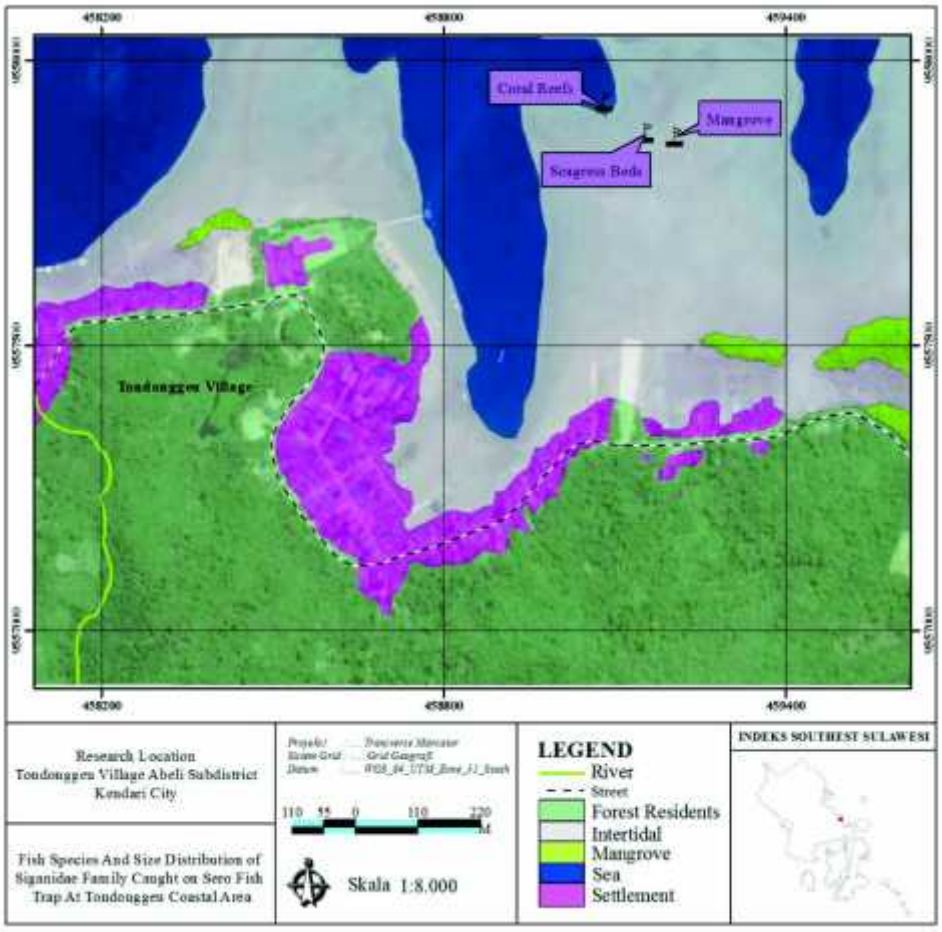

Figure 1. Map of research location in Tondonggeu Waters, Kendari City

Sampling

Data collection was conducted through survey method by following the *sero* fishing operation conducted by fishermen. Sampling was done monthly at firs a quarter, full moon and third a quarter following the fish operation time and collection. Sampled were recorded from the fish traps location close to mangrove areas, seaggrass beds and coral reef. Siganidae family fish caught were identified according to Peristiwady (2006); Matsuura *et al*. (2000) and Kuiter (1992), then the total length measurement (TL) was measured.

The catch data is presented in the form of catch type composition, length-frequency distribution and composition of mature fish (based on above of Lm size). Each of these data is displayed according to the time and location of the capture.

Results and Discussion

Results

Sero is used intensively in Tondonggeu waters. Like most *sero*, *sero* used in Tondonggeu waters has four main parts: main fence/leader net, wing, body and crib (cod end). Each section has a 3cm mesh size for main fence/leader, wing and body and 2.5cm for the cod end part. The number of trips known as "palo" done by fishermen generally twice a day. Based on the classification according to Von Brandt (1984) , *sero* is classified as a fishing trap.

Species Composition and Distribution of the Siganidae

The fish species captured in the *sero* is presented in Table 1. There were 1.099 individuals siganidae caught that belong to the siganidae family namely *Siganus canaliculatus, S.guttatus, S. stellatus, S. doliatus, S. javus* and *S. virgatus*. *S. canaliculatus* species has the highest species composition of 93.54% with a total of 1028 individuals. With such a composition it can be assumed that the species becomes the dominant siganids fish caught on a *sero* trap. The species with the lowest composition found was *S. stellatus* and *S. javus* with a composition of 0.09% with the number of catch 1 individual per species. Nafsah (2014) found 4 types of siganids fish caught in *sero* in Lentea waters using mesh size 3.75 cm and 3 types caught on *sero* with mesh size 5.5 cm. Type *S. canaliculatus* has the largest composition of the other 3 types respectively 20.25% for mesh size 3.75 and 3.38% for mesh size 5.5 cm.

Table 1. Spesies Composition of The Siganidae Family Cought on The *Sero* Fish trap at Tondonggeu Water

No	Fish species	Numbers of catch (individuals)	Composition (%)
1	*Siganus canaliculatus* (Park) / White-spotted spinefoot	1.028	93.54
2	*Siganus guttatus* (Bloch, 1787) / Orange-spotted spinefoot	62	5.64
3	*Siganus doliatus* (Cuvier) / Barred spinefoot	5	0.45
4	*Siganus stellatus/* Brown-spotted spinefoot	1	0.09
5	*Siganus javus/* Streaked spinefoot	1	0.09
6	*Siganus virgatus/* Barheadspinefoot	2	0.18
	Total	**1.099**	**100**

The number of fish *S. canaliculatus* caught is influenced by the composition of fish species at each time of capture as presented in Table 2. *S. canaiculatus* and *S.guttatus* were found at each catch time both the first a quarter moon in phase, full moon and the third a quarter moon phase. The largest number of fish species is found in the third a quarter moon phase (5 species). While the lowest number of species is found in the full moon phase consisting of 2 species of fish (Table 2).

Table 2 also shows that although *S. canaliculatus* dominated at any time of capture, the composition of the species tended to decrease along with the development of the lunar phase. In contrast, the composition of *S. guttatus* tended to increase along with the development of lunar phase. This is a guide in determining the exact fishing time for each species of fish. Radiyah (2001) found that siganidae catches appear to be the same for each period except in period I and IV periods of August. Period I (in August is the most caught period of siganids fish, otherwise in period IV (third a quarter) , there is no siganids fish caught.

Table 2. Composition of fish species caught according to fishing time

No	Fish Species	Numbers of Catch (individuals)			Species Composition (%)		
		first quarter	full moon	third quarter	first quarter	full moon	third quarter
1	*S. canaliculatus*	593	212	223	97.53	92.58	85.11
2	*S.guttatus*	11	17	34	1.81	7.42	12.98
3	*S. doliatus*	3	0	2	0.49	-	0.76
4	*S. stellatus*	1	0	0	0.16	-	-
5	*S. javus*	0	0	1	-	-	0.38
6	*S. virgatus*	0	0	2	-	-	0.76
	TOTAL	**608**	**229**	**262**	**100**	**100**	**100**

In addition to the composition of fish species according to the time of capture, observations are also made to the composition of fish species according to the location of the catch. The results of the observations are presented in Table 3.

Table 3. Composition of fish species caught according to fishing location

No	Fish Species	Numbers of Catch (individuals)			Species Composition (%)		
		Mangrove	***Seaggrass***	***Coral Reef***	***Mangrove***	***Seaggrass***	***Coral Reef***
1	*S. canaliculatus*	0	36	992	-	51.43	97.06
2	*S.guttatus*	7	31	24	100	44.29	2.35
3	*S. doliatus*	0	0	5	-	-	0.49
4	*S. stellatus*	0	0	1	-	-	0.10
5	*S. javus*	0	1	0	-	1.43	-
6	*S. virgatus*	0	2	0	-	2.86	-
	TOTAL	**7**	**70**	**1022**	**100**	**100**	**100**

From Table 3 it can be seen that in *sero* operated near mangroves, the *S.guttatus* species has a composition of 100%, meaning that no other siganidae species is found other than that species. In contrast, sero operated on seagrass beds area had two species domniance the same composition; *S.canaliculatus* and *S.guttatus* with 51.43% and 44.29% respectively. The sero in coral reefs was dominated by *S.canaliculatus* species with a composition of 97.06%.

Based on the distribution of siganidae fish caught in the capture device both on capture time and fishing location, it can be seen that the *S. canaliculatus* and *S.guttatus* species are two species of siganidae which have a wide range of distribution. As shown in Table 4, *S. canaliculatus* is caught at any time of catching as well as the location of the catch, except in *sero* near the mangroves. In contrast, *S.guttatus* species were found at all times and at all location.

Table 4. Fish distribution of siganiids family by time and fishing area

Fishing periods	Fishing time			Fishing area		
	First a quarter	**Full moon**	**Third a quarter**	**Mangrove**	**Seaggrass**	**Coral reefs**
April	*S. canaliculatus* *S.guttatus*	*S. canaliculatus* *S.guttatus*	*S. canaliculatus* *S.guttatus*	*S.guttatus*	*S. canaliculatus* *S.guttatus*	*S. canaliculatus* *S.guttatus*
Mei	*S. canaliculatus* *S.guttatus* *S. doliatus* *S.stelatuss*	*S. canaliculatus*	*S. canaliculatus* *S.guttatus* *S. doliatus*	*S.guttatus*	*S. canaculatus* *S.guttatus*	*S. canaliculatus* *S.guttatus* *S. doliatus* *S. stelatus*
Juni	*S. canaliculatus*	*S. canaliculatus* *S.guttatus*	*S. canaliculatus* *S.guttatus* *S. virgatus* *S. javus*	*S.guttatus*	*S. canaliculatus* *S.guttatus* *S. virgatus* *S. javus*	*S. canaliculatus* *S.guttatus*

Size Composition and Distribution of the siganidae family caught on the *sero*

In fishing activities, the size of each fish species caught is influenced by the size of the mesh size of the fishing gear. Especially in *sero* fish trap, the mesh size of the net of crib/cod end is very influential. Of the total siganidae fish caught on *sero*, the range of captured fish sizes is 3.6-26cmTL as shown in Figure 2. Arami and Nurgayah (2016) found the range of fish sizes caught on *sero* fish trap for all fish species 3.6- 95cmTL.

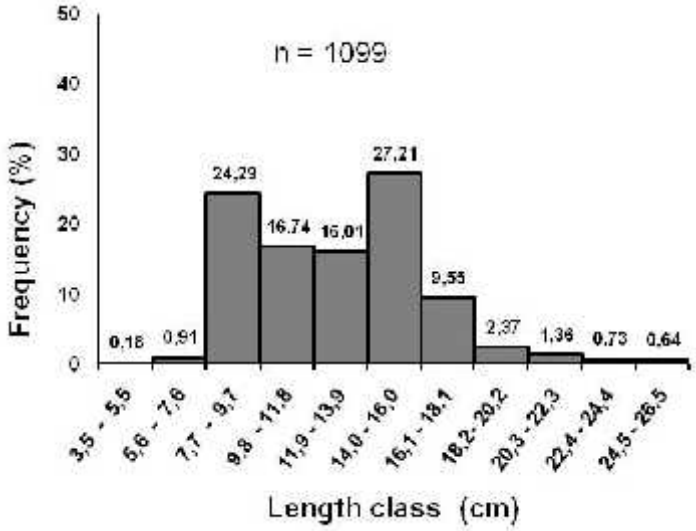

Figure 2. Length-frequency Distribution of The Siganidae Family Cought on The *Sero* at Tondonggeu

Figure 2 shows that the highest length-frequency distribution of fish catch is in the class range of 14.0-16.1cmTL (27.21%). The second class with the second frequency is 7.7-9.7cmTL of 24.29. The lowest length-frequency distribution is found in the 3.5-5.5cmTL class range (0.18%).

From the Table 5, it can be seen that the species *S.canaliculatus* and *S.guttatus* have the same number of class sizes. Species *S.canaliculatus* has a wide size distribution ranging from 3.5-5.5cmTL up to 20.3-22.3 cmTL, with the highest frequency is in size 14.0-16.0cmTL, while *S.guttatus* has a spread class size 7.7-9.7cmTL up to 24.5-26.5cmTL with highest frequency equal to 19.35% exist in two class size 18.2-20.2cmTL and 20.3-22.3cmTL. Although they have the same number of class size distribution but the *S. canaliculatus* species had the smallest class size, while *S.guttatus* had the largest size class.

Table 5. Length-Frequency Distribution of Siganids Species

Length class (cm)	Numbers of Catch (individuals)						Frequency (%)					
	Sc	***Sg***	***Sd***	***Ss***	***Sj***	***Sv***	***Sc***	***Sg***	***Sd***	***Ss***	***Sj***	***Sv***
3.5 - 5.5	2	0	0	0	0	0	0.19	-	-	-	-	-
5.6 - 7.6	10	0	0	0	0	0	0.97	-	-	-	-	-
7.7 - 9.7	261	1	4	0	1	0	25.39	1.61	80	-	100	-
9.8 - 11.8	177	6	1	0	0	0	17.22	9.68	20	-	-	-
11.9 – 13.9	174	1	0	1	0	0	16.93	1.61	-	100	-	-
14.0 – 16.0	293	6	0	0	0	0	28.5	9.68	-	-	-	-
16.1 – 18.1	94	9	0	0	0	2	9.14	14.52	-	-	-	100
18.2- 20.2	14	12	0	0	0	0	1.36	19.35	-	-	-	-
20.3 – 22.3	3	12	0	0	0	0	0.29	19.35	-	-	-	-
22.4 – 24.4	0	8	0	0	0	0	-	12.9	-	-	-	-
24.5 – 26.5	0	7	0	0	0	0	-	11.29	-	-	-	-
Total	**1.028**	**62**	**5**	**1**	**1**	**2**	**100**	**100**	**100**	**100**	**100**	**100**

Notes : *Sc = S. canaliculatus; Sg = S.guttatus;*
Ss = S. stellatus; Sd = S. doliatus;
Sj = S. javus; Sv = S. Virgatus

Figure 3 shows the size distribution of fish according to time and location of fishing. There was a shift in the size of the fish to a larger size along with the development of the lunar phase. In the first a quarter moon phase, the highest frequency of fish size is in the class of size 7.7-9.7cmTL. In the full moon phase, the largest size of the frequency is in the class size 14.0-16.0cmTL and in the third a quarter phase, although the highest class size is still at 14.0-16.0cmTL, but in the higher sizes the class begins to

show the increase of the number of fish caught. This can be seen in the highest class size (24.5-26.5cmTL) where in the previous two phases each had a frequency of 0% and 0.44% to 2.29% in the third quarter phase.

Based on the locations, it can be seen that the length-frequency distribution of fish caught in fishing gear in *sero* traps close to the mangrove community tended to be smaller. The fish caught in *sero* in the seagrass area were spread over all sizes, but the highest frequency was found in fish sized 14.0-16.0cmTL. Furthermore, the results of *sero* catches operated in the coral reef area tended to be evenly distributed from 7.7-9.7cmTL to 4.0-16.0 cmTL.

Composition of allowable length of fish

In an effort to utilize sustainable fish resources, the regulation of fish sizes that can be caught in fishing activities is highly considered. One approach used is through the allowable length. This measure is based on the length at first maturity. It is expected that the fish should be caught when size is above the length at first maturity.

The fish caught on *sero* showed that there were 91.62% of the *S. canaliculatus* captured under the allowable size/the length at first maturity. Whereas *S. guttatus* caught had only 5.53% under the allowable size. The composition of fish caught at allowable length was very low, 2.75% for *S. canaliculatus* and 0.18% for *S.guttatus*. The size of the catch is influenced by the size of fishing gear, such as the mesh size of the *sero* fish trap used. Arami (2006) found the composition of fish *S. canaliculatus* at allowable length as much as 17.24% in *sero* fish trap operated in Wakatobi Archipelago. Nafsah (2014) reported the proportion of the fish that has length at first maturity at 5.4cm mesh size is much higher (88.42%) while for mesh size 3.75cm, the proportion of fish that has length at first maturity was 29% .

Composition of fish at allowable length according to the fishing time for *S.guttatus* species tended to increase in number following the development of the lunar phase. This can be seen in Table 6 and Figure 5 where in the third a quarter phase, the number of fish that has size above the length at first maturity has reached 5.56%. In contrast, the amount of fish at allowable length for *S. canaliculatus* species exhibited larger numbers in the full moon phase. A study done by Mambrassar, *et al* (2014) in Amurang Bay found that in the new moon phase, the first aquarter and teh third a quarter gave more catch, but in the full moon phase, the catch was little.

Table 6. Composition of dominant fish at the allowable length according to fishing time

No	Fish species	Numbers of Catch (individuals)			Number of Catch (above of Lm Size) (individuals)			Keterangan
		first a quarter	full moon	thirda quarter	first a quarter	full moon	thirda quarter	
1	*S. canaliculatus*	593	212	223	7	15	8	Lm male = 186.68mm TL; female = 174.9mm TL *)
2	*S.guttatus*	11	17	34	0	0	2	Lm male = 25.5mm TL; female = 26.4mm TL **)
	TOTAL	**604**	**229**	**257**				

Notes : *) = Latuconsina and Wasahua 2015; **) =Widiana (2015)

According to the fishing location, it is seen that the composition of fish that has passed at the length atr first maturity of the highest is found in *sero* in the seagrass area, then on the *sero* located in the coral reef area. This condition is seen in both dominant fish species, as shown in Table 7 and Figure 6. Widiana (2015) found the length at first maturity of *S.guttatus* at 255mmTL male and 264mmTL for female, while Latuconsina and Wasahua (2015) for *S. canaliculatus* was found to be the first at length maturity of 186,68mmTL male and 174,62mmTL females.

Table 7. Composition of dominant fish at the allowable length according to location

No	Fish species	Numbers of Catch (individuals)			Numbers of Catch (above of Lm size) (individuals)			Keterangan
		Mangrove	Seaggrass	Coral Reef	Mangrove	Seaggrass	Coral Reef	
1	*S. canaliculatus*	0	36	992	0	2	28	Lm male = 186.68mm TL; female = 174.9mm TL*)
2	*S.guttatus*	7	31	24	0	1	1	Lm male = 25.5mm TL; female = 26.4mm TL**)
	TOTAL	**7**	**67**	**1016**				

Notes : *) = Latuconsina and Wasahua 2015; **) =Widiana (2015)

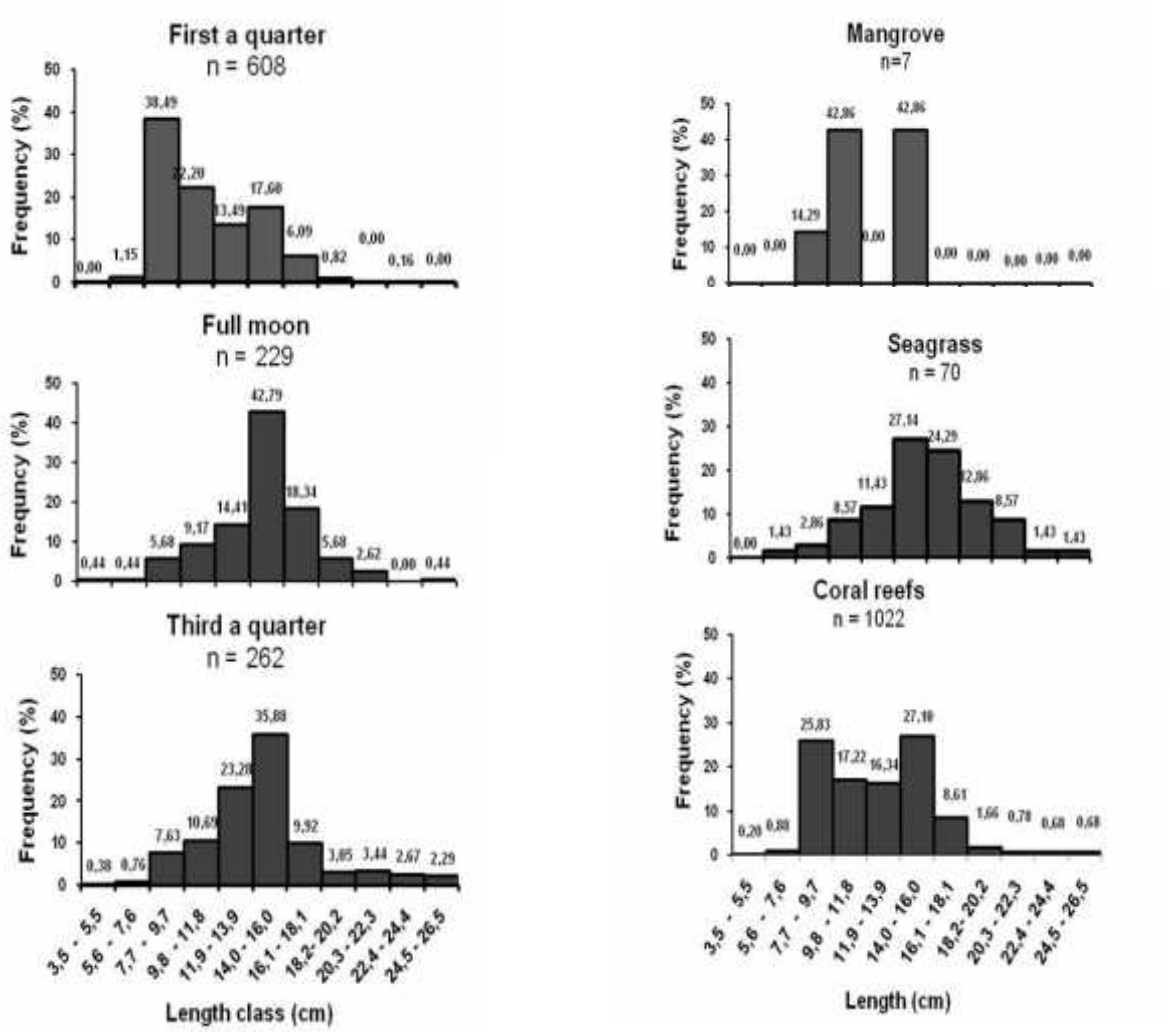

Figure 3. Length-frequency distribution of the siganidae by time and fishing area

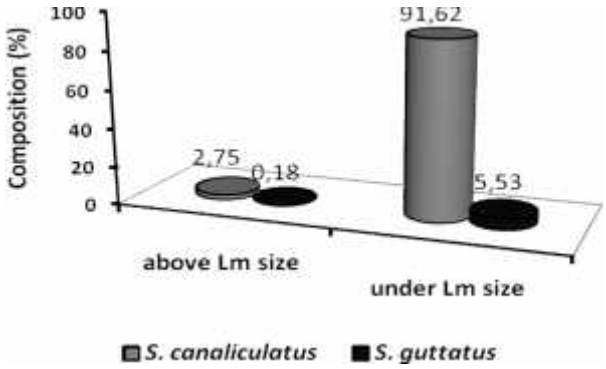

Figure 4. Composition of dominant fish at the allowable length

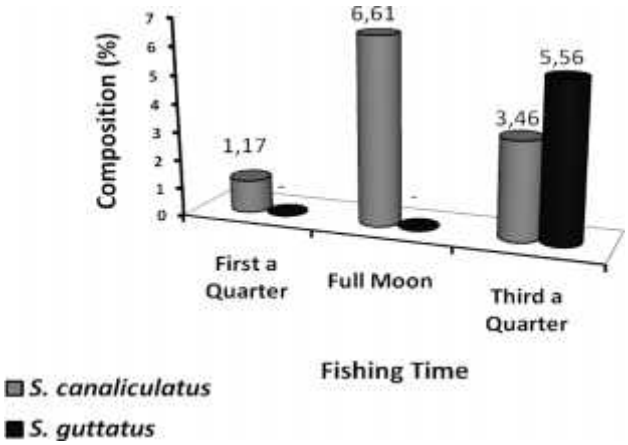

Figure 5. Composition of dominant fish at the allowable length according to fishing time

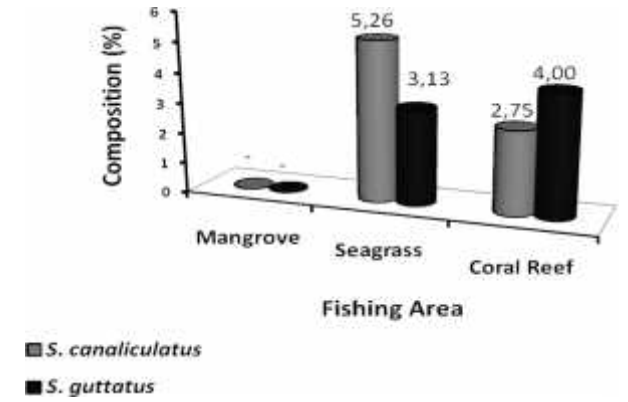

Figure 6. Composition of dominant fish at the allowable length according to fishing location

Discussion

Knowledge of the distribution of fish species and size according to time and location of fishing is very important. The information provides clues about the condition of fish populations in the fishing grounds. Such information is needed to support the efficiency and effectiveness of fishing, and also to support in the management and arrangement of fishing activities. In relation to fishing efficiency in accordance with Table 1, it provides information to fishermen concerning fish species especially in siganidae families within fishing grounds making it easier to locate fishing sites.

The results of the study provide guidance on the importance of the management of fishing activities in Tondonggeu waters. The management is more specifically directed to the mesh size of the *sero* capture device (2.54cm) in order to increase the size of the mesh size of the fishing gear. This is based on the research on the wide siganidae fish length and the length-frequerncy distribution of the fish as shown in Figure 2. From the results, it can be seen that the size of the fish caught on *sero* fishing equipment is in the range of 3.6cm to 26cmTL. In addition, it is also seen that the dominant length of fish is in a small size class that is 7.7-9.7 cmTL and 14.0-16,0cmTL. This illustrates the low selectivity of *sero* fish trap operated in Tondonggeu waters. According to Robichaud, *et al* (1999), the effect of mesh size on fishing power of traps was investigated by comparing the catch rates of fish large enough to be retained by both trap types (i.e., body depths >5.5 cm; termed adjusted catch). The adjusted catch of large mesh traps was 24–35% lower by number and about 30% lower by weight than that of commercial traps, indicating that the fishing power of large mesh traps is substantially lower than that of commercial traps (maximum aperture 4.1 cm).

More details about the low selectivity of *sero* fish trap can also be seen from the length-frequency distribution of *S. canaliculatus* species as the dominant fish, where the size distribution captured is at the smallest size of 3.6 to 22.3cmTL. Frequency distribution of the largest size is under the length at first maturity. This can be seen from the low composition of allowable length fish as presented in Figure 4. Arami and Nurgayah (2016) found that as much as 95.9% of the composition of *S. canaliculatus* caught on *sero* fish trap was at un allowable length. From the results of this study also explained that the *sero* trap with 2.54cm mesh size of crib/codend operated in Tondonggeu waters is not selective for catching *S. canaliculatus*. It is based on L50% of *S.canaliculatus* that is 13,29cmTL lower than the value of length at maturity *S. canaliculatus*. Furthermore, Tenriware (2012) also found that *sero* selectivity in Pitumpanua with 4 cm mesh in experimental crib found that the selectivity of mesh size 4 cm at the *sero* experimental crib obtained the *Siganus canaliculatus, Siganus guttatus, Lethrinus lentjam, and Terapon jarbua* is far from the allowed length.

In exploitation activities and management of fish resources, information on spatial and temporal of species and sizes distribution is needed. From the results of this study it can be explained that the right time to carry out the fishing of *S.canaliculatus* is at the full moon in the seagrass beds area. This is because in the full moon phase of seagrass beds area it is tend to have the larger composition of the allowable length of the fish than the other two periods (Figures 5 and 6). As for catching fish *S. guttatus*, more effective fishing is in the third a quarter phase in *sero* trap in the coral reefs area because it tends to have a larger composition of fish catching. Tenriware (2012) explains that the management of *sero* should pay attention to the variety of ecosystems that exist because of differences in fish communities in the three habitats.

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TOPIC E : SOSIO-ECONOMIC OF FISHERIES

Contribution of Seaweed Fisherwomen of Bajo Community to Fulfill Consumption of Fishermen's Household in Southeast Sulawesi

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Abstract

Fisherwomen have dominated the cultivation of seaweed in Bajo community and this practice has become their prominent daily activity. The study examined the contribution of seaweed fisherwomen of Bajo community to fulfill consumption of fishermen's household in Southeast Sulawesi. This research was carried out in two villages of Bajo community; in Wawonii Island and North Buton district from 2011 to 2013 by using primary and secondary data. The research aims to analyze the contribution of fisherwomen through seaweed cultivation to fullfill their family routine consumption. The results showed that the average production of seaweed was about 1,167-1,380kg/year. If labor wages was entirely included in the production costs, then the average revenue ranged between IDR 5,110,638-6,688,252/ year. However, if only take into account the actual labor wages incurred, namely IDR 6,334,638-8 ,366,672/year. Meanwhile, the analysis R-C Ratio was about1.844–1.969 resulting in profit as much as 84.4–96.4% for the fisherwomen. In addition, the analysis of the exchange rate of fishermen consumption (NTKN) ranged between 0.635 and 0.394, indicating that the fisherwomen were able to meet 34.7–53.5% of their family routine consumption.

Keywords: Contribution, fishermen consumption, fisherwomen

Introduction

Seaweed represents one of main commodities of Indonesia at a global level. The production of seaweed in this country has increased since 2008, and by that year, Indonesia had been acknowledged as the biggest producer of seaweed in the world (Hurtado, *et al*., 2014; FAO, 2016). In 2015, Indonesia produced 10,335,000 ton of seaweed (Ministry of Marine Affairs and Fishereis, 2016). This achievement has been caused by the national policy that had placed seaweed as the main commodity forfishery sectors of Indonesia. The Ministry of Marine Affairs and Fisheries of Republic of Indonesia (KKP) in 2017 aimedto increase the production of seaweed to 13.4 million tons from 11.4 million tons in 2016.

The seaweed production in Indonesia has been evenly distributed throughout the provinces. Currently there are five provinces which have become the biggest suppliers of seaweed: namely South Sulawesi, Southeast Sulawesi, Central Sulawesi, East and West Nusa Tenggara (General Directorate of Aquaculture - KKP, 2016). As one of the biggest seaweed suppliers in Indonesia, Southeast Sulawesi has a huge potentialfor seaweed development (mariculture) because it has a marine area as ± 114.879 km^2, with total coastline reaching 1.740 km (DKP-Sultra, 2014). With these facts, Southeast Sulawesi turns into one of the biggest potential cultivation areas for seaweed development in almost all of its regencies/cities (Albasri, *et al*., 2010; Aslan *et al*., 2015). According to the available data retrieved from the Office of Marine Affairs and Fisheries of Southeast Sulawesi (DKP Sultra, 2015), this province had produced 956,495 ton of seaweed in 2014.

