Exploitation Status of Devis’ Anchovy in Kei Island Waters: Based on Total Length Data

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Abstract. Devis’ anchovy (Encrasicholina devisi) are a group of small pelagic fishes, which is thought to be one of the most abundant fishery resources in Indonesian waters. The high utilized of this resources will certainly affect to population status. This research aimed to know the exploitation status of anchovy in Kei Island waters. Sampling was carried out by using the data collected from lift net catches during April to July 2016 at Sathean, Selayar and Lebetawi, Kei Islands. A total of 3,524 anchovies were analyzed based on total length that ranged from 23 to 87 mm with a mean length of 55.4 ± 11.8 mm. The von Bertalanffy growth parameters estimated were $L_\infty = 89.25$ mm and $K = 0.74$ year⁻¹, with the growth models equation is $L_t = 89.25 \left(1 - e^{-0.74(t+0.161)}\right)$. The result of mortality analysis showed that $Z = 2.97$, $M = 1.098$, $F = 1.87$ year⁻¹ and $E = 0.63$. This study reveals that exploitation status of anchovy in Kei Island is on fully exploited and leads to the over exploited condition.

1. Introduction
Devis’ anchovy (Encrasicholina devisi) are a group of small pelagic fishes, which is thought to be one of the most abundant fishery resources in Indonesian waters. This resource is a neritic whose spreading in the near coastal. In areas where is a process of upwelling, these resources can form large biomass [1].

The potential of anchovy resources in southeast Maluku is quite high and important resource to advancing coastal community [5]. In Kei Island waters anchovy is caught mainly by lift nets. The preliminary study reveals that fishing activity is carried out throughout the year with the peak season during August to October. Until 2015 the lift net in Kei islands approximately 81 units, and the production reaches 1,016 tons. The fishing ground of anchovy in this region spread on the west coast of Kei Kecil Island, Nerong strait and north coast of Dullah island.

The high utilized of these resources will certainly affect to population status. Therefore it is necessary to steps that can support the sustainable uses of anchovy related to population structure information.

According to Smith in [15], determining stock status can be made on biological reference points, such as mortality rate, spawning, biomass or age groups. It is used to obtain diagnosis that warns of diminishing stocks. Some countries are trying to develop and implement of fish resource management policy based on study of biological and population dynamics (9, 17, 8). [2] Describes six indicators of sustainable fishing: mean length of catch, length-at-50% maturity, total mortality, exploitation rate, ratio of bycatch, and center of gravity of commercial catches. In this study, we emphasize on three indicators of Fairweather, namely length of catch, total mortality and exploitation rate.

Fishing effort, ideally supported by more information about biology, economics and stock assessment. Information of stock includes the total catch data, a number of fishing effort and the catch per units effort (CPUE), while a biological aspect includes length and weight size, gonad maturity level, sex
ratio and others according to Gulland in [12].

The sustainable uses of devices' anchovy in Kei islands influenced by how these resources were exploited. Therefore, the responsible and sustainable of fishing management needs supported by data and information of stock status. Today, information on various parameters of anchovy in this region is very limited; therefore it is necessary to study the status of the exploitation of these resources.

2. Methodology

2.1. Data collection

Monthly samples of anchovies were collected from the landings of lift net in Sathean, Selayar and Lebetawi during April to July 2016. A total of 3,524 specimens of anchovy, total length was measured to the nearest mm.

Figure 1. Map of the sampling station

2.2. Data Analysis

Ford-Walford plot was used for estimating growth parameters $L_\infty$ and $K$ from the von Bertalanffy equation with the same sampling time interval [7]. The theoretical age at length zero was estimated separately using an empirical equation as described in [11], then the natural mortality coefficient ($M$) was estimated using Pauly's equation, while total mortality rate ($Z$) estimated with curve of length-converted catch [13] and the fishing mortality coefficient ($F$) were estimated [3]. The exploitation rate ($E$) was calculated according to Gulland in [14], to judge whether the stock is overfished or not. Exploitation ratio was estimated:

$$E = \frac{F}{F+M} = \frac{F}{Z}$$

The exploitation rate is compared to the optimum rate according to Gulland in [11] which is 0.5.

3. Result and Discussions

3.1. Length frequency distribution

As shown in Table 1, a total sample 3,452 anchovies with the maximum and minimum total length was 23 and 87 mm, respectively. The mean total length of anchovy was 54.4±11.8 mm. The size frequency distribution of anchovy in presented in Figure 1, in Kei Island water, anchovy were caught in the range of length of 23 mm to 87 mm and were dominated by anchovy the size of 58-62 mm.
Figure 2. Length frequency distribution of devis’ anchovy

Catches of anchovy during study greater than 43 mm of 84.02 percent, while smaller than 43 mm of 15.98 present.

