Fishery of mud crab *Scylla serrata* of Kotania Bay, Western Seram District: potency, stock status and sustainable management

J M S Tetelepta$^{1,2*}$, Y Natan$^{1,2}$, J A Pattikawa$^{1,2}$, O T S Ongkers$^{1,2}$ and B J Pattiasina$^{1}$

$^1$ Faculty of Fisheries and Marine Science, Pattimura University, Ambon-Indonesia

$^2$ Maritime and Marine Science Center of Excellence, Pattimura University

*E-mail: jms.tetelepta@fpik.unpatti.ac.id jmstetelepta57@gmail.com*

**Abstract.** Study on the fishery of mud crab *Scylla* sp. of Portunid crab at Kotania Bay of Western Seram District was conducted between March and August 2018. The objectives of this study were to analyze biological parameters, the potency, stock status, sustainability, and to propose a sustainable management plan for this fishery. A total of 592 individual mud crab sample were collected from local fisher for biological parameters analysis. Historical catch data from local fisher, mud crab collector and fishery enumerator were used to analyze stock biomass, fishing intensity and stock status using Graham-Schaefer dynamic model. Raptfish analysis was used to analyze the sustainability of the stock. The carapace width ranged from 7.80 - 23.50 cm with an average of 13.68 cm (±2.25). There was a strong relationship between carapace weight ($r = 0.9405$) with overall growth pattern of isometric. The estimated stock biomass of mud crab of Kotania Bay was 130,000 t with BMSY of 22,425 t yr$^{-1}$, and mud crab fishery was under overfishing status. The overall sustainability was 46.92% and was considered as less sustain according to the ecosystem approach to fisheries management. Most sensitive attributes affecting sustainability were catching before maturity, consumer attitude towards sustainability, gear side effect, just governance, and government quality. Law enforcement, education and training on ecosystem approach to fisheries management, mud crab pot with escape gab, community based fishery management as well as monitoring and reporting should be conducted for mud crab sustainability.

1. **Introduction**

Mud crab of the genus *Scylla* spp. is found to distribute throughout tropical to temperate zone of Pacific regions and the Indian Ocean. This mud crab is sometimes also called as mangrove crab