Currently the role of seaweed farmers has been shown to be very significant to increase of seaweed production in Southeast Sulawesi. Seaweed cultivation is not only practiced by the fishermen, but it is also conducted by the fisherwomen. The latter has evendoubled the functions of both domestic and industry production workers. Their productive roles are not limited to only seeking additional livings, but also for lookingamain source of livelihood, and to attain financial needs of their family (Aslan *et al*., 2014; Periyasamy, *et al*., 2014).

The role of fisherwomen who practice seaweed cultivation for supporting their family economics in Southeast Sulawesi has not been studied thoroughly enough, whereas in other places such as in India, this subject is generally considered a part of the research developmental plan. For instance, Periyasamy (2013) stated that in a form of groups, fisherwomen have been involved directly in all cultivation processesof seaweed with the average production of 3,132 kg/rotation of wet seaweed (comparasion of wet and dried was 10:1). From this, each of them could earn an average revenue as Rs 10,000/cycle, or equalto IDR

2,087,700/cycle. Another research conducted by Rajasree and Gayathri (2014) also pointed the same trend. They claimed that the fisherwomen who had previously joined in the training, and then later formedgroups to produce seaweed, were able to earn an average revenue,to up as much as Rs 8,000/person, or the equivalent of IDR 1,670,160/cycle, where each cycle lasted for 35 days.

The revenue of fisherwomen is determined by the efficiency level of costuses that can be seen from R-C ratio. The higher value of a R-C ratio equates to a bigger profit percentage, and a greater advantage earned from a number of expenses (Padangarang, 2010). In addition, Central Bureau of Statistics (BPS) and other literarysources have suggested that to understand the welfare indicators of fisherwomen, we should know their purchasing power against production factors in fishery businesses, and their family's consumption needs through the Exchange Rate of Fisherwomen (Nilai Tukar Petani; NTP). Assigning the Exchange Rate of Fisherwomen is similar to determination of the exchange rate of farmers that generally applied by BPS and Bappenas.

In the Exchange Rate of Fisherwomen (NTP), the purchasing power against production factors should be separated from the power to purchase towards family consumption needs. The exchange rate of production factors and fishermen consumption is more suitably used to know the purchasing power of fisherwomen against production factors, and against the family's consumption needs respectively. This is in line with the work of Simatupang and Muliana (2008) who suggested conducting a measurement of exchange rate of production and consumption that isclearer and more accurate indicator to the relationship with the welfare of farmers. Moreover, the exchange rate of farmer's consumption (Nilai Tukar Konsumsi Petani; NTKP) represents a determined (with a positive relation) purchasing power of farming results against the consumption of goods by the farmer's housholds (Muliana, 2008; Riani, 2012). Researches about seaweed production, revenue, R-C ratio of seaweed cultivation practiced by the fisherwomen, and their ability to fulfill the family daily consumption needs to sustain a family in Southeast Sulawesi, particularly in Konawe Archipelago and North Buton Regencies are still limited in scope. Therefore, a study on “The Contribution of Seaweed fisherwomen of Bajoto the Consumption Needs of Fishermen’s Households in Southeast Sulawesi“ was carried out.

Materials and Methods

This research was conducted on Bajo community area in West Wawonii of Konawe Islands District and Kulisusu of North Buton District from August 2012 to March 2013. The tools used in this research were the camera, stationaries, and tape recorder while the used material wasthe questionnaires.

Population in this research was all fisherwoman at research location which have done seaweed production in 2012 and 2013 which amounted to 64fisherman. Determination of the number of samples is done by using the Slovin formula in Rianse and Abdi, (2008) as follows:

$$n \text{ X } \frac{N}{1 \Gamma \ Ne^{2}} \text{ X } \frac{64}{1 \Gamma \ (64)(0,1)^{2}} \text{ X } 39 \text{ Respondens}$$

were:
n = Number of Responden
N = Total Population
E = Standar Error (10%)

The research method used was the survey research with a quantitative approach which was then described descriptively. The type of data was primary and secondary data. The primary data was derived from the samples, whereas the secondary data constituted as supporting data related to theresearch obtained from various sources or agencies, such as the subdistrict office, Subdistrict Department of Marine and Fisheries and Statistics Agency.

Primary data collection was carried out by direct interview with the respondents in the form of questioning and answering based on guided questionnaire. The secondary data was collected from different sources and relevant agencies. All available data were recorded at this stage. Some operational definitions used in this research are fisherwomen income, production, product price, and expenditure of production factors and consumption needs.

The income of Fisherwomenis net profit received by fisherwomen from seaweed cultivation namely the difference between the total revenue and the total cost of seaweed cultivation, which was counted in a year (Rp/year). Meanwhile, production is the amount of dried seaweed produced by the fisherwomen ina

year (kg/year). Moreover, the product Price is the price of dried seaweed received by the fisherwomen (Rp/kg). Fisherwomen's revenue is the price received by fisherwomen from dried seaweed produced in ayear (Rp/year).

Variables Measured in this study werethe total production of dried seaweed, product prices, and the total expenditure of production factors and routine consumption of fishermen's household. In order to know the quantity of seaweed produced by the fisherwoman,the calculation was conducted by summarizing the amount of production in a year accordingly.Moreover, fisherwomen's income from seaweed cultivationwas analyzed by counting the difference between total production value (total revenue) and total production cost (Total Cost) that was actually issued (Yunanto, 2006) with formulation as follows:

$$Pd = TR - TC$$
$$TR = P.Q$$
$$TC = TFC + TVC$$

were:
Pd = Income
TR = Total revenue
TC = Total cost
P = total Production
Q = Product price

The Return of Ratio (R/C) formula, ratio between Revenue (R) and Cost (C), was applied in order to perceive the ratio between the expenditure for production and or percentage of profit that the fisherwoman experienced from the seaweed cultivation practices (Rianse and Abdi, 2008). Furthermore, Hansen and moven, 2001 suggested that the results of the R-C Ratio analysis would illustrate whether a business results profit or experiences loss. The revenue (R) and cost (C) ratio can be calculated by using the following formula:

$$R/C = \frac{\sum(Yi.Pyi)}{\sum(Xi.Pxi)}$$

were:
R = Revenue
C = Cost
Yi = Total Production of dried seaweed
Pyi = price/kg product of dread seaweed
Xi = Input production of seaweed cultifation
Pxi = price/kg product of dread seaweed

The production factor price includes production factor price used in seaweed cultivation until post harvest namelythe seeds, fuel, nilón straps, rapiah ropes, buoys, weights, motor boat, boat, drying facilities and wage oflabor.

The formula of exchange rate of fishermen consumption, the ratio between the price received by fisherwomen and the price of household consumption, was used to understand the ability of fisherwomen in fulfilling their family consumption needs. The used formula is in Erison equation (2004) as follows:

$$NTKP \quad X \frac{HTP}{HKP} x100\ \%$$

were:
NTKP : TheExchange Rate of Fishermen Consumption
HTP : The Price receivedbyfisherwomenfromseaweedcultivation
HKP : Theprice of householdconsumption

The price of consumer goods consists of routine food consumption that was spent by the seaweed farmers at the research sites was rice, sugar, cigarettes and snacks. Meanwhile, education and clothing constituted as the non-food consumption in a year

Results and Discussion

Results

The Role of Fisherwomen of Bajo in Seaweed Production Process

Fisherwomen of Bajo in West Wawonii District, Konawe Archiphelago Regency and in Kulisusu District, North Buton Regency have dominated seaweed cultivation activities. They have actively involved in each process of the cultivation, post harvest handling until product marketing (Table 1). In some processes of cultivation activities, their involvement has revealed a high percentage in Caring and Maintenance period (90%), seed preparation (70%), seed provision and post harvest handling (60%). Moreover, in ropes installation and marketing activities, they shared equal percentage (50%). The only work that they contributed less was Setting up of farms (25%).

Table 1. Role Division Percentage between Fisherwomen and Fishermen from Production Process to Seaweed Cultivation Products Marketing

No	Kind of Activities	Number of Working Days	Women (%)	Men (%)
1	Setting up of farms	3-5	25	75
2	Seed Provision	3-5	60	40
3	Seed Preparation	5-10	70	30
4	Rope Installation	3-5	50	50
5	Caring and Maintenance	60-90	90	10
6	Harvesting	5-10	50	50
7	Post Harvet Handling	5-10	60	40
8	Marketing	2-3	50	50

Seaweed Production by Fisherwomen of Bajo

Fisherwomen of Bajo in Kulisusu have used more land area (963 m^2) than their colleagues in West Wawonii (806 m^2) (Table 2). However, the production ability of fisherwomen in West Wawonii (1,380 kg/year) was higher than in Kulisusu (1,167 kg/year). Furthermore, the price of dried seaweed in both locations was also different. In West Wawonii, the price per kilogram ranged between IDR 8,000 to 10,000 while in Kulisusu, it ranged from IDR 7,000 to 12,000.

Table 2. Land Area, Production, Production Cost, Price of Seaweed Products

No	Location	Land Area (m^3)	Production (kg/year)	Production Cost (Rp/Year)	Product Price (Rp/kg)
1	West Wawonii	806	1380	6.688.252	8000-10.000
2	Kulisusu	963	1166,7	6.056.028	7000-12.000

Fisherwomen's Net Income from Seaweed Cultivation Bussines

The net income of fisherwomen from seaweed cultivation in two research sites tended to differ (Table 3). The number of production, production cost, and product price will influence the revenue and income earned by the fisherwomen. The revenue and net income of fisherwomen in West Wawonii District were higher than what fisherwomen in Kulisusu district received. The average revenue of fisherwomen in West Wawonii was IDR 12,972,000/year and earned income as IDR 6,688,252/year. In Kulisusu, the fisherwomen earned IDR 11,166,667/year of the average revenue and made income as much as IDR 5,110,638/year. The R-C ratio was used to show efficiency in using costs of production factors or received income percentage from numbers of production expenditures**.** The R-C ratio of seaweed cultivation business conducted by the fisherwomen in West Wawonii was 1.969, whereas in Kulisusu the ratio was 1,844. Based on the figure, it can be claimed that the fisherwomen of Bajo in West Wawonii was more efficient in using the production costs than the fisherwomen in Kulisusu.

Table 3. The Revenue and Income Earned by The Fisherwomen and Their R-C Ratio

No	Location	Revenue (Rp/year)	Income (Rp/year)	R-C Ratio
1	West Wawonii	12.972.000	6.688.252	1,969
2	Kulisusu	11.166.667	5.110.638	1,844

Seaweed production costs consist of expenditures for cultivation and drying facilities, transportation means and fuels, and labor wages. The highest expenditure was the wages of labor that consist of seeds binding (5%) and rearing costs and harvesting (36%).

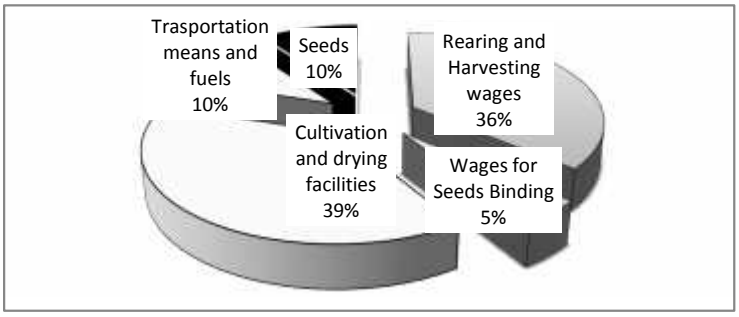

Figure 1. Expenditure Percentage of Production Factors of Seawees Cultivation

Expenditure percentages that are directly related to the seaweed production were the expenditure for cultivation and drying facilities (39%) and the seeds (10%). Moreover, the expenditure of transportation means and fuels were 10% out of the total expenditure.

The Contribution of Fisherwomen's net income to the Fulfillment of Family Consumption Needs

There are five items of daily consumption routinely spent by fishermen family namely rice, ciggarate, snacks, sugar and education/clothes. These family expenditures were categorized into food and non-food groups (Table 4). In overall, it can be stated that that the food consumption (79.6%) was higer than the non-food uses (23.4%). Compared to the food consumption in Kulisusu, the food uses in West Wawonii was higher 8% than in Kulisusu (83.6% to 75.6%). However, this figure was different in the sector of non-food consumption. Fishermen families in Kulisusu spent 8% higher than families in West Wawonii (24.4% to 16.4%).

Table4. Expenditure of Fishermen Family Consumption and Excahnge Rate of Consumption

No	Location	Expenditure for Consumption Needs			Exchange Rate of Consumption
		Food (%)	Non Food (%)	The Amount of Expenditure (Rp/year)	
1	West Wawonii	83,6	16,4	12.276.579	0,533
2	Kulisusu	75,6	24,4	15.488.556	0,347
	Average	79,6	23,4	13.995.900	0,440

Based on the table 4, it demonstrated that the average expenditure for consumption needs of fishermen of Bajo in the two sites of research was IDR 13,995,900/year. The family expenditure for consumption in Kulisusu was higher than the expenditure in West Wawonii. The Exchange Rate of Fishermen Consumption (Nilai Tukar Konsumsi nelayan; NTKP) was used to describe the ability of fishermen in fulfilling the consumption needs or the contribution percentage of income towards the fulfilment of fishermen households. The average NTKP in the research sites was 0.440. Furthermore, the figure was higher in West Wawonii (0.533) than in Kulisusu (0.347). These figures indicated that the contribution of fisherwomen of Bajo in West Wawonii to their family consumption was higher (53.3%) than in Kulisusu (34.7%). In overall, it could be stated that the revenue of fisherwomen of Bajo from the seaweed cultivation business contributed 44% to their family consumption needs.

The Exchange Rate of Fishermen Consumption is not only determined by income but also

influenced by family consumption pattern. The expenditure percentage for rice, sugar and snacks was higher in fishermen family in West Wawonii than in Kulisusu. Meanwhile the family in Kulisusu spent more in cigarette and education/clothers than in West Wawonii (Figure 1).

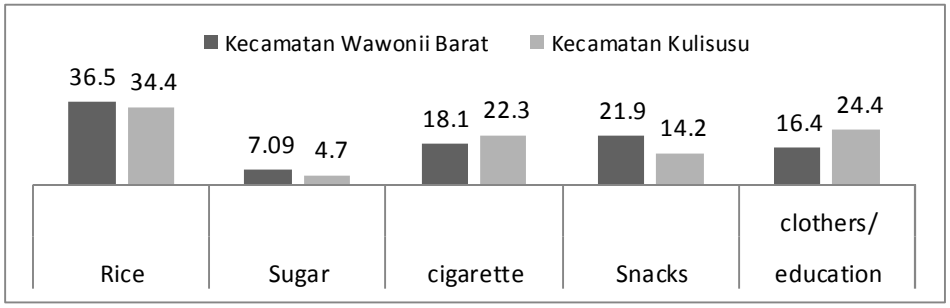

Figure 2. The Expenditure Percentage of Consumption Needs of Fishermen Family

Discussion

The Role of Fisherwomen in the Seaweed Production Process

Fisherwomen of Bajau in West Wawonii District, Konawe Archipelago Regency, and in Kulisusu District, North Buton Regency have dominated seaweed cultivation activities, because the fishermen generally have gone for fishing. In the production process of seaweed, the fishermen only assist in setting up of farms (75%) that requires more physical power. Meanwhile, the rest of the activities such as the caring and maintenance, seeds preparation, seeds provision, and post harvesting require the prominent contribution of fisherwomen, who tend to be more persistent and determined than the fishermen. The seeds' caring and maintenance is conducted by cleaning the seaweed from epiphyte (attaching plant), and rubbish or other unknown materials that also attach along the stretching ropes (*Tali bentangan*). Out of all stages of production, the rearing period demands more time, namely 60 – 90 days, and includes a twice daily cleaning. Generally, the seaweed is harvested at the average age of 45-50 days; however, due to lack of seeds, the coastal communities in West Wawonii and Kulisusufirstly grow the seeds for about 25 days, until there is enough to fill all the stretching ropes.

The fishermen contribute more in the land preparations that require extra physical power, particularly in ballast installation to the four points in the ropes. When doing this, the men go diving to 3 – 5 meters depth to set the ballast using small rope; after that, they install the main ropes forming a quadrangular shape in accordance with the installed ballasts. The main ropes then function as an installation spot for the stretching ropes to where the seeds of seaweed are tightly tied. In the land preparation, the fisherwomen only provide support in the installation of *talibentangan* and pin ropes.

In the installation of *tali bentangan* and marketing, the role of fisherwomen and fishermen tends to be equal (50%). In addition to physical power, the installation also needs speed to avoid the seeds being damaged, the fisherwomen in this case tend to work fast. In the meantime, there is an agreement between fishermen and fisherwomen when determining the price in the marketing process.

Figure 3. The Activities of Fisherwomen of Bajau in Seaweed Cultivation

Studies have shown that the contribution of fisherwomen of Bajau at all stages of seaweed cultivation; post harvest handling and marketing trends in West Wawonii and Kulisusu seem different than the results of other researches. One possible reason is because the other researches were carried out on coastal communities in general, or in other words, with various ethnic groups where the fishermen have tended to dominate the works. Rosmawati (2015) explained that the fishermen have controlled the setting of land area and the installation of buoys. A similar pattern of the prominent role of the fishermen occurs in Takalar Regency, South Sulawesi. In addition to the setting of land area and land preparation, the fishermen have led in determining the cultivation methods as well (Astanty and Arief, 2014). According to Lal and Vuki (2010), women play an important role in both farming andprocessing. Women select planting material beforethe seaweed is planted. This is an important role because if the planting material is of poor qualitythen the growth of the seaweed will generally be poor. Bacaltos *et al*. (2013) pointed out that although men took the main leadership roles, women were active in production and, particularly, post-harvest processing. Men were also active in post-harvest processing and their skills should not be overlooked. Furthermore, Ariwidodo (2016) claimed that the fishermen in Sumenep Regency, East Java have dominated all cultivation processes and marketing. Even though the contribution of fisherwomen in these three areas of research was substantially different than in West Wawonii and Kulisusu, there remained similarities in some aspects.

Like the fisherwomen in North Buton, Takalar,Sumenep, Philiphines, and Solomon Island the fisherwomen in West Wawonii and Kulisusu have participated in the process of rearing, seeds binding, post harvest handling, and marketing; moreover, it has been revealed that in West Wawonii and Kulisusu, the percentage of involvement between the fishermen and fisherwomen in harvesting process was equal (50%), similar with what happens in Sumenep (Ariwidodo, 2016).

Seaweed Production by the Fisherwomen

The seaweed production, land area and product price in West Wawonii and Kulisusu tended to differ. Even though the land area in Kulisusu (963 m^2) was wider than in West Wawonii (806 m^2), the seaweed production in the latter (1,380 kg/year) was higher than the first (1,166.7 kg/year) as a result of the overall land productivity difference. The productivity of land in West Wawonii, was in fact better than in Kulisusu.

In general, bigger scales of business and land productivity will produce a higher production. The fisherwomen of Bajau in West Wawonii, for instance could produce between 2 – 4 times in a year, whereas in Kulisusu, they could only merely make up to 3 times per year. Patadjai (2007) stated that the growth of seaweed is influenced by the environmental factors of the waters that support physical, chemical and biological growth. If the conditions of waters are suitable with the growth of seaweed, then the planted production could be higher, even though they are being cultivated in the same land mass area; moreover, Riani (2015) also claimed that the production of seaweed in West Wawonii was higher than in Soropia and Toli-Toli districts, due to carrying capacity difference between them. In West Wawonii, the carrying capacity was higher, thus supporting better production.

The next contribution of fisherwomen of Bajau is in the marketing sector. In terms of product marketing, the price of seaweed in the research sites was notably different. In West Wawonii, the fisherwomen sold the dried seaweed with a price between IDR 8,000 and IDR 12,000 while in Kulisusu, the price ranged from IDR 7,000 to IDR 12,000. The fisherwomen tend to have no plans in marketing their produce because the lack of marketing information, and institutional capacity of farmers' groups. In addition, they should trade the product immediately in order to meet the daily expenses of their family. Aslan *et.al*. (2016) noted that the groups of farmers have tended to be directed by the ease of getting seeds, rather than strengthening the capacity of the groups instead; and as a result, many of the groups nowadays remain inactive.

Theoretically, the production and product price will influence the amount of revenue that the fisherwomen might earn; and furthermore, the revenue and expenditures would affect their income. Labor wages by 41%, constituted the biggest expenditure of production factors, since the laborers were members of the family (internal labors), so this expenditure could be categorized as the family income as well. An exception occurs to the wages allocated for the external labors who tied the seeds, because they were paid as much as 5% out of the total expenditure of production factors; and in addition, motorized boats as a means of transportation have been generally used at the initial planting, harvesting and fishing.

The Income of Fisherwomen from Seaweed Cultivation Business

The revenue and average income of fisherwomen of Bajau in West Wawonii was higher than in Kulisusu. In West Wawonii, the fisherwomen received IDR 12,972,000 of revenue per year and IDR 6,688,252 in a year as the average income while in Kulisusu the figures were slightly lower than the first district. The fisherwomen in the latter made IDR 11,166.667 of the revenue per year, and about half of it was the profit, giving them an income of (IDR 5,110,638/year). This difference was caused by the individual marketing strategy applied by the fisherwomen in the two research areas. In West Wawonii, the dried seaweed were sold at higher price i.e. IDR 10,000/kg and by contrast, the majority of fisherwomen in Kulisusu sold their product at low price i.e. IDR 7,000 and 8,000/kg.

The fisherwomen income above includes the wages of internal labors; however, if the labors were non-family members or external workers then the amount of income was lower. The fisherwomen in West Wawonii earned an average income of IDR 8,366,672/year or IDR 706,389 in a month; meanwhile in Kulisusu, the fisherwomen received IDR 6,334,638/year or IDR 527,887 in a month. The average income was lower than what the fisherwomen in India had made.

Periyasamy *et al*. (2013) stated that the average income of fisherwomen in India wasRs 10,000/cycle or equals to IDR 2,087,700 per cycle (45 days). Rajasree and Gayanthri (2014) revealed that the fisherwomen received incomes as much as Rs 8,400, or equal with IDR 1,753,668/cycle (35 days). Kronen *et al*. (2010) stated thatin Solomon Island, a positive and statistically significant correlation was found between the number of women per household participating in seaweed farming and the household's revenues from this income source.

If the fisherwomen's income from seaweed cultivation is linked to the number of the dependants in the family, then the result changes the value of per capita income. On average, the number of family dependents in West Wawonii was 5 persons, so the value of per capita income from seaweed cultivation was IDR 1,337,650/year or in a month it reached IDR 111,471. In Kulisusu, the average number of family dependents was 4; therefore the value of per capita income was slightly lower than the per capita income in West Kulisusu. In a year, fisherwomen families in this district have obtained IDR 1,022,128 or IDR 106,472. Different values of the per capita income occur when the wages for external labors was included. In West Wawonii, the value of per capita income was IDR 1,673,334/year or IDR 141,278/month. In Kulisusu, the value was not significantly different than the per capita income in West Wawonii. In a single year, the fisherwomen families could earn IDR 1,583,660, or in a month they might receive IDR 139,445. Based on the poverty indicators released by the Central Agency of Statistics, the fisherwomen of Bajau in West Wawonii and Kulisusu were categorized as poor family. According to the agency, in 2013, the poverty line of Konawe Archipelago was IDR 230,486/capita/month while in North Buton Regency, a family was categorized as poor in 2013 if it only had IDR 242,884/capita/month (BPS Sultra, 2017). Even though the families of fisherwomen were poor but in accordance with Ratio Revenue-Cost (R-C) value, the fisherwomen have significant potential opportunities to develop their business, thus contributing to the family's overall daily needs, and thereby alleviating their poverty.

Ratio Revenue-Cost value constitutes a ratio between expenditures for production, and revenue (or profit percentage that are generated from the seaweed business.) The fisherwomen in West Wawonii have R-C value of 1.969, whereas their counterpart in Kulisusu scored 1.844. These two figures indicated that the purchasing power of fisherwomen, from seaweed business against the total production factors that were used in the process of seaweed production, was 196.9% and 184.4% respectively. In other words, out of expenditures for production factors in a years time, the fisherwomen in West Wawonii and Kulisusu had profited as much as 96.9% and 84.4% correspondingly. La Ola (2010) claimed that by using IDR 5,000,000 as capital, fishermen could produce 1.2 ton of seaweed with profit as much as IDR 4.600.000 or the R-C ratio was 192.0% which indicated a profit level as much as 92.0%.

The Income Contribution of Fisherwomen towards the Fulfilment of Family Consumption Needs

In the two research areas, the fishermen of Bajo's family have spent daily consumptionon food and non-food categories such as rice, snacks, sugar, cigarettes, education, and clothing. In a year, each family of the fishermen spent IDR 13,995,900 or IDR 1,166,325/month. Out of the total expenses for daily consumption, 97.6% was allocated for food, and the rest was for others expenses (20.4%). It is then suggested that the fisherwomen in the two areas of research, have allocated their income more in the purchase of food. This is in line with the research of Listiyandra, *et. al* (2016) on fishermen community in

Muara Angke, North Jakarta. They explained that the expenses for food consumption was higher 67% than non-food uses with the total average of consumption costs was IDR 1,449,244/month. In the Bungin Permai village, another spot of fishermen of Bajau, the consumption costs was even higher. Aslan *et.al* (2014) reported that the average expenditure of respondents for food consumption was about IDR 24,017,014/year and IDR 13,176,214/year for non-food goods; however, in this study, all of expenditure items in a year were counted, whereas in the two research areas above, the calculation was limited to the daily consumption of the fishermen's families.

IN conclusion, the consumption needs of the fishermen's families were partly satisfied by the income of fisherwomen from the seaweed business. The income contribution of the fisherwomen against the fulfilment of family's consumption needs in West Wawonii was higher than in Kulisusu. Studies show that 53.3% of family's consumption needs in the Bajau community of West Wawonii was supported by the income of fisherwomen; while in Kulisusu, the fisherwomen contributed a bit less, namely 34.7%. In Kulisusu, the low contribution of fisherwomen to the family's consumption needs was influenced by a consumptive culture. In this area, the family expenditures (IDR 15,488,556/year) surpassed the fisherwomen's income (IDR 5,110,638/year). A different condition applies to the families of fisherwomen of Bajau in West Wawonii. In a year, the fisherwomen contributed IDR 6,688,252 out of IDR 12,279,579 for the total expenditure of the family's consumption needs.

The value of exchange rate for family's consumption was below the indicated income of fisherwomen's seaweed cultivation business, and could not fully satisfy the routine consumption needs of the family; nevertheless, the average Exchange Rate of Consumption Fishermen value of fisherwomen (44.0%) implied that the Fisherwomen's income, within the study areas, had supplied 44.0% of the total daily family consumption needs.

The Exchange Rate of Consumption Fishermen besides determining the amount of income, it has also shown the influence of family's consumption pattern. The most striking consumption of the fishermen of Bajau family was cigarettes, that ranged between 18.1% and 22.3% from the total of the family's income. This consumption pattern should be highly considered by the fishermen, because all family members do not require cigarettes or smoking. The differences of consumption patterns between the fisherwomen families in West Wawonii, and in Kulisusu were the number of members, and the price of consumption per type that were used and spent by the family members. The fisherwomen family in Kulisusu consumed more kinds of expensive cigarettes and clothes, so that the total expenditure of the consumable income was higher. A different pattern of consumption occur in the fishermen families in West Wawonii, where they spent more on rice, sugar and snacks due to the bigger size of family dependents.

Conclusion

The average production of dried seaweed by the fisherwomen of Bajau was about 1,166,7 to 1380kg/year (1248,9 kg/year). Using production costs and carrying capacity of the land efficiently could increase the production. Moreover, the revenue of fisherwomen could be bigger if there are interventions on marketing management. The bigger the revenue is, then the higher contribution of fisherwomen to their family routine consumption where in this case the percentage of their contribution (44.0%) could be multiplied. Furthermore, the revenue should be wisely used in fulfilling the family needs consumption likewise.

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Impact Analysis of Government Policies on Competitiveness of Skipjack Fishery in Kendari City

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Abstract

Analysis of competitiveness and impact of government policy on skipjack fisheries is not only provide information to stakeholder about ways to improve the competitiveness but also provide information to the government related to the development of tuna fisheries as the leading commodity in Kendari. This study used data from 25 ship owner selected from the entire population of skipjack fishermen in Kendari City conducted from March to May 2014. Policy analysis matrix showed that skipjack fishing gears in Kendari were both comparative and competitive with the highest competitive values found in troll line at boat capacity 5 -10 GT, followed by pole and line at 30 GT vessel capacity. This finding implied that the skipjack fisheries in Kendari economically viable. In addition, the results also indicated that government policies had a very important role in the level of competitiveness of skipjack fisheries. Government policies impacted the fishermen in form of subsidies of input such as fishing gears, gasoline and vessels. However, a new breakthrough from the government to regulate the output price to be more pro fisherman in order to increase fishermen income and to increase the production of skipjack fisheries.

Keywords: Competitiveness, skipjack fisheries, impact of policy

Introduction

Fishing is a reliable source of income for a lot of people in coastal areas in Indonesia. Although it has been contribute to fisheries products and consumption for decades, some fisheries are still have a great potential to be developed particularly in eastern part of Indonesia. One of Indonesia's fishery with a promising potential is skipjack fisheries in Kendari, South East (SE) Sulawesi. This is because Kendari regional waters which is part of the Regional Fisheries Management (*Wilayah Penangkapan Perikanan*/WPP) 714 is the area of skipjack migration. To date, the status of most fisheries in WPP 714 is still allowed to be exploited (KKP, 2012). Skipjack fisheries activities have been contributed to increase the welfare of fishermen and processing businesses that in turn develop the regional economy and increased national income. In 2002, the potential for sustainable skipjack fisheries in the waters of Indonesia and the Indonesian EEZ was estimated at 294.975.000 tons per year (Directorate General of Fisheries, 2003). Moreover, the production of skipjack caught in Regional Fisheries Management of the Republic of Indonesia (WPP-RI) and the high seas of the Pacific Ocean from 2000 to 2011 showed an increase in production every year. In 2000 the estimated total production was only 20.759 tons and in 2011 it increased significantly to 330.048 tonnes, with an average of 107.855 tons of annual catch (KKP, 2012).

In order to increase exports of non-oil commodities, the skipjack fisheries should be supported by government policies to increase production. According to Cahya (2010), skipjack export was dominated by frozen products of skipjack and yellowfin skipjack. Indonesia export data of skipjack in 2011 accounted to 141.774 tons increase compared to the year of 2010 that was at 122.450 tons (KKP, 2012). Increased export volume of skipjack indicated that the marketing planning process is done not only after the product is ready for sale, but has been started since the catch, post-harvest handling up to the product selection strategy to market more competitive products.