Table 1. Statistics of length size of devis’ anchovy during the study.

| Month       | N   | Total length (mm) |          |          |          |
|-------------|-----|-------------------|----------|----------|----------|
|             |     | Maximum           | Minimum  | Mean     |          |
| April 2016  | 537 | 30                | 87       | 52.2     |          |
| May         | 1,695 | 24               | 77       | 56.4     |          |
| June        | 820  | 23                | 73       | 47.7     |          |
| July        | 472  | 53                | 81       | 68.7     |          |
| Total       | 3,524 | 23               | 87       | 55.4     |          |

The normal separation method used in the separation of age groups also produced a normal curve that describes the number of cohorts of length frequency distributions. From the figure it is also seen that April and July there was a shift mode which tended to the right, but in May there was a slight shift mode to the left. The growth showed by the shift curve to the right shows and the shift to the left shows the of recruitment. Based on Figure 3 showed that the results of the grouping of size contained two age groups of anchovies caught during the study.
3.2. Growth

Growth parameter analysis by using von Bertalanffy models (13, 7) with FISAT program, Elefan 1 sub program obtained value of asymptotic length ($L_\infty$) anchovy in Kei island waters is 89.25mm, while growth coefficient (K) is 0.74 yield⁻¹. The analysis result based on (Figure 4) showed one age group of anchovies population in Kei island waters occurs from August to September, in other words of spawning season of anchovy from August to September.

$$L_t = 89.25 (1 - e^{-0.74(t+0.161)})$$
The resulting analysis used Pauly approach for anchovies to be $t_0 = -0.161$. Then from growth parameter value above, with using Von Bertalanffy obtained by the growth of anchovy as follows:

$$L_t = 89.25 \left(1 - e^{-0.74(t+0.161)}\right)$$

Figure 5 showed that the anchovies found in the Kei island waters could reach a maximum length of 89.25mm, while the actual length obtained 87mm during of research. The analysis result showed anchovies reach infinity length ($L_\infty$) in months 13.5. In figure 5 above shows that the growth of anchovy is significant in the 1\textsuperscript{st} until the 6\textsuperscript{th} month, then experiencing a slowdown until it reaches the asymptotic length.

In general, fish will experience rapid growth in young fish, because most of the energy obtained from food is used for growth. While the old fish, in addition to growth is also used to self-reliance and replace damaged cells [6].

3.3. Mortality
Measured mortality is the total mortality rate (Z), natural mortality rate (M), and fishing mortality rate (F). Total mortality rate to estimate with curve of length converted catch based on total length [14] and natural mortality rate used empirical formula Pauly with mean of sea surface temperature 29°C. While fishing mortality rate (F) is total mortality rate minus the natural mortality rate.

![Figure 6. Curva of length-converted catch](image)

The analysis result showed that the total mortality rate ($Z$) = 2.97 year\(^{-1}\), natural mortality rate ($M$) = 1.098 year\(^{-1}\), and the fishing mortality rate ($F$) = 1.87 year\(^{-1}\).

| Parameter               | Value (year\(^{-1}\)) |
|-------------------------|------------------------|
| Total mortality ($Z$)   | 2.97                   |
| Natural mortality ($M$) | 1.098                  |
| Fishing mortality ($F$) | 1.87                   |
| Exploitation rate ($E$) | 0.63                   |

From the analysis shows that mortality rate is dominated by fishing factors compared with natural factors. This is due to the fishing of anchovy resources in the Kei island waters throughout the year. Anchovy is also one of the small pelagic species that has important economic value in the research location.
3.4. Exploitation status

Exploitation rate (E) is obtained from the values of Z and F with the equation \( E = F/Z \). Based on criteria from [11], the value of exploited rate of the rational and sustainable in water is at value of <0.5 or the highest \( E = 0.5 \). In such conditions a will be obtained of maximum sustainable yield/MSY. Exploitation rate of anchovy in Kei island waters \( E = 0.63 \), that meaning exploitation status is fully exploited and leads to the over exploited condition.

| Location  | E = exploitation's pace | Status exploitation | Sumber                  |
|-----------|-------------------------|---------------------|-------------------------|
| Belawan   | E = 0.34                | Under exploitation  | [16]                    |
| Belawan   | E = 0.68                | Fully exploitation  | [4]                     |
| Ambon     | E = 0.55                | Fully exploitation  | [10]                    |
| Kei islands | E = 0.63              | Fully exploitation  | This study (2016)       |

According to Jones in [14], if the value of the natural mortality rate (M) and the fishing mortality rate (F) is equal, then the rate of exploitation can be assumed to be \( F/Z= 0.5 \). If the value of E is greater than 0.5, it can be categorized more biologically. This condition is occurring in the devis’ anchovy resources in the Kei island water where exploitation rate of the value greater than 0.5 indicates that there has been a biological overfishing.

4. Conclusion

A total of 3,524 devis’ anchovies were analyzed based on total length that ranged from 23 to 87 mm with a mean length of 55.4 ± 11.8 mm. The von Bertalanffy growth parameters estimated were \( L_\infty = 89.25 \) mm and \( K = 0.74 \) year\(^{-1} \), with the growth models equation is \( L_t = 89.25 \left(1 - e^{-0.74(t+0.161)}\right) \). The result of mortality analysis showed that total mortality rate \( Z = 2.97 \), natural mortality rate \( M = 1.098 \), fishing mortality rate \( F= 1.87 \) year\(^{-1} \) and exploitation rate \( E = 0.63 \). This exploitation status of devis’ anchovy in Kei Island is on state fully exploited and leads to the over exploited condition.

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