Growth and exploitation rate of *Anadara gubernaculum* (reeve, 1844) Arcidae Family in Asahan Aquatic of North Sumatra

M Fauzan, D Bakti*, I E Susetya and Desrita
Department of Aquatic Resources Management, Faculty of Agriculture, Universitas Sumatera Utara, Medan 20155  
*E-mail : dbakti06@yahoo.com

**Abstract.** High market demand for *A. gubernaculum*, tends to increase the greater catching capacity so that the decreasing population. The aims of this study were to determine the growth and rate of exploitation of *A. gubernaculum* in Asahan aquatic. It was conducted for 1 Month 14 Days from October to November 2016. Data analyzed by (Electronic Lenght Frequencys Assesment Tool) ELEFAN I method by using (FAO-ICLARM Fish Stock Assesment Tool) on FiSAT II software. Shells obtained 855 individual. The growth pattern of shells is negative allometric. The range of condition factor was 0.81 – 2.15. The frequency distribution of the *A. gubernaculum* ranges from 14 to 43 mm, the dominant size group was 20 - 22 mm. The prediction of growth parameter Von Bertalanfy showed that the asimpot length (L∞) is 43.05 mm, the growth coefficient (K) is 1.2/year and the theoretical life (t₀) of the *A. gubernaculum* is -0.12. The total Mortality (Z) of *Anadara gubernaculum* was 2.121/year. Natural mortality estimation rate (M) was 1.9/year. The exploitation rate of *Anadara gubernaculum* is 0.1/year.

1. Introduction
Asahan aquatic is located in the east coast of North Sumatra. Asahan aquatic have a high potential and provide many marine products for the Province of North Sumatra. One of the main commodities of marine fisheries from Asahan aquatic is shells. The types of shells in Asahan aquatic are *Anadara granosa*, *A. gubernaculum*, *Perna viridis*, and *Meretrix meretrix*.

High market demand for *A. gubernaculum*, can lead to the greater catching and decrease populations. This situation will disrupt the resources in Asahan aquatic. Based on the above indication, basic information is needed to support its resources in sustainabling in exploitation. Assessment of stock is very important to be done in order to maintain the population of *Anadara gubernaculum* in Asahan aquatic of North Sumatra.

2. Material and Method
2.1 Study site
The research was conducted in Asahan Aquatic of North Sumatera. Data were collected from October to November 2016. The Tools used were Analytical Scales, Calipers, Dark Bottle Sample, Stationery, Paper Label, Book identification, Black Plastic Bag, Coolbox. The materials used in this research are Shells
Samples, Microsoft Excel Software, FISAT Applications, Paper Label, Rubber, Aquadest, Alcohol, Tissue.

2.2 Sampling of Anadara gubernaculum
Shells sampling was done from October 2016 until November 2016 times with sampling time interval 2 weeks. Shells were taken randomly from 3 stations. Sampling using a scratching tool. It was made of iron. This tool has a size of 0.39 m x 0.24 m. How to operate this “garuk” by descending into the aquatic. After a few minutes, the “garuk” is lifted on to the boat.

2.3 Problem formulation
Size Distribution
The analysis of the length of shells data is:

a. Length-size data are grouped into long classes. Grouping shells into long classes is done by setting the first "range" or class region, class interval and length-term boundaries based on the number.

b. The data is plotted into a graph connecting the length of the shells (L) to certain length classes with the number of shells in that particular long class. The division of long-sized class hoses is done by \(1 + 3.3 \log N\), while for the width of the hose (Maximum length - Minimum length) divided by the number of class intervals that have been previously obtained.

Length and weight relationships Anadara gubernaculum
Long-weight relationships have practical value that allows converting long values into weight or vice versa. This Weight can be regarded as a function of its length, and this long-weight relationship follows the law of cubic expressed by the formula [1]:

\[ W = aL^b \]

Information:
\( W \) = Weight (gram)
\( L \) = Length (mm)
\( A \) = Intercept
\( B \) = Prediction Length and weight growth patterns

Condition Factor of A. gubernaculum
The condition factor often referred to as K factor is applied from the analysis of length and weight relationships is an important derivative in the growth of bivalves. In this case, condition factors can illustrate both at least bivalve conditions seen in terms of physical capacity for survival and reproduction. To see the condition factors in bivalves used formulas [1]:

\[ K_n = \frac{W}{aL^b} \]

Information:
\( K_n \) = Relative condition factor
\( W \) = Body weight (gr)
\( L \) = Body length
\( a \) = Constants
Growth parameter of A. gubernaculum

To know the growth parameters used growth model Von Bertalanffy namely [2]:

$$L_t = L \infty (1 - e^{-K(t-t_0)})$$  \( (3) \)

Information:

- \( L_t \) = shells length at time \( t \) (cm);
- \( L \infty \) = Asimtot length of shells (cm);
- \( K \) = growth coefficient (per year);
- \( T_0 \) = Theoretical age of the shells on the same length as zero (year);
- \( T \) = Age of shells at \( L_t \) (year).

