Reproductive Biology Analysis of Mullet (*Mugil dussumieri*) Captured by Fixed Lift Net in Mangrove Ecosystem in Western Coastof South Sulawesi

Kasmawati[1][2]*, Natsir Nessa[3], Sudirman[3], Nadjamuddin[3]

[1]Doctoral Program of Agricultural Sciences, HasanuddinUniversity, Makassar.
Jl.Perintis Kemerdekaan Km. 10, Indonesia
[2]Faculty of Fisheries and Marine Sciences, Muslim University of Indonesia, Makassar.
Jl Urip Sumoharjo Km. 5, Indonesia
[3] Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar.
Jl.Perintis Kemerdekaan Km. 10, Indonesia

Abstract : South Sulawesi province covers a land area of $62,482.54$ km^2 and sea area of about $48,000$ km^2. This province has an abundant marine resources, successfully produced 247,173 tonnes from fish capture activities in 2012[3]. Fixed lift net, is one of traditional and small-scale fishing gear, is long time-but-exist carried out by fishermen. This gear is often installed in an area adjacent to mangrove forests, aimed to capture small pelagic species, especielly mullet (*Mugil dussumieri*) – one of predominantly captured. This research examined the reproductive biology of mullet such as : length–weight relation, sex ratio, composition of catch, and proportion of mullet captured from mangrove ecosystem in one season. The results showed the allometric negative growthof mullet, indicated by length growth domination compared to weight growth. The sex ratio proportion indicated the male and female mullets of 55.37% and 45.27%, and reached total sexual maturity (LT100) at 750 and 186 mm total length (LT) for males and females respectively.

Keywords : reproductive biology, mullet, fixed lift net, mangrove ecosystem.

Introduction

Prodution of capture fisheries in Indonesia reached 6.5 million tonnes/year, whereas contributed to national economic growth of 6.5% in 2011-2012[5]. South Sulawesi province, with a land area of $62,482.54$ km^2 and sea area of about $48,000$ km^2, has the potential of marine resources with 247,173 tonnes capture fisheries catch in 2012 [3]. This province has the coastal line of 1,973.7 km, covers marine areas e.g. Makassar Strait, Flores Sea and Bone Bay, and expanses small archipelagos. This condition encourages most of the inhabitants to live as traditional fishermen, about 85% small-scale capture fisheries dominates the whole fish capturing activities [6.]

Fixed lift net, one of the small-scale and traditional fishing gears,is often found to be carried out by traditional fishermen. In line with the fact, [1]suggest the eco-friendly fisheries development for small scale fisheries activities. Besides, the application of fixed lift net has been practiced by local fishermen, introduced by Bugis-Makassar fishermen since about 1950 and already known throughout Indonesiawithin a relatively short period [14]. The rapid-growth of this fishing gear is supposed to be triggered by several factors, e.g. easy to find material, easy to use, and economically reachable for fishermen. However, this unexpected growth, such as

in Java and especially a case in Kepulauan Seribu regency, has disrupted shipping lines, so that a regulation to manage the use of this fishing gear is essential [8]

The fact indicates the decline of fixed lift net application in the western coast of South Sulawesi province every year. Production in 2007 to 2009 has decreased along with the decrease in the number of fishing gear, but in has increased 2009 to 2013 production while the fishing gear tremulously decreased.

Fixed lift net is usually installed in the coastal area, adjacent to mangrove forests or coral reef areas at 5-9 mdepth. The fishing spot is a fertile area in nutrients. Thus, the caught fishesare whom inhabit the spot [15]Coastal ecosystems, as part of coastal areas, have a range of natural resources, which are potential to develop. One of the potentials is biodiversity ecosystems, which include coral reefs, sea grass, and mangrove. The ecosystems serve as nursery ground habitat for a variety of reef fish species, gastropods, bivalves, and the mangrove crab [9.]