The demand for skipjack that is rich in protein and vitamins will continue to increase every year along with continuous increasing population, rising middle class incomes and awareness of the nutritional needs of society. Therefore skipjack fishery needs special attention

from the government and related stakeholder in order to improve its productivity. Skipjack fishing effort by fishermen in Kendari has grown quite rapidly. Skipjack is ranked first in fish production among the other economically important fish. In 2012, the production of skipjack in Kendari reached 9598.25 tons and has been shown an annual increase. This indicates that in Kendari, skipjack stock is abundant. In addition, the price of skipjack in Kendari was able to compete in which the price offered is relatively cheaper than the price of the other districts in Southeast Sulawesi, which is in line with the value of Kendari skipjack production in 2012 at $ 34.5172 million (DKP Kendari, 2013). Common fishing gears used in Kendari to catch skipjack are trolling (troll line) and *huhate* (pole and line). Skipjack in Kendari is mainly sold to meet the needs of the local community, but some are also marketed outside of the region to Makassar, Surabaya, Denpasar, Banyuwangi and Jakarta. Recorded volume of skipjack in 2012 that was exported outside of Kendari reached 2421.25 tons, a significant increase from 2011 that was 1,937 tons (DKP Kendari, 2012). In addition, in 2012, skipjack was one of the non- oil export commodities that was consistenly contributed to export volume from Kendari. Skipjack commodities had been exported in the form of frozen skipjack at 3191.88 tons to some countries such as Japan, Hong Kong, and Australia.

Application of appropriate technology on commonly used fishing gear is crucial for skipjack fishermen in Kendari to enable them to compete with skipjack fishermen from other areas as a result of globalization and free trade. Pacing national skipjack production is important to further improve the competitiveness of three types of fishing gears used in skipjack fisheries. Analyzing the competitiveness of skipjack fisheries will determine to what extent that the system commodity of skipjack fisheries in Kendari is able to compete with commodity system of skipjack in other areas both at regional and national level in order to increase the income of fishermen, local revenue and national income. Government policies also affect the increase business competitiveness skipjack fishery at both production and trade.

Government policies such as the implementation of import tariffs, subsidies, export taxes and other external factors can affect the development of skipjack fisheries. Those impacts can be positive (incentives), negative (disincentives) or no impact at all. The government policy in form of supervision on fisheries business (technology use, the unit of fishing effort etc.) is now more necessary to overcome the decline of skipjack resources due to over fishing. Therefore, the effort to improve the competitiveness of skipjack fishery in Kendari is very important to be studied with the aim to investigate the comparative and competitive advantages of troll and pole line gear in skipjack fishing and to analyze the impact of government policies in increasing business competitiveness of skipjack fishery using those both fishing gears in Kendari.

Materials and Methods

Study Area

The experiment was conducted in Kendari SE-Sulawesi from March to May 2014. The location of this research was chosen puIDRosively based on some considerations: (a) Kendari city is a center for fishing activities including skipjack fishing effort in SE-Sulawesi which is supported by the presence of fish landing station (*Tempat Pendaratan Ikan/TPI)* in Sodohoa and fisheries harbor (*Pelabuhan Perikanan Samudera/PPS* in Lapulu, (b) Kendari is the highest skipjack producer in SE-Sulawesi within Regional Fisheries Management (WPP) 714-rich skipjack fish resources, (c) Kendari is potential to be developed as a regional business center for skipjack fishery because of its position as the capital city of the province with well-established skipjack agroindustry and (d) high demand for skipjack commodities in Kendari.

Population and Sample

The population in this study was the owners of skipjack fishing vessels using either troll-line with vessel average size of 5-10 GT or pole-line vessels with average size of 30 GT. Such vessels were active vessels that landed their catch in *TPI* Sodohoa and *PPS* Lapulu Kendari. The total population or number of fishing vessel owners was up 40 people consisting of 30 people using troll-line and 10 people of pole and line vessels. Given the heterogeneous and stratified population we divided the owners into two groups according to the type of fishing gear.

Furthermore, the determination of sample size for each stratum/group carried out proportionaly and then samples were randomly selected. Therefore, we interviewed 25 respondents consisting of 19 of troll line owners and 6 samples of pole and line vessels.

Data Analysis

Primary data were collected from selected fishermen through direct interview using questionnaires consist of number of fishing effort or trip in a month, level of education, number of workers, means of production, capital and equipment as well as the purchase price of all inputs. Secondary data were collected from various offices / agencies that was related to the study include geographic and climatic conditions around the waters of Kendari, the number of fishermen, the number of fishing gear, and fleet and also production data of skipjack catch in recent years. Collected data were then analyzed using Policy Analysis Matrix (PAM) as in Table 1. PAM analysis was used in this study because this analysis is able to analyze simultaneously of both private and social benefits, analyzing competitiveness, discuss comparative advantage (economic efficiency) and competitive (financial efficiency) as well as identifying the impact of government policy on skipjack fisheries.

Table 1. Analysis of Policy Analysis Matrix (PAM). Unit price is in IDR

Description	Income	Tradable Input Price	Non-tradable Input Price	Profit
Private prices	A	B	C	D
Social Price	E	F	G	H
Policy Impact	I	J	K	L

Source: Pearson et al (2005)

Specification:
Advantage Analysis:
Private Gain (PP) D = (A) - (B) - (C),
Social Advantage (PS) H = (E) - (F) - (G)
Competitiveness Analysis: Private Cost Ratio (PCR) = C / (A-B)
Domestic Resource Cost Ratio (DRC) = G / (E - F)
Input Policy Impact Analysis:
Transfer Input: IT = B - F
Nominal Protection Coefficient to Input: NPCI = B / F
Transfer Factor: FT = C - G
Policy output:
Output Transfer: OT = A-E
Nominal Protection Cofficient Output: NPCO = A / E **Input-Output Policy**
Effective Protection Coefficient: EPC = (AB) / (EF)
Net Transfers: NT = D - H
Profitability Coefficient: PC = D / H

Results and Discussion

Analysis of the competitiveness of skipjack

Analysis of the competitiveness of skipjack Kendari using appropriate macroeconomic assumptions in PAM analysis, such as the nominal interest rate (% per year), social interest rate (% per year) and exchange rate (Rupiah per US Dollar) in 2014 is presented in Table 2.

Table 2. Macroeconomic Assumptions 2014

No	Macroeconomic Assumptions	Total
1.	Nominal Interest Rate (% per year)	13
2.	Social Interest Rate (% per year)	22,25
3.	The Rupiah (IDR/$) (March April 2014)	11.425

Source: Bank Indonesia and the Coordinating Ministry for Economic Affairs (2014)

The detailed data on the number and private prices for inputs and outputs skipjack fisheries with troll line and pole and line fishing gears in Kendari from March - May 2014 are presented in Table 3. Most of ship owners earned more revenue per trip in troll line fishing. This was because operational costs and number crews on troll line vessels were less than pole and line, as well as composition of skipjack catches.

Table 3. Total and Private Rates for Tradable inputs, non-tradable inputs, and output Skipjack Fishery in Kendari in March - May 2014.

Type and unit	***Tradable input***					
	Amount per trip		Price per unit (IDR)		Total value (IDR/*trip*)	
	Troll line	Pole and line	Troll line	Pole and line	Troll line	Pole and line
a. Diesel (L)	600	800	5.500	5.500	3.300.000	4.400.000
b. Oil (L)	10	20	22.500	22.500	225.000	450.000
c. Gasoline (L)	20	50	6.500	6.500	130.000	325.000
d. Kerosene (L)	10	20	7.000	7.000	70.000	
e. Salt (Kg)	1,25	1,25	6.000	6.000	7.500	140.000
f. Rice (Kg)	10	60	9.000	9.000	90.000	
g. eggs (dozen)	15	30	14.882	14.882	223.230	7.500
h. Instant Noodle (dos)	4	7	75.240	75.240	300.960	
i.Recovery of capital equipment	131.314	395.439	-	-	131.314	540.000
					4.478.004	446.460
						526.680
						395.439
						7.231.079

Type and unit	***Non-tradable input***					
	Amount per trip		Price per unit (IDR)		Total value (IDR/*trip*)	
	Troll line	Pole and line	Troll line	Pole and line	Troll line	Pole and line
a. clean water (m^3)	2	3	4.194	4.194	8.388	12.528
b. ice beam (beam)	90	90	15.000	15.000	1.350.000	1.350.000
c. artificial bait (box)	1	300	50.000	-	50.000	1.875.000
d. live bait (kg)				6.250		
e. Labour (people)	7	18	1.125.823	912.991	7.880.761	16.433.838
f. Rcovery of capital equipment	739.616	936.748	-	-	739.616	936.748
g. Equipment Treatment (IDR)	125.000	150.000	-	-		150.000 +
					125.000	
					10.135.765	20.758.168
a. Total input /Unit sheep	100%	100%			14.613.769	27.989.247
b. Skipjack input price	70%	52%			10.242.238	14.554.408
a. *Out put* Skipjack (kg)	1.480		12.000	12.000	17.760.000	21.000.000
b. Income					7.517.762	6.445.592

The calculation of the cost of social capital recovery equipment was basically the same as the calculation of capital recovery costs in private equipment. Based on the calculation of the input and output border price of skipjack fisheries and explanation of non-tradable inputs, we calculated the economic value of the use of tradable and non-tradable inputs as shown in Table 4.

Table 4. Total and Social Prices for Tradable inputs, non-tradable inputs, and output of skipjack fishery in Kendari from March to May 2014.

Type and unit	Tradable input					
	Amount per trip		Price per unit (IDR)		Total value (IDR/*trip*)	
	Troll line	**Pole and line**	**Troll line**	**Pole and line**	**Troll line**	**Pole and line**
a. Diesel (L)	600	800	10.000	10.000	6.000.000	8.000.000
b. Oil (L)	10	20	23.000	23.000	230.000	460.000
c. Gasoline (L)	20	50	10.000	10.000	200.000	500.000
d. Kerosene (L)	10	20	9.700	9.700	97.000	194.000
e. Salt (Kg)						
f. Rice (Kg)	1,25	2	1.366	1.366	1.708	2.732
g. eggs (dozen)	10	60	6.000	6.000	60.000	360.000
h. Instant Noodle	15	30	16.549	16.549	248.235	496.470
(dos)	4	7	129.200	129.200	516.800	
i. Recovery of						904.400
capital equipment	210.412	501.511	-	-	210.412 +	501.511 +
					4.478.004	11.749.700

Type and unit	Non-tradable input					
	Amount per trip		Price per unit (IDR)		Total value (IDR/*trip*)	
	Troll line	Pole and line	Troll line	Pole and line	Troll line	Pole and line
a. clean water (m^3)	2	3	4.194	4.194	8.388	12.528
b. ice beam (beam)	90	90	15.000	15.000	1.350.000	1.350.000
c. artificial bait (dos)	1	-	50.000	-	50.000	
d. live bait (kg)	-	300	-	6.250		1.875.000
e. Labour (people)	7	18	1.125.82	912.99	7.880.761	16.433.838
f. recovery of capital equipment	985.733	1.457.436	3	1	985.733	1.457.436
g. Equipment Treatment (IDR)	125.000	150.000	-	-	125.000+	150.000+
					10.399.882	21.278.856
a.Total input /unit vessel	100%	100%			17.964.037	23.028.556
b. skipjack input cost	70%	52%			12.574.826	17.174.849
a. *Out put* Skipjack(kg)	1.480	1.280	18.280	18.280	27.054.400	31.990.000
b. Income					14.479.574	14.815.151

Competitive Analysis of Skipjack Fisheries Based on Comparative Advantage and Competitiveness

Table 5. Calculation of PAM model in skipjack fishery with troll line at 5-10 GT from March - May 2014.

Description	**Acceptance (IDR/ha)**	**Tradable Input cost (IDR) (57%)**	**Non-Tradable input cost *(*IDR) (57%)**	**Profit (IDR)**
Private cost (1)	17.760.000	3.134.603	7.107.636	7.517.762
Social cost (2)	27.054.400	5.294.909	7.279.917	14.479.574
Policy impact (3) = (1) – (2)	(9.294.400)	(2.160.306)	(172.282)	(6.961.812)

Table 6. Calculation of PAM model of skipjack fishery with pole and line gear in 30 GT vessels from March - May 2014.

Description	**Income (IDR/ha)**	***Tradable Input***	***Non-Tradable Input Price (*IDR)**	**Profit (IDR)**
Private Cost (1)	21.000.000	3.760.161	10.794.247	6.445.592
Social Price (2)	31.990.000	6.109.844	11.065.005	14.815.151
Police Effect (3) (3) = (1) – (2)	(10.990.000)	(2.349.683)	(270.758)	(8.369.559)

Table 7. Competitive indicators of skipjack fishery in Kendari on Troll line 5-10 GT and pole line 30 GT from March-May 2014.

No.	Indicator	Price	
		Troll line	***Pole and line***
	Profit Analysis		
1.	PP (*Private Profitability*)	7.517.762	6.445.592
2.	PS (*Social Profitability*)	14.479.574	14.815.151
	Competitiveness		
3.	PCR (*Private Cost Ratio*)	0,48	0,63
4.	DRC (*Domestic Resource Cost*)	0,33	0,43
	Input Police Impact IT		
5.	(Input Transfer)	(2.160.306) (172.282)	(2.349.683)
6.	TF (Transfer Factor)	0,59	(270.758)
7.	NPCI (*Nominal Protection Coefficient On Tradable input*)		0,62
	Input Police Impact	(9.294.400)	(10.990.000)
9.	OT (*Output Transfer*)	0,65	0,65
10.	NPCO (*Nominal Protection Coefficient On Tradable Output)*		
	Input-Output Policy Impact		
11.	NT (*Net Transfer*)	(6.961.812)	(8.369.559)
12.	EPC (*Effective Protection Coefficient*) PC	0,67	0,66
	(*Profitability Coefficient*)	0,52	0,43

Discussion

Production and Analysis of the Competitiveness of Skipjack

Skipjack production by fishermen in March and April 2014 varied based on type of fishing gear. The data obtained showed that the range of production of skipjack on troll fishing gear using 5-10 GT vessels ranged between 998 - 1,750 kgs or an average of 1,480 kg per trip with a percentage of 70% of the total catch. As for the pole and line fishing gear in 30 GT vessels, skipjack production ranged between 1250 - 1961 kgs or an average of 1,750 kg per trip to the percentage of 52% of the total catch. In terms of fish quality caught by skipjack fishermen in Kendari, it was found that they were in accordance with ISO skipjack quality issued by the Department of Marine and Fisheries of Indonesia. Test results through testing methods of SNI based on organoleptic characteristics, microbiological and chemical skipjack landed in Kendari found that the scores were not less or not exceed the limits of established quality standards (DKP Southeast Sulawesi Province, 2012).

Nominal interest rate was obtained from formal credit level information (bank-owned, local government banks, private banks, commercial banks and other credit institutions). In this study, we used the nominal interest rate, instead of the real interest rate for the entire capital cost component because PAM budget reflected the impact of inflation that would be inconsistent if the impact of inflation on capital component was removed only by using the real interest rate. Nominal interest rate used was the average interest rate for the private capital sourced from formal credit institutions that exist in the study area, which was 13% per annum for the retail scale People's Business Credit (*Kredit Usaha Rakyat/KUR* > 20 jt - 500 jt) (Ministry of Finance, 2014).

Calculation of Private Price

Private prices in the analysis of competitiveness are the value or price of inputs and outputs applicable to fisheries in the study area at the time of the study. The price of the equipment used in skipjack fishing effort is a capital recovery costs of equipment during a certain period (annual cost recovery), by taking account of the economic life of the equipment and private rates that have been determined. We used capital recovery cost in this study because it takes into account the opportunity cost of capital that is tied to the fixed input where the fishing vessel owners can save money in the bank when not invested in the fixed input. Therefore, the real cost of capital is the cost per year plus interest that should be

obtained by the capital. Fixed input load is then allocated to skipjack commodity beneficiaries or input usage.

According to the fishing vessel owners or managers, the use of capital goods and equipment in skipjack fishing effort varied by usage and type. The cost of investment depended to the prevailing price in the market. After the expiration of the investment operations, such investment may still have residual (salvage) value in the form of scrap metal or parts that still can be used. Residual value will be accepted several years to come and should be discounted at the interest rate of the data private and social use. This value then subtracted from the value of the initial investment to get the net present value.

Recovery ratio was obtained by calculating the interest rate (private or social) and the age of the investment. If the recovery ratio has been obtained, then the actual value can be calculated. Furthermore, capital recovery cost was calculated in units of charge per hour or other unit (Monke and Pearson, 1998). Unit cost of capital recovery equipment used in this study was a unit per trip because all inputted components were calculated based on the amount of time spending at sea per trip. Similarly, the catch of skipjack being an output was the catch per trip. The calculation of the cost of capital recovery equipment on a troll line fishing unit in 5-10 GT vessels was essentially the same as the calculation of capital equipment on pole and line fishing unit ≥ 30 GT. In troll line 5-10 GT business unit, the required investment was much lower than the pole and line. This was mainly due to the capacity of fishing vessels in term of machinery used. In both types of skipjack fishery, the largest business investment was on fishing vessels.

Calculation of Social Price

Social prices or economic value is the border or frontier price of goods that can be traded between countries (tradable goods). Border price used was the price of free on board (fob) on various types of machines, and commodity consumption of skipjack and cost of insurance and freight (cif). The use of the fob price at the skipjack output was because it assumed that the skipjack catch landed in PPS and TPI Kendari was potential for export. There is also a social price in a perfectly competitive market price or prices that are not distorted by government policies such as subsidies on fuel prices. Data on the fob and cif value as well as social price in skipjack fishery were obtained from provincial office of Central Statistics Bureau of SE Sulawesi and the official websites of the Ministry of Energy and Mineral Resources and the Ministry of Industry and National Trade.

In this study, the social price for the maintenance of ships and other equipment was calculated using the actual price paid by fisherman. This was because the cost of care services was in the category of non-tradable inputs, in which such costs incurred to maintain and repair equipment abroad was more expensive if maintained and repaired within the country. Gray et al. (1997) stated that an item was categorized as tradable inputs when its exported fob price was larger than the cost of domestic production, and if imported, cif price of domestic production must be higher. A non-tradable goods were categorized as input goods if cif price was larger than domestic production costs and the fob price was lower than the cost of domestic production. In labor cost calculation, we used shadow wage. However, because of labor used in skipjack fisheries are generally classified as unskilled labor, then the shadow wage was equal to the value of corresponding private wage. This trend was similar to the plantation sector workers, as found in study by Amrun (2011) that the economic value of labor was extracted from the corresponding private wage or salary received at the time.

We found that social price of fuel (diesel, kerosene, gasoline) in addition to rice and salt consumption was higher than the private prices (Table 4). This was because of government intervention in form of subsidies on fuel. In addition, due to fuel and consumption, there were some potential products that were sold abroad at a higher price such as instant noodles and eggs. Similarly, the social price of skipjack was higher than private prices because skipjack are potential commodities for export where export prices were higher than domestic one. The calculation of the shadow price in this study was consistent with the definition of Gittinger (1986) with some necessary adjustments price. In general, shadow price was calculated by removing the distortion due to the transfer of payment policies such as taxes,

subsidies and other transfers form. This price was an indicator of social advantage over potential or comparative advantage of skipjack fishing business.

Competitive Analysis of Skipjack Fishery Based on Comparative and Competitive Advantage in Kendari City

The level of competitiveness of skipjack fisheries and the impact of government policies with two types of gear using PAM were presented in details in Table 5. There was a significant difference in price between private and social costs of tradable inputs. These differences resulted in divergence effect value gain or a net profit of IDR-6961812 in troll line fishing. This value of net divergence effect suggested that fishermen were not able to pull the excess profits earned by the community. In skipjack fisheries with pole and line fishing gear in 30 GT vessels, the effects divergence value gained a higher net income than troll line in 5-10 vessels. The detailed calculation of revenue cost of private, social costs, benefits and impact of government policy on skipjack fisheries by using those two types of gear is presented in Table 6.

Any fisheries industry are highly dependent on natural conditions, resulting in fishermen do not have full capacity in determining the market price capacity. Based on calculations of reception, private prices, and policy impacts on social and business units of both troll line pole and line fishing, we obtained the indicator of profitability, competitiveness and the impact of commodity policies as presented in Table 7. Analysis of the competitive advantage consisted of financial benefits or private profit and PCR. Skipjack pole and line fishing produced financial benefits of IDR6.445.592, whereas the troll line fishing was able to reap the financial benefits of IDR7.517.762 which was the highest advantages in skipjack fishing. Financial efficiency can be measured by using PCR which also showed the competitive advantage of skipjack fisheries. PCR coefficient value was higher in troll line skipjack fishing at 0.48 compared to pole and line fishing at 0.63 (Table 7). PCR values less than 1 implied that the costs incurred by the fishermen for every single IDR received were only 0.48 dollars troll line and 0.64 dollars on pole and line fishing. This means that efficient use of domestic factors was worth the effort. PCR values can be minimized by lowering the domestic factor cost and tradable inputs.

The value of comparative advantage was measured using social profit and Domestic Resource Cost (DRC). Social profits are beneficial if they occur in a perfectly competitive market where there is no government intervention and market failures. The private profits of troll line gear in 5-10 GT vessels were higher, whereas pole and line in 30 GT had a higher social benefit although the difference was not significant. Social benefits derived from skipjack fishermen using troll line gear 5-10 GT were IDR 14.479.574 and for pole and line fishing gear in 30 G was IDR 14.815.151. Both of skipjack fishing gears were positive, which means that the exploitation of skipjack stock was economically profitable so that it can compete with the skipjack fishing effort in other areas. This is consistent with study by Unang (2003) in Pearson (2005) in chicken farm who found that if the social line for all businesses showed a positive profitability, it was an efficient business. Also, level of economic efficiency reflected comparative advantage or competitiveness as described by the value of the DRC. In this case because the DRC was less than one, it was suggested that the skipjack fishing in Kendari was efficient in terms of domestic resource usage for each of the rupiah driving the economic benefits of skipjack fisheries in Kendari. In troll line gear of 5-10 GT vessels, the DRC value was only for IDR 0.33 which was the most efficient fishing gear in the use of domestic resources and the value of IDR 0.43 on pole and line fishing gear 30 GT suggested similar economic benefit. In other words, economically skipjack production in the country was much more efficient because domestic factors were used efficiently and profitably than import. In an effort to increase the rate of economic growth, commodity with a smaller DRC value will get higher priority in its development.

PAM results showed that the level of private profitability of skipjack fisheries in the both fishing gears in Kendari was smaller than social profitability. This may be attributed to the presence of monopsony practices in the study area. Pearson *et al*. (2005) stated that several factors can lead to divergence. The first one was market failure. There were three types of market failures that lead to divergence, namely: 1) monopoly (seller who control the market price) or monopsony (buyer control over the market price), 2) negative externalities (costs,

which the party has led to an expense that cannot bear the cost thereof) or positive externalities (benefits, which the party causing such benefits cannot receive compensation or reward for the benefits thereof), and 3) imperfect of domestic factor markets, which is not an institution that can provide competitive services and complete information. The second divergence contributor was distorted government policies, which was applied to achieve the goal of non-efficiency either equity or food security. This would hamper the efficient allocation of resources and thus creates divergence. PCR values of both fishing gears was smaller than the value of the DRC in this study suggested that to add competitiveness in private, skipjack fisheries in Kendari need to raise the output price and reduce the cost of domestic factors and tradable inputs particularly in pole and line fishing. This study implied that the skipjack landed in PPS and TPI Kendari was competitive both domestically and abroad when used troll line in 5-10 GT but not in pole and line in 30 GT because lower market price than the price of skipjack from other regions, assuming the cost of production and marketing costs unchanged from the data used in this calculation.

Government Policy Impact Analysis of Competitiveness

A government policy in economic activity can provide a positive or negative impact on economic behavior. The impact of policies may also decrease or increase the production and productivity of economic activity. In the literature review pointed out that the government's policy covers three areas of policy inputs, outputs and policy input-output policy.

Policy input

Policy input prices in form of subsidized price (positive or negative) or barriers to trade (basic pricing for a particular output or quotas) may encourage an optimal resource utilization by manufacturers and protect domestic producers. Policy on tradable inputs on skipjack fisheries in Kendari included subsidies on fuel, taxes on consumer goods and Value Added Tax (VAT) on the equipment. The amount of subsidy provided by the government on each trip of troll line and pole and line fishing was IDR 2.160.306 and IDR 2 .349.683, respectively with a ratio of 40.8% and 38.45% of the cost if it was without a policy. NPCI value was less than one that was 0.62 for purse seine ≥ 30 GT, 0.59 to troll line 5-10 GT and 0.62 for pole and line 30 GT (Table 7). This suggests that government intervention in form of subsidy on prices of tradable inputs reduced the prices paid by fishermen to these inputs. Therefore, in general, the policy and market performance input subsidies and tax levies have been in the side of skipjack fisheries.

Policy output

Skipjack OT commodity value in Kendari was negative or less than zero which was IDR -9.294.400 in troll line and IDR -10. 990,000 on the pole and line fishing (Table 7). OT negative value indicates that the social price of skipjack was better than the private prices received by skipjack fishermen. It implied that domestic consumers bought skipjack at a lower price than the actual price if the market was not distorted or without government intervention. Nevertheless, this policy benefited consumers in the country, giving rise to the incentives transfer from fishermen to consumers.

Input-Output Policy

Lower value of EPC coefficient was found in troll line compared to pole and line fishing (Table 7). This implied that the impact of government policy on the formation of the input-output markets of skipjack fisheries generated disincentives or inhibition for the development of skipjack fishing effort in Kendari, making the value-added benefits received by fishermen lower than they should receive. The relative size between private and social net profit can be used to look at the level of net profit is Profitability Coefficient (PC). In this study, the PC figures showed that government policies affected private and social profits. PC value less than one indicated the level of benefits received by fishermen lower than the social benefits. In this study, we found the PC value less than one in both types of fishing gear that was 0.52 for troll line and 0.43 for pole and line. It is suggested that the actual profit that should be

received by the skipjack fishermen decreased by 52% in troll line and 43% in pole and line. Higher advantages deprivation was found in troll line compared to pole and line fishing.

Conclusion

Skipjack fisheries in Kendari was viable as showed by its competitive and comparative advantage. Troll line with boat capacity of 5-10 GT was the most efficient gear compared to pole and line fishing gear at 30 GT boat capacity. Competitiveness for skipjack commodity both domestically and abroad are on skipjack landed in PPS and TPI Kendari because theoretically in the country can still be suppressed price lower than the price of skipjack from other regions, assuming the cost of production and marketing costs unchanged from the data used in this calculation. The impact of government policy on input prices current causes input prices paid by fishermen lower or cheaper than it should be. This has provided the stimulus for fishermen, but on the other hand needed a new breakthrough from the government to the output price policy should be more pro fisherman fishermen so that more exciting to increase the production of skipjack fisheries.

Based on the conclusions derived from the results of this study, the authors suggested that the fishermen or vessel owners can further increase their productivity in troll line fishing gear, but it needed a new breakthrough from the government to regulate the output price through policies that should be more pro fishermen to increase their fishing effort thus skipjack production.

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Study on Business Development of Seaweed Community Based on the Order of Revenue Improvement in the Coastal Fisherman of Southeast Sulawesi

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Abstract

The utilization of seaweed farming area/seaweed business in Indonesia has not been maximal, including Southeast Sulawesi, which is only able to seek less than 5 percent of the potential of existing land. The objectives of the present study were to identify the problems faced by seaweed farmers in increasing production, to know the problems encountered in the effort of community empowerment, (3) to find out the marketing systems conducted by seaweed farmers. This study used qualitative methods. Data were analysed using interactive models adopted from Miles and Huberman. The sample area was Tinanggea, sub-district of South Konawe Regency which is the center of seaweed production. This study concluded that; (issues that increase production such as; unpredictable weather pattern, lack of capital, environmental pollution by mining companies, local government policies were less supportive, issues in community empowerment efforts, namely: insufficient awareness of groups, less participation of members , relatively limited farmers' farming in business management, and seaweeds were marketed by using two channels, most still relying on collecting swimmers in the village and seaweed sold in the form of dried seaweed there was no production process in other forms.

Keywords: Seaweed Business, Community Empowerment, Fisherman's Income, Coastal Area.

Introduction

Economic development is essentially an effort to continuously increase per capita income in the long term. Therefore, one of the indicators to measure the success of economic development is the continuous increase of per capita income of community. A steady increase in income will have implications in improving people's welfare. In addition, the increase in income per capita will also contribute to poverty reduction.

Development should be able to increase the dignity of human beings universally and everyone is entitled to enjoy the results of development. Todaro and Smith (2003) stated that the success of a country's economic development is indicated by three basic values, namely (1) the development of society's ability to fulfill its basic needs (sustenance), (2) increasing self-esteem society as human beings, (3) increasing the ability of the public to choose (freedom from servitude) which is one of human rights. Therefore, development policies and priorities should be directed towards achieving the above objectives, all of which will lead to improving the lives and welfare of the people. Development policies and priorities should take into account the potential of resources owned by both natural and human resources.

Indonesia has vast sea territory with the second longest coastline in the world after Canada. Indonesia's marine is rich in minerals and sunlight so it becomes a fertile ground for seaweed growth. The potential of distribution of seaweed in Indonesia is very wide, both naturally grown and cultivated in almost all regions of Indonesia such as Sumatra, Java, Bali, Nusa Tenggara, Kalimantan, Sulawesi and Papua (Anggodiredja, 2008).

The potential of Indonesia's marine resources makes marine resources as a source of livelihood to increase the income and living standards of people living in coastal areas.

Although seaweed commodity has good market prospect in local, inter island, and export markets, it is not fully able to improve living standard and prosperity of coastal community. Seaweed farmers continue to be in poor income conditions so that their welfare and living standards are low. Meanwhile, seaweed traders, especially exporters, have achieved an established economic resilience and seaweed farmers are economically fragile and socially unempowered.

Strategic area that can be used for seaweed cultivation throughout Indonesia covers approximately 1.2 million hectares (DKP, 2006). From this wide potential, until 2010 Indonesia can only afford less than 5 percent of the existing land potential (Ministry of Marine Affairs and Fisheries, 2010).

Two things are often associated with indicators of empowerment that is the degree and base of empowerment. Suharto (2008) reported that four of the indicators concerning degree of empowerment namely: a. level of consciousness and desire to change (power to), b. level of ability to increase the capacity to gain access (power within), c. the level of ability to face the barrier (power over), d. level of ability of cooperation and solidarity (power with). While the other five related to the basis of the empowerment Friedman (1992) in Rafiy (2014), namely: a. Community-based development, b. sustainability, c. Community participation, d. Development of social capital of society, e. Abolition of gender imbalances.