To estimate the theoretical age \( (t_0) \) when the shells length is equal to \( 0 \) (zero), as follows [3]:

$$\log_{10} (-t_0) = -0.3922 - 0.2752 \log L \infty - 1.038 \log_{10} K$$  \( (4) \)

\( L \infty \) is the maximum length of the shells theoretically (asymptotic length), \( K \) is the growth rate coefficient (per unit time) and \( t_0 \) is the theoretical age of the shells when the total length of the shell is equal to zero.

Mortality and Exploitation Rate

The coefficient of total mortality is estimated by using the length-converted catch curve with the following equation [4]:

$$\ln M = -0.0152 - 0.279 \ln L \infty + 0.6543 \ln K + 0.463 \ln T$$  \( (5) \)

\( M = e(\ln M) \)

The rate of mortality of catching \( (F) \) is determined by: \( F = Z - M \). Furthermore, the rate of exploitation is determined by comparing the catch mortality \( (F) \) to total mortality \( (Z) \) [5]:

$$E = F / (F + M)$$  \( (6) \)

Information :

- \( E \) = Status of exploitation;
- \( F \) = Coefficient of catching mortality;
- \( M \) = Natural coefficient of death;
- If: \( E > 0.5 \) indicates a high level of exploitation (over fishing);
  - \( E < 0.5 \) indicates a low level of exploitation (underfishing);
  - \( E = 0.5 \) indicates optimal utilization

3. Results And Discussion

3.1 Results

3.1.1 Biological A. gubernaculum

A. gubernaculum have a left shell bigger than the right shell (inequivalvis). An elongated elliptical shell. The shell is thick, heavy, and white. The surface of the shell is decorated with very real radial ribs. Flat radial ribs, without bulge. The periostrakum layer is thick and there are modifications in the form of layers such as "hair". Layers of periostrakum is dark brown.
3.1.2 Length frequency distribution
Based on observations made during 1 month 14 days, the frequency distribution of *Anadara gubernaculum* showed different results at each station. The total length of the *A. gubernaculum* ranges from 14 to 43 mm. Groupings are differentiated based on each station and grouped by 10 class interval.

**Figure 1.** Length Frequency Distribution *Anadara gubernaculum* at Station 1

**Figure 2.** Length Frequency Distribution *A. gubernaculum* at Station 2

**Figure 3.** Length Frequency Distribution *Anadara gubernaculum* at Station 3
3.1.3 Length and weight relationship of A. gubernaculum

The result of measurement of length and weight of shells to get the coefficient of determination ($R^2$), intercept value, and regression coefficient based on the overall catch.

![Figure 4. Length and weight relationship of A. gubernaculum at Station 1](image)

![Figure 5. Length and weight relationship of A. Gubernaculum at Station 2](image)

![Figure 6. Length and weight relationship of A. gubernaculum at Station 3](image)

3.1.4 Condition Factor

The result of calculation of the condition of the A. gubernaculums sampling in October - November 2016 where at station 1, it has value of condition factor ranged from 0.81 – 1.11. At station 2, it has a condition factor value ranged from 0.85 - 2.15. At station 3, it has a condition factor value ranged from 0.95 - 1.87.

3.1.5 Growth parameter of A. gubernaculum
Result of analysis of growth parameters of *Anadara gubernaculum* consist of growth coefficient (K) is 1.2/year and infinitive length (L∞) is 43.05 mm and theoretical age of shells at the same length equal to zero (t0) is -0.12 presented in Table 1 that was analyzed by ELEFAN method I in FiSAT II program.

Table 1. Growth parameter of *A. gubernaculum* in Asahan aquatic In October - November 2016

| A. gubernaculums | Growth parameter |
|------------------|------------------|
| L∞ (mm)          | K (year⁻¹)      | t0 (year) | Lt (mm)         |
| 43.05            | 1.2             | -0.12     | 43.05(1-e⁻¹.2(t+0.12)) |

3.1.6 Mortality and Exploitation Rate
Estimation of natural mortality rate of shells use empirical formula Pauly (Sparre and Venema, 1999) with average temperature of Asahan surface aquatic 31.17 °C. The results of the analysis of alleged mortality and the rate of exploitation of the *A. gubernaculum* consist of total mortality (Z) is 2.121/year, natural mortality (M) is 1.9/year, mortality of catching (F) is 0.21/year, and the rate of exploitation (E) is 0.1 (Underfishing)

3.2 Discussion

3.2.1 Frequency Distribution of Length *A. gubernaculum*
The results obtained can be seen that at station 1 is 205 individuals and most measuring 26 mm - 28 mm is 55 individuals, at station 2 is 450 individuals and most sized 20 mm - 22 mm is 114 individuals, and in station 3 is 200 individuals, and the largest size 29 mm - 31 mm were 33 individuals. The results of the three stations indicate that the amount of shells at station 2 more than at station 1 and at station 3 because *Anadara* did not occur in catches from this area at that time. So that its larger size as well as its great abundance at the time [6]