Mangrove ecosystem is a fertile area, has the ecology, biology, and economic interests. The ecology and biology interests tend to the habitat, nursery ground, spawning ground and feeding ground for various types of marine life, make it as an importance with abundant biodiversity[16.] Mangrove is important as habitat, provide food source, maintain ecological quality, and contribute economic value to human perspective[10].Also, an economic function of mangrove ecosystem is that reserves natural stock for various types of biota important economic. Various types of marine lives(e.g. fishes, shrimps, crabs and shellfishes) are the main livelihood of fishermen. However, this unstable and sensitive ecosystem is threatened by various threat, especially those derived from human activitiessuch as the no environmentally friendlyfishing. The decline in fish catchescan due to various natural conditions and human activities such as coastal pollution, exploitation, uncontrolled fishing activities, etc. [7.]

The phenomenon might negatively impact to fish resources, especially reduces biodiversity to extinction of some fish resources. Thus, we need to make the anticipatory measures to improve the fixed lift net management to be sustainable by using bioecology assessment in order to achieve the environmentally friendly fisheries. Thus, we aimed this study to analyze the reproduktive biology (, gonad maturity level and minimum catchable size) of fish caught around the mangrove ecosystem in a fishing season is specially of mullet

Methods

Time and place

This study was conducted on March2015–March 2016, taken in the west coast of South Sulawesi province, administratively located in Pangkep regency. Location of the study was limited by the fixed lift net installment area located around themangrove ecosystem (see fig. 1).
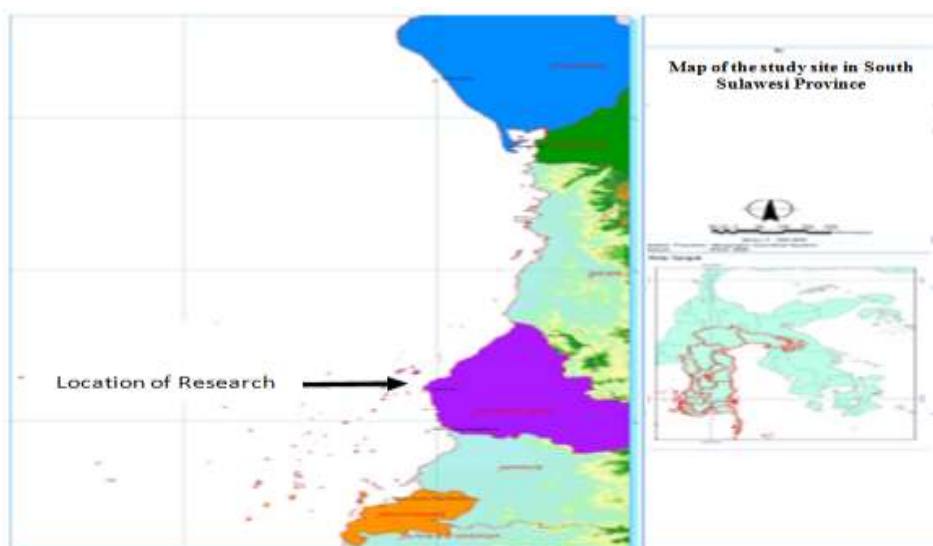

Figure 1. Location of research (West coast of South Sulawesi)

Material and Method

Examples of fish catches, chart obtained from step in the mangrove ecosystem. Data is collected once every two weeks for twelve monthsas 296 tail. Fish catches are calculated number (tail), measured weight (gr), and measured the total length (cm).

Data analysis

The reproductive biology data of fishes catch from mangrove ecosystem were analyzed with following steps:

Length-weight relationship

The calculation of length-weight relationship referred to the formula of [4]:

log W = log a + b log L.

Thus, this equation could be solved such as completing the usual linear equation. This measurement was intended to determine the length-weight relationship of the fish. The b value is an indicator of fish body – isometric or plump. The b = 3 indicates the balance growth which compared on both length and weight. The b> 3 or b <3 indicates an allometric growth which means either slower or faster length growth compared by weight growth. The b <3 means negative allometric (slim), while the b> 3 means positive allometric (plump).

The b = 3 could be tested by using t-test at α = 5% [11] with the following formula:

$$t_{obt} = \frac{3 - b}{s / \sqrt{n}}$$

Where b is the calculated length weight ratio of fish, s is the standard deviation, n is the number of samples. If t_{obt}greater than t_{table} (95% confidence interval), the b value is not equal to 3 or the length-weight relationship of fish is positive allometric (b>3) or negative allometric (b <3). Meanwhile, the smaller t_{obt}compared by t_{tabel}indicates the b value is equal to 3 or the length-weight relationship of fish is symmetrical.

Length at first maturity (Lm)

The length of the caught fishwhich 50% getting mature is called as *length fifty*(L50) or the length of the caught fish for the first maturity or known as *length of firstmaturity* (Lm). The linear regression analysis was performed by using formula proposed by [18].

$$Q = \frac{1}{1 + e^{-a(L-l_m)}}$$

Where:

Q = Fraction of already-mature length classes (III and IV)

L = Fish total length (mm)

Lm = Fish length for the first maturity (the mature threshold point)

Results and Discussion

Biological aspects of the catch

Fish composition of the catch

The catch of captured fishes using fixed lift net consists of demersal fish species. Some dominant species which are economically valuable include mullet (*Mugil dussumieri*), scat (*Scatophagus* sp.), banana shrimp (*Penaeus merguiensis*), and rabbitfish (*Siganus* sp.).

The other catches include mud crab (*Scylla serrata*), tiger perch (*Terapon jarbua*), tinfoil barb (*Puntius schwanefeldi*), *Chandra borvensis*, goatfish (*Upeneus vittanus*), snakehead (*Channa striatus*),black-barred halfbeak (*Hemirhamphus* sp.), jawla paste shrimp (*Acetes indicus*), mosquitofish (*Gambusia affinis*) deep pugnose ponyfish (*Leiognathus ruconius*). pufferfish (*Diadon holocathus*), and ballonfish (*Lagocepalus inemis*).

Proportion of the catch

The proportion of the catch obtained by fixed lift net that installed in the mangrove ecosystem consists of: 10% of mullet (*Mugil dussumieri*), 15% scat (*Scatophagus* sp.), 12% banana shrimp (*Penaeus merguiensis*), 15% of rabbitfish (*Siganus* sp.), 10% of mud crab (*Scylla serrata*), 3% of tiger perch (*Terapon jarbua*), of tinfoil barb (*Puntius schwanefeldi*), 5% of *Chandra borvensis*, 4% of goatfish (*Upeneus vittanus*), and 20% of the other species (Figure 1).
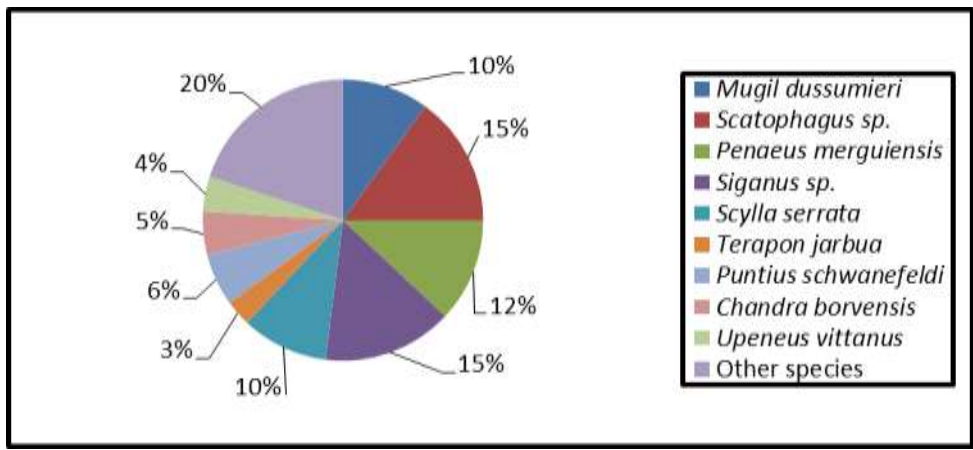

Figure 1. Species composition captured by of the fixed lift in the net in western coast of South Sulawesi .

Totalcatch

The total catch obtained from the West coast of South Sulawesi during the study consisted of 296 mullets with an average of length of 15.11 cm and the average of body weight of 46.45 grams. The highest number of catches obtained in January, 35 mullets, and the lowest in May, 16 mullets. (Table 1; Figure 2, 3 and 4).

Table 1.Totalcatch (individuals), average of total length (cm) and weight (g) of mulletevery month during the study

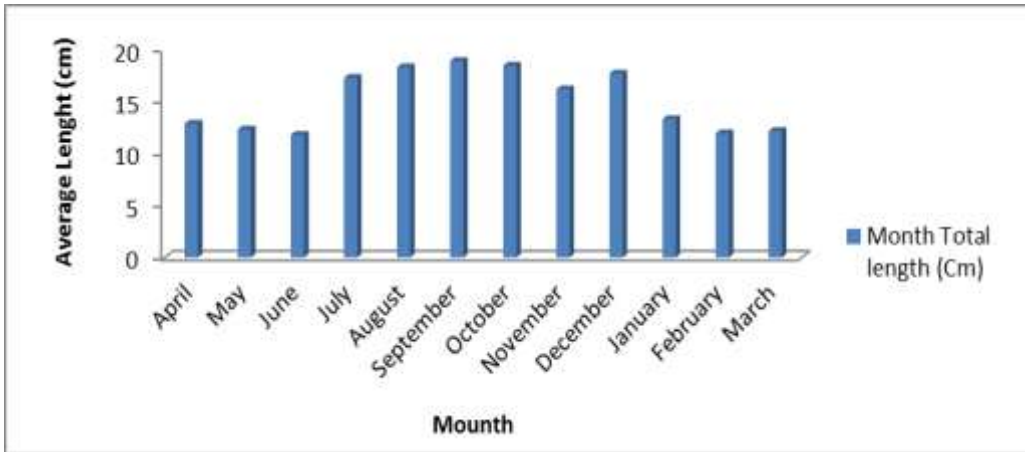| Month	Average catches		Total catch (individuals)
	Total length (Cm)	Weight (Gram)	
April	12.88	24.09	33
May	12.34	22.38	16
June	11.82	21.36	33
July	17.29	63.38	24
August	18.32	74.24	21
September	18.92	80.06	18
October	18.47	78.83	20
November	16.2	53.32	25
December	17.72	65.94	17
January	13.33	30.86	35
February	11.95	19.79	28
March	12.17	23.15	26
Total			296

Figure 2. Relationship of the average leght of mullet (individuals) every month during the study periode
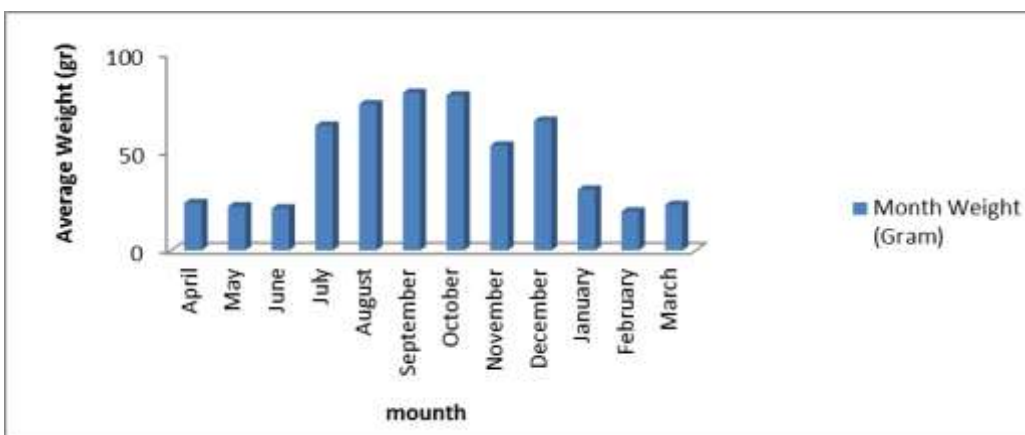

Figure 3. Relationship of the total length (cm)of mullet every month during the study periode.
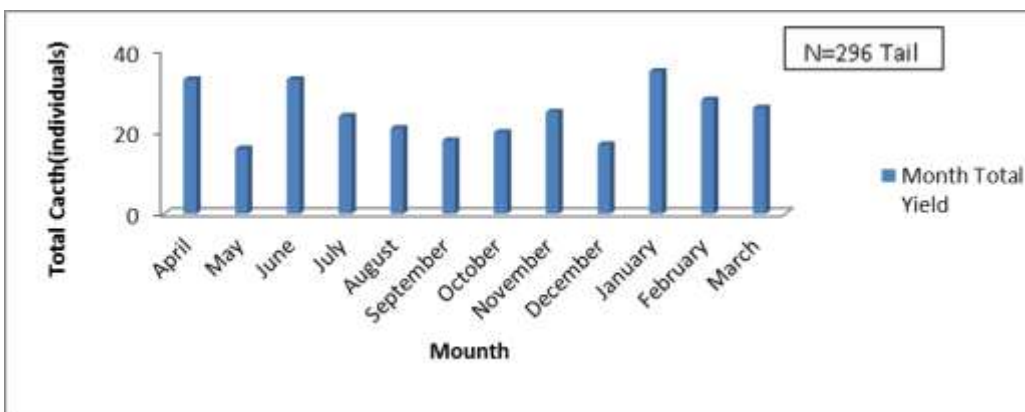

Figure 4. Relationship of the total weight (gram) of mullet every month during the study Periode.

Length-weight relationship of mullet around mangrove ecosystem

Several factors might affect the proportion of total length and standard length, which include the growth phase, the availability and the quality of food, fish age, and preservation techniques[2.] This factors could be possible to affect the length weight relationship of mullet. During the study, the lengthsof mullets are observed in the range of 7.5 cm - 24.5 cm with an average of total length (TL) of 14.683 cm. The obtained data of fish length and weight then be processed or regressed using Microsoft Excel to indicate the length-weight relationship (Figure 5).
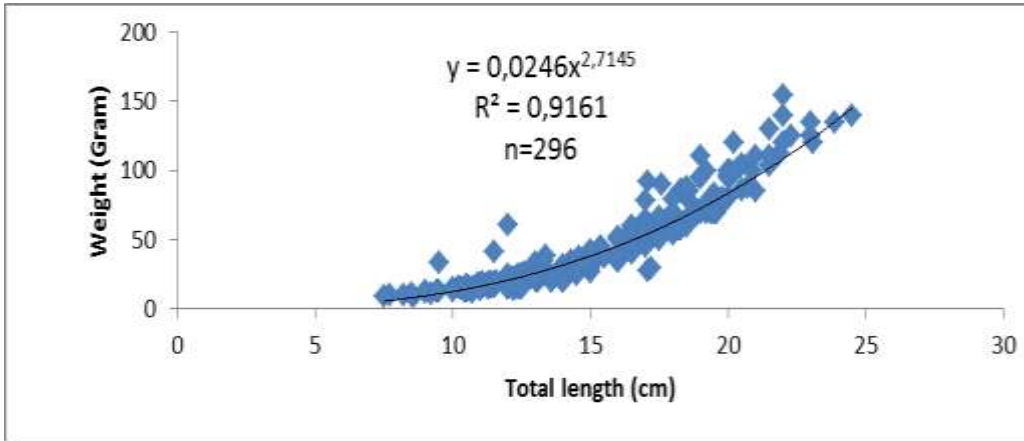
Figure 5. Length-weight relationship of mullets (males and females) during the study periode

The figure above shows the intercept (a) = 0.0246 and the slope (b) = 2.7145 with r^2 = 0.9161. The result explains that the length weight relationship of mullet is classified in negative allometric where b = 2.7145 (b <3) [4.] Meanwhile, the value of r^2 is close to 1, which means that the growth in length highly influencesthe growth in weight. According to [13,] the length-weight relationship of fish has an important role in the biomass estimation that is the basic and routine fishery assessments.

Then, the length-weight relationship of mullet by sex can be seen in Figure 6 and 7.
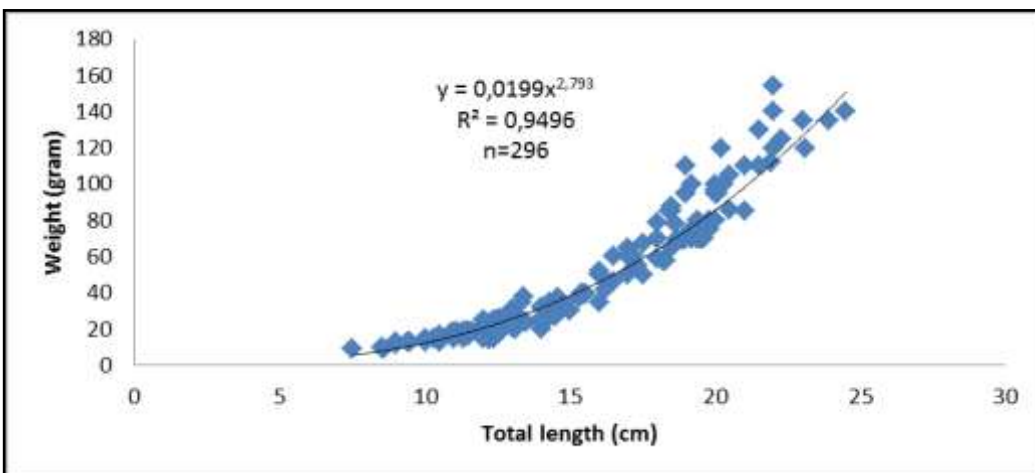

Figure 6length-weight relationship of female mullet during the study periode.
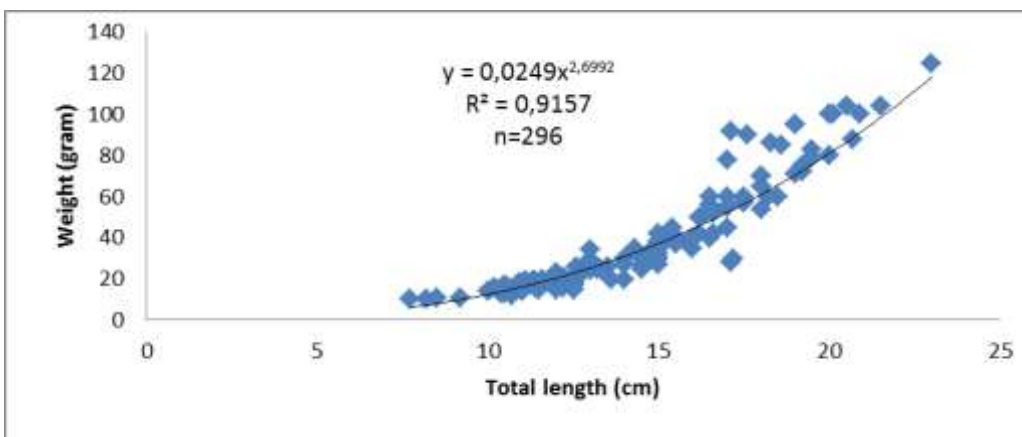

Figure 7. length-weight relationship of male mullet during the study periode

The figures 6.7indicate the negative allometric growth of both male and female mullets, described by b = 2.793 for female and b = 2.6992 for male (b <3). Referring the r^2 values of both graphs, the growth in length highly influencesthe growth in weight, indicated by r^2 values that close to 1.

Sex Ratio

Sex ratio on the other hand, is a comparison of the number ofmales and females in any population. The sex ratio is a sign ofpopulation behavior and fecundity and observation of the sexratio of a fish[17]

Sex ratio is the ratio between male and female mullets in the fishing areas around ecosystem mangrove in the west coast of South Sulawesi. The captured mullets are amounted 162 males or 54.73% and 134 females or 45.27% (Table 2; Figure 8 and 9).

Table 2. Sex ratio of mullets obtained during the study

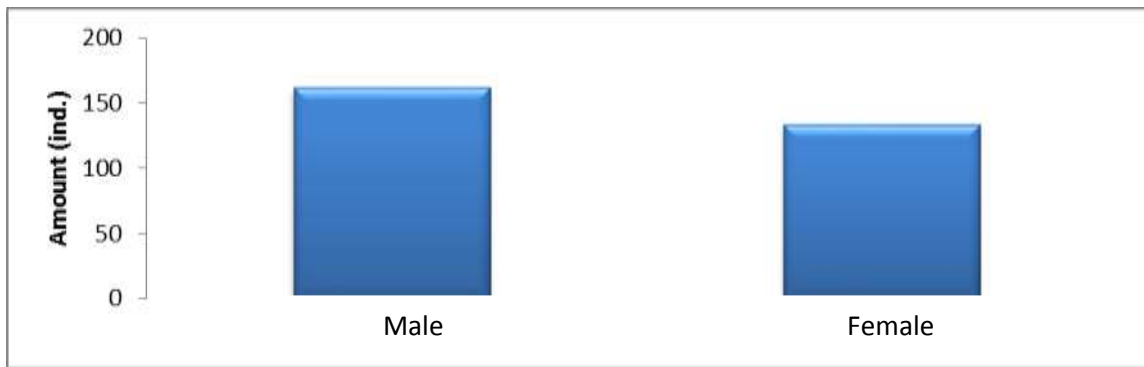| Sex	Amount (ind.)	Percentage (%)	Sex ratio
Male	162	54,73	1,21
Female	134	45,27	0,83
Total	396	100	

Source: Analysis 2016

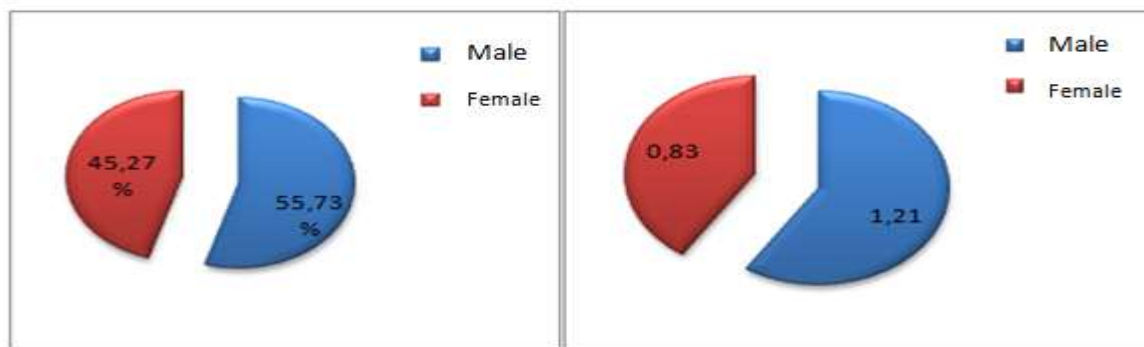**Figure 8. Comparison of male and female mullets catch during the study**

Figure 9. Sex ratio of male and female mullets catch during the study(represented by percentage and decimal)

Population of Mullet Undetermined   sexual maturity   at the size of 75 mm to 186 mm   and   reached total sexual maturity (LT100) at 750 and 186 mm total length (LT) for males and females, respectively and at tropical Brazilian Bay The population *Mugil sp* reached total sexual maturity (LT100) at 550 and 570 mm total length (LT) for males and females, respectively. Females attained a larger size than males[11].

The results show that the calculation of male and female mullets ratio is 1.21 :1. It shows that the territorial the west coast of South Sulawesi has a mullet spread of males more than females.

Conclusion

1. Mullet is one of the dominant fish species captured from mangrove ecosystem by using fixed lift net
2. The growth of mullet is classified into allomatrik negative
3. The sex ratio of mullets is dominated by 55.37% males and rather than 45.27% females and reached total sexual maturity (LT100) at 750 and 186 mm total length (LT) for males and females respectively.

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