Community-based seaweed development is aimed at increasing the production and productivity of seaweed is also very important to increase the income and living standards of the community, especially the coastal communities. In addition, the of seaweed business based on community empowerment is expected to increase seaweed exports and state revenues, the development of raw materials to meet the needs of various processing industries, and the improvement of the coastal economy through expansion of employment opportunities and income increase.

Based on the above description, research on seaweed development based on community empowerment in order to increase income in coastal area of Southeast Sulawesi is very important to provide input for the government in the framework of formulation of policy of increasing production and income of society.

Methods

Object of Research

This research was conducted at seaweed production center in Tinanggea, sub-district of South Konawe Regency, Southeast Sulawesi. The place was selected based on the consideration that seaweeds in the area have been cultivated since the late 1970s. However, until 2014 most of the seaweed farmers in the area still had low income and were classified as poor so that their living standard was still relatively low.

Selection and Determination of Informants

Qualitative research emphasized in the amount of information not on the number of informants, so the issue of the number of informants was not questioned, as long as the information obtained was considered sufficient and valid (Fatchan, 2011). The research informants were grasshopper farmer in Tinanggea Sub-district of South Konawe Regency. Tinanggea sub-district is a seaweed production center in the coastal area of Southeast Sulawesi. Informants were selected based on these criteria: 1). Seaweed business as the main source of family income, 2). The farmers have been working on seaweed for at least 3 years, 3). They were willing to provide information related to the research.

Table 1. List of Informant Research

No.	Name	Age	Gender	Level of Education	Working	Period (year)	Place
1	Masnawati	43	Female	Senior high school	Farmer	20	Akuni
2	Irwan	38	Male	Senior high school	Farmer	18	Tinanggea
3	Sardin	50	Male	Junior high school	Farmer	25	Tinanggea
4	Jamal	45	Male	Senior high school	Farmer	20	Bungin

Data Collection Techniques

Data and information in this research were collected using several ways, namely:

- Observation, (before and after the interview) i.e.: the researcher was in the environment of the object of research and trying to understand the situation and condition on the object of research, this was done before the interview. Meanwhile, the

observation was made after the interview to verify the information provided by informants with real conditions in the field (triangulation).

- In-depth interviews were conducted with semi-structured interviews and no structures. The length of the interview was adjusted to the situation and circumstances of the informant. In fact, the interview took place variably ranging from 30-90 minutes. Each interview used several instruments in the form of tape recorders, cameras and interview notes.
- Documentation i.e.; collect various data from government and other reliable sources.

Data Validity

To ensure the quality of the data used, tested with several criteria, as described by Lincoln and Guba (1985) in Fatchan (2013): Triangulation, this research performs triangulation of data in several ways, namely:

- Comparing the observation data with the result obtained from interview, when there was inconsistency of informant's words and reality, then the researchers asked the informant to get the valid and accurate information.
- Comparing the understanding of informants with the other informants and others (not informants), if researchers feel the statements of informants were different then confirmation was made to the related informants.

Data analysis

Data were analyzed by interactive techniques adopted from Miles and Huberman (1992). The interactive model is done with three stages of analysis, namely;

1. Data reduction, i.e. conducting the selection process, selection, simplification, grouping of data found in the field, be it the results of observations and interviews. Next encode the data and make a summary of the themes relevant to the research focus, so that data that were not relevant to the research focus had to be removed.
2. Data presentation, namely the process of organizing information and described in the form of narrative text as well as in the form of matrix, graph, network and chart.
3. Conclusion.

Results and Discussions

Problem of Seaweed Farmers in Increasing Production

The result of observation and interview with some informants in Tinanggea Sub district, concluded some problems, obstacles and challenges faced by seaweed farmers. The problems and obstacles were climate/weather, capital, local government policy and environmental pollution by mining companies.

Climate/Weather/Season

Seaweed is one commodity that is relatively sensitive to climate change / weather / season. Favorable climate will generate good quality of seaweed. A few informants in the village of Akuni, Bungin Permai, Torokeku and Tinanggea reported that the dry season was unfavorable for the growth of seaweed.

Dry season causes seaweed unable to grow to the maximum, even the seaweeds became whitening, besides seaweed can be infected with hairy disease that prevent seaweed to grow well. For the Tinanggea District the dry season usually takes place from September to November, so in those months seaweed farmers were less interested in planting and tend to do other productive activities.

In addition to the dry season, heavy rainy season is also unfriendly for the development of seaweed, especially in the rainy season that causes the rivers to overflow even to the flood. In this season, seaweed conditions experience disease with the color of seaweed turned to white and eventually die. However, such conditions were rare, the last incident occurred in Tinanggea Sub-district in2013.

Ideal conditions or the most conducive to seaweed according to the informants was the rainy season is not too dense, where the sea atmosphere surges, causing seaweed "wiggle". When the season arrives then seaweed farmers can harvest between 4 times to 6 times, so the season is always awaited by seaweed farmers.

Capital

Capital is one of the classic problems that occur in farmers / fishermen due to the assets owned by farmers relatively little or less and lack of good access to the banking world. Due to several things, such as, the absence of collateral / bankable collateral or no asset that can be used as collateral, farmers are unable to take advantage of opportunities in the banking world.

Currently there are several business credit schemes provided by the government such as KUR (People's Business Credit) which should not be required for loan guarantee with a maximum value of Rp. 25.000.000,- however, in practice the bank as a distributor KUR always ask for additional guarantees (such as: house/land certificate, vehicle ownership book/BPKB both motor and car).

The source of seaweed farmers' business capital in Tinanggea sub-district comes from their own capital and loans, for capital sourced from loans consisting of loans from banks, cooperatives and middlemen. For banks there are two banks that become partners of seaweed farmers, namely BRI and BNI, while for cooperatives there are also two cooperatives namely Samaturu and Toromeambo Cooperatives. For the number of middlemen quite varied from time-to time.

The amount of loans granted by banks ranges from Rp. 30.000.000, - Rp. 50.000.000, - / person, while for the cooperation range between Rp. 1,000,000, - up to Rp. 15.000.000, -. Loans provided by banks and cooperatives are sufficient to assist farmers in purchasing seaweed cultivation equipment, such as; ropes, buoys and seeds as well as labor costs.

Disclosed by some informants that loans provided by banks and cooperatives are very helpful in the process of seaweed cultivation and the repayment of the loan is relatively smooth and not experiencing bad credit. However, this was before many mining companies were operating in Tinanggea sub-district.

This is very different from the current situation where, there are some bad credits due to the inability of seaweed farmers in production, where the costs incurred to plant more seaweed than the production.

Environmental Pollution by Mining Companies

The existence of a nickel mining company in South Konawe District, especially in Tinanggea sub-district has had positive and negative impacts. Positive impacts felt by the public were the availability of job opportunities and the increase in the income of the communities located around the mining area. However, there were negative impacts on the community around the mining area.

Since the existence of mining companies, the production of seaweed began to decline. In the beginning, seaweed farmers experienced a decrease in seaweed production due to changes in the color of the water became red or turbid, especially on land or area around the mining area or traversed by ships from mining companies.

Along with the increasing number of mining companies operating in Tinanggea sub-district, the impact of mining companies was wider. Seaweed farmers from several villages in Tinanggea sub-district suffered significant decrease in production. Even they reported that the production decline was very sharp, where in normal conditions (before mining companies start to operate) seaweed farmers can harvest 4 to 6 times each year.

Since 2017 the production of seaweed farmers, especially land/seaweed area around the mining area or traversed by the ships of the company experienced a drastic decline, not even a few seaweed farmers experiencing crop failure. Narrated by a respondent from the village of Akuni that for the year 2017 before the fasting month to do "rope drop" of 300 ropes but suffered crop failure, resulting in so many losses.

It said some informants from Akuni Village and Tinanggea Village that under normal conditions (before sea water pollution) farmers can produce 500 Kg until 1 ton for every 100

ropes. However, in 2017 the production of seaweed farmers, especially those located in the vicinity of mining areas or the area/land traversed by ships mining companies experienced a sharp decrease even most of the crop failure.

Seeing the increasingly unfavorable situation, most of the seaweed farmers were forced to do not "decrease the rope" and the equipment commonly used for production such as ropes, buoys and others become neatly dotted around the home of seaweed farmers. This is done because the cost to "decrease the rope" becomes more than the harvest.

Seaweed conditions that do not have good prospects forcing seaweed farmers from several villages in District Tinanggea to switch their professions in order to fulfill their daily basic needs. Some of the selected professions were motorcycle taxi drivers, drivers and construction workers, etc. This change of work is something difficult because being seaweed farmers have been done for so long, but they have to in order to support their family.

Local Government Policy

The role of local government is certainly crucial for the continuation of small businesses including farmers and fishermen. The alignment of local government was needed by seaweed farmers in Tinanggea Sub-district, the policy that pro-farmers will support productivity. The informants reported that the attention of local governments was not maximized, it was seen the lack of policies associated with seaweed farmers. Assistance provided by local government, especially South Konawe relative yet exists, either in the form of equipment, as well as seed capital.

Problems in Community Empowerment

Based on the results of the analysis, the synthesis and comparation of informant answers can be formulated several problems in the effort of community empowerment, namely group awareness, less participation of members and relatively limited knowledge of seaweed farmers in business management.

Group consciousness

The benefits and objectives of the group are not well understood by seaweed farmers, this is because the level of education was low and the experience of fishermen was relatively limited relative to business in the form of groups. Mutual trust between members was still relatively low. In Tinanggea, there were some groups of seaweed farmers, but not functioning optimally because of the lack of awareness in groups. Even some of the formed groups disband or vacuum because of suspicion from the board or fellow members.

Very Low Member Participation

Participation and cohesiveness of seaweed farmer group members in Tinanggea sub-district in group activities is still relatively low. This is reflected in the low attendance of members in group meetings (only 50 percent). This causes various development and empowerment programs did not run properly, one of the factors that cause by the formation of seaweed farmer groups still use approach from top down, so awareness for grouping not yet exist.

Farmers' Knowledge of Limited Management and Business Management

The knowledge of seaweed farmers was still very minimal, especially about good business management, so that the effort done to increase farmer's income did not run well, such as; business activities of seaweed farmers do not have a good financial record. Besides, seaweed farmers in Tinanggea sub-district only focus on production activities (on farm) and have not been involved in downstream business from seaweed production.

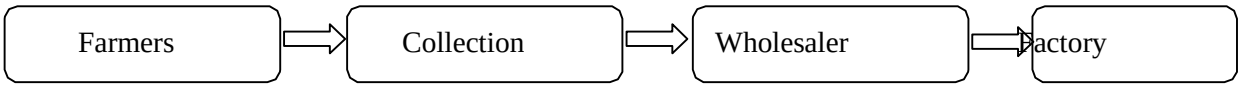
Seaweed Farmers Marketing System.

Marketing channels were people or institutions that liaise in the process of transferring, possessing, and delivering commodities from producers to consumers. Price fluctuations were a marketing problem (off-farm) that is often disclosed by seaweed farmers. Such price fluctuations were often more detrimental to seaweed farmers than to traders because farmers generally unable to manage their sales time to get a more profitable selling price.

Otherwise, high price fluctuations also give traders the opportunity to manipulate price information at the farm level so that the transmission of prices from the consumer market to farmers tended to be asymmetric in the sense that if there was an increase in price in the level of consumer then the price increase was not passed on to the farmers quickly and perfectly, and vice versa if price declined occur. Supply and demand conditions that occur in the market mainly affected fluctuations in seaweed prices.

The marketing channels established by seaweed farmers in Tinanggea are presented as follows:

First model



Second model

The chain of seaweed marketing in Tinanggea establishes two marketing channels involving two marketing institutions: middle men and wholesalers on the first and second line involving a marketing agency that is wholesalers, farmers and factories/exporters.

Conclusion

Based on the analysis, synthesis and comparison it can be concluded, that issues that increase production such as; unpredictable weather patterns, minimal capital, environmental pollution by mining companies, local government policies were less supportive; Problems in the effort of community empowerment, namely: insufficient awareness of groups, less participation of members, and relatively limited knowledge in business management; Seaweeds were marketed with two channels, most still relying on collecting swimmers in the village and seaweed sold in the form of dried seaweed. There is no production process in other forms.

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Factors Affecting Revenues of Seaweed Farmers in North Konawe Regency South East (SE) Sulawesi

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Abstract

The objectives of the study were to formulate variables that may affected the income the seaweed farmers and to examine the effect of land area, business capital, and the number of work days on seaweed farmer's income at Konawe Utara Regency SE Sulawesi. This research used a mixed of qualitative and quantitative method design. The samples used were 50 seaweed farmers that were purposively selected in Lembo and Wawolesea Sub-district of North Konawe Regency. Observation, interviews and focus group discussions were conducted to define suspected variables that affected the income of seaweed farmers. Formulated variables were then further designed into questionnaires to be used for interview. Qualitative data obtained from seaweed farmers were analyzed with an interactive model from Milles and Huberman, to determine the variables affected the income of seaweed farmers. The data respondent answers related to those variables then analyzed by using multiple linear regression. This study concluded that variables affected the income of farmers seaweed were farm area, business capital and number of work days. Simultaneously, those variables had a significant effect on seaweed farmer's income but partially, only farm area and business capital that significantly affected the seaweed farmer's income, and not number of work days.

Keywords: Seaweed, Farmer's Income, North Konawe

Introduction

Poverty remains a problem in Indonesian economic development although alleviation of poverty has been the country agenda of millennium development goals (MDGs). Development with less attention to aspects of equalization will increasingly create regional imbalances which will further increase the level of poverty in these areas (Pamungkas, 2009). Although the government has taken some policies to alleviate poverty, the poverty problem has not been fully resolved yet. Bureau of Central Statistic of Indonesia (2015) showed an increasing number of people lived in poverty in 2014 and 2015. In March 2014 it was recorded 28.28 million people and it was increased in March 2015 to 28.59 million people or an increase of 0.31 million people.

Poverty reduction with entrepreneurship has been clearly described by Onn (2013), stated that entrepreneurship can no longer be underestimated because of an increasingly essential development in the goal of eradicating poverty that the last few decades have become a common problem for developing countries in the Asia-Pacific region. Furthermore, Onn (2013) also added that the essential role of entrepreneurship in poverty alleviation increasingly crystallize as the opening of access in order to increase the standard of education as well as the level of employment. Ludovick (2013) in his study of poverty through entrepreneurship and innovation found that entrepreneurial reduce poverty significantly. Poverty comes down to a much greater magnitude when interacting with entrepreneurship. Furthermore Adofu (2013) in his research in Nigeria found that 65 percent of respondents stated that lack of entrepreneurship skills among youth was closely related to high levels of poverty in Nigeria. The results of this study also showed that at least 60 percent of the population who attended entrepreneurship skills training had been able to to meet their basic needs through entrepreneurship. In Somalia, Ali (2013) found that there was a weak positive correlation between entrepreneurship development and poverty reduction. Muthalib (2014) found that entrepreneurship has a positive and significant impact on poverty alleviation, and entrepreneurship also had a positive and significant impact on performance of micro business.

Farmers are one of community group that need an entrepreneurship intervention to increase their income thus reduce poverty.

Selection of seaweed farmers as the object of this study because of high marine potential of Indonesia as the second longest coastline in the world after Canada to support seaweed cultivation. Indonesia's marine waters are rich in minerals and sunlight so it becomes a fertile ground for seaweed growth. The distribution of seaweed in Indonesia is very wide, both naturally grown and cultivated in almost all regions of Indonesia such as Sumatra, Java, Bali, Nusa Tenggara, Kalimantan, Sulawesi and Papua (Anggodiredja, 2008) in La Nalefo (2013).

Although the seaweed commodity had a fairly bright market prospect both in local and regional market, it was not fully able to improve the living standard and prosperity of coastal community. Seaweed farmers continue to live in poverty with limited income conditions so that their welfare and living standards are low. Meanwhile seaweed traders, especially exporters, have achieved an established economic resilience and seaweed farmers are economically fragile and socially not empowered. Strategic area that can be used for seaweed cultivation in Indonesia is approximately 1.2 million hectares (DKP, 2006). However, until 2010, Indonesia was s only able to cultivate less than 5 percent of the existing land potential (Ministry of Marine Affairs and Fisheries, 2010). The development of seaweed business is aimed at increasing the production and productivity of seaweed but also very important to improve income and living standards of the community. This research, therefore, was conducted to find variables that could increase the income of seaweed farmers in the coastal area of North Konawe Regency. Through identifying these variables, some necessary development actions and policies can be generated to increase the income of seaweed farmers and therefore the poverty level of seaweed farmers in the coastal area of North Konawe Regency may be reduced.

The problems formulated in the research were as follows:

1. What variables do affect the income of seaweed farmers.
2. Does the land area, business capital and number of work days have a significant effect on seaweed farmers either simultaneously or partially in North Konawe Regency?

The purpose of this research was:

1. Formulating variables that can affect the income of seaweed farmers.
2. Testing the influence of farm area, business capital and number of work days on seaweed farmer's Adaptation either simultaneously or partially in North Konawe Regency?

Research Methods

Research Design

This study used a mixed design between qualitative and quantitative method. This research observed the research area and conducted discussions and interviews including focus group discussions (FGD) to formulate variables that were expected to influence the income of seaweed farmers. Variables that had been formulated were further asked to the respondents using questionnaires.

Population and sample

The research was conducted on seaweed production centers in coastal areas of North Konawe. The population of this research was all seaweed farmers in coastal area of Konawe Utara. Given the limited time and funding, this study was conducted a sampling on some districts that were considered to represent the characteristics of the existing population.

The selected sub districts were Lembo and Wawolesea sub-districts. Each sub-district was selected or determined again by a sample unit of 25 seaweed farmers selected purposively (purposive sampling). Selection of unit samples based on several criterions include: 1)seaweed farming was the main source of family income, 2)farmers had been working on seaweed at least for 3 years, and 3)they were willing to provide information related to the research objectives.

Data Collection Techniques

Data collection was done as follows:
1. Observation, which was collecting data in the field by visiting seaweed farmers who have been specified as a sample.
2. Questionnaire, which was data collection by distributing a list of structured and open questions to seaweed farmers sample.
3. Documentation, which recorded all information obtained from seaweed farmers.

Data analysis

Qualitative data obtained from seaweed farmers were analyzed with an interactive model from Milles and Huberman (2009), this was done to determine the variables that could affect the income of seaweed farmers. The data of respondent answers related to the variables that affected the income of farmers were analyzed using linear regression in SPSS version 20.

Hypothesis

Based on the results of observations and interviews, some hypotheses below were formulated to be answered in this study:
Hypothesis 1: Does the farm area, business capital and number of work days have a significant effect on seaweed farmers' revenue in North Konawe?
Hypothesis 2: Does the area of farm have a significant effect on the seaweed farmers' revenue in North Konawe?
Hypothesis 3: Does the business capital have a significant effect on the seaweed farmer's revenue in North Konawe?
Hypothesis 4: Does the total number of work days have a significant effect on the seaweed farmer’s revenue in North Konawe?

Results and Discussions

Respondent's Characteristic

Characteristics of respondents included in this study were age of respondents, gender, education, farmers experience and the number of working days.

Age

The age of the respondents calculated in this study was the age of the respondent from the date of birth until the last birthday at the time of the research conducted. Most of the respondents of seaweed farmers were still in productive age. This was in accordance with the productive age in Indonesia which ranges from 19-54 years. Based on the results of this study, seaweed farmers in the research were still have the potential to increase their production and thus income.

Table 1. Respondents by Age Group

No	Age Group (Year)	Number of Respondents (Person)	Percentage (%)
1	28 – 37	13	26,00
2	38 – 47	15	30,00
3	48 – 57	11	22,00
4	58 – 67	6	12,00
5	68 – 77	5	10,00
	Total	**50**	**100,00**

Gender

The results showed that most of the respondents of seaweed farmers were male. This illustrated that seaweed business was predominantly performed by men than women. This was because the business management of seaweed requires a lot of field work in the sea which was quite difficult to do by women. Nevertheless seaweed farm owned by women in the research area generally used male labor, and women only provided cost and capital for seaweed farm. Women seaweed farmers in the entire research area were single women either divorced or separated by death, and therefore they were the sole breadwinner for the family.

Table 2. Respondents by Gender

No	Gender	Number of Respondents (Person)	Percentage (%)
1	Male	46	92,00
2	Female	4	8,00
	Total	**50**	**100,00**

Level of Education

Education is one of the important factors that influence the mindset, attitude and actions of a person including in managing the business. We found that most of the respondents of seaweed farmers in the study site were elementary school, which was 27 respondents or 45%, followed by senior high school with 14 people or 28%. Respondents who had a junior high school level was 9 respondents or 18 percent. This education level data showed that seaweed farmers in the research area were still relatively low-educated, therefore their business management tended to be more static from year to year without showing any significant development of business to be more advanced. Therefore, it was natural that the seaweed business management in the research area was still traditional.

Table 3. Respondents by Education

No	Level of Education	Number of Respondents (Person)	Percentage (%)
1	Elementary	27	54,00
2	Junior High	9	18,00
3	Senior High	14	28,00
	Total	**50**	**100,00**

Farming Experience

The results showed that the respondents farming experience in the research area ranged from 3-26 years. The experience of respondents in doing seaweed business was closely related to the level of production and income they earned. Respondents who had long-standing experience could obtain higher production and income than respondents who were recently done seaweed farming.

Table 4. Respondents according to business experience

No	Experience (years)	Number of Respondents (Person)	Percentage (%)
1	3 – 10	11	22,00
2	11 – 18	25	50,00
3	19 – 26	14	28,00
	Total	**50**	**100,00**

Labor

The labor calculation used in this study was the number of work days. One number of work days was equivalent to 8 hours of work. The use of labor in the seaweed farm in study site was generally done by mutual cooperation or helping each other in one farmer group. Each farmer group consisted of 8-10 people.

Table 5. Respondents according to labor usage.

No	Total Labor (h)	Number of Respondents (Person)	Percentage (%)
1	60-160	12	24,00
2	161-260	10	20,00
3	261-360	28	56,00
	Total	**50**	**100,00**

Seaweed Business Revenue

Seaweed business income calculated in this research was net income obtained by seaweed farmers for one year. This income was an accumulation of income earned for each harvest season. Every year seaweed farmers can harvest seaweed between 4-5 times. Net income in question was net income obtained by seaweed farmers after deducting expenses incurred including the cost of depreciation of investment. The obtained data of net income of the respondents varied greatly from IDR 12,000,000 - 52,000,000.

Table 6. Respondents according to net revenue

No	Nett Revenue (Million IDR)	Number of Respondents (Person)	Percentage (%)
1	22-Dec	15	30,00
2	22-32	7	14,00
3	32-42	21	42,00
4	42-52	7	14,00
	Total	**50**	**100,00**

Factors Affecting Seaweed Farmers Income

To determine the factors that affect revenue seaweed farmers, we used multiple linear regression analysis. The independent variables that expected to affect the income of seaweed farmers were; farm area (X1), working capital (X2), and labor (X3). The land area was measured in units, working capital was calculated from all costs incurred in the production process including the cost of depreciation of the investment. Meanwhile, labor was calculated from the number of work days. The dependent variable was the income of seaweed farmers as measured by the net income received.
Multiple linear regression analysis model was as follows:

$$Y = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3\ X3 + e$$

where:
Y = Seaweed Farmers Revenue
X1 = Area of farm
X2 = Working capital
X3 = Number of work days
e = Standard Error

Hypothesis Test Results

To prove the research hypothesis proposed in this research, we used multiple linear regression method with the result of analysis as follows:

Table 7. Multiple Linear Regression Analysis Results

Variables (X)			Regression Coefficient (β)	t	T Sig	Description
Land Area (X1)			0,521	2,562	0,014	Significant
Business Capital (X2)			0,764	3,517	0,001	Significant
Number of NUMBER OF WORK DAYS (X3)			-0,338	-1,480	0,146	Not Significant
Constant (β0)	=	4,300 with t significant 0,000				
R Square	=	0,895				N = 50
R	=	0,946				α = 0,05
F	=	131,186				
F sig	=	0,000				
Standard error	=	0,138				

Based on the calculation results as in table 7, it can be explained as follows:

The number of constant (β0) of 4,300 with a significance value of 0,000 which means greater than the value of α = 0.05, it can be interpreted that statistically the constant value (β0) is significantly different from zero (β0 ≠ 0). Therefore, the value of the constant (β0 = 4,300) can be included in the regression model.

R-Square of 0.895 indicates the magnitude of the direct effect of the variable of land area (X1), venture capital (X2), and the number of number of work days (X3) to income (Y) was 89.5 percent so that other variables described in the model of 10.5 percent.

R (number of correlation coefficients) of 0.946 indicates that the level of closeness of direct relationship between variable land area (X1), venture capital (X2), and number of number of work days (X3) to income (Y) was 0.946. This relationship was statistically very strong, as Sugiono (2006) pointed out that the relation was very strong when R value was 0.70-1,000. Therefore, the resulting regression model can be regarded as a "Fit" model or can be a good estimator model. On this basis, the regression model generated as the explanatory model of the effect of farm area, business capital and the number of work days on seaweed business income in the coastal area of North Konawe.

Partial and Simultaneous Test Results

Regression analysis results in table 7 above can be interpreted as follows:

- F value of 131.186 with a significance value of F_{sig} = 0,000 meant that (F_{sig} < 0.05), so that statistically, farm area (X1), business capital (X2), and number of work days (X3) simultaneously had a significant effect on income (Y) at 95 percent confidence level.
- Significance effect of farm area to income obtained at t value (0.05 = 2,562) with significance value of t_{sig} = 0,014 which was smaller than α = 0.05. This indicated that the value of β1 coefficient of 0.521 is significantly different from zero (0,521 ≠ 0). Therefore, the farm area was partially significant to income. On this basis, farm area can be included as one of the predictor variables for seaweed business income in the coastal areas of North Konawe Regency.
- Significance effect of business capital to income obtained at t value (0.05 = 3,517) with t_{sig} = 0.001 <0,05). These results indicated that the value of β2 coefficient of 0.764 is significantly different from zero (0.764 ≠ 0). Thus it can be stated that business capital alone had a significant effect on income. This means that business capital can be one of the predictor or predictor variables for income. Therefore, the business capital can be included in the model for seaweed business revenue estimation in the coastal area of North Konawe Regency.

- The significance of number of work days variable to income obtained with t value (0.05 = -1,480) with tsig = 0,146 > 0.05). These results indicated that the β3 coefficient value of -0.338 was significantly different from zero (-0.338 ≠ 0), thus it can be stated that partially variable of number of work days had no significant effect on income. As the relationship between number of work days and income was negative, it can be concluded that the longer the farmers worked in their seaweed farms, they will get less income.

Conclusion

Based on the results of the analysis it can be concluded, that variables that expected to affect the income of seaweed farmers in North Konawe Regency, were farm area, business capital and number of work days; Simultaneously, all variables tested (farm area, business capital and number of work days had a significant effect on seaweed farmer's income in North Konawe Regency; Partially, only farm area and business capital that significantly affected seaweed farmer's income in North Konawe Regency, whereas number of work days had no significant effect.

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Added value development of seaweed *(Eucheuma cottonii)* as a potential commodity for the prosperity of East Sumba regency communities, East Nusa Tenggara

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Abstract

This study was aimed to raise the added value of seaweed to people's economy. The study applied a qualitative and quantitative method through survey, direct observation and interviews. Data were representatively and puIDRosively collected. The study used descriptive analysis, focus group discussion, and simple mathematics. Results showed that Pay Back period was 0.72 meaning that the investment in seaweed culture could be returned in 8 months; Break Even Point per seaweed culture business unit was IDR. 3,435.77; the Break Even Point of production was 2,007.50 kg; Benefit Cost Ratio (B/C) was 1.09 meaning that the seaweed culture was feasible to do. There were three successive seaweed marketing channels, i.e. producer, collector, merchant, manufacture, consumer, or direct delivery from producers to consumers, producer to collecting merchant, and big merchant to consumer. The added value was IDR. 3,575/kg for the seaweed farmer,I DR.2,175/kg for big merchant, and IDR. 41,000/kg for seaweed industry.

Keywords: *Eucheuma cottonii*, the *added value*, *benefit Cost*, BEP, Pay Back Period

Introduction

East Nusa Tenggara (ENT) Province is an archipelago with a semi-arid climate where two thirds of its territory is the ocean and therefore has many potential areas for the development of seaweed cultivation include Kupang, East Sumba, Alor, Rote Ndao, Sabu Raijua and Lembata (Provincial Agency of Industry and Trade, 2014). Since the establishment of *minapolitan* area of aquaculture and fishery in 2010, seaweed production in these areas have been continued to increase and in 2014 reaching a total production of 2,400 tons (Provincial Agency of Marine and Fisheries, 2014). This great achievement cannot be separated from the regional government's support in developing these areas to be an integrated and developed aquaculture *minapolitan* area. In responding to this situation, the government of Sumba regency, East Sabu Raijua Districts built a seaweed landing base to cut off the monopoly practice from certain merchants and to accommodate the seaweed farmer's and fishermen's complaint on price access and prevent discrimination (Provincial Agency of Industry and Trade, 2015).

The potential of seaweed culture area in ENT is very high, reaching a total arable area of 151.473 ha which is supported by favorable weather conditions for the seaweed culture (Provincial Agency of Industry and Trade, 2014). Seaweed culture development in ENT also supported by the high number of seaweed farmers living in this region, i.e. 64.095 people, who also created opportunities to develop seaweed as regional superior commodity (Provincial Agency of Marine and Fisheries, 2014). To date, the potential of seaweed culture area in the province is 51,870 Ha or 5% of its the coast line but only 5,205.70 ha of that area is utilized, with annual production potential of 1.7 million tons of wet seaweed or 250,000 tons of dried seaweed in 2-3 cultivation cycles per year. If these potential areas are optimally managed, total seaweed production in ENT province is estimated to reach 750,000 – 1,250,000 tons of dried seaweed per year (Agency of Industry and Trade, 2016). The Ministry of Marine Affairs and Fisheries (MMF) (2015) stated that seaweed production of Indonesia reached a total of 10,335,000 tons wet seaweed or 6,201,000 tons dried seaweed, 60% of which was produced in ENT province.