3.2.2 Length and weight relationship of *A. gubernaculum*
The obtained results at station 1 has growth pattern (b) of 2.093, at the station 2 is 2.157 while at the station 3 of 2.159. At each station has a negative allometric growth type (b<3) which is the increase in shells length is faster than the total weight gain. Therefore, the value of ‘b’ in the current study demonstrates that shells grows negative allometrically instead of isometrically and food availability can affect tissue growth, storage and utilization, which have the ability to change the ratio of total weight to shell length [7]. And negative allometric growth suggest that a negative growth may result in a rounded shell or body shape and may also influence the maximum shells length so that negative allometric growth may affect its maximum shells length and consequently their total weight [8]

3.2.3 Condition Factor of *Anadara gubernaculum*
The value of the condition of the shells *A. gubernaculum* station 1 was 0.81 - 1.11, station 2 of 0.85 - 2.15, and station 3 of 0.95 - 1.87. values of 1.0 and above indicate for better growth of the species, whereas values less than 1.0 indicate a stress condition or spent condition of the species [9]

3.2.4 Growth parameter of *A. gubernaculum*
Based on the analysis results obtained asymptotic length of $L\infty$ *A. gubernaculum* is 43.05 mm with growth coefficient (K) is 1.2. There are big changes in growth between the same species in different populations. A variety of environmental factors such as the immersion period, turbidity, seawater temperature, salinity
and water pollution have been confirmed to influence the growth rate of different *Anadara* spp populations [5].

### 3.2.5 Mortality and Exploitation Rate of *A. gubernaculum*

The value of mortality rate (Z) of *A. gubernaculum* is 2.121/year, natural mortality value (M) of *Anadara gubernaculum* is 1.9/year and the value of mortality of catching (F) of 0.21/year. Mortality that occurred in the study site was considered to be from natural causes (M). There were little empty shells and dead samples in the study site, which could be the reason for the existence of natural mortality. In addition, the results of the theoretical calculation of total mortality in the current study showed that the shells mortality level was very low [8]. These results indicate that the analysis of the rate of exploitation (E) of shells in Asahan aquatic has a value of 0.1. The value of exploitation of *A. gubernaculum* is less than 0.5 indicated the ‘under-fishing’ condition (under-exploitation) which led to a decrease in biomass in the study area [7].

### 4. Conclusions

The conclusions obtained from this research are:

1. *Anadara gubernaculum* in the aquatic of Asahan has a negative allometric relationship.
2. The total mortality rate (Z) of *Anadara gubernaculum* of 2.121/year with natural mortality (M) of 1.9/year and the mortality of catching (F) of 0.21/year, and the rate of exploitation of 0.1/year. The value of exploitation rate indicates that this asahan aquatic is still under sustainable condition.

### 5. References

[1] Le Cren C D, 1951 The length-weight relationship and seasonal cycle in gonad weights and condition in perch, *perca fluviatilis*. *J. Anim. Ecol.* 20 201-209

[2] Pauly D Soriano-Bartz M Moreau J and Jarre-Teichmann A 1992 A new model accounting for seasonal cessation of growth in fishes. *J. Mar. Freshwater Res.* 43 1151-1156

[3] Pauly D 1983 Some simple methods for the assessment of tropical fish stocks. (Manila: Food and Agriculture Organization) pp 1-60

[4] Pauly D 1999 On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J. Cons. CIEM* 39 175-192.

[5] Gulland J A and Rosenberg A A (1992) A review of length-based approaches to assessing fish stocks. (Rome: Food & Agriculture Organization) ISBN 92-5-103121-5

[6] Tebano T and Paulay G 2000 Variable recruitment and changing environments create a fluctuating resource: the biology of *anadara uropigimelana* (bivalvia: arcidae) on tarawa atoll *Atoll Research Bulletin* 1 - 15

[7] Mirzaei M R Yasin Z and Hwai A T S 2014 Length-weight relationship, growth and mortality of anadara granosa in penang island, malaysia: an approach using length-frequency data sets *Journal of the Marine Biological Association of the United Kingdom* 1 - 10.

[8] Albuquerque FS Peso-Aguilar MC Assuncao~Albuquerque MJT and Galves L 2009 Do climate variables and human density affect *achatina fulica* (bowditch) (gastropoda: pulmonata) shell length, total weight and condition factor? *Braz. J. Biol.* 879-885.

[9] Sharma R, Venkateshvaran K and Purushothaman C S 2005 Length-weight relationship and condition factor of *perna viridis* (linnaeus, 1758) and *meretrix meretrix* (linnaeus, 1758) from mumbai waters *J. Indian Fish. Assoc.* 32 157-163

**Acknowledgment**

This researchs have financed by Non BNPB fund of University of Sumatera Utara on TALENTA research. We say thank you very much.