*Original Research Article*

# Size Distribution And Growth Pattern Of Mackerel Scad (*Decapterus* Sp.) Caught By Boat Lift Nets InDoreri Bay Waters, ManokwariRegency, West Papua, IndonesiaAnd Its Management Implications




## ABSTRACT

**Aims:** The present study aims to explore some of biological characteristics of mackerel scad, such as size structures and length and weight relationship in which that information is important for the management of the fish resources.

**Place and Duration of Study:**The data collection was conducted from April to June 2019 in the waters of Doreri Bay, ManokwariRegency.

**Methodology:**The data were collected from 6 boat lift nets during their fishing operation, 7 days every month for 3 months of research. The data collected was the catch of mackerel scad fish and the size of total length and weight the individual fish samples. The data were then descriptively analyzed to explore the fish size structures. Simple regression analyses was used to estimate the length weight relationship (LWR) of fish.

**Results:**The production of mackerel scad caught in the waters of Doreri Bay from April to June was around 68.5 tonnes which was dominated by the species *Decapterus*macerellus. The individual size structure of each species varies. *D. macerellus* has a size range of 17.8 cm to 25.7 cm, *Decapterus*macrosoma measures 10.5 cm to 12.7 cm, *Decapterus*akaadsi measures 7.9 cm to 19.0 cm, *Decapterus*kuroides measures 9.4 cm to 14.9 cm, and *Decapterus*scrombinus measures 10.3 cm to 18.0 cm. On average, the size of the individuals caught is smaller than the size at first smaturity (Lm). The growth pattern of mackerel scad fish varies between species. Fore example species *D. macrosoma* tend to follow a positive allometric growth pattern, while *D akaadsi* and *D. macerellus* tend to follow a negative allometric growth pattern.

**Conclusion:**Mackerel scad caught on average were dominated by individuals with a size less than the size of the first maturity ($L_m$); Growth pattern of Mackerel scad varied among different species and among different months; and Mackerel scad fish caught using boat lift nets in Doreri Bay, Manokwari Regency need to be managed properly by considering the minimum legal sizes and the aspect of carrying capacity.


*Keywords: Decapterus,Dorery Bay, Growth pattern, Manokwari,Size composition*

## 1. INTRODUCTION

Mackerel scad *(Decapterus* sp.) is an important economic fisheries resource in tropical and subtropical waters [1]. It is highly contributed socially and economically to people because it is the most widely consumed [2].Approximately 70% of animal protein consumed by the human comes from fish and this species is important in terms of food security, and is even used as a supplement to traditional food [3,4].

Apart from its role in economic and social aspects, several studies about *Decapterus* sp.,are focused on the aspects of the development of fish eggs [5], utilization optimization [6].In biological aspects are the studies about genetics and population kinship [7], size distribution, growth patterns, condition factors [8], and stock discrimination [9].Other aspects related to the level of fish utilization have also been widely reported, with various approaches such as production models based on the fish catch [10,11] and based on the length of fish life [12,13].Further, studies on stock identification are especially about morphometry, otolith measurements [14], and stock potential estimation [15].

There areseveral studies are limited in local context in accordance with the interests and conditions of the waters being managed, for example, Ambon Waters [8], Fisheries Management Areas 716 and 715 [9], and Java Sea [16].Meanwhile, the studies conducted in Doreri Bay,Manokwari, were very limited, only on the growth aspect of the mackerel scad fish[17]. Information available about the species is reported by Sala et al. [18] at Wondama Bay where close to Doreri Bay.Knowledge of biologicalaspects such asfish sizes (minimum legal size), fishing season, and the reproductive biology of fish stocks are important as basis information for the fisheries management [19].

Boat lift net in Doreri Bay are dominant fishing gear in catching scads, besides purse seines and hand lines.Scientific data on the dynamics of the mackerel scad fish population is still very limited in order to support management decision for the species in the bay. The lack of scientific data on mackerel scad fish resources in Doreri Bay is a challenge in determining and formulating appropriate management directions. In fact, mackerel scad fish is one of the main target of the fishery [17,18,20].Therefore, comprehensive and up-to-date data on the condition of the mackerel scad fish in Doreri Bay is required. This study aims to determine the size distribution of the fish, the length-weight relationship, and the growth pattern of the mackerel scad fish and its management implications. Thus, the results of this study can be used to fulfil gap of information required for the management mackerel scad fishery in Doreri Bay.

## 2. MATERIAL AND METHODS

### 2.1 Data Collection

The data collection was conducted from April to June 2019 in the waters of Doreri Bay, ManokwariRegency. The data were collected from 6 boat lift nets during their fishing operation, 7 days every month for 3 months of research. The data collected consisted of the catch of mackerel scad fish and the total length and weight the individual fish samples.