Seaweed was considered as a high value commodity with very wide utilization, high labor usage, easy culture technology, short culture period (45 days), and inexpensive cost per production unit (Parenrengi *et al.*, 2006). Nevertheless, the living standard of the seaweed farmers is, in fact, still below of other farmers such as finfish and shrimp farmers. Also, seaweed raw material supply that was related to the use of low quality seed, low quantity and discontinuity of seed supply**,** unstandardized seaweed raw material handlings and control based on either national or international standard, limited raw material supply, and lack of price and market information is still existed in seaweed production which

hinder the added value gained by seaweed farmers. Seaweed culture is highly opportunistic to develop for sustainable fisheries production in order to increase the added value (Giyatmi *et al.*, 2003). The development of the added value from seaweeds occurs in each chain of flows from the producer to the consumer (Purwaningsih and Widjaja, 2014). The added value of each chain is different depending on the input and the treatment (Van Staden CJ, 2000). Therefore, in line with aquaculture fisheries development policy or sustainable industry, an agroindustry-based management strategy is needed to be created. To overcome these problems, an assessment study was done on the added value gained in seaweed culture business up to the seaweed industry such as in Alkali Treated Cottonii (ATC). This study is expected to be able to help the policy makers (central and regional governments), investors, merchants, farmers, exporters, and other stakeholders involved in the seaweed industry development to yield the added value of seaweed commodity for the benefit of all stakeholders.

Materials and Method

This study was carried out from July to September 2015 in East Sumba regency with focus on red seaweed *Eucheuma cottonii*. The study employed survey method, observation, and interviews. The data were obtained through respondents from related government institutions, seaweed farmers, traders, retailers, and entrepreneurs.

Data Analysis

This study applied qualitative and quantitative descriptive analysis. The former describes the condition of the production center and the present market, and the latter is used to measure the business at each level of seaweed production chain from farmers to buyers. Through this analysis, the extent of seaweed business revenue and marketing will appear using the following formula:

$$\Pi = TR - TC$$

where:

Π = income
TR = total revenue
TC = fixed cost + variable costor total cos

Break Even Point (BEP): Fixed Price: (Price – Variable Cost)

Payback Period (PP) = Initial investment: cash inflow per period

Benefit Cost Ratio = *PV of Net Positive Cash Flow/PV of Net Negative Cash Flow*
if B/C >1: the project/business is feasible to do
B/C < 1 : the project/business is not feasible to do

Mathematically, the function of the added value, according to Hayami, et al. (1987) could be formulated as follows:

$$NT = f(K, B, T, H, U, h, L)$$

where,
K : production capacity
B : number of raw material used (kg)
T : number of labors needed (person) *H* : output price (IDR/kg)
U : wage (IDR)
h : raw material price (IDR/ kg)
L : other input value (IDR/kg)

Results and Discussion

Major Executor in seaweed production

Seaweed farmer in East Sumba regency

Based on 2014-2016 survey conducted by Provincial Agency of Industry and Trade in ENT, almost all of human resources of the seaweed farmers in East Sumba did not finish secondary school education. The farmers were 39.35 years old with about 9.35 years of experience in seaweed production. They used their own capital as initial investment, and the farming started from fishermen's collection. This finding supports the study by Parenrengi *et al*. (2006) that the seaweed business is highly promising due to its easy practice, short harvest in only 45 days, and easily available family labors (males or females). The technology used was relatively easy and inexpensive that applying long line method. The seaweed seedlings were obtained from the harvest.

In the marketing system of seaweed, the buyers directly visited the culture sites or farmer financial institution or *Koperasi* to buy the seaweed products. In average, each farmer own about 4,920 m^2 seaweed farm, with annual dried seaweed production in range of 1.3 – 12.8 tons and average selling price of IDR. 6,000 – 11,000/kg. The seaweed was sold to the collector, middlemen or *Koperasi*. The domestic markets covered Bali, Makassar, and Surabaya. According to Ngamel (2012), usual problem faced by farmers was low bargaining power against the processing industry as major seaweed buyer. This industry has made a previous agreement with the seaweed farmers that resulted in fixed selling price for the farmers.

The seaweed culture business analyses results in East Sumba regency were as follows: average annual cost was IDR 1.266.955, average annual dried seaweed product was 4.330 kg, with an average annual investment of IDR 13.669.455, per-cultivation cycle. Income per cultivation cycle was IDR 7.345.000 with annual income was IDR 29.135.000 so that the total annual profit was IDR 15.465.545. According to Irmayani *et al.* (2014), profit was a net income gained by the farmer and was the difference between production value and total expenditure. The Pay Back Period was 0.72 per year, similar to that obtained by Hidayat *et al.* (2012), who found that seaweed cultivation business was capable of returning the investment in 0.72 year or 8-9 months. Ngamel (2012) stated that payback indicated the length of time an investment could be returned. Seaweed farmers in East Sumba was able to return their investment less than a year because they allocated no labor cost and all production activities were run by the family members so that the high production costs could be cut off as suggested by Irmayani, *et al.* (2014). The production breakeven point (BEP) was achieved at 2,007.50 kg, whereas the price of BEP was reached at about IDR. 3, 435.77. Under these values, the seaweed culture business does not have any loss of profit.

Seaweed merchants

The traders involved in the seaweed marketing were collectors in the village, retailers at the regency level, and large traders at provincial or regional levels. In East Sumba, the trader's age were in average about 43.46 years old with mean experience in seaweed business of 3 years. The business could be either individual or in form of *koperasi*. The seaweed traders purchased the seaweed product from the farmers in form of dried seaweed with 35-38% water content. Approximately 90% of the traders bought the seaweed directly from the production sites whereas the rest 10% of the collecting merchants sold the dried seaweed to the big merchants. We found in the present study that only 1-2 local traders, one district-level traders and one large merchant involved in the seaweed marketing in the research location.

The big merchant's access to the seaweed investment and marketing was sufficient, in contrast with the traders that had only a limited access to the market. Hence, the traders just sold the seaweed to certain big merchants. The seaweed price at the farm gate was lower at about IDR.6, 825/kg, compared with the price at national level that had mean selling price at IDR.8, 300/kg. These prices was in line with the statement of the Provincial Agency of Industry and Trade Services of East Nusa Tenggara (2016) who found that the price of dried seaweed at the farmer level ranged from IDR. 6,000 to IDR. 8,000/kg and the selling price from the local trader to the big trader ranged from IDR. 7,000 to IDR. 9,000/kg. The differencee between the seaweed price at the farm gate and that at the big trader level was IDR.1, 500 on average.

Total monthly cost for the merchant was IDR.126,300,000.- with the average monthly profit was IDR.130,900,000. Thus, merchant's monthly profit was about IDR.4, 600,000, equals to an annual profit of IDR 55,200,000. Our study results revealed that the B/C ratio value of the seaweed business was 1.09 meaning that parties involved in seaweed business obtained the revenue as much as 1.09 times the spent capital, and therefore, the business is feasible to do. This finding is in agreement with Soekartawi (1993) who stated that in agriculture business, the executor will always think of how to allocate the input efficiently to obtain a maximum production.

Seaweed Industry

Agroindustry has a comparative superiority since its development is more directed to the utilization of local raw material sources. Agroindustry is also capable of sustaining in critical condition so that the industry should become a priority to be developed (the Ministry of Industry and Trade, 2015). It is an economic activity that processes the agricultural materials and other natural resources to yield higher value products. According to the Provincial Agency Industry and Trade Department of ENT (2015), the agroindustry in ENT province focused on seaweed and located in East Sumba and Sabu Raijua regencies (established in May 2016). Seaweed as a superior commodity (the core competence of the regional industry) in East Sumba regency was established under a Memorandum of Understanding between the government of East Sumba regency and the Ministry of Industry and Trade numbered 139.A/PERINDAG.530/800.A/XII/2006.975.A/59-IND/12/2006 concerning Regional Core Competence-based industrial development of 2010 and Ministry of Fisheries and Marine Science decree No. 32/MEN/2010 about Establishment of Minapolitan Area. East Sumba regency is established as one of the sample regencies of seaweed culture-based *minapolitan* among 24 regencies/municipalities in 2010.

The seaweed industry in East Sumba belongs to the government of East Sumba (*Badan Usaha Milik Daerah or BUMD*) by the name of PT Alga East Sumba Lestari (Astil). This company has been operated since 2010. PT Astil bought dried seaweeds from the collector or *koperasi* at the price of IDR.6,000-8,000/kg. They bought around 250,000 kg of seaweed/month or total monthly purchase cost of dried seaweed was IDR. 2,000,000,000. The monthly dried seaweed used to produce intermediate material known as alkali treated cottonii (ATC) was 249,999 kg yielding around 83.333 kg with a selling price of IDR. 49,000/kg. Monthly operational cost was IDR. 12,000/kg of ATC and total monthly operational cost was IDR. 999,996,000, so that total monthly operational cost was entirely IDR 2.999.996.000. Monthly profit was IDR.1, 083,321,000 or IDR. 12,999,825,000/yr.

Seaweed Added Value as an Intermediate Material (ATC)

All seaweed products from ENT Province were in forms of raw materials with a relatively low added value. The added value obtained from the processing activity, according to the Ministry of Marine Affair and Fisheries (2012), was about 6 to 14.6 times higher than that of unprocessed ones. Added value is a value increment of a commodity due to cultivation, processing, storage, and transportation in a production chain (Hayami *et al.*, 1987). Seaweed cultivation development should also be followed by processing industry development (Ya'la, 2008). According to Provincial Agency of Industry and Trade (2016), the added value obtained by farmers because of seaweed processing to intermediate material (ATC) was IDR 2.958 – IDR 50.000 per kg. PT Astil in East Sumba produced 83,333 kg of intermediate seaweed material per month from 250,000 kg of dried seaweeds or each 1,000 kg of dried seaweed could yield 300 kg of intermediate seaweed product and had an added value of IDR. 30.000,-/kg of intermediate product.

Compared to seaweed raw material price range that was in range of IDR.3,000 to 8,000/kg, the ATC price was higher that ranged from IDR. 49,000 to 50,000 per kg. This high added value provided a good profit to the seaweed industries. However, the continuity of this industry certainly depends upon the seaweed farmer's cultivation activities resulting in more added value for the farmer as well. The benefit/profit ratio of seaweed cultivation is determined by the amount of revenue minus the operational cost and investment. In the marketing transaction of the seaweed products from farmer to collector, the farmer often had weak bargaining position so that the seaweed could be sold at low price. In this situation, there will be much higher benefit gained by the seaweed industry producing ATC than that gained by the farmer. The interaction intensity among business executors in a supply chain will be highly affected by four factors (Xu and Beamon, 2006), i.e. resource sharing structure, decision making pattern, control measurement, and risk/reward sharing. The investor's interest to run

any business, including agro industrial business, is the presence of balance regulation between risks and rewards (Preckel *et al.*, 2004). Van Staden (2000) defined the added value as a value generated from the activities of a company and its labors calculated by reducing the sales gain with the costs of material purchase and services.

In East Sumba, added value gained by the seaweed farmer as the impact of seaweed processing plant was IDR.3,575, whereas it was about IDR.2,175 at the collecter and IDR.41,000 at the seaweed industry level (Table 1). This showed that the highest added value was gained by the seaweed industry and unfortunately the profit and added value gained by the seaweed farmer were still relatively low.

Table 1**.** Mean added value of each seaweed supply chain in East Sumba in 2017. Unit is in IDR/kg.

No	Buying price	Total cost	Selling price	Added value
1	Seaweed farmer			
	3,250	13,669,455	6,825	3,75
2	Merchant			
	6,825	126,300,000	9,000	2,175
3	Seaweed agro-industry			
	9,000	2,000,000,000	50,000	41,000

Since the seaweed famers did not do the marketing and sold all their available products to the collector, the role of collector was important in seaweed product marketing. Also, price completion affects the income gain of the seaweed farmers. From this model, it is apparent that the industrial group gets the highest benefit from the product value development process**.** High added value obtained by the agro industrial executors resulted in increasing competition to collect raw materials or to sell the processed products (Zulkarnain, *et al.* 2013). Therefore, it is reasonable that the seaweed processing industries are competing to get the local fresh seaweed than the importer one, even though this competition could not increase the seaweed price at the farm gate level due to the patron-client system. Susilowati (2013) stated that traditional management model has not been successful in managing the resources, whereas the ecosystem-based fisheries resources management has provided a prospective indication. Hence, several countries are developing the implementation framework of the *Ecosystem-Based Fisheries Management* (EBFM). Study on the added value of processed fisheries product will inspire people to deeply assess the market and marketing aspects, such as consumer's appetite and product price (Nurhayati, 2004).

Conclusion

BEP per unit of seaweed culture farm was IDR. 3,435.77 and production BEP was 2,007.50 kg. The seaweed marketing was done in 3 pathways, from producer to buyer to merchant, factory to consumer, or producer to consumer, and producer to collector, large buyer to consumer. The added value was IDR.3.575 per kg for seaweed farmer, IDR.2.175 per kg for merchant, and IDR. 41,000 per kg for seaweed industry. Thus, the industrial group got the highest profit from the product value development process.

This information is expected to contribute to the fisheries policy makers in issuing regulations in relation to prosperity development efforts of the seaweed farmers and industrial labors**.** Collaboration among government, private sector, NGO, universities, and local communities is needed to improve the rural economy through income development. In addition, it is necessary to have training on seaweed cultivation, hygienic post-harvest handling, and market standard requirement fulfilment.

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Correlation of Consumption Patterns and Polymorphism Genes of *Angiotensin Converting Enzyme* with Hypertension Occurence in Coastal Communities

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Abstract

Hypertension is still a major health problem in the world. Some of the factors that cause hypertension include high sodium intake, high fat intake, and gene polymorphism Angiotensin Converting Enzyme Insertion/Deletion (ACE I/D). This study aimed to determine the correlations between consumption patterns and polymorphism of Angiotensin Converting Enzyme Insertion/Deletion (ACE I/D) genes with the incidence of hypertension in coastal communities of Kendari City. The design of this research was observational analysis with experimental method through molecular biology approach with case control design study. The research location was in the working area of Public Health Centre located in the coastal area. The amount of samples used was 70 people consisting of 35 cases and 35 controls, according to inclusion and exclusion criteria chosen by Purposive Sampling method. The data were collected by interview using semi-quantitative food frequency questionnaire (FFQ-SQ) to find out the diet and laboratory analysis. Data was analyzed using Chi-Square statistic test with p value <0.050, accompanied by the value of Odd Ratio. The result of bivariate test analysis showed fat consumption pattern with incidence of hypertension (OR=4,760; 95% CI: 1,735-13,06; p=0.002), sodium consumption pattern with incidence of hypertension (OR=6,469; 95% CI: 2,256-18,548; p=0.000); ACE I / D gene polymorphism with incidence of hypertension (OR=0,794; 95% CI: 0,310-2,037; p=0.631). In conclusion, there was a correlation of fat consumption and sodium consumption patterns with hypertension occurrence. There was no correlation of ACE I/D gene polymorphism with hypertension occurence in coastal communities.

Keywords : Fat Consumption, Sodium Consumption, Polymorphism, ACE Genes, Hypertension

Introduction

A parallel epidemiological transition with demographic transitions and technological transitions in Indonesia result in a change in the pattern of illness from infectious diseases to non-communicable diseases. Hypertension is one of the non-communicable diseases that is a very serious health problem, called the silent killer (Rahajeng, 2009).

Health statistics in the United States say that 1 in 4 adults suffer from hypertension (WHO, 2013). Hypertension has caused the death of 9.4 million people worldwide each year. There are 36% of adults in Southeast Asia, who suffer from hypertension, while in Asia, hypertension has caused 1.5 million deaths, annually (Yuliantari *et al*., 2014). Based on the Basic Health Research data of 2013, the prevalence of hypertension in Indonesia, through measurement at age ≥ 18 years, amounted to 25.8%. The highest proportion was in Bangka Belitung (30.9%), South Kalimantan (30.8%), while the lowest prevalence was in Papua (16.8%). Based on data from the Health Office of Southeast Sulawesi Province, the number of hypertension patients, in 2013 amounted to 46,465 cases. Patients with hypertension in Kendari City in 2014, amounted to 6,856 cases and in 2015 hypertensive patients, amounting to 8,550 cases (Dinkes Kota Kendari, 2015).

The geographic data of Kendari City shows there are three puskesmas whose working area is in the coastal area, namely: Puskesmas Nambo, Puskesmas Abeli and Puskesmas Mata. According to data from Puskesmas Nambo, people with hypertension in 2015 amounted to 729 cases. Based on data from Puskesmas Abeli, people with hypertension in 2015 recorded 1,394 cases, whereas according to data of Puskesmas Mata, hypertension sufferer in year 2015 counted 1276 cases (Dinkes Kota Kendari, 2015).

The pattern of food consumption, containing salt and excess fat, is one of the risk factors that can increase the incidence of hypertension. Excess fat intake causes increased levels of fat in the body, especially cholesterol that causes weight gain so that the volume of blood has increased greater pressure.

Excess intake of sodium salt will increase the extracellular blood volume that affects the onset of hypertension (Mahmudah *et al*., 2015).

Several studies have suggested the association of ACE gene polymorphism with hypertension. For example, Markus *et al*. (1995) reported a positive relationship between allele D angiotensin converting enzyme polymorphisms Insertion / Deletion with hypertension. A study done by Azizah (2010) reported that insertion / deletion polymorphism of the ACE gene affects the concentration of ACE in the blood and affects blood pressure.

Hypertension is a disease with various causes. One of the hypertensive risk factors is the geographic location of an area. People who live in coastal areas have a higher risk of hypertension than people living in highland areas (Kartikasari, 2012). The tendency to increase cases of hypertension is influenced by various factors, so it takes an effort to analyze the polymorphism of genes associated with the incidence of hypertension in coastal communities. The purpose of this research was to know the relationship of consumption pattern with Angiotensin Converting Enzyme (ACE) gene polymorphism (deletion / deletion) with incidence of hypertension in coastal community of Kendari City.

Materials and Methods

This study was an observational analysis with molecular biology approach, case-control research design. Research locations were in the coastal area of Kendari City, namely in the work area Public Health Center of Mata, Nambo and Abeli. DNA isolation and PCR examination (please give more details) were performed at Integrated Laboratory, Faculty of Medicine, University of Halu Oleo.

The study was conducted from February to August of 2017, with samples meeting the inclusion and exclusion criteria of 70 samples, consisting of 35 case samples and 35 control samples. Primary data were obtained through direct interviews, using semi-quantitative food frequency questionnaires (FFQ-SQ), to determine diet and laboratory analysis. Secondary data about hypertension based on physician diagnosis of Public Health Center in coastal area of Kendari City.

Results and Discussion

Results

The distribution of sample characteristics based on genotype frequencies and allele of ACE I / D genes can be seen in Table 1. The genotype of Insertion-Insersi (II) genotype had the highest percentage (54.3%) as well as the largest allele of ACE Insertion (I) gene (72.9%).

Table 1. Genotype Frequency Distribution and Frequency of Allele ACE I / D genes

Charecteristics	Respondent Categories				Total	
	Cases		Controls			
	n	%	n	%	n	%
Genotype ACE genes						
II	20	28.6	18	25.7	38	54.3
ID	12	17.1	13	18.6	25	35.7
DD	3	4.3	4	5.7	7	10.0
Alelle ACE genes						
I	29	41.5	22	31.4	51	72.9
D	6	8.6	13	18.5	19	27.1
Total	**35**	**50.0**	**35**	**50.0**	**70**	**100.0**

There was a relationship of sodium consumption pattern (p=0,000, OR=6.46, CI 95% = 2.25-18.54), fat consumption pattern (p=0,002, OR=4.76, CI 95% = 1.73-13.06) with hypertension occurrence. While the polymorphism of ACE I / D genes was not related to the incidence of hypertension (p=0.631, OR=0.79, CI 95% = 0.31-2.03) (Table 2)

Table 2. Relationship pattern of sodium consumption, fat consumption and polymorphism of ACE I/D genes with Hypertension occurence on coastal communities of Kendari City

Charecteristics	Hypertension Occurence				Total		*p value*	OR	95% CI	
	Hypertension		No Hypertension						LL	UL
	n	%	n	%	n	%				
Sodium consumption pattern										
Risky	23	32.9	8	11.4	31	44.3	**0.000**	**6.46**	**2.25**	**18.54**
Not Risky	12	17.1	27	38.6	39	55.7				
Fat consumption pattern										
Risky	24	34.3	11	15.7	35	50.0	**0.002**	**4.76**	**1.73**	**13.06**
Not Risky	11	15.7	24	34.3	35	50.0				
Polymorphism ACE genes										
Risk Factor	15	21.4	17	24.3	32	45.7	**0.631**	**0.79**	**0.31**	**2.03**
Not Risk Factor	20	28.6	18	25.7	38	53.3				
Total	**35**	**50.0**	**35**	**50.0**	**70**	**100.0**				

Discussion

Based on the results presented in Table 2, it shows that there was a relationship between sodium consumption pattern with hypertension occurence (p=0.000) in the coastal community of Kendari City. Most respondents have consumed more sodium than the recommended sodium requirement (> 2000 mg / day). The maximum intake of sample sodium intake was 3808.4 mg / day and the minimum intake of sodium sample was 958.6 mg / day. Types of food containing sodium consumed by respondents are soy sauce, sauce, seasonings, and instant noodles.

Sodium elements are usually consumed in the form of salt. Excessive consumption of sodium causes the concentration of sodium in the extracellular fluid to increase (Maria, 2012). When sodium intake is increased, then the kidneys will respond to increase excretion of salt out with urine. But if the effort to excrete sodium exceeds the threshold of kidney ability, the kidneys will retain oxygen so that the intra vascular volume increases. Increased blood volume make the heart contract to drain more blood into the blood vessels and increase blood pressure (Manawan, 2016).

This results of this study is in line with the study done by Aliffian (2013) which shows the correlation between sodium intake to systolic blood pressure (p=0.040) and diastolic (p=0.013) in outpatient hypertension at PKU Muhammadiyah Hospital, Surakarta. Manawan (2016) also found that there was a relationship of sodium intake with the incidence of hypertension (p=0.000) in the Village Tandengan Satu District Eris, Minahasa District.

In contrast, Maria (2012) found no significant relationship between sodium intake and hypertension (p=0.652) at Guido Valadares Hospital Dili East Timor. Mulki's study (2014) also showed no significant association between sodium intake, either with systolic blood pressure (p=0.114), as well as diastolic blood pressure of the sample (p=0.114). The variation of the results can be attributed to individual reactions to the amount of sodium in the body which is different depending on the sensitivity of the response.

Based on results, there was a correlation between fat consumption pattern with hypertension occurrence (p=0.002) at coastal community of Kendari City. Most respondents have consumed more fat than the recommended fat requirement (> 67 g / day). Excessive fat intake was due to the careless of the respondents to food containing fat. The maximum fat intake of the sample was 150.7 g / day and the minimum value was 12.10 g / day. Types of food sources containing fat often consumed by the samples were fresh fish (skipjack, snapper, and single fish), chicken eggs, coconut milk, and biscuits. Saturated fat found in butter, biscuits, meat products, and creams, has been shown to increase blood cholesterol levels. Cholesterol that is too high in the blood can narrow the arteries that cause blood circulation clog (Siringoringo, 2013).

The high fat consumption of the respondents was due to their less attention to the selection of food sources of fat. Excessive saturated fat intake can lead to dyslipidemia, as a risk factor for atherosclerosis, which can lead to hypertension. This is due to blood vessels that have atherosclerosis. In addition to increased blood vessel wall resistance, there is also a narrowing of the lumen of the arteries, thus triggering an increase in heart rate and increased blood flow volume, resulting in increased blood pressure and hypertension (Lidiyawati, 2014).

The results of this study were in line with a research done by Salman et al (2015) in Banjarbaru which showed a significant relationship between risk factors of fat consumption pattern with the

occurrence of hypertension (p=0.029). Siringoringo *et al* (2013) also reported a significant relationship between the habit of consuming saturated fat with the incidence of hypertension in the elderly (p=0.032) in Sigaoi Village Samosir District. Lidiyawati's (2014) study showed that saturated fatty acid intake had significant relationship and hypertensive risk factor in menopausal women (p=0.02, OR=5.76, 95% CI = 1,141-29,078), in Bojongsalaman Village. In contrast, a study done by Masfufah (2015) showed no relationship between fat intake with blood pressure in elderly (p = 0.92) in Blulukan Village of Karanganyar Regency. Also, Ismuningsih (2013) reported no relationship between fat intake with blood pressure in patients with hypertension (p=0.15), outpatient at Hospital PKU Muhammadiyah Surakarta. According to Ismuningsih (2013), other factors such as sodium intake, age, family history, and the presence of other diseases could increase blood pressure (Ismuningsih, 2013).

There is no correlation between polymorphism of ACE I / D gene and hypertensive incidence (p=0.631) in coastal community of Kendari City. This is in line with research done by Rasyid *et al* (2012) who found no significant difference in genotypic distribution and allele frequencies between the genotype groups of DD, genotype ID and genotype II (p=0.903). In contrast, there was a significant relationship between ACE I / D gene polymorphism and hypertension in Yogyakarta, Indonesia (Azizah *et al* 2010). In addition, the results also showed that the frequency of D alleles of the ACE gene in Yogyakarta, Indonesia was very low, based on the analysis of the ACE genotype. Some experiments have shown that although ACE plasma levels are very stable in individuals, there are striking differences between individuals. Population studies linking ACE genes with hypertension need to study ACE gene deviations in the context of ethnicity, age, gender, environmental and geographical factors (Shanmuganathan *et al*., 2015).

Conclusion

There were a relationship of fat consumption pattern and consumption pattern of sodium with hypertension occurrence. There was no relationship of gene polymorphism Angiotensin Converting Enzyme Insertion / Delesi (ACE I / D) genes, with incidence of hypertension in coastal communities of Kendari City. Need to check serum ACE levels, before laboratory tests with different research designs were performed. People need to check blood pressure regularly to control it properly.

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Business Management of White Shrimp *(Litopeneaus vannamei)* Farms (Case Study of PT Beroro Jaya Vanname Farms in South Konawe)

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Abstract

The aims of this study was to analyze the application of managerial functions and the productivity performance in the white shrimps cultivating business. The study was conducted at PT. Beroro Jaya Vanname in the village of Ranooha Raya, analyzing the data on shrimp farming business and practices from 2012 to 2016. The company data indicated that the managerial functions (the planning, organizing, actuating and controlling) had a very strong effect on the management of the shrimps cultivating business. The increase productivity was inseparable from the good management. The weaker the implementation of the managerial functions, the lower the productivity. In contrast, the better the implementation of the managerial functions, the higher the productivity. A well-managed farming which takes into account the seedlings quality, preparation of ponds, and management of water quality as well as management of animal feeds, disease, harvesting and marketing determined the succeed of this business. In 2012 the volume of production at harvesting time reached 15 tons in one production period, and increased in the following years by 5 tons from the previous year. In 2014 the production leaped to 27 tons, which was an increase of 7 tons from the previous year, and then in 2015 the production of white shrimps rose to 32 tons and in 2016 it jumped to 37 tons. The average increase in the production of shrimps across the five-year period was 146.7%, which was parallel to the upward trend of shrimp production. Factors that supported increased productivity of the shrimp business were labors, the expanding of shrimp farms, and the types of feeds given to shrimps.

Keywords: Business management, productivity performance, intensive farming

Introduction

South Konawe in Southeast Sulawesi is a strategic area for the development of aquaculture as it has the longest coastline of 400 km, surrounded by ten small islands (Department of Marine and Fisheries South Konawe, 2013). Various aquaculture species were developed in the district include seaweed, sea cucumbers, black tiger shrimp, grouper and white shrimp. Ranooha Village is one area where many aquaculture farms are existed. Farming activities have been conducted intensively, especially for white shrimp farming conducted by PT. Beroro Jaya Vanname (BJV). This company has been in operation for 10 years and the farming is not slowing down. White shrimps produced by this company were exported with annual increase in production. The company is a success story in farming of white shrimp in Southeast Sulawesi given the fact that many intensive shrimp farming in the region failed. In contrast to other companies that used high stocking density, PT. BJV has been maintained a considerably low stocking density throughout their shrimp farms which reduces the risk of failure and automatically prevents major losses.

PT BJV has been in operation since 2006. The company had an excellent farm management and have been constantly able to produce and to export white shrimp on regular basis, unlike other companies that sometimes only able to survive the first year of operation or for some traditional farmers, just to meet daily needs. Some factors that hinder the aquaculture company to thrive and succeed in maintaining sustainable production include both good business and culture management up to handling after harvest and product transportation. Based on PT BJV success story, it is interested to know how their management and farming activities conducted. Therefore, this research was done to investigate the application of business management functions and the performance level of production in white shrimp farming operation at PT BJV.

Research methods

This research was conducted at PT. BJV, Village Ranooha Raya Subdistrict of Moramo, South Konawe, from January to August 2016. We conducted a survey on the company data by observing several variables such as company profile and white shrimp farming practices include their annual production.

We recorded the stock density, feeding, and water quality management as well as management of disease and harvesting by direct observation in the farms and interviews with company staffs and farmers. We also obtained data from entities that have a relationship with this study such as The Office of Village Administration and The Sub-District Office, Agency of of Marine and Fisheries of South Konawe and The Central Bureau of Statistics in Kendari.

Results and Discussion

Company profile

PT. BJV is an aquaculture company specialized in white shrimp farming. The company is located in Ranooha Village, Moramo Sub-District of South Konawe. PT BJV is owned by Mr. Suwondo Wijaya and was established in 2006. At the beginning, the farm occupied only 5 hectares of land and now it increases to 11 hectares. Production or farming activities began in the mid of 2006, starting with the traditional system farming practice with two ponds as a field trial.

Shrimp seed used in this company farms was obtained from PT. CP Prima in Takalar, South Sulawesi. White shrimp juveniles used for grow out in the farms were carefully selected to ensure they were in outstanding quality. Good quality seed is the most important requirement in the process of white shrimp farming that determines good growth and thus final biomass. Low quality seeds were more susceptible to disease and exhibited poor growth that could hinder the success of the company. WWF (2014) explained that juveniles used in white shrimp culture should be free of viruses and obtained from the certified hatchery issued by the Directorate General of Aquaculture (DJPB). The hatchery must had applied A Good Hatchery Practices (*Cara Produksi Benih dan Induk yang Baik* or *CBIB*). It was known that shrimp juveniles from PT. CP. Prima met the standard of healthy seed as they already have Best Aquaculture Practices (BAP) and also Global Aquaculture Practices (GAP) certificates from the DJPB.

Farming Practices

Land Preparation

This company did not apply the different inlet and outlet system as required by CBIB and ISO guidelines, however the company have been able to treat the water to avoid problems such as parasites contamination that could decrease shrimp production. Instead of inlet and outlet system, the farm used the tendons in the ponds to collect water that has been treated before supplied into the farms. The Marine and Fisheries Ministry Regulation (2016) stated that the water inlet and outlet in shrimp farm must be separated. In case there was only one channel, its function should be specified either as an inlet or outlet. The ponds preparation process for shrimp farming in this company was conducted for 3 months. This process consisted of several stages from a total drying, of ponds, cleaning the walls and bottom of pond from contaminants (mud, mussels, algae, etc.), embankment repair, preparing water supply up to culturing bacteria, fertilization and growing plankton.

Seed Stocking

White shrimp seedling were stocked after ponds were prepared and water conditions were adjusted characterized by bright green or brown color. Standard seed size was 8 ml or equivalent to post larva (PL) 10. Post larvae were stocked in the afternoon to minimize stress. Adjusting similar temperature between ponds and seedling containers during acclimatization was practiced to prevent stress at the time of stocking. Halimah et al (2005) stated that acclimatization was done to adapt to the water temperature and salinity between the transport medium and ponds. During acclimatization process, oxygenated plastic bags containing post larvae were floated on the floating rectangular fence made of bamboo or plastic rope for approximately 15-20 minutes to adjust the water temperature of post larvae bags to the pond. After that, the plastic bags were opened and post larvae were poured into the tank filled with pond water and aerated to minimize the difference in salinity. After going through this stage, the post larvae were dispersed into the ponds.

Feeding

Shrimp feeds that were given from the initial stocking up to harvest were also from PT. CP. Prima. This feed was given because they had a good water stability and preferred by shrimp. A feeding program

at this company was called Blind Feeding Program, which used formulations of 4-4-6-8 and lasted for 30 days. This means that the initial feed per 100,000 seed was 4 kg, then feeding increased at 0.4 kg per day until the first 10 days. Total feed given was adjusted to not exceed the requirement of shrimp post larvae as they still utilized natural food grown in the ponds. After 10 days, feeding was increased at 0.6 kg per day per 100,000 shrimp juveniles. The feeding was increased again at 0.8 kg for every 100,000 juveniles per day after another 10 days. By applying this feeding program, shrimp body weight after 30 days reached 4 grams and has been successful for the last 5 years since the program was implemented in the company. After 30 days, the feed was given based on the estimated magnitude and conditions of using feed tray that was controlled for every 2.5 hours.

The feeding was used blind feeding program because most of feed consumption can still be controlled via feed tray. After the first sampling at the age of 35 days, feeding can only be done using feed tray (Typhoon, 2007). Feed tray was useful for monitoring the rate of feed consumption and predicted stocking density. In addition, feed tray also controlled the health and growth of shrimp. The number of feed tray in each pond in this company was 4-5 pieces that was placed at each pond corner and one at the middle of the pond. The amount of feed in feed tray was 0.6% of the total feed given. At the age of 30 days, artificial feed provided was in the form of pellets and feeding frequency was five times a day at 7 am, 11 am in the morning and 2 pm, 5 pm and 10 pm in the afternoon. Briggs (2004) stated that shrimp feed normally would be processed for 3-4 hours after the food was consumed, then the rest was expelled as feces. If the feed on feed tray was not finished, the dosage of feeding was subsequently reduced by 10-29%.

Water Quality Management

Measurement of water quality parameters at PT. BJV is presented in Table 1 below:

Table 1. Water Quality Measurement at ponds of PT. Beroro Jaya White

Parameter	Method or Test equipment	Test Time	Results Test	Reference Numbers *
Salinity	Hand refractometer	Morning, afternoon	29-33	15-25 ppm
DO	DO meter	Morning, afternoon, evening	3,4-4,2	> 4 ppm
Temperature	Thermometer	Morning, afternoon evening	29-30	26-32
pH	pH meter	Morning, afternoon	7-8	7-8

Table 1 describes the salinity, dissolved oxygen, temperature and pH values obtained in white shrimp ponds in the company. Although the value obtained on salinity measurements exceeds the reference number but in the farming process, the white shrimp salinity tolerance range reached 35 ppt, therefore the company did not do any treatment to reduce the water salinty. WWF (2014) stated that the salinity tolerance range in white shrimp can reach 35 ppt although white shrimp preferred water culture medium with salinity lower at 10-35ppt, good growth obtained at salinity range of 15-20 ppt. Dissolved oxygen was recorded in the range of 3-4 ppm. The range was good for white shrimp as supported by WWF (2014) which stated that the dissolved oxygen for white shrimp culture should be >4 ppm. Furthermore, the Indonesian National Standard (SNI) of white shrimp production (2015) also described that water quality in term of dissolved oxygen should be maintained at least at 4 mg /l. The temperature measured was in the range of 29-30^{0}C. It was also in the range suggested by SNI of White Shrimp Production (2015) and Halimah *et al* (2005) at 26-32°C.

The company would take necessary management action to maintain water quality if water quality parameters were fallen below optimal range for normal growth of white shrimp. For example if DO was below optimal level, they will add aeration windmills or do water changes. If the pH was low then calcification would be done and at high pH gradual water change will be conducted. At water brightness below 20 cm, there is going to be additional water flowed into the pond, and if it was above 40 cm subsequent fertilizing will be done.

Disease Management

The management of disease in white shrimp ponds conducted by this company was divided into two procedures. The first was sold the shrimp directly if diseases affected the shrimp in economic size. The second procedure was complete eradication of affected shrimp stocks by burning them if the shrimp cannot be sold immediately. This was done to prevent contamination to other ponds. Another problems that often arise was a decline in shrimp appetite due to molting. The form of anticipation was done by

adding lime as much as 15 ppm in one pond. This anticipation aimed to supply calcium as a shrimp-forming carapace to accelerate the molting process. Halimah *et al* (2005) explained that during the process of molting, the white shrimp's body condition weakened and more susceptible to disease, therefore during molting, many shrimps died. Disease control was carried out at the company with assistance from PT CP regarding some disease types and characteristics commonly found in white shrimp culture. Prima but the company workers and technicians identified shrimp diseases based on morphological characteristics in affected shrimp.

Harvest

Harvest of white shrimps at PT. BJV was done either partially or total harvest. Partial harvest was done when white shrimp condition were healthy and had good appetite, low daily mortality and there was no indication of virus attack or other diseases. The amount of biomass taken during the partial harvest can be calculated by sampling the shrimp and estimated carrying capacity of the ponds. Calculations of partial harvest conditions in PT. BJV is presented in Table 2. Table 2 shows that in a 5000 m^2 farm with a stocking density of 100 ind/$m^{2,}$ therefore total number of juveniles shrimp was 500,000 ind./ha and it was estimated that at day 70 survival rate was 80%. This was called size 72 with average weight of 13.9 grams and estimated annual biomass harvest was 5,556 kg. In this scenario, the number of partial harvest was 20 ind./m^2 or 1.389 kg. The the population left after harvest was 300,000/ha or 60 ind./m^2 and final harvest would be 5500 kg. Therefore, the total number of harvest per hectare was obtained from the sum of total and partial harvest.

Table 2. Calculation and provision of partial harvesting at PT BJV

Pool Area	**5,000 m^2**
Density	100 ind/m^2
Number of juveniles	500,000 ind.
Survival Rate day 70	80%
Population	400,000 = 80 individuals/m
Size	72 = 13.9 g
Estimated Biomass	5.556 kg
Partial 20 ind/m^2	1.389 kg
Biomass Left	4.167 kg
Residual	300.000 = 60 ind./m^2
Harvest size 60	5,500 kg
Total Harvest	7.500 + 1.389 = 8.889 kg

The total harvest of white shrimp was done when culture age reached 120 days and the size of shrimp reached 50 individuals per kg. This practice was supported by ISO (2015) who stated that partial harvest of white shrimp was done at about 30% at day 60-70 to adjust the carrying capacity of the pond, while the total harvesting was done after reaching culture period of 120 days or marketable size. At the end of 120 days culture period, buyer was usually came to the farms and picked up the shrimp directly.

Marketing

The white shrimp produced in PT BJV farms had a permanent buyer from PT. Muha Jaya in Banyuwangi. Shrimp price was vary depending on the price of shrimp at domestic and international market. The company has been adjusted harvest time based on the best price in the market. Average white shrimp price during this study was IDR 45,000 in size 50 (the number of shrimp in one kilogram) but it has been fluctuated in the last five years. Price was always lower at partial harvest compared to total harvest because of different number of individual shrimp per kilogram or ‘size’ (Table 3).

Table 3. Selling price of white shrimp from 2012-2016

Year	**Partial Harvest**		**Total Harvest**	
	Shrimp Prices (IDR)	**Size**	**Shrimp Prices (IDR)**	**Size**
2012	32,000	70	35,000	50
2013	32,000	80	35,000	50
2014	32,000	80	40,000	50

2015	30,000	100	45,000	50
2016	32,000	70	45,000	50

Production Level

PT. BJV has been running a management functions in accordance with the Standard Operating Procedure (SOP) in terms of farming and management during the last five year. This company shrimp production was constantly increase within five years period since it was established. The increase in white shrimp production from 2012-2016 is displayed in Figure 1.

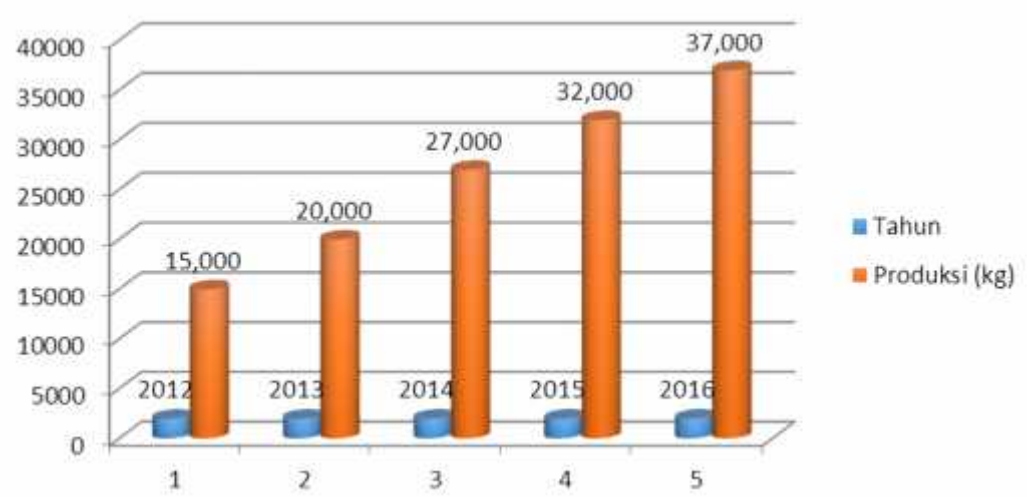

Figure 1. Increase in shrimp production white PT. Beroro Jaya White Year 2012-2016

White shrimp production at PT BJV increased partly because its partnership with PT CP. Prima in terms of procurement of seeds and farming management. The average increase of shrimp production during the last five years was 146.7%. In line with the trend in increasing shrimp production, the volume of shrimp exports during the last five years also showed a positive trend (Table 4). In 2012, the production of shrimp within three culture cycles times increased in average up to five tons. In five years period from 2012 to 2015, annual production was around 5-10 tons. Target production by the company was not fulfilled until 2016 when production reached 18 to 19 tons in one production cycle. It is suggested that weather played an important role in determining shrimp production. Before 2016, air temperature was very high due to prolonged dry season that in turn increased the water salinity in ponds due to high evaporation. As a result, most of shrimp were not able to survive. However in 2016, the weather and the humidity were quite stable during two production cycles so that the survival rate of shrimp was higher.

Therefore, the company was able to generate higher production level than previous years.

Table 4. Shrimp production in several cycles during the past five years

Year	Production Achievements			Average Increase	Production Target (ton)
	Cycle 1 (Ton)	Cycle 2 (Ton)	Cycle 3 (Ton)		
2012	5	5	5	5	14
2013	6.5	6.5	7	6.7	15
2014	8	9.5	9.5	9	15
2015	10.5	11	10.5	10.7	15
2016	18	19	-	18.5	16

Conclusion

The BJV company managed farm area of approximately 11 hectares consisted of brackish ponds with average of 0.5 ha/pond ready to do the process of farming activities around three times a year. Application of management functions (planning, organizing, implementation and monitoring) on the company carried out with full preparation and well managed. Both the production planning and the use of production inputs were performed and the company conducted farming activities based on standard operational procedures that were already defined by the company. The application of good management functions at this company have a positive impact on annual shrimp production. Production of white shrimp in 2012-2016 period experienced an increase of 146.7%.

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Fish Consumption Habits and Study of Nutritional Status of Pregnant Women in The Coastal Area of Kendari

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Abstract

Pregnancy causes major changes to nutritional needs and metabolism in pregnant women. Dietary of pregnant women have an important role for fetal growth and when the mother gives birth. During pregnancy a mother will experience an anatomical, physiological, and other changes that will increase the nutritional needs in her diet. The nutritional status of pregnant women has a direct impact on the journey of pregnancy and the baby. Fish are animal foods that are low in saturated fat, high in protein, and also rich in omega 3 fatty acids. Therefore, fish is a very good source of nutritional support for pregnant women. The aim of this study was to study fish consumption habits and description of nutritional status of pregnant women in the coastal area of Kendari City. This study was a descriptive study by collecting secondary data.. The samples were 156 pregnant women in coastal area of Kendari City. Assessment of nutritional status of pregnant women was done through secondary data of upper arm circumference of pregnant women and birth weight of baby. Information about fish consumption habits were obtained through interviews and questionnaires. The upper arm circumference data showed that 106 subjects(67.95%) had normal upper arm circumference and often consumed fish, 33 subjects (21.6%) frequently consumed fish but had an upper arm circumference < 23.5 cm, 10 subjects (6.4%) rarely ate fish but had a normal upper arm circumference, and 7 (4.5%) rarely ate fish and had an upper arm circumference < 23.5 cm. Birth weight measurement data showed 132 subjects (87.62%) who often consume fish with normal birth weight, 7 subjects (4.5%) often consume fish but birth weight <2500 gram, 16 subjects (10,25%) rarely consume fish and normal birth weight, and 1 subjects(0,64%) rarely consume fish and birth weight <2500 grams. The habits of consuming fish are very good for the pregnant women's and fetus nutrients.

Keywords: Fish Consumption, Pregnant Women, Nutritional Status

Introduction

The pregnancy causes a variety of major changes to metabolism and nutritional needs in pregnant women. Pregnant women's food plays an important role for fetal growth and in parturition. During pregnancy a mother will experience either anatomical, physiological changes, or other changes that will increase the nutritional needs in her diet. In the mother's womb, there is a growing fetus and elsewhere some of the mother's organs undergo a change of function in order to prepare for the presence of the baby (Path, et al., 2005). The nutritional status of pregnant women has a direct impact on the journey of pregnancy and the baby to be born. Several studies have shown that most pregnant women consumed energy, protein, folic acid and calcium below of the recommended amount of adequacy. Malnutrition that occurs in the early months of pregnancy affects the development and capacity of the embryo to survive, poor nutrition in late pregnancy affects fetal growth (Ambarwati, 2012).

Maternal nutrition needs attention because it is very influential on the development of the fetus. Inadequate intake of energy and protein in pregnant women can lead to Chronic Energy Deficiency (CED). Pregnant women are at risk of experiencing CED if they have an upper arm circumference of <23.5 cm. Pregnant women with CED are at risk of delivering low birth weight babies (LBW). LBW will cause the risk of death, disorders in child growth and development (Kemenkes RI, 2016).

Fish are source of animal foods. They are low in saturated fat, high in protein, and also rich in omega 3 fatty acids. In addition, fish are good for dietary supplements because they are rich in vitamins, minerals, and nutrients needed to keep the body healthy. Omega 3 fatty acids in fish are very good at keeping the supply of oxygen and nutrients carried through the mother's bloodstream and then through the placenta. The habit of fish consumption during pregnancy helps fetal development, long pregnancy, and parturition process (Olsen *et al*., 1993).

Kendari is largely a coastal area and very close to the sea. The habits of fish consumption in daily diet has been entrenched in the community of Kendari City. Geographical conditions of Kendari cause the community to easily get various types of fresh fish. Therefore, this study aimed to examine the effect of fish consumption habits on nutritional status of pregnant women in the coastal areas of Kendari City which was assessed through the upper arm circumference and birth weight babies.

Materials and Methods

The design of this study was an observational descriptive study by collecting data in the form of secondary data obtained from Puskesmas Mata, Kendari City. Instruments in the study were interviews and questionnaires. The number of research samples were 156 pregnant women who livein coastal area of Kendari City.

Results and Discussion

Results

Characteristics of research subjects

Table 1. Characteristics of research subjects

Characteristics	Number of subjects (n= 156)	Percentage (%)
Age		
17–25 years (final adolescent)	76	48,72
26–35 years (early adult)	68	43,59
36–45 years (final adult)	12	7,69
Intake of iron (Fe) (mg)		
< 30 mg	31	19,87
30-60 mg	78	50
>60 mg	47	30,13
Frequency of antenatal care (ANC)		
< 4 times	39	25
>4 times	117	75

Based on the secondary data information obtained, the age of the subjects was dominated by the final adolescents category (48.74%) and early adult (43.59%). Both categories of age were the productive age for pregnancy. During pregnancy, pregnant women with iron intake of 30-60 mg were 78 subjects (50%), > 60 mg were 47 subjects (30,13%), and <30 mg were 31 subjects (19,87%). Frequency of antenatal care (ANC) > 4 times were 117 subjects (75%) and <4 times were 39 subjects (25%).

Descriptive analysis of fish consumption habits and nutritional status of the subject

Table 2. Frequency of fish consumption habits and nutritional status of the subject

Characteristics	Number of subjects (n= 156)	Percentage (%)
Frequency of fish consumption		
Frequent	139	89.1
Rarely	17	10.9
Upper arm circumference		
< 23,5 cms	41	25.64
23,5 cms (normal)	116	74.36
Birth Weigth		
< 2500 grams	8	5.13
>2500 grams (normal)	148	94.88

The results of interviews and questionnaires showed that pregnant women with frequent consumption of fish were 89.10%, while the frequency of women that rarely consume fish was 10.90%. Maternal nutritional status were assessed based on the upper arm circumference and birth weight of the baby. A total of 116 pregnant women (74.36%) had normal upper arm circumference and 148 pregnant women (94.88%) gave birth to normal weight babies.

Table 3. The relationship of frequency of fish consumption with upper arm circumference

Upper arm circumference	**Frequency of fish consumption**	
	Frequent	**Rarely**
< 23.5 cms	33 subjects (21.6%)	7 subjects (4.5%)
23.5 cms (normal)	106 subjects (67.95%)	10 subjects (6.4%)

The upper arm circumference measurements showed that 106 subjects (67.95%) had normal upper arm circumference and frequently consumed fish, 33 subjects (21.6%) frequently consumed fish but had an upper arm circumference <23.5 cm, 10 subjects (6.4%) rarely consumed fish but had a normal upper arm circumference, and 7 (4.5%) rarely consumed fish and had an upper arm circumference of <23.5 cm.

Table 4. The relationship of frequency of fish consumption with birth weight

Birth weigth	**Frequency of fish consumption**	
	Frequent	**Frequent**
< 2500 grams	7 subjects (4.5%)	1 subjects (0.64%)
> 2500 grams (normal)	132 subjects (84.62%)	16 subjects (10.25%)

Data of birth weight measurements showed that 132 subjects (87.62%) who frequently consumed fish had normal birth weight. 7 subjects (4.5%) with frequent fish consumption fish had birth weight of <2500 gram. 16 subjects (10.25%) that rarely consumed fish had normal birth weight, and 1 person (0.64%) that rarely consumed fish had birth weight <2500 grams.

Discussion

Secondary data of the study showed that there were 139 subjects (89.10%) of pregnant women consumed fish frequently. A total of 102 subjects (65.38%) of pregnant women with frequent consumption of fish showed a normal upper arm circumference and normal birth weight babies. The results of questionnaires and interviews indicated the types of fish often consumed by pregnant women such as skipjack (*Katsuwonus pelamis*), anchovy (Engraulidae), milkfish (*Chanos chanos*), single fish (*Decapterus*), and mackerel (*Rastrelliger*). Various types of these fish are very rich in protein, omega 3, vitamin B, and calcium. They are important for pregnant women's nutrition. Table 3 shows pregnant women with frequent consumption of fish tend to had a normal upper arm circumference. The upper arm circumference is a way of assessing the energy intake and protein of pregnant women. Meanwhile, pregnant women with frequent consumption of fish would also give birth to babies with normal weight (Table 4). Research conducted by Olsen & Secher (2002) mentioned that less of fish consumption during pregnancy provided a major risk factor for the incidence of preterm delivery and low birth weight (LBW). In addition, in women with less fish intake or no fish at all, the amount of omega-3 fatty acids in the body was very less to protect against the incidence of preterm delivery and low birth weight (LBW).

A total of 7 subjects with a frequency of fish consumption rarely had an upper arm circumference <23.5 cm, but the baby's weight was born normal. 4 subjects consumed iron > 60 mg during pregnancy, 2 subjects with iron intake <30 mg, and 1 person with iron intake 50 mg. Iron is a very important mineral to form red blood cells. Pregnant women need more iron than normal people. Although they were rarely consume fish, these seven pregnant women visited and checked antenatal care regularly. The average of visits were 8-9 times, so the condition of pregnant women and fetus could still be controlled properly. Antenatal care is very important for pregnant women to be able to control and optimize the mental and physical health of pregnant women, so as to be able to prepare for the period of parturition, breastfeeding,

and the return of normal reproductive health. In addition, antenatal care also aims to prevent obstetric complications and ensure that complications can be detected and treated early on.

As many as 3 subjects with birth weight <2500 gram and upper arm circumference <23,5 cm had frequent consumption of fish. However, iron intake was less than <60 mg. One subjects with normal upper arm circumference gave birth to a baby weighing <2500 grams. These pregnant women were rarely consumed fish and only consumed 20 mg of iron during pregnancy. As many as 4 subjects who often consumed fish with birth weight <2500 grams, had a normal upper arm circumference and adequate iron intake. In addition, 1 subjects with frequent of fish consumption and normal upper arm circumference had very low birth weight of 1900 grams. It was caused by the antenatal care was undertaken during pregnancy only 1 time and iron intake <60 mg.

There were various factors that can affect the period of pregnancy such as nutritional status, health status, psychological, social environment, economy, and culture. Nutritional status of pregnant women is influenced by the intake of nutrients from the diet consumed. In addition to adequate intake of nutrients in the diet of pregnant women, sometimes extra vitamin supplements are also needed so that the nutritional needs of pregnant and fetal mothers are met. However, it should also be tailored to the conditions of pregnant women and the fetus.

Conclusion

Pregnant women with frequency of consumption of fish often during pregnancy had an upper arm circumference and normal birth weight of 102 subjects (65,38%) so it could be concluded that the habit of fish consumption was very good for the pregnant women's and the fetus nutrients.

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Marketing Efficiency of Seafood Production in Bajo Sector of Boalemo Regency Gorontalo

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Abstract

Marketing is one of the most important activities in marketing seafood in Bajo Village in Boalemo, because one of the factors that becomes a constraint is the availability of adequate infrastructure. Bajo Lemito Village in Boalemo Regency has high potential for fishery such as; Cucumbers and Seawater pearls, Mabe and Japing. The purpose of this study was to study the economic situation in Bajo Tilamuta Village Boalemo District, living conditions of fishermen, production and marketing of the fishery products. The research method used was descriptive method by using purposive sampling method. The data analysis used quantitative and qualitative methods. The qualitative method is to provide a discussion of quantitative data relating to the theoretical aspects and separated by categories to get conclusions. The results of this study showed that the sea cucumber classified as having a good marketing efficiency and categorized into the marketing as efficient whereas marketing of pearl shells, Mabe, Japing was inefficient.

Keywords: Marketing Efficiency, Sea Cucumber Cucumber, shell mabe, japing shell

Introduction

Fishery Development is a part of national development where the main target of development in the field of fishery sub-sector economy is implemented by the Indonesian people themselves, whether the business of producing, processing, and marketing. To achieve these fisheries development objectives, various policies are adopted by the government as set out in the Guidelines of State Policy (GBHN) in the five-year development plan. In the Pelita ke- IV, it can be seen seen that the fisheries development policies outlined by the government aimed at improving production and business productivity as well as providing business opportunities in productive employment in addition to improving facilities and infrastructure to increase the income of fishermen and fish farmers, expanding work in the field of fishery sub sector to reduce damage to resources and foreign exchange resources from non-oil commodities. Although many policies have been established to achieve the aims of fisheries development, but the reality has not been able to meet the desired expectations. Increased production and productivity of fishermen and fish farmers programmed has not provided satisfactory results. In general, the income level of fishermen is still relatively low. Marketing is one of the most important activities to help increase the income of fishermen. Marketing is one of the most important activities to improve the economy, especially in the field of fisheries. In marketing seafood, it is necessary to provide facilities and infrastructure such as fishing port, fish market and others. The Bajo fishermen in Boalemo Regency produce seafood such as: sea cucumber, mother shell, Mabe shell and Japing shell. Mubyarto (1985) states, Marketing or distribution is a kind of economic activity that serves to bring or deliver goods from producers to consumers. Hippy (1992) that the stated that the types of marine products in the village of Bajo Boalemo were fish such as tude, skipjack, mullet, sea cucumber and shellfish. However, no research has been done to disclose data and information on the marketing efficiency of Bajo's fishery products. Therefore, there is a need to research about the marketing efficiency of the fisheries products in Bajo.

Materials and Methods

The method used is the sampling method or sampling, because it has been done pre-survey before, then the village that is sampled is Bajo Tilamuta village Boalemo district where most of the populations are Bajo tribe. Sampling is done purposively, are selecting the sample directly because it has been known before that the selected sample can represent it. While the data analysis using the trading margin as a measuring tool that is the average price of producers divided the market selling price. According Sutarno (2014), mathematically the amount of marketing margin can be calculated based on the formula

$$MP = Pr - Pf$$

MP= Marketing Margin
Pr: prices at retailers level
Pf : prices at fishermen level.
For efficiency can be seen from the percentage of income received by the Farmer's share (Fs).

$$\textit{Farmer's share} \quad LP = \frac{He - M}{He} \times 100\%$$

LP : Prices received by fishermen
M : Total Margin (Rp / kg)
He : Producen Prices
HK : The Price is Consumers

Results and Discussion

The average price / kg of these types of seafood can be seen in the table below.

Table 1. Average Prices at Fisherman's level, Wholesaler Traders and wholesalers

No	Type of seafood	Average Price Per / Kg		
		Fisherman	**Traders**	**Whole Traders**
1	Sea Cucumber	140000	170000	190000
2	Shellfish Pearl	26000	29000	34000
3	Shellfish Mabe	18000	22000	27000
4	Shellfish Japing	14000	18000	24000

From the table above it can be seen that the margin obtained by wholesalers and exporters has a very large margin while margin from fisherman to collecting merchants have a smaller difference than big traders.

Table 2. Marketing Efficiency of marine products in Bajo Tilamuta village of Boalemo District

No	Type of seafood	Presentage (%)	Efficienty Marketing
		Fisherman	Whole Traders
1	Sea Cucumber	53	Efficient
2	Shellfish Pearl	13	inefficient
3	Shellfish Mabe	16	inefficient
4	Shellfish Japing	19	inefficient

Sea cucumber has an efficient marketing due to the higher percentage of income received at the producer level (> 50%). Margin marketing is done to determine the marketing efficiency of a product from producer level to consumer level. Margin marketing is the price difference that occurs with the amount of profit in each marketing agency involved in marketing activities. There are several different cost components of each marketing channel pattern impacting marketing margins on existing marketing institutions in Bajo Tilamuta village, Boalemo District as seen in Table 2 above.

Conclusion

Sea cucumber has the most efficient marketing channel and farmer's share of fisheries products in Bajo, Boalemo district, Gorontalo.

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TOPIC F : PROCESSING OF FISHERIES PRODUCTS

Characteristic of high calcium chips contains freshwater clam (*Batissa violacea celebensis* Marten 1897) shells

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Abstract

Chips or *Kerupuk* in Indonesian is a widely consumed snack food that has a crunchy and rigid texture, contains high starch. Utilization of freshwater clam shells as additive material in the chips ingredients was aimed to increase its nutritional value, particularly the calcium content that is important for children's growth and people with calcium deficiency. This research was conducted in two steps. We analyzed physic-chemical characteristic of flour made from endemic freshwater clam shells and incorporated the flour into chips ingredients. Five treatment levels was used in the addition of clam shells flour into chips namely 0, 5, 10, 15 and 20%. Proximate analysis, hardness, whiteness, and calcium content of chips with clam shells flour addition were then analyzed. Moreover, chips rising volume and sensory analysis such as appearance, color, odor, crunchiness, flavor, and the physic-chemical characteristics were also measured. Addition of 15% clam shells flour was the best treatment among others. The value of the hedonic test of color, odor, flavor and crunchiness was 3.83; 3.67; 3.17; 4.03 respectively. Physical analysis showed that hardness test value, whiteness and rising volume of chips with 15 % clam shells flour were 3.43; 3.7 and 101.88% respectively, whereas moisture content, protein, fat, ash and carbohydrate were 11.80; 0.76; 0.93; 17.86 and 68.64% respectively. At 15 % addition level, calcium content of chips was 520 mg/100g.

Keywords: Calcium, chips, freshwater clams shells flour

Introduction

Batissa violacea celebensis Marten, 1897 is a freshwater clams from the Family of Corbicula. Local name of this organism is *pokea*. According to Bahtiar et al. (2008) this freshwater clam is endemic to Southeast Sulawesi. Currently, this clams resources are overfishing due to continuous exploitation of wild stock. The high demand of this species is for its meat whereas unused shell will be end as by products that generates waste.

Currently, clam shells waste was used as hanging furniture, handicrafts, and additive material for animal feed. Nevertheless, utilization of clam shell for such products still generates low demand thus production. Therefore, it is necessary to diversify the clam shells waste into more valuable products for human consumption. The use of clam shells which was converted into flour as a source of natural calcium has been applied in other areas in Indonesia as a fortification ingredients in chips, a popular side food and snack preferred by many Indonesian because of its crunchiness, tasty and light weight (Wahyuni 2007; Anindita *et al*., 2013; Kusumaningrum and Asikin, 2016).

Mass production of high starch contained chips, in most cases, only consider the amount of chips produced regardless the value and quality of nutrition. Mustofa and Suyanto (2011) stated that low nutrient content and typical taste of the usual chips became an opportunity to make it more nutritious and delicious. Therefore in this study we explored the potential use of shell waste converted into high calcium flour and applied it as an additional ingredient in chips products. This was expected to increase the chips nutritional value of calcium. According to Zimmerman *et al*. (1994), calcium plays an important role in blood coagulation, nerve, muscle contraction and liver function. Calcium also reduces high blood pressure, colon cancer and reduced bone composition or known as osteoporosis. Incorporating clam shell flour into chips can be a solution to meet the intake of calcium in infant children, people with calcium deficiency and bone disorders (osteoporosis).

Method

This study consisted of two stages. First step was to measure the potential use of clam shell waste. Second stage was the process of making chips with the addition of clam shell flour.

Treatment

The treatment factor used was the addition of clam shell flour (0% as control, 5%, 10%, 15% and 20%) into chip's ingredients.

Organoleptic Assessment

Organoleptic test was assessed on general appearance, such as the color, odor, crunchiness, hardness, whiteness, and rising volume. Measurement of those organoleptic factors was done subjectively by 30 semi-trained panelists.

Biochemical Analysis

Proximate content of the chips include protein, lipid and carbohydrate was analyzed. Ash, water and calcium content were also analyzed using standard methodologies.

Data Analysis

Data were analyzed by ANOVA using Statistical Package for Social Science (SPSS) software on computer. If the variance results showed a significant effect, then it was proceed with the Duncan test at the level of 0.05.

Result and Discussion

Potential of Clam Shell as Calcium Source

The economic value of clam shell as food material was assessed by determining the value of yield from clam shells. Average length of clam shell used in this study was 5,338 cm with average weight of 40.36 g. With those size, the yield was 79.72%, so it can be estimated that from every one ton (1000 kg) of whole clam shell obtained, final weight of clam shell that can be utilized for clam shell flour will be 797. 2 kg. The research conducted by Bahtiar *et al*. (2008) showed that the length of clam found in the area near the estuary was 6.59 cm and the average length of small clams was 4.79 cm. The results showed that exploitation and capture activity affected the quality of clam population growth. Increased in clam fishing activity will lead to an increase in clam shell waste, so it needs an action to utilize the clam shell waste produced.

Organoleptic Assessment

Color

Determination of the quality of food in general depends on several factors such as taste, color, texture and nutritional value as well as microbiological properties. Before any other factors is considered, the color factor usually appears first and sometimes plays as decisive factor for consumer (Winarno, 2008). Hedonic test showed that the average value of panelist's preference for color ranged from 3.57 to 3.83 or in moderately like range. The addition of 15% clam shell flour had the highest value of 3.83% compared to control treatment and other concentration added (Figure 1).

Duncan's test showed that the color of chips with the addition of clam shell flour was not significantly different when compared with the 0% control chips ($p > 0.05$). Control treatments chips was a representative of commercial chips because of the absence of additional clam shell flour, thus representing the standard chips sold on the market. A snack that is considered nutritious, tasty and excellent texture will not be eaten if it has unsightly color or gives the impression that it has deviated from its intended color. Color acceptance of a material varies depending on natural factors, geographical and social aspects of the recipient community (Winarno, 2008).

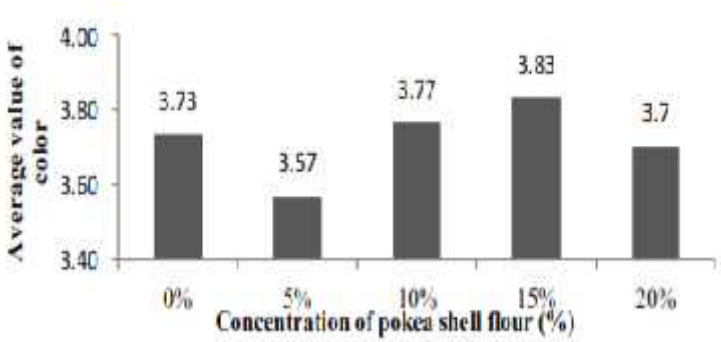

Figure 1. Average value of panelist's favorite level against color of the chips

Odor

The odor determines the delicacy of food and related to the five smell senses of human (Winarno, 2008). The hedonic test showed that the average value of panelist's against the odor of chips with the addition of clam shell flour ranged from 3.17 to 3.67 (moderately like) (Figure 2).

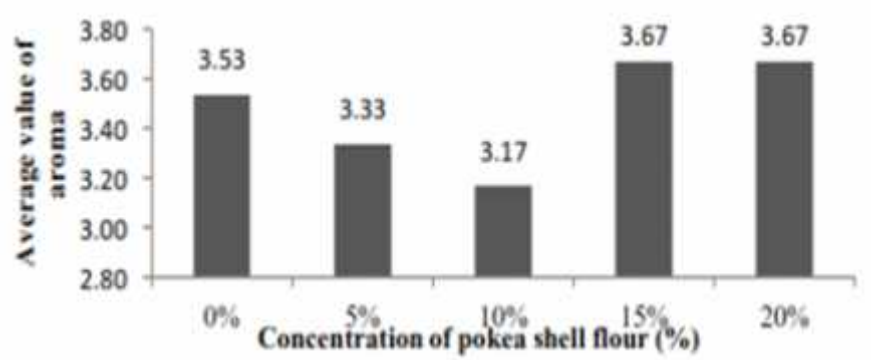

Figure 2. Average value of panelist's favorite level against the chips odor

The addition of 15 and 20% clam shell flour in chips obtained the highest panelist value of 3.67 similar to color value. Both treatments of shell flour additions had a higher value when compared with control treatment of 0%. Duncan's test showed that the addition of shell flour had no significant effect on odor when compared to the control chips ($p > 0.05$). Addition of clam shell flour with a fairly high percentage did not give a negative effect on the odor of chips but gives a positive effect. The odor produced by the addition of clam shell flour has a distinctive odor but preferred by the panelists. According to Soekarto (1985) the smell of food in many ways determines whether it is a good food or not. The smell sense is more complex and sensitive and also considered higher human sense than the sense of taste. The food industry considers it is critical to do the odor test because it quickly gives the result of the panelist's favorite judgment.

Taste

The taste is a sensation that supplied by food to the sense of taste, which involves the tongue (Anisa and Adi, 2013). The result of hedonic test indicated that the average value of panelists to taste with the addition of clam shell flour chips ranged from 2.97 to 3, 17. The addition of 15% clam shell flour resulting in the highest value compared to other concentrations and had the same value as the 0 % control treatment with a value of 3.17 (moderately like) (Figure 3).

Duncan's test showed that the addition of shell flour had no significant effect on odor when compared to the 0% control chips ($p > 0.05$). This indicated that addition of clam shell flour did not give a different flavor effect when compared with chips without addition of clam shell flour. This means that panelists considered the taste of chips relatively similar with the addition of clam shell flour at various concentration levels. According to Winarno (2008), the savory taste in chips can be caused by denaturation of protein into amino acids especially glutamic acid that gives them a delicious taste during the steaming process.

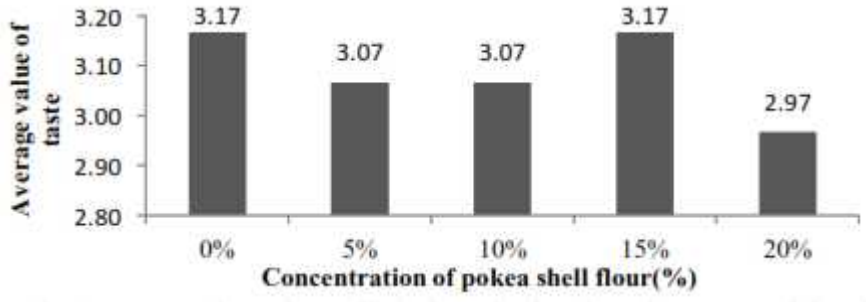

Figure 3. Average value of panelist's favorite level against taste of the chips

Crunchiness

One important factor that determines consumer acceptance of chips products is crunchiness. The hedonic test showed that the average value of panelist favorability to chips crunchiness with the addition of clam shell flour ranged from 3.80 to 4.07 (moderately like to like) (Figure 4).

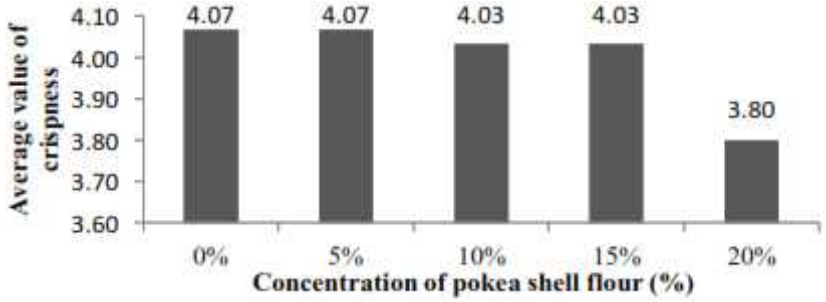

Figure 4. Average value of panelist's favorite level against crunchiness of the chips

The addition of 5% clam shell flour obtained the highest value of 4.07 (like) among other treatments, similar to 0% control chips. Duncan's test showed that the addition of shell flour had no significant effect on crunchiness when compared to the 0%control chips ($p > 0.05$). The higher the concentration of shell flour, the level of panelist fondness to crunchiness decreased. This may attributed to the lack of starch in chips because clam shell flour addition reduced the amount of tapioca flour usually used in chips. Siew et al. (1985) stated that tapioca starch plays a considerable role against the crunchiness of crackers. Crunchiness in chips is influenced by the process of gelatinization of starch in the chips dough. High amylopectin content on starch in tapioca flour causes starch granules easily swell in hot water gives the perfect gel formation. The addition of clam shell flour to chips may affect this process of gelatinization. Addition of shell flour may reduce the ability of starch granules in tapioca flour to bind water. Therefore, when chips was fried, the air cavity decreased resulting in less crunchy chips. In regular chips frying process, there will be evaporation of water bound in starch gel due to increasing temperature and subsequently vapor pressure was produced that pushes the starch gel that makes the chips to rise and form air cavities on fried chips.

Hardness

The addition of 20% clam shell flour showed the highest panelist value of 3.47 (rather hard) compared to less concentration added whereas the addition of 15% clam shell powder was similar to 0% control chips with a value of 3.43 (rather hard). Hardness analysis showed a range of values from 3.17 to 3.47 (Figure 5).

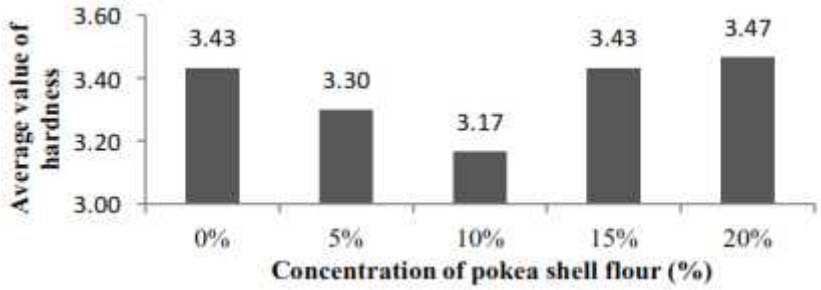

Figure 5. Average value of chips hardness

Duncan's test showed that the addition of shell flour does not significantly affect the level of hardness when compared with 0% contro chips ($p > 0.05$). This means that the value of hardness chips with the addition of clam shell flour was relatively the same for all treatments. Chips with the addition of clam shell flour had a finer surface. Zulviani (1992) stated that a smooth surface in chips is caused by air pockets formed on chips become smaller as the pockets were filled with other materials and made the pockets more solid.

Whiteness Level

Whiteness analysis showed a range of values of 3.6 to 3.7 (Figure 6). The concentration of 15% had the highest value of 3.7 (moderately white) compared to other treatments and the value was equal to 0% control chips without the addition of shell flour. This concentration of clam shell flour to chips produced in this study had a better value (slightly white) when compared with fish chips with the same addition of 15% clam shell flour that produced a brownish yellow color (Kelliat et al., 2013).

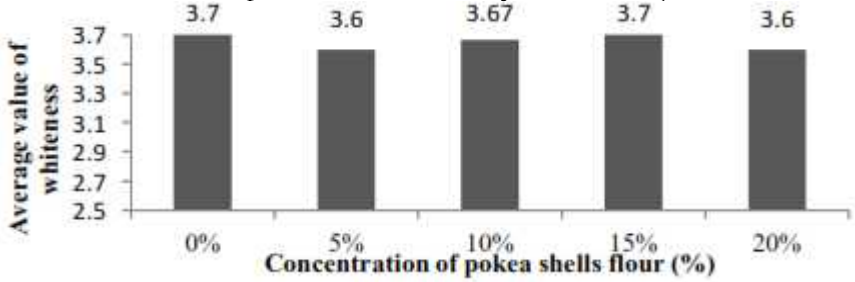

Figure 6. Average value of chips whiteness

Duncan's test showed that the addition of shell flour to chips did not significantly affect the degree of whiteness when compared with 0% control treatment ($p > 0.05$). This means that the value of whiteness level of chips with the addition of clam shell flour was relatively same for all treatments.

Rising Volume

Rising volume is one of important quality parameters of fried chip (Muliawan 1991) other than color and taste. Quality assessment of fish chips is also based on the bloom or the rising volume when it fried. Consumer prefers the well rising fried chips (Aryani and Norhayani, 2011). Value of rising volume of chips with the addition of clam shells flour can be seen in Figure 7.

Concentration of 5% clam shells flour had a value of 112.81% and followed by addition of 15% shell flour (101.88%). Addition of clam shells flour at all concentrations tested had a higher rising volume value when compared with 0% control chips, and the value was also greater when compared with chips with the addition of green mussel shell flour (Permana 2006). Chips with the addition of tapioca (80%) and 20% salted egg had a rising volume at only 53.3% (Anindita et al., 2013). It is suspected that the addition of shell flour can improve the process of starch gelatinization from tapioca. In addition, substitution of tapioca starch with clam shell flour may decrease the amount of protein content in tapioca starch, thus increase the ability of chips to rise. According to Lavlinesia (1995) one of the factors that affect the rising volume of chips is the protein content. High protein content will tend to lower the rising volume of chips.

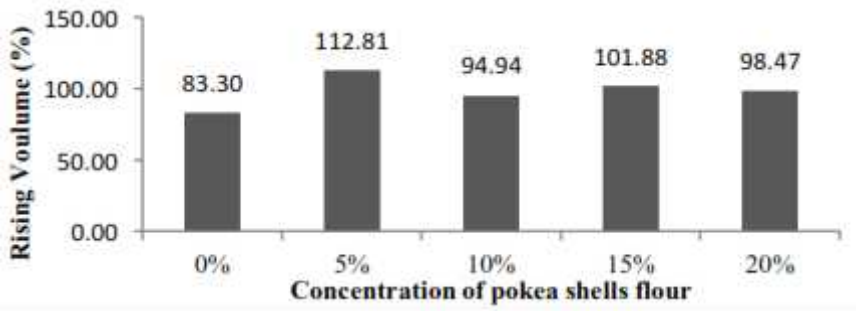

Figure 7. Average value of chips rising volume

Proximate Analysis

Proximate analysis is a method of chemical analysis to identify nutritional content such as water, protein, carbohydrates, and lipid. The result of proximate analysis is presented in Table 1.

Table 1. Proximate analysis of chips with addition of clam shell flour

Treatments	Water (%)	Protein (%)	Carbohydrate (%)	Fat (%)	Ash (%)
0 % (Control)	13,48	0,87	72,05	1,03	12,57
5 %	11,04	0,86	75,54	0,96	11,60
10 %	11,45	0,77	69,21	0,94	17,62
15 %	11,80	0,76	68,64	0,93	17,86
20 %	12,21	0,76	63,44	0,90	22,69

Water Content

Water is an important component in food, because water affects the appearance, texture, and taste of food. Even in dry food, there is still a certain amount of water (Winarno 2008). High water content was found in 0% control treatment, whereas addition of shell flour decreased the water content. Chips with addition of 5, 10 and 15% clam shells flour concentration had a water content of 11%. Value of 11% is suitable for food according to Indonesian food standard (SNI, 1999). Water content above 11% will lower the volume of chips during frying. Chips with a water content of 12% produced a rough and less fluffy texture (Sumarno 2011). Our finding was similar to study by Zulviani (1992) who added sago flour in chips dough and found that the higher the sago content in the dough, the lower water content contained in the product. This is because the product with high carbohydrate content tend to be fluffier, making the pores and surface area of the product become larger thus higher water vapor.

Protein

Protein is important compound for human body that is critical for growth and maintaining normal metabolism. Protein is a source of amino acids that containing C, H, O and N elements that is not found in lipid and carbohydrates (Winarno, 2008). The highest protein content was in treatment 0% (control) with value of 0.87% and then followed by the addition of 5% clam shells flour at 0.86%. The value of protein content is higher when compared with the addition of 5% green mussel shells flour (0.73%) as found by Permana (2006). Chips usually have low protein content because less protein source ingredients are used in chips production. The main protein source in chips is from garlic and since garlic is only used in a small quantities, the low protein content is obvious. In addition to garlic, tapioca flour is also a source of protein although only in a small quantities, because tapioca is dominated by starch or carbohydrates. Substitution of clam shells flour on tapioca flour may had affected protein content, therefore the higher addition of clam shells flour, the lower the protein content of the chips.

Carbohydrate

Carbohydrates can be obtained from every day food. Carbohydrates have an important role in determining the characteristics of food, such as taste, color and texture (Winarno, 2008). The highest carbohydrate content was in treatment of 5% addition of clams shells flour with a value of 75.54%.

Increasing the concentration of clam shell flour decreased the carbohydrate content in chips. This may due to the presence of shell flour as substitution of tapioca flour thereby reducing the amount of carbohydrate. Shell flour is the main source of calcium whereas tapioca is the main source of carbohydrate. Mulyandri (1992) stated that starch was the main component of tapioca flour. Starch is a compound that has no taste and smell (bland flavor) so that the tapioca flavor modification is easy to do. The tapioca starch contains 17% amylose and 83% amylopectin. Winarno (2008), stated that the main sources of carbohydrates from food are cereals and tubers, such as starch content in cassava.

Lipid

Lipid in form of fat and oil are important food substances to maintain the health of human body. In addition, fats and oils are also a more effective source of energy than carbohydrates and proteins. One gram of lipid produces 9 kcal, whereas carbohydrates and protein at one gram only produces 4 kcal (Winarno, 2008). The value of lipid content of clam shells chips in Table 1 showed that the highest value was in 0% control at 1.03%. Increased concentration of clam shells flour lowered the lipid content. This indicated that the substitution of tapioca flour to clam shells flour decreased lipid content of chips as tapioca flour is one source of lipid in chips.

Ash Content

Ash is an inorganic substance that does not burn in the combustion process (Winarno, 2008). The ash content of a foodstuff showed a residual organic matter remaining after the organic material in the food is decomposed. The value of ash of clam shell chips in Table 1 showed that the highest ash content found in chips with the addition of clam shell flour of 20% concentration with value of 22.69% compared to other treatments. The higher concentration level of clam shell flour, the higher the ash content. It is suspected that high ash content may come from clam shell flour, as the outer shell layer composed of calcium carbonate components or called periostracum layer (Asikin 1982).

Calcium Content

Calcium is one of the most needed minerals for humans. The body contains more calcium than other minerals. It is estimated that 2% of adult body weight or about 1.0 to 1.4 kg consisted of calcium (Winarno, 2008). The addition of 20% clam shell flour produced the highest calcium value of 560 mg /100g than other concentration treatments (Figure 8). The value of calcium clam chips obtained in this study was higher compared to the research of Mustafa and Suyanto (2011) who found that calcium content of cassava chips was 3,267 mg/100 g when added 40% of crab shell and lower than Ariyani and Ayustaningwarno (2013) at 7.18 g of calcium/100 g with the addition of 25% catfish dumplings.

The calcium content in chips was dictated by clam shell flour concentration. Increasing calcium content was linearly correlated with the concentration of clam shell flour. In this study we found that calcium content of shell flour was considerably high at 680 mg/100g. The high calcium content may derived from the constituent components of clam shells in the form of lime ($CaCO_3$) which serves as a protector of the body/meat. Chips with the addition of clam shell flour can be used as a source of calcium, especially for bone growth and biological processes that occur in the body. According to Winarno (2008), the role of calcium in the body in general can be divided into two, which was to help form of bones and teeth and regulate the biological processes in the body. High calcium intake is needed for growth, although continuous calcium requirements is still needed despite reaching adulthood period. Zimmerman et al. (1994) stated that one percent of the body's calcium circulated through the blood would be absorbed in bones and teeth. Based on recommended calcium intake in the United States, children aged 12 years or older and adults need 1000 mg of calcium, whereas for pregnant and elderly women need 1200 mg of calcium.

Conclusion

Shell waste by-products can be used as raw material for high calcium chips production. We found that the best treatment was obtained in concentration of 15% clam shells flour, with hedonic test value of color, odor, flavor and crunchiness are respectively 3.83; 3.67; 3.17; 4.03. For physical analysis, the value of hardness test, whiteness degree and rising volume were 3.43; 3,7 and 101,88% respectively,

while water content, protein, fat, ash and carbohydrate respectively 11,80%; 0.76%; 0.93%; 17,86% and 68,64%, and calcium content has a value of 520 mg/100 g.

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Creative and Innovative Products Material Floor From Shellfish (*Anadara Grandis*)

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Abstract

The potential wealth of marine resources such as marine fisheries resources is owned by Indonesia. The wealth of marine resources has not been utilized and managed optimally. Today, a lot of business is driven in various fields. The business of building floor crafts from sea shells (anadara grandis) can be pioneered into one form of business. Buton Regency is an archipelago, more than 80% of its territory consists of sea. During this time, shellfish cultivated fishermen only used the meat alone, while the shell removed and become waste. This research is aimed to utilize shell waste into floor material. The method used in this research is exploration method. The data begins with the selection of materials, work tools, and stages of manufacture. Information from various sources is captured and interpreted into a creative idea. The process of analysis is done qualitatively, so it is obtained and raised the shape of the floor. This study concluded that the use of waste shellfish shells into composite floor material is done in three stages. In the first stage, prepared work tools such as glass molds, measuring cups, stirring spoons, brushes, flooring boards, measuring tools, hammers, cutter knives, sandpaper and plastic. The second stage is prepared work materials such as shells, hardener, resin oil, and mirror glass. The third stage is made of floor like shell stage filled with resin oil; The floor stage is printed like a glass mirror smear on the mold, the resin oil is mixed with the hardener, the composite mixture is poured into the mold, the shells are placed in the mold, the shells are poured again with resin oil, and hardener; Stage of removable glass mold and; Floor stage given ballast.

Keywords: Floor, composite, shellfish, stage created

Introduction

Indonesia is the largest archipelagic country and maritime nation in the world. Waters area is the largest part of the total area of Indonesia. Indonesia has a wealth of potential marine resources such as marine fisheries resources, marine cultivation, marine agriculture resources, and mangrove timber. Wealth of marine resources has not been utilized and managed optimally (Adisasmita, 2010). Currently, many businesses are driven in various fields, ranging from home industry, medium, to macro business. Types of goods used for business also vary, ranging from food, clothing, and household goods at low prices up to hundreds of millions of rupiah (Sari, *et al*., 2013). The business of building floor crafts from sea shells (anadara grandis) can be pioneered into one form of business. Buton Regency is an archipelago, more than 80% of its total area or ± 21,054 km2 consists of sea. Potential fisheries and marine is quite high owned by this region, such as coral reef ecosystems, seagrass ecosystems, mangrove forests, and high seas. Cultivated Mollusca commodities such as pearl shells, japing shells, fur shells, green shells, abalone, lola, axes, and giant kimah. The coral and sand substrate biota are inhabited by lola and abalone in Lasalimu, South Lasalimu, Batu Atas, Sampolawa, Siompu, Lakudo, Wabula, and Mawasangka. During this time, shellfish cultivated fishermen only used meat, while the shell is removed and become waste. Thus, this phenomenon is captured and processed creatively and innovatively as a floor material. This research is aimed to utilize shell waste into floor material.

Methods

The method used in this research is exploration method. Data begins with the selection of materials, work tools, and stages of manufacture. Information from various sources is captured and interpreted into a creative idea. The basic concept is done and developed pragmatically on the shape of the floor. The process of analysis is done qualitatively, so it is obtained and raised the shape of the floor. The ground floor shape obtained is transformed from the parameters to the resulting flooring of clamshells and can be applied to the building.

Results and Discussion

Work Tools

The work tools used to make flooring material from shellfish *(Anadara grandis)* are, as follows: 1) Glass molds made of clear glass type with 5 mm thick. The glass mold is made as follows: The first glass mold is made base mold with the size 250 mm x 250 m. A second mold is made of a frame placed on top of the base mold. The frame is made according to the size of the base print. The thickness of the molded frame made is 10 mm, because the frame of the mold is arranged into two layers. The inner mold thickness is 10 mm. The frame mold placed on the base mold is adhesive by using a mixture of resin and hardener by dripping on the edge of the base mold. All of the frame frames at the angular assembly are patched with *plastisin* to keep the wet composite material out of the mold. Thus, mold of floor material from shells is formed; 2) Measuring cup used glasses of mineral water with dosage 240 ml; 3) The stirrer spoon is used to stir the mixture of resin and hardener oil to mix evenly; 4) The brush is used to smear the glass mirror on the glass mold so that the floor material is not sticky when lifted from the mold; 5) The boards used are plywood boards or gypsum that have been unused. This tool is used as an idler during the printing stage to allow the floor volume to be flat and symmetrical; 6) The measuring instrument used is meter and ruler; 7) Stationeries are used during the manufacture of prints such as markers; 8) The hammer is used to break shells that are not fit in the mold and to destroy the shells. The crushed shells are used as floor fillers; 9) The cutter knife is used to cut out the edge of the mold that appears; 10) The abrasive tool is used to smooth the sides of the printed floor for aesthetics; 11) *Plastisin* is used to cover the gap at the assembly of the frame so that the liquid in the mold does not come out of the mold.

Work Materials

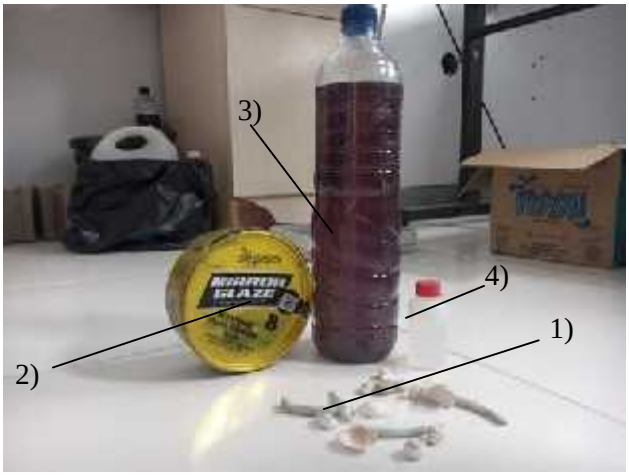

Figure 1. Working materials used to make flooring material from shellfish (Source: Author collections, 2017)

The working materials used to make the floor material from the shells (anadara grandis) are (shown in Figure 1), as follows: 1) Seed shells used are taken from Pasarwajo Sub-district, Buton Regency. The characteristics of shellfish from this area of the most prominent are clean white as sand. So good when used as a material filler floor of shellfish. Shellfish prior to use as a floor material should be washed with clean water and laundry. Whole shellfish is used as the main object of floor material. Shellfish are crushed as filler elements and placed between the complete shells, so that the filler material in the mold becomes solid. The size of the shells used as floor fillers varies, so the shell material placed in the mold appears. The maximum size of whole shells inserted as filler material is 15 mm. The size of the shellfish exceeding that size is destroyed as a floor filler; 2) Hardener is used as an accelerating material to harden the composite material. The price of one bottle of hardener sold in the market is Rp. 7.000, - (Seven thousand rupiah) per bottle. The hardener composition used for resin oil to create a floor with a size of 200 mm x 200 ml is 4 ml; 3) The resin oil used per 240 ml dose of the hardener is 2 ml (99%: 1%). Price of 1 kg resin oil valued Rp. 40.000, - (Forty thousand rupiah). One piece of floor material with a size of 200 mm x 200 mm is used 480 ml of resin oil. Resin oil functioned as the main raw material for forming

flooring; 4) Mirror glass functioned as a polishing material before the mold is filled so that the floor easily separated from the mold. Mirror glass one tin valued Rp. 150.000, - (One hundred fifty thousand rupiah).

Floor Stages Created

Stage of Shells Filled with Resin Oil

Fan shaped shells are filled one by one using resin and hardener oils with the content composition used 99%: 1%. The filling of the composite mixture against these shellfish is intended to make solid shell so that the floor is sturdy. The shells filled with quick dry oil resin for about 5 minutes. This stage of the preparation is done with great care that the mixture of resin and hardener oil is not spilled (shown in Figure 2).

Figure 2. Fan shaped shells filled with a mixture of resin and hardener oils (Source: Author Collections, 2017).

Printed Floor Stage

Figure 3. Stages of printed floor (Source: Author colections, 2017)

The stages of the floor are printed (shown in Figure 3), as follows: 1) Mirror glass is smeared with brush on a glass mold. Mirror glass smeared across the glass surface including the thick edges of the glass. The more glass mirrors smeared in the mold the easier it is to release the floor; 2) Oil resin and

hardener mixed with 99%: 1% composition. The mixture is stirred with a spoon to keep it flat; 3) The composite mixture is poured into a mold with a thickness of 3-4 mm and is waited until it is rather dense. Solid composites are known by piercing with stick; 4) Mixture of composite that began solid put shells. The shells are placed one by one and close together. The shapes and types of shells used as floor fillers vary. The gaps between the shells are filled with shellfish crushed in order to be aesthetically pleasing. The shell stage placed in the mold needs to be done quickly, because to anticipate a quick solid resin mixture; 5) After all the shells have been installed immediately pour the resin oil mixture over the entire shell surface. Poured resin oil needs to get out of mold. At this stage it should be carefully observed so that the mold is not tilted. Sloping mold is feared uneven floor thickness. At this stage also need to be observed because of frequent bubble phenomena. The empty air inside the mixture is called a bubble phenomenon. This happens because the heat from the composite mixture presses the air from the shells. This phenomenon is anticipated by removing the air by stabbing it with a stick. After the floor is printed and waited until solid for 10 minutes. Floors that have been dry and dense can be known by the way when touched hot.

Stage Matter Glass Removed

After the floor is hot touched immediately remove the mold frame with great care so as not to damage the floor (in picture 4). Frames should be opened on both sides in advance. After the floor is not too hot, the next frame is released.

Figure 4. Frame mold removed from solid floor (Source: Author collections, 2017)

The Weighing Stage is Placed on The Floor

Figure 5. The floors are weighted in the corners and floors that have been created (Source: Author Collections, 2017)

The removable floor material has the potential of curved corners due to the heat released from the composite mixture. This is anticipated by weighing the corners of the floor. Loads that are fed on the floor corners for 15-20 minutes or until the floor is not hot. After that, the floor is released from the ballast above it. Thus, the floor material formed from the shell is flat and the corners are not curved. The size of the floor material made is 200 mm x 200 mm x 5 mm. The amount of floor material made is one piece (shown in figure 5).

Conclusions

This study concluded that the use of waste shellfish shells into composite floor material is done in three stages. In the first stage, prepared work tools such as glass molds, measuring cups, stirrer spoons, brushes, flooring boards, measuring tools, hammers, cutter knives, sandpaper and plastisin. The second stage is prepared work materials such as shells, hardener, resin oil, and mirror glass. The third stage is made of floor like shell stage filled with resin oil; The floor stage is printed like a glass mirror smear on the mold, the resin oil is mixed with the hardener, the composite mixture is poured into the mold, the shells are placed in the mold, the shells are poured again with resin oil, and hardener; Stage of removable glass mold and; Floor stage given ballast.

This study can be continued to calculate the flexural strength and tensile strength of the flooring material from the seams with different treatments.

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Potential uses of Marine Bean (*Vigna marina*), a Tropical Marine Legume grown in the coastal areas, Southeast Sulawesi, Indonesia as a food source

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Abstract

The Marine Bean (*Vigna marina*) is one of the most interesting tropical legumes inhabited high salinity land in the coastal areas, Southeast Sulawesi, Indonesia.The present study aimed to assess the nutritional potential of the Marine Bean (*Vigna marina*) as a food source for the coastal community. The vegetative and generative organs of Marine Bean were taken from The Toronipa beach, South Konawe Regency, Southeast Sulawesi. The nutritional aspects, such as protein, fat and ascorbate acid contents were determined. The results showed that the protein content of the leaves of marine bean ranged from 1.73 to 3.59 mg/100g, while the protein content in the seeds was about 5.0 mg/100g. The fat content in the leaves and seeds ranged from 4.94 to 6.22 % and 6,92 to 8,54%, respectively. The ascorbat acid content in the leaves and seeds ranged from 5.56 to 6.27 ppm and 5.2 ppm, respectively. The findings of this study indicate the potential of the Marine bean (*Vigna marina*) as a renewable food source for coastal communityand as materials forfood industries.

Keywords: Marine bean, Nutrition content, food source.

Introduction

Legumes are known as an important part of traditional diets in most of developing countries in Asia, Africa and South America (Narasinga 2002). Although more than 1,000 species of legumes are known but only 20 species have been cultivated by farmers for use as food. In many regions of the world, legume seeds are the unique protein supply in the diet. Very often they represent a necessary supplement to other protein sources (Duranti and Gius, 1997). A fruit of legume plants ischaracterized by edible seeds, borne in pods that often open along two seams, by pea-shaped flowers, and by compound stipulate leaves (Mazur *et al*., 1998). It is one of the important source of protein, carbohydrate, dietary fibre and minerals (Tharanathan and Mahadevamma, 2003). Due to rich sources of nutrition, the legumes have an important role in human nutrition (Rockland, and Nishik 1979). Meanwhile, the importance of legumes in sustainable cropping systems has been extensively documented (Siddique *et al*. 20012). However, these information mention only for legumes growing in the terrestrial land, while little is known regarding potential of legumes that growing in the coastal area.

The Marine bean (*Vigna marina*) is a tropical legume that is widely distributed in the coastal areas of the tropical and subtropical regions (Andi 2009). Many peoples in that region use this plant for multiple purposes include the seeds use as substituted of coffee in West Africa, Tanzania, Mozambique, and South Africa, while in Maladewa, the seeds are consumed as a food. In Malaysia, *Vigna marina is also* use as a food. However, there is no information about parts of the legume that is better to be used as a food material. In Marshall Island, *V. marina* was reported as a food. In Amazone, Indian people were often observed in the fields eating the plants , though they did have a pouch of salt from which they would occasionally take a pinch to give a bit of favor and incidentally aid digestion. In addition, leaves of *V. marina* are used as vegetable in Australia and America.

The *V. marina* has also been reported to have medical uses. In the Marshall Islands, powder of leaves and seeds are use to heal skin burns of babies. In Polynesian, the leaves are used as medicine for urinary tract infection, vomiting blood and puerperal infection. In Indonesia, the root of *V. marina* can be used as medicinal for blocking the blood. In spite of these usefulness, there is no information concerning how nutritional potential of *V. marina* to be used as new food source for the coastal community. Therefore, the aim of this study was to determine the potential uses of the Marine bean (*V. marina*) as renewable food source.

Materials and Methods

Study site

The plant materials of the Marine bean *V. marina* were collected from Toronipa beach, which is located at the nortern part of Kendari city, Southeast Sulawesi, Indonesia. The *V. marina* grow along the sandy beach and far away from tourism activities. This plant covered about 1000 m^2 and show nice panorama in the beach. This plant produces abundant leaves and fruits at rainy season and has few leaves at dry season.

Sampling and Preparation of The Marine Bean

The young leaves and fruits of the Marine bean were sampled from three sites namely sun area, shaded area and on the trees. The samples were then labelled according to their sites and kept in the box contained dry ice and brought to the laboratory of Forensic and Molecular at University of Halu Oleo. In the laboratory, all samples were washed thoroughly in tap and distilled water and then separated for the fresh and drying samples analysis.

Nutritional analysis

Extraction and estimation of total protein

The fresh of young leaves and fruits of the Marine bean were taken about 100 mg each and homogenized with pre-chilled mortar and pestle in ice-cold protein extraction buffer. The homogenate samples were then centrifuged at 10,000 rpm at 4°C for 30 minute and the pellets were washed with 10% TCA and incubated overnight at 40 C. The pellets were suspended in 2 ml of 0.1N NaOH. Estimation of total protein was made according to Lowery *et al*. (1951). Proteins in the unknown samples were estimated at 750 nm using bovine serum albumin (fraction V) as standard and calculated using standard curve and expressed as mg per g fresh weight basis.

Extraction and estimation of ascorbic acid content

Ascorbic acid content of the yound leaves and fruits of the Marine bean was estimated following the method of Harris and Ray (1935). Extraction was done by grinding 0.5g of sample material in 6% oxalic acid solution followed by centrifugation at 3000 rpm for 10 mins. Transferred the aliquot and made up the volume to 100 ml. 5 ml of supernatant was added to 10 ml of 0.6% oxalic acid solution and it was titrated against dye solution (standard indophenols solution) till pale pink colour was seen. Standardization of dye was done with standard ascorbic acid (1 mg/ml). Total ascorbic acid content (mg/100 g) of fruits was calculated by (0.5 mg/volume 1) × (volume 2/5ml) × (100 ml/ wt. of the sample) × 100, where, volume 1 is burette reading of titration of dye against standard ascorbic acid and volume 2 is burette reading of titration of dye against sample.

Extraction and estimation of fat content

The fat content ofthe vegetative and reproductive organs of the Marine bean was extracted by using a modi"ed AOAC method 14.019 (Conway and Adams, 1975). Fat was extracted from 1 g sample of each organ by heating in alcoholic HCl, followed by the addition of 95% ethanol. The sample was allowed to cool. Ether and sodium sulphate were added, and then the sample was shaken. Petroleum ether was added, and the sample was shaken again. The acidic ethanol layer was re-extracted twice with a mixture of ether and petroleum ether. The combined, recovered supernatants were allowed to evaporate in a ventilated area, and any trace of moisture was eliminated by drying in a forced air oven (1003C, 1.5 h) prior to gravimetric determination.

Statistical analysis

The data were expressed as Mean value. The means of all the parameters of the nutrients contents were analyzed for any significant different by *t-test*.

Results and Discussion

The results of the present study described the nutritional and antioxidants potential of marine bean (*V. marina*) that grown in the Toronipa beach, Southeast Sulawesi Indonesia in terms of nutrition including protein, ascorbit acid and fat contents (Table 1).

Table 1: Protein, total sugar and reduction sugar contents on vegetative and generative organs of marine bean *Vigna marina* growing in Southeast Sulawesi, Indonesia. Similar letters indicate no significantly different at 5 % level.

No	Organs position of marine bean	Protein content (mg/100 g)	Fat content (%)	Ascorbite acid (ppm)
1.	Sun leaves	1.73^{a}	6.22^{b}	6.27^{c}
2.	Leaves on trees	3.57^{b}	4.94^{a}	5.84^{b}
3.	Shaded leaves	3.59^{b}	5.52^{a}	5.56^{b}
4.	Seeds on sandy	5.10^{c}	6.92^{b}	5.17^{a}
5.	Seeds on trees	4.98^{c}	8.54^{c}	5.07^{a}

As shown in Table 1, the content of protein of the leaves and fruits of *V. marina* was significantly different among tissues ($p< 0.05$). The protein content of young seeds (4.98-5.10 mg/100g) was much higher as compared that sun leaves (1.73 mg/100g), shaded young leaves (3.59 mg/100g) and canopy leaves (3.57 mg/100g), but it was not significantly different among seeds as well as among shaded and canopy young leaves ($p > 0.05$). Similarly, the content of fat of theleaves and fruits of *V. marina* was significantly different among tissues ($p< 0.05$). The fat content of theyoung seeds (8.54 %) was significantly higher ($p < 0.05$) as compared that canopy seeds (6.92 %). In addition, the content of fat of the sun leaves (6.22 %) was much higher as compared that of the shaded leaves (5.52 %) and canopy leaves (4.94 %). However, fat content was signifcantly different ($p < 0.05$) among seeds and leaves. On the other hand, ascorbate acid contents on the sun leaves (6.27 %) was signifcantly higher ($p < 0.05$) as compared to that of the leaves on trees (5.84%) as well shaded leaves (5.56%). In addition, the ascorbate acid content was significantly higher in young leaves than that of seeds. Meanwhile, ascorbate acid content of the seeds on sand (5.17%) was not significantly diferent compared to that of the seeds on trees (5.07%). Therefore, vegetative organ of the Marine bean seemed to contain much higher nutrition as compared to the generative organ.

The fat content of the sun leaves and seeds of the Marine bean was higher compared to the fat content of the Mung bean (5.69%), though it was lower than the fat content of soy bean (20.07%). Although, the protein content of marine bean organs was lower compared to Kidney bean (37%), Mung bean (46.09%) and Soy bean (30.88%), but protein content of marine bean was comparable with white rice (6.45%), black rice (8.6%), red rice (6.06%) and brown rice (6.35) reported by Rusydi et al. (2011). However, the fat content of the organs of the Marine bean wass higher than that of the seeds of white rice (1.42%), black rice (1.29%), red rice (1.5%) and brown rice (1.89) reported by Rusydi *et al*. (2011).

These results of nutrients contents of the organs of marine bean (*Vigna marina*) provide important information for coastal people as of this legume is widely distribution in the coastal areas of the tropical and subtropical regions. The information about the nutritional content in the seeds is important as many people have been using this legume for multiple purposes such as as a substite of coffee in West Africa, Tanzania, Mozambique, and South Africa and as as a food in Maladewa, Marshall Island, Australia and America.

In addition, higher ascorbate acid content of theorgans of *Vigna marina* is also potential to be used for medical purposes. The powder of the leaves and seeds has been used for healing skin burns of babies in Marshall Island. Meanwhile, higher ascorbate acid content of the leaves of the Marine bean has been used asthe uses of this plant in Polynesian as medicine for urinary tract infection, vomiting blood and puerperal infection in Polymesian. Therefore, this study result revealed the potential uses of the Marine bean as renewable food source for the local people as well as as materials for food industry.

Conclusion

The present results showed the potential uses of marine bean *Vigna marina* growing in the coastal area of Southeast Sulawesi, Indonesia, as renewable food sources. This marine bean contains considerable amount of nutrition and antioxidants, whose might be potential to be used as food material and bio-nutrition alternative. Thus, the findings suggest the potential of the Marine bean as food sources which will also be useful for conservation and management of coastal resources.

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Nutrition Potential of Mangroves Fruits Growing in Rawa Aopa Watumohai National Park, Southeast Sulawesi

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Abstract

The present study aimed to assess the nutrition potential of protein, total sugar and sugar reduction of mangrove fruits of *Xylocarpus granatum*, *Sonneratia alba* and *Bruguiera gymnorrhiza* growing in Rawa Aopa Watumohai RAWN Park. The protein content of the fruits of *X. granatum* (4.50 mg/g) was significantly higher ($p < 0.05$) than that of *S. alba* (0.93 mg/g) and *B. gymnorrhiza* (1.09 mg/g). The fat content of the fruits of *X. granatum, S. alba* and *B. gymnorrhiza* was 4.88 %, 4.42 % and 4.74 %, respectively ($p > 0.05$). The total sugar content ofthe fruits of *X. granatum, S. alba* and *B. gymnorrhiza* was 14.8 (mg/100g), 14.9 (mg/100g) and 13.52 (mg/100g) ($p>0.05$).. On the other hand, the content of sugar reduction of the fruits of *S. alba* (7.74 mg/100g) and *B. gymnorrhiza* (6.24 mg/100g) was significantly different ($p < 0.05$), while the content of the reduction sugar offruits of *X. granatum* (6.36 mg/100g) was not significantly different compared to other mangroves fruits. Thus, this study revealed the potential nutrition uses of the mangroves fruits growing in RAWN Park., Southeast Sulawesi.

Keywords: Mangrove fruits, Nutritional content, potential uses, RAWN Park

Introduction

As an increasing problem human population and depleting natural resources, there is a need to explore the nutritive potential of mangroves and extending their possible uses as renewable nutritional source. Mangrove fruits are well known food consumed by coastal society in Indonesia as a food material or ingredient in various processed food products (Jariyah *et al*. 2014). Several mangroves growing in Indonesia are known to produce edible fruits including *Sonneratia*, *Ceriops*, *Bruguiera*, *Avicennia*, *Xylocarpus*, *Aegiceras*, *Lumnitcera*, *Waru* and *Bariringtonia asiatica* (Noor *et al.*, 2006; Chen *et al.*, 2009), and some food products have been produced from mangrove fruit such as syrup (Abeywickrama and Jayasooriya, 2010), cakes and steamed pudding (Brown *et al*., 2006).

Mangroves are one of among the most potential natural resources in Rawa Aopa Watumohai National RAWN Park, Southeast Sulawesi, Indonesia with high diversity of mangroves (Analuddin et al. 2013) and higher biomass stock (Analuddin *et al*. 2016). However, there was no information about nutrition potential of the mangroves fruits growing in RAWN Park till now, knowlegde of which important for sustainable management of this mangrove forest. Therefore, the objective of this study was to determine the nutritional contents of the fruits of several mangrove species growing in the RAWN Park, Southeast Sulawesi, Indonesia.

Material and Methods

Study site

The fruits of several mangroves including *Xylocarpus granatum*, *Sonneratia alba* and *Bruguiera gymnorrhiza* were collected from mangroves growing at the RAWN Park, which is located at the eastern part of Kendari city (S : 04°33'12.1" and E : 122°0.3'20.4"), Southeast Sulawesi, Indonesia. The mangrove forests are covered about 6000 hectar and protected by government. Theyprovide an excellent site for taking mangroves fruits because the growth and development of mangroves showed good condition, while degradation occured at unprotected mangroves outside the RAWN Park.

Sampling and preparation of mangrove fruits

The fruits of each mangrove species were sampled from three individuals of mature trees and labelled according to species and then kept in the box contained dry ice and brought to the laboratory Forensic and Molecular at University of Halu Oleo. In the Laboratory, all fruit samples were washed thoroughly in tap and distilled water and then separated for the fresh and drying samples analysis. For elemental analysis, the samples were finally dried in oven at 500^{o}C temperature and then grounded until fine powder and stored in air-tight containers at 40^{o}C for further analysis.

Extraction and estimation of total protein.

The fresh fruits of mangroves *X. granatum, S. alba* and *B. gymnorrhiza* were taken about 500 mg each and homogenized with pre-chilled mortar and pestle in ice-cold protein extraction buffer. The homogenate samples then centrifuged at 10,000 rpm at 4°C for 30 minute and pellets washed with 10% TCA and incubated overnight at 40 C. Pellets were suspended in 2 ml of 0.1N NaOH. Estimation of total protein was made according to Lowery et al. (1951). Proteins in the unknown samples were estimated at 750 nm using bovine serum albumin (fraction V) as standard and calculated using standard curve and expressed mg per gm fresh weight basis.

Extraction and estimation of total sugar content

Total sugar was estimated by using the method of Rangana, (1979). About 0.5 gram of fresh fruit samples were taken and homogenized with 80% alcohol and centrifuged the sample for three times at 5000 rpm for 20 minutes. The supernatant were collected in fresh beaker and added small quantity of distilled water into the beaker. The content of the beaker was heated at hot plate till the smell of alcohol disappears (for about 3-4 hrs). The volume was made up to 100ml with distilled water and stored for further analysis. 1 ml of alcoholic extract was taken in a test tube and chilled. After a while, 4 ml of anthrone's reagent was carefully run down the walls of the test tube. The test tubes were thereafter immersed in ice water. The tubes were brought to ambient temperature and boiled in water bath for 10 min. After proper cooling, the absorbance was measured at 625 nm. Total sugar content was calculated using standard curve (D-Glucose used as standard) and expressed as mg per gm fresh wt.

Extraction and estimation of reducing sugar content

Reducing sugar was estimated using Dinitrosalicylic acid (DNS) reagent (Miller, 1972). 100mg of the fruits sample were homogenized with 80% ethanol by centrifuging three times at 5000rpm for 20 minutes (5ml each time). The supernatant was collected and evaporated by keeping it on a water bath at 80°C. The sugars were dissolved by adding 10ml of distilled water. 3 ml of DNS reagent was added to 3 ml of sample in a lightly capped test tube. The mixture was heated at 900 C for 5-15 minutes to attain a red brown color. Then 1 ml of Rochelle's salt solution was added to stabilize the colour. After cooling to room temperature, absorbance was recorded at 575 nm. Reducing sugar content was calculated using standard curve (D-Glucose used as standard) and expressed as mg per gm fresh wt.

Statistical analysis

The data were expressed as Mean ± Standard deviation values. The means of all the parameters nutrients contents were analyzed for observing any significant different by *t-test*.

Results and Discussion

The results of the present study described the nutritional and antioxidants potential of mangroves fruits of three mangrove species growing in the RAWN Park, Southeast Sulawesi Indonesia in terms of nutrition (Table 1). As shown in Table 1, the protein content of the fruits of *X. granatum* (4.50 mg/g) was significantly higher ($p < 0.05$) compared to that of *S. alba* (0.93 mg/g) and *B. gymnorrhiza* (1.09 mg/g), but it was not significantly different ($p > 0.05$) among *S. alba* and *B. gymnorrhiza* fruits. However, the total sugar content (mg/100g)of the fruits of *X. granatum, S. alba* and *B. gymnorrhiza* was 14.8, 14.9 and 13.52 (mg/100g), respectively though it was not significantly different among these mangroves fruits. On the other hand,the reduction sugar of the mangroves fruits was significantly different ($p < 0.05$) among

S. alba (7.74 mg/100g) and *B. gymnorrhiza* (6.24 mg/100g), though reduction sugar on fruits of *X. granatum* (6.36 mg/100g) was not significantly different as compared to other mangroves fruits.

Table 1. Nutritional content of mangrove fruits growing in the RAWN Park, Southeast Sulawesi. Similar letters indicate no significant different at 5 %

Mangroves	Nutrition content of mangroves fruits		
	Protein (mg/100g)	Total sugar (mg/100g)	Sugar reduction (mg/100g)
Xylocarpus granatum	4.4 ± 0.00^{a}	14.80 ± 0.09^{a}	6.75 ± 0.38^{a}
Bruguiera gymnorrhiza	15.6 ± 1.11^{b}	14.90 ± 0.54^{a}	6.24 ± 0.04^{ab}
Sonneratia alba	14.4 ± 0.70^{bc}	13.52 ± 0.43^{a}	7.74 ± 0.00^{ac}

The present results revealed that the protein content in fruits of *X. granatum* at present study was much higher than that *B. gymnorrhiza* (4.40 mg/g), though the protein content of fruits of mangroves studied was lower than that of *Kandelia candel* (15.6 mg/g) and *R. apiculata* (14.4 mg/g) (Rout *et al*. 2015). Futhermore, the protein content of *X. granatum* grown in RAWN Park was higher than the protein content of *C. caseolaris* (2.24%), though the protein content of the fruits of *B. gymnorrhiza* and *S. alba* was lower than that of *C. caseolaris* (Patil and Chavan, 2013). These nutrition contents of mangrove fruits grown in RAWN Park revealed their future potential uses as a food source.

Conclussion

The present results demonstrated the potentiality of fruits of mangroves grown in RAWN Park, Southeast Sulawesi, Indonesia, whose contain considerable amount of nutrients,and could be able to address many nutritional related subtitution food for local community and also might be potential as renewable bio-nutrition.

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Proximate Profile of Dried Stingray Produced in Konawe Utara District South East Sulawesi

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Abstract

Proximate Profile of Dried Stingray Produced in Konawe Utara District South East Sulawesi had been studied. The aim of this study is to identify the proximate profiles dried stingray produced in Konawe Utara District Southeast Sulawesi, which include moisture, protein, fat, ash and crude fiber content respectively. The research method is by taking a simple random sample of dried stingrays (Simple Random Sampling) obtained from the producer. Sampling is done 3 (three) times over a period of 1 (one) week. The samples collected were then analyzed their proximate content in the laboratory. The results showed that the content of dried stingray proximate produced in Konawe Utara dictrict, still appropriate the required quality standards for dried fish products.

Keywords: Stingray, Konawe Utara District, drying process, proximate profile

Introduction

Fish as food has high nutritional value with mineral content, vitamins, fats and proteins are arranged in essential amino acids that are indispensable for human growth and intelligence. Fish contain high enough protein: fresh fish about approximately 20% and dried fish approximately 50%. Murtini (1995) mentions the fish protein is rich in essential amino acids are indispensable human body and fish protein has a content of essential amino acids more complete (complete protein). The results revealed that the quality of fish protein can be said to be level with other animal protein qualities such as meat and eggs. In general, fresh fish contain fat and calories in low amounts. Fish fats contain more unsaturated fats that other animal foods do not have. Fish are also rich in sources of Fe, Iodine, and Zn (Maroni *et al*., 1997; Purba, 2001).

The existence of stingrays in Indonesia is one type of biological resource wealth. This is supported by the large number of population and the diversity of stingrays owned by Indonesian waters. Stingrays can be found throughout the territorial waters of Indonesia, both in territorial waters, ocean waters, and Exclusive Economic Zone. Worldwide there are an estimated approximately 500 species of stingrays scattered throughout the ocean. While in Indonesia there are about approximately 250 species of stingrays, or half, but there are only 7 types of stingrays are widely known both by the fishermen and the wider community as well as by scientists (Icthyologist). The types of stingrays are most economically valuable, among others: a) Pari Kembang or Pari Macan (Sting rays); b) Pari Kelelawar (Devil rays, Manta rays); c) Pari Burung (Eagle rays / *Aetobatus narinari*); d) Pari Hidung Sekop (*Guitarfishes*/Shovelnose ray) e) Pari Kekeh (Whitespotted / Wedgefishes), f) Pari Mondol (*Himantura geraldi / Himantura jenkinsii*)); g) Pari Mutiara (*Himantura jenkinsii*). Today stingrays have been utilized optimally, fishermen processing stingrays into salted fish, smoked fish, fish skin crackers (rambak) and the skin can also be tanned into accessories.

Based on statistical data of Indonesian fishery, in 2008 recorded the number of stingray volume captured and landed by the fishermen in Indonesia reached 35,784 tons with a nominal value of approximately IDR. 260.395.143.000,00. Increasing the production of stingray will greatly affect the production volume of dried salted fish processing.

The Indonesian government has set up salted fish as one of the nine basic needs of the community. This suggests that salted fish is not only favored by lower-class economies, but also by the middle and upper classes. The attractiveness of salted fish is mainly located to the taste, aroma and texture that is very

typical, especially after fried. The principle of making salted fish is salting and drying. Salting is generally done by dry (dry salting) or the way of wet (brine salting). Dry aging is done by arranging fish and salt in layers and alternating in a container. Salting the wet way is done by immersing the fish in a saline solution. Wet droplets are generally performed on high-fat fish to prevent fat oxidation (Astawan, 1997).

Several studies have been conducted to observe the drying process on the quality of the salted fish in different fish species (Wibawa and Wahyudi, 2015; Sulaiman et al., 2015; Imbir *et al*., 2015). However, information on the nutritional value of dried rayfish produced in the North Konawe District of Southeast Sulawesi is not yet available, so the study is expected to provide new information about dried stingrays.

Konawe Utara District is one of the districts that have a lot of stingray potential, and the stingray became one of the main menu icons of the local local people. However, salted stingray products are commonly sold, processed using a variety of methods, so it is suspected that with the use of different methods of drying, will affect the nutritional value of the stingray. It is therefore necessary research to identify these parameters on the quality of dry stingray products.

Methods

Survey and collected sampling of dried stingray

This research phase starts from survey of dried stingray produced in North Konawe Regency of Southeast Sulawesi, then samples of dried stingray of approximately 1 kg from producer using simple random sampling method based on preliminary survey data. Sampling is done 3 (three) times with an interval of 1 (one) week.

Laboratory Analytical

The analysis performed in this study were: proximate analysis (moisture content, ash content, protein content, fat content and carbohydrate content) based on AOAC (2005). Moisture content analysis was done by oven method, while the determination of ash content was done by combustion method at 600oC or more. The protein content was determined using the Kjeldahl method, for the fat content using the Soxhlet extraction method, and for the determination of carbohydrate content using carbohydrate by difference method, which was calculated by the difference of the analysis of moisture content, ash, protein and fat.

Statistics Analytical

Observational data of proximate analysis were analyzed using descriptive analysis to give an overview of data that has been obtained with replication 3 times (n = 3). The results presented represent the mean ± standard deviation (SD).

Results and Discussion

Result

Table 1. shows the proximate composition dried stingray *Dasyatis sephen* produced in Konawe Utara District, South East Sulawesi.

Table 1. Proximate composition of dried stingray (*Dasyatis sephen*)

Parameters	Producer			Mean±SD
	1	2	3	
Moisture (%)	24.96	24.87	25.04	24.96±0.09
Protein (%)	50.44	50.77	50.5	50.58±0.18
Fat (%)	0.32	0.43	0.54	0.44±0.11
Ash (%)	5.97	5.66	5.77	5.81±0.16
Carbohydrate (%)	1.41	1.61	1.41	1.48±0.12

Discussion

The result of proximate analysis shows that the moisture content of the dried stingray is 24.96% is still low, which means that the durability of the stingray can be longer. In addition, according to the recommendation of SNI number 8273 in 2016, states that the maximum moisture content for dry fish is 40.0%. This can be a reference that the moisture content of dried stingrays still in accordance with the SNI. Protein content of dried rays is also quite high at 50.58%. However, low fat content is 0.44%, compared with Reo reported (2013) which reported protein content and fat content of dry red snapper that is 46.04% and 11.03% respectively.

The difference of proksimat content of dried salted fish can be influenced by several factors, such as fish type, drying method, drying time, and salt concentration. Several other researchers have reported proximate test results for several different fish species. Yusra (2017) also reported that the proximate content of salted gulamah fish traded in Padang Pariaman District, which consisted of moisture content, ash, fat, protein and carbohydrate were 34.03%; 17.38%; 8.11%; 28.38% and 12.07% respectively. While Riansyah *et al*. (2013) reported that the results of proximate analysis of fish *Trichogaster pectoralis* dried by oven at 70^{o}C for 12 hours, water content, ash, protein, fat and carbohydrate were 39.05%; 6.65%; 42.41%; 10.28% and 1.66% respectively. As a result, the salted stingray produced from North Konawe District will differ from the proximate composition when compared to other fish species, however the results obtained still show the standard value required by National Standarization Agency (BSN), especially moisture content.

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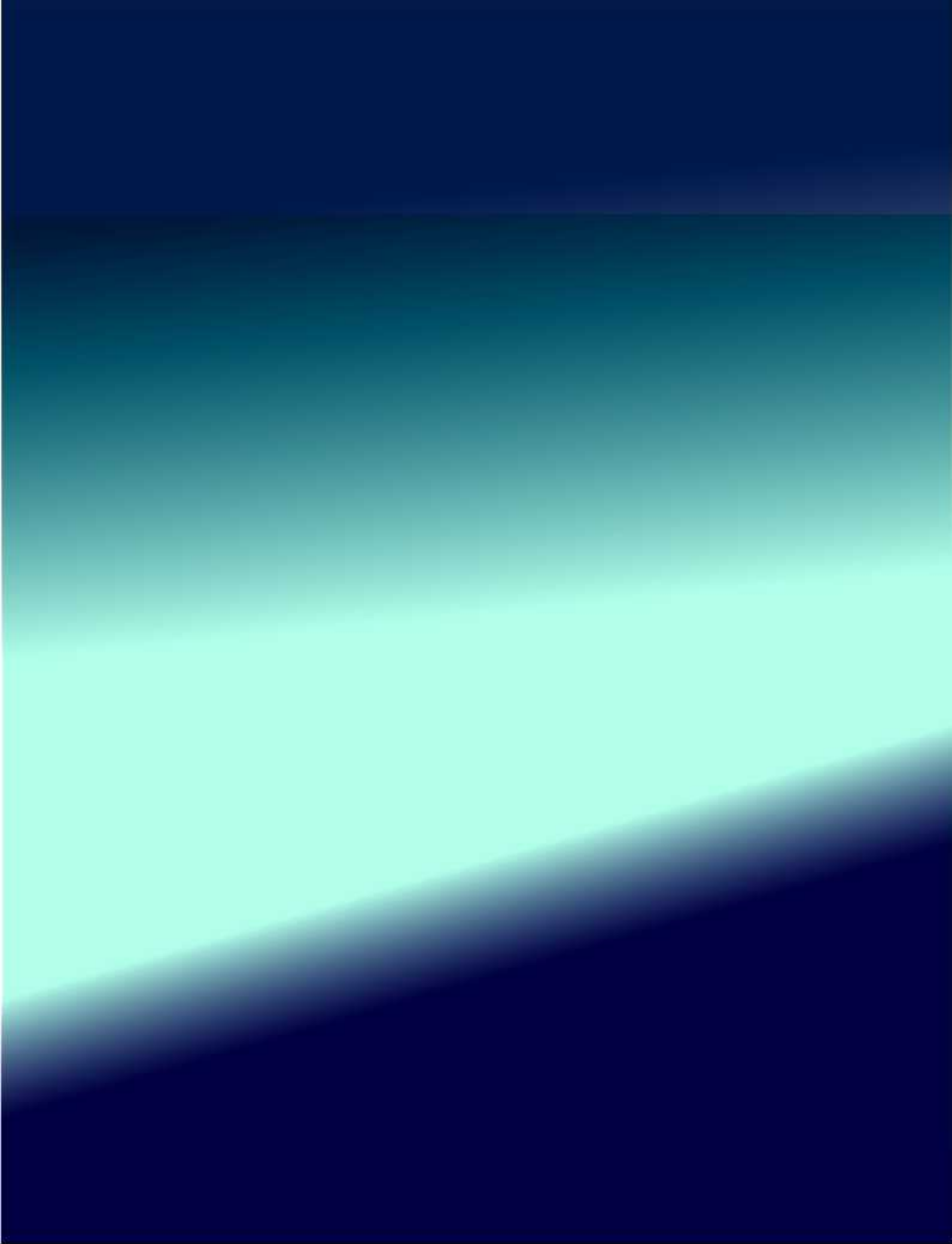

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