Fishing operations of lift boat nets were taken place during the dark moon.Based on the results of field observations, the size of the boat lift nets was varied.Large boat lift nets have total length of 9 meters, with a length and width of nets were 40 x 40 meters, and while the small one has a total length of 7 meters, with a width and length of nets were 25 x 25 meters and 30 x 30 meters. The size of the boat lift nets affects the numberand location of the catch.

Large nets usually haul 3-5 times in one fishing operation, while small nets usually haul 2-3 times in one fishing operation. The plots of fishing locations of the 6 boat lift nets were presented in Figure 1.

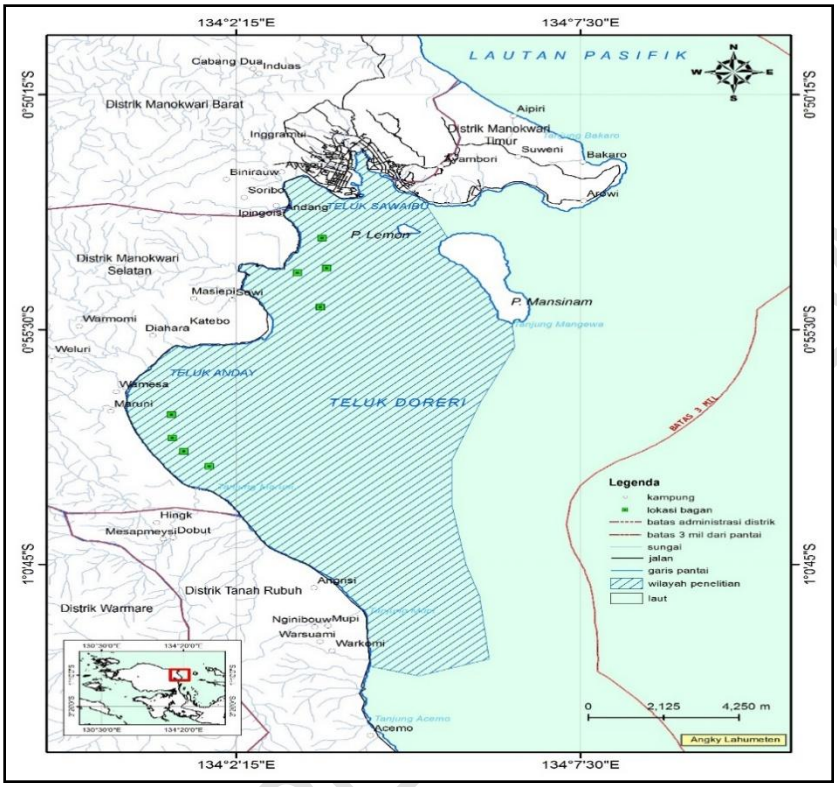


Figure 1. Fishing location of boat lift nets in Dorery Bay water

**2.2 Data Analysis**

**2.1.1 Length – Weight Relationship (LWR)**

To analyze the relationship between the length and weight of fish, the length of the fish is converted into weight by using power function [21] (Pauly 1984), namely:

$W = aL^b$

Where:
W = Weight of fish (gram);
L = Length of fish (Cm);
aand b = Constants

The b value is the power value that must match the length of the fish to be in accordance with the weight of the fish.The value of a is the intercept.The b value from the results of the

long-weight relationship analysis describes the pattern of growth in length and body weight growth of fish [22, 23] (Suruwaky&Gunisah, 2013; Jisr et al., 2018):

- Value of b = 3,scad (*Decapterus*spp) has an isometric growth pattern, namely the growth in length of Mackerel scad fish is proportional to weight growth.
- Value b > 3, scad (*Decapterus* spp.) has a positive allometric growth pattern (where the weight gain is faster than the increase in length), or it tends to be fat.
- The value of b < 3, the scad Fish (*Decapterus* spp.) has a negative allometric growth pattern (the increase in length is faster than the increase in weight), indicating a thin condition of the Mackerel scad fish (*Decapterus* spp.).

The t-statistical test used to determine the value of b = 3 or b ≠ 3 was [24] Weaver and Wuensch, (2013), as follows:

$$t = \frac{b - b^*}{sb}$$

Where:
$s_b$ = Standard error of b
b = regression coefficient (slope)
b* in this study is equal to 3
If t-count > t-table then the value of b ≠ 3 or allometric growth form and if t-count ≤ t-table then the value of b = 3 or isometric growth form.

## 3. RESULTS AND DISCUSSION

### 3.1 Catch

Catch in April for the *D. macerellus* type was18,966 kg which was higher than that of *D. akaadsi*(8,949 kg), and *D. macrosoma(*6,610 kg) (Figure 2).Catch in May for the *D. macerellus* species was also the highest (4,704 kg) followed by other species.The same catch composition was foundin June, where the Mackerel scad fish species *D. macerellus* still dominated with the highest total production value of 10,577 kg, followed by *D. akaadsi* with a total production of 7,801 kg.

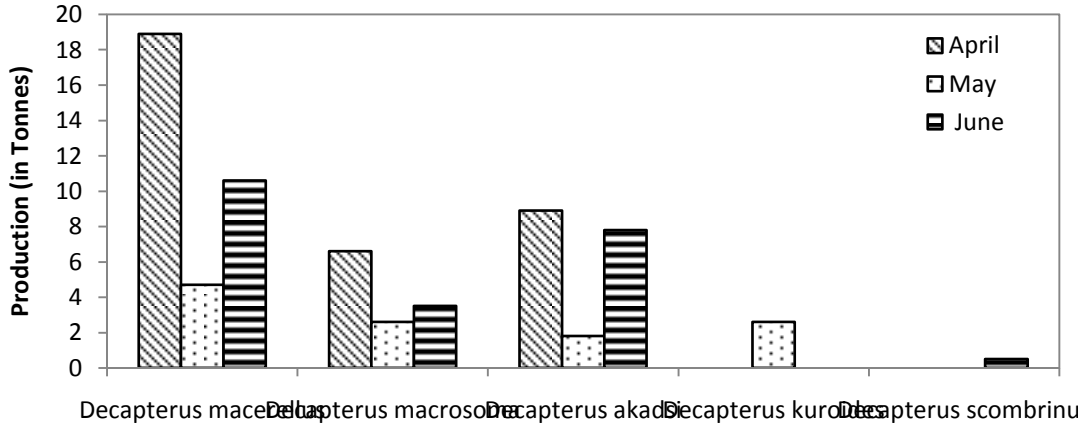


Figure 2. Total production of scad fish catches

## 3.2 Fish Size Distribution

Frequency of sizeof *D. macerellus, Decapterusmacrosoma, Decapterusakadasi*caught during April, May, and June 2019 is presented in Figure 3, 4 and 5. *D. kuroides*was only found in May (Figure 6) and *Decapterusscombrinus*was only found in June (Figure 7).

The size distribution of *D. macerellus* caught using boat lift nets in Doreri Bay waters in April ranged from 158 to 277 mm, in May ranged from 118 to 277 mm from a total sample data of 46 fish. The size of the fish caughtmostly ranged from 198 – 237 mm and in June ranged from 138 to 317 mm. In April the sizewas dominated by fish with a size range of 178 - 197 mm, in May it was dominated by the size fish that ranged from 198 – 217 mm and the highest was in June with the size range of 218 -237 mm. The length size composition of *D. macerellus*was not significantly different from the frequency of *D. macerellus* landed at the Kendari Port caught by purse seine[25].

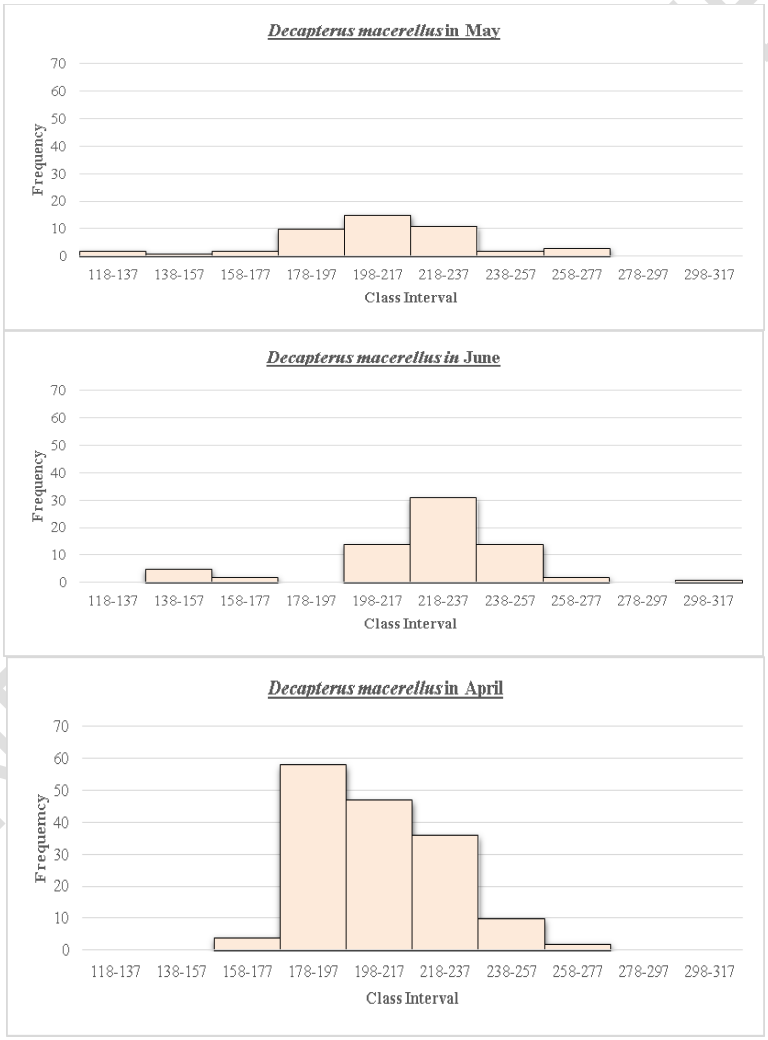


Figure 3. Frequency Distribution based on *Decapterusmacerellus* Length Class Intervals in April (top), May (middle), and June(bottom)

Size distribution of *D. macrosoma*type caught in April were ranged from 82 to 265 mm (Figure 4).The most caught sizeswere 105 – 127 mm.In May, *D. macrosoma*type were caught in ranged of size 59 – 288 mm, with the most caught fish ranged from 105 – 127 mm. In June,the species were caught at ranged of 82-173 mm, with the most commonly caught at ranged of 105 – 127 mm. According to Randongkiret al [17], the length distribution of *D.macrosoma* landed for males has a size of 109 – 303 mm and for females with a size of 125 – 299 mmwith the highest catches in April. Another finding byNursinar and Panigoro[26] stated that*D. macrosoma*had the highest catches in the class interval range of 165 – 184 mm.

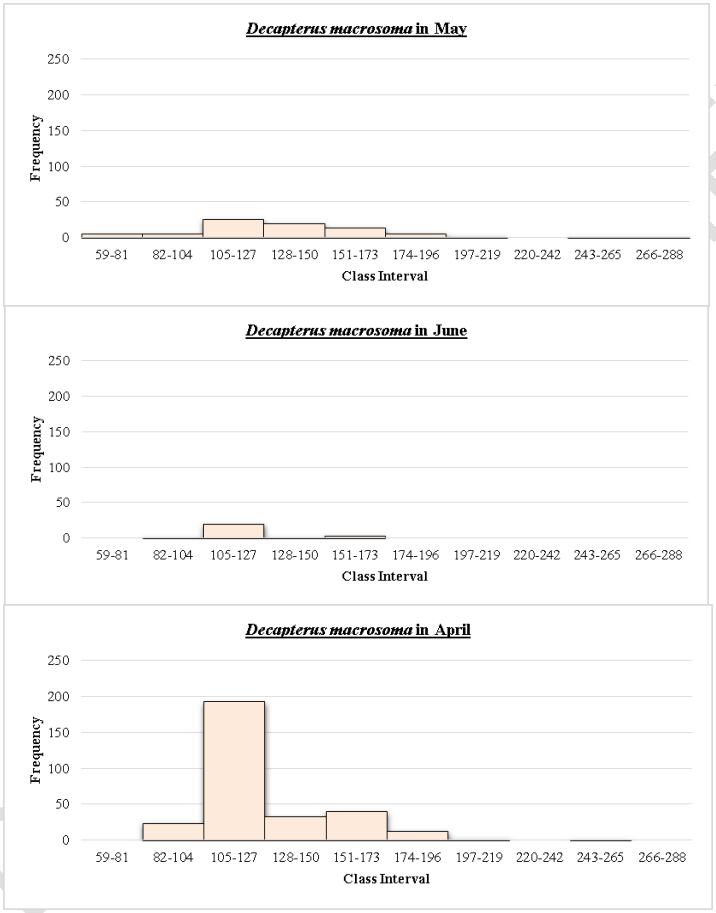


Figure 4. Frequency Distribution based on *Decapterusmacrosoma*Length Class Intervals in April (top), May (middle), and June (bottom).

Size composition of *D. akaadsi*type caught in April were ranged from 79 – 254 mm, with most catch was at ranged of95 - 110 mm.In May, the sizes of*D. akaadsi* caughtwere distributed from 95 to 158 mm and the catch dominated by size of range 127 – 142 mm. *D. akaadsi*caught in June ranged from 95 – 190 mm where most individuals size ranged from 127 – 147 mm.

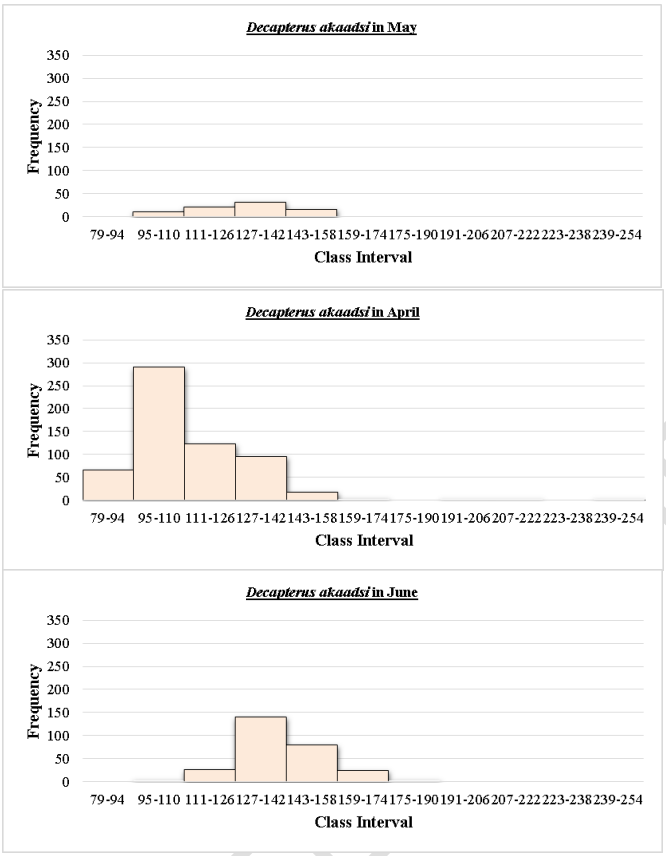


Figure 5. Frequency Distribution based on *D. akaadsi*Length Class Intervalsin April (top), May (middle), and June (bottom).

*D.kuroides*caught in May has sizes ranged from 86 to 157 mm with the most catches ranged from 142 to 149 mm (Figure 6). The length size distribution caught inDoreri Bay waters was not different significantly from *D. akaadsi*taken in Amurang Bay waters with a length range of 141 – 190 mm [27].

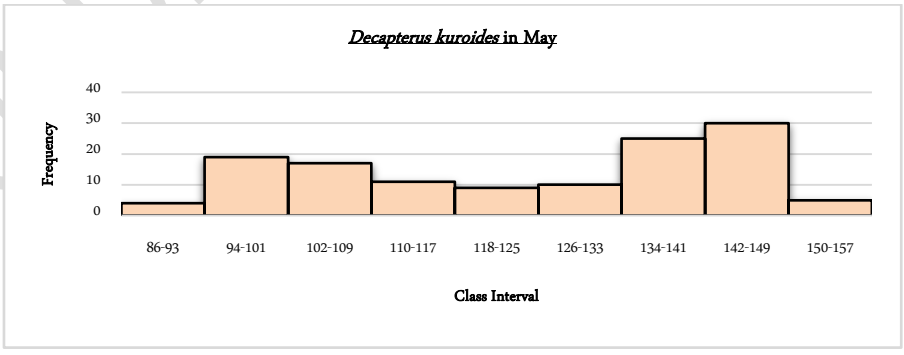


Figure 6. Frequency Distribution based on *Decapteruskuroides* Length Class Intervals in May

*D.scombrinus* was only found in June with the least number of fish caught compared to other types of mackerel scad fish found in Doreri Bay waters. The size class intervals of the catch were ranged from 103 to 115 mm. Size distribution of the species caught in June is presented in Figure 7.

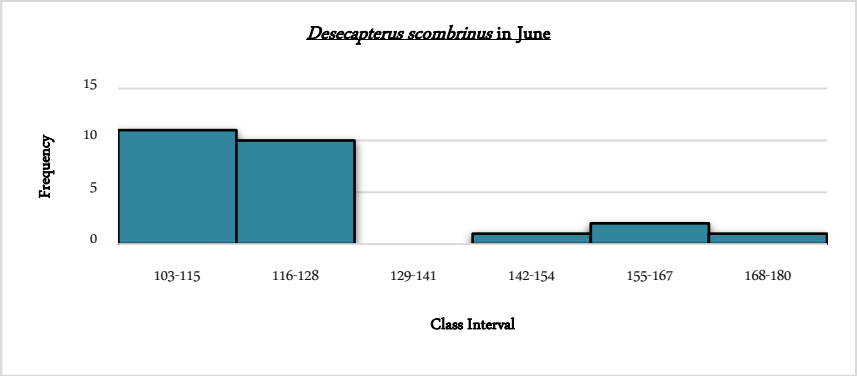


Figure 7. Frequency Distribution based on *Decapterusscombrinus* Length Class Intervals in June.

Comparison of size ranges of mackerel scad caught in Dorery Bay based on the present research with several previous studies in variousl regions is presented inTable 1. It showed that the average length interval of *D. macerellus*was smaller than that taken in the CelebesSea and also smaller than the size at first maturity (Lm), namely 26.89 cm[15].

The average class interval for *D. macrosoma*based on the present study was 10.5 – 12.7 cm which wassmaller than the size of the species taken in the Java Sea (14.5 – 15.5 cm) and also less than the Lm of the species (14.3 – 14.9 cm) [28].

The other three species, *D. akaadsi*, *D. kurroides*and *D. scrombinus* caught in Dorery Bay had significantly different length class interval from that reported by Fish Base in Pacific Waters (Table 1).The average sizes of the species were very much smaller which indicated that most of the catch consisted of young fish.

Table1. Comparison of Class Intervals between this Research Results with Literature Studies of Mackerel scad fish (*Decapterusspp*) for the Lm50% Category

| Species | Average Class Intervals | | $L_m$ 50% | Data Source | Site |
|---|---|---|---|---|---|
| | Present Study | Literature | | | |
| D. macerellus | 17.8-25.7 | 10.3-32.3 | 26.89 | [12] | Celebes sea |
| D. macrosoma | 10.5-12.7 | 14.5-15.5 | 14.3-14.9 | [28] | Java Sea |
| | | | 25.5 | [29] | Coastal Fishing Port of Gunung Kidul Yogyakarta |
| D. akaadsi | 7.9-19.0 | 30.0 | 30.0 | Fishbase Data | Western Pacific |
| D. kuroides | 9.4-14.9 | 30.0-45.0 | - | Fishbase | West Pacific |
| D.scrombinus | 10.3-18.0 | 30.0-50.0 | - | Fishbase | Indo-Pacific |

### 3.3. Length and Wight Relationship of Mackerel Scad (*Decapterus*sp.)

The analysis of LWRof fish can predict the weight of the fish based on length or vice versa [30].Based on the results of the present research there were several growth patterns for Mackerel scad fish species in Doreri Bay, Manokwari, positive allometric, negative allometric, and isometric growth patterns. Fish growth patterns are strongly influenced by the fish's condition. The condition of fish is influenced by several factors, such as diet, age differences, food availability, environmental conditions, and gonadal maturity levels.

The LWR analysis (Figure 8) of *D. macrosoma*found the estimation value of bin April equals to 3.14 ($t\text{-}_{count}$ = 2.881 >$t\text{-}_{table}$ = 1.968), in May equals to 3.01 ($t\text{-}_{count}$ = 4.033 >$t\text{-}_{table}$ = 1.991) and June equals to 3.76 ($t\text{-}_{count}$ = 4.326 >$t\text{-}_{table}$ = 2.069) was positive allometric, which explainsthat weight gained was more dominant than length gain. These may relate to habitat conditions, time of foraging, and availability of food in waters where fish grow faster when there is sufficient food. The fishing activities of the boat lift nets were carried out when the mackerel scad fish was looking for food, for example planktons attracted by light and gathering around the boat lift nets.

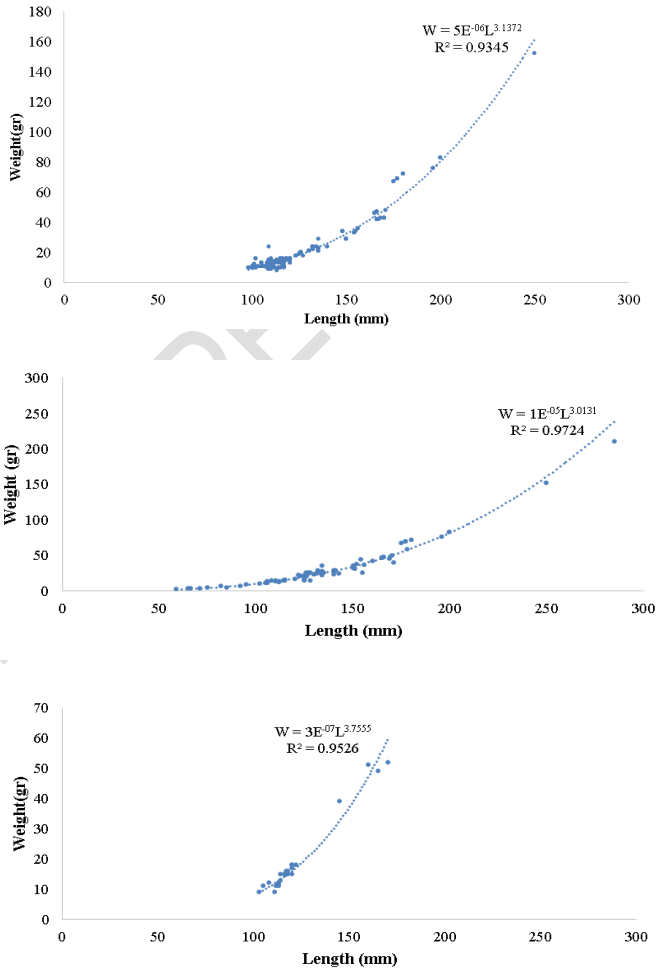


Figure 8. *Decapterus macrosoma* Growth Pattern inApril (Top), May (Middle) and June (Bottom)

The result of LWR for*D. akaadsi*showed the value of b in April was 2.84 ( $t\text{-}_{count}$= -3.434 < $t\text{-}_{table}$= 1.964) and in June was 2.99 ($t\text{-}_{count}$= -0.133 < $t\text{-}_{table}$= 1.969) which indicated negative allometricgrowth pattern. In May, the value of b equals to 3.413 ($t\text{-}_{count}$= 2.868 >$t\text{-}_{table}$= 1.995) indicating positive allometricgrowth pattern. These results shows that the growth pattern of *D. akaadsi (*Figures 9)variedbetween month. It may related to food availability and maturity state of the fish.

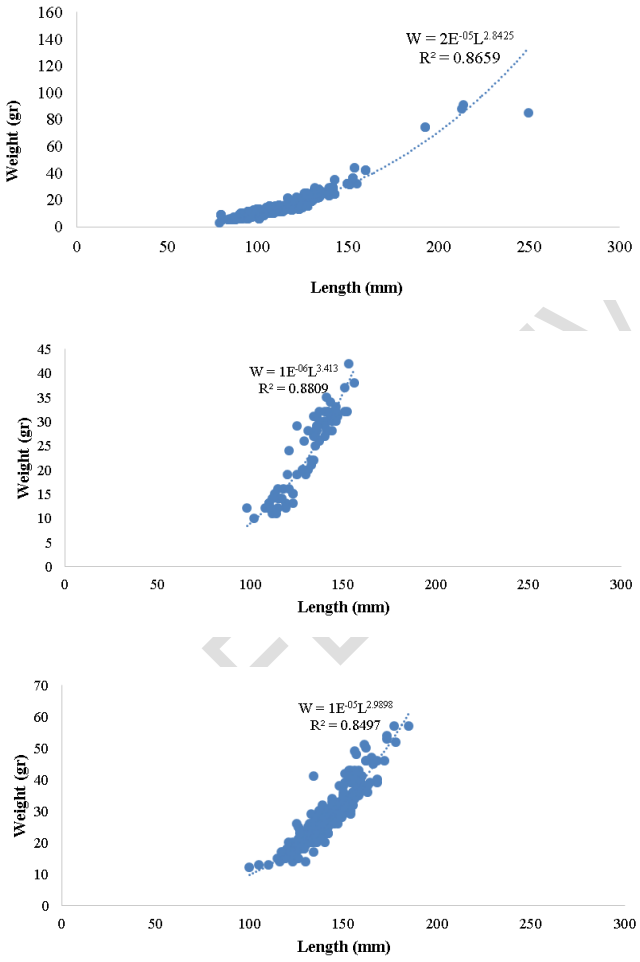


Figure 9. *Decapterusakaadsi*Growth Pattern in April (Top), May (Middle) and June (Bottom)

The results of LWR analysis of *D. macerellus*(Figure 10) showed the value of b in April equals to 2.18 ($t\text{-}_{count}$= -7.549 < $t\text{-}_{table}$= 1.975), in Mayequals to 2.53 ($t\text{-}_{count}$= -1.723 <$t\text{-}_{table}$= 2.015), and in June equals to 2.73 ($t\text{-}_{count}$ = -0.754 <$t\text{-}_{table}$= 1.996). These figures explain the growth pattern of *D. macerellus* in the three observed months was negative allometric

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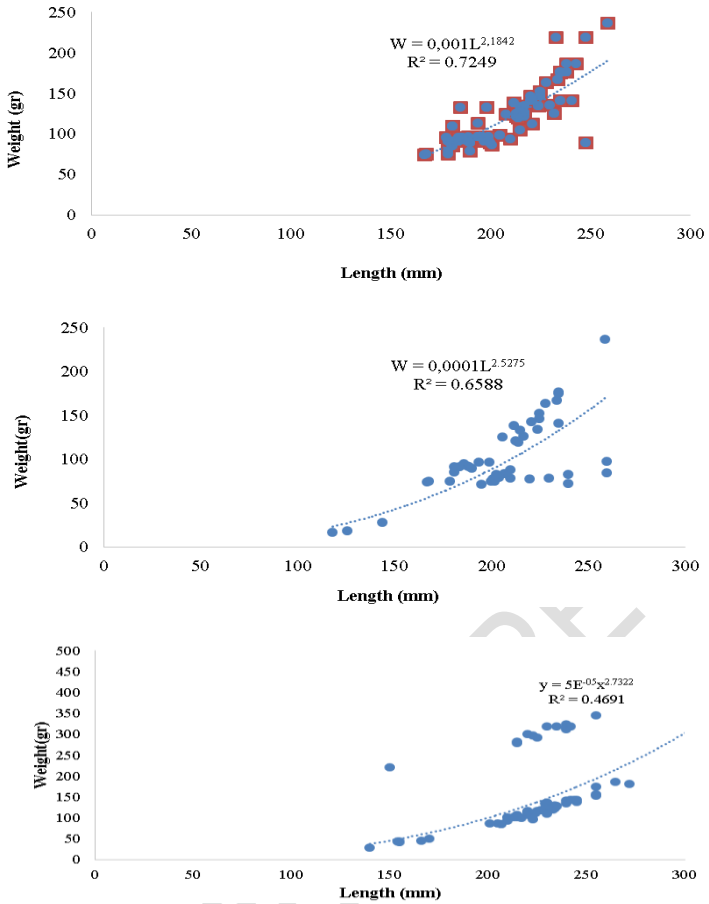


Figure 10. *Decapterusmacerellus* Growth Pattern inApril (Top), May (Middle) and June (Bottom)

Based on the analysis of LWR for *D.kurroides*, it was found that in May, the value of b was 2.83 (see Figure 11)with $t\text{-}_{count}$ = -1.881 >$t\text{-}_{table}$= 1.979. This indicates that the species has negative allometricgrowth pattern).On other hand, the species of *D.scombrinus*caught in June had b value of 3.76 (Figure 12)with $t\text{-}_{count}$= 4.326 > $t\text{-}_{table}$= 2.067 which indicate a positive allometric growth pattern.

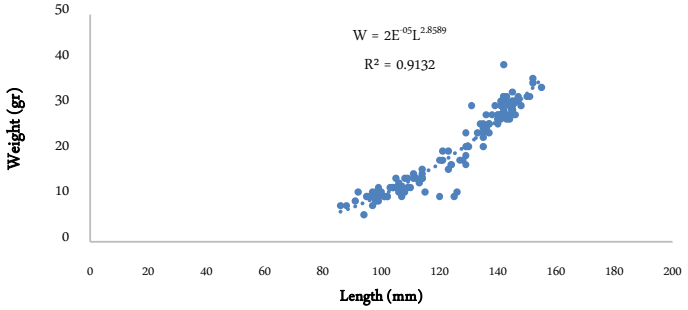


Figure 11. *Decapterus kurroides* Growth Pattern in May

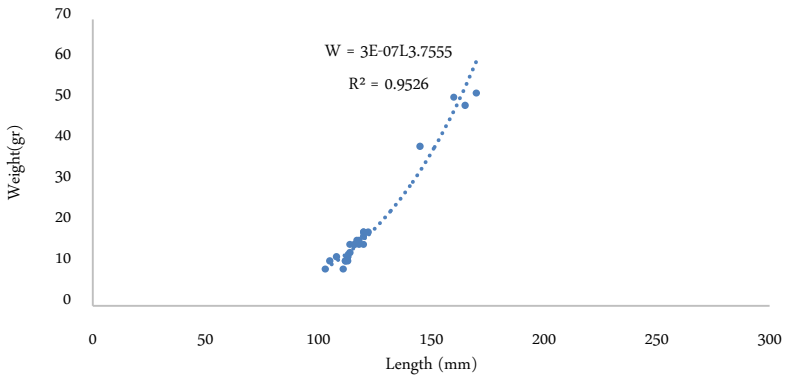


Figure 12. *Decapterus scombrinus* Growth Pattern in June

The b value in LWR of fish is indirectly related to the condition factor. The condition factor is one of the most important things in fish growth. It is used to determine the plumpness of the fish in the form of a number calculated based on an analysis of the LWR of the fish [31].The value of fish condition factor will increase towards the peak of spawning and decrease after spawning because the main energy source is used for gonad development and the spawning process. A decrease in the condition factor of male and female fish can occur because they have just finished spawning or are adapting to the environment. According to Lawson and Doseku [32], differences in b values may influenced by season, habitat, gonadal maturity, sex, stomach fullness, and fish health.There are two influential factors in the study of fish growth, namely internal and external factors. Internal factors include heredity, sex, disease, hormones, and the ability to utilize food, while external factors include food availability, competition in utilizing space and water temperature, fishing time, and environmental pressure [31].

### 3.4 Fish Management Implications

The results of the present studyreveal some important information to support the management of the mackerel scad fish fisheries, in particularly in the local context of Dorery Bay. Firstly, catch production of mackerel scad fish (*Decapterus* spp.) caught with boat lift nets in the waters of Doreri Bay, Manokwari Regencyneed to be monitored regularly in order to warrant the sustainability of the fishery. Secondly, there were significantly high proportion small sizes of individuals in the catch. It is necessary to pay attention on the individual size of catch in order to prevent fishers targeting young and immature individuals since it could lead to growth and recruitment overfishing.

## 4. CONCLUSION

- Mackerel scad caught by boat lift net fishing gear in Doreri Bay, on average were dominated by individuals with a size that is still young or smaller than the size of the first maturity ($L_m$).
- Growth pattern of Mackerel scad varied among different species.
- Mackerel scad fish caught using boat lift nets in Doreri Bay, Manokwari Regency need to be managed properly by considering the minimum legal sizes and the aspect of carrying capacity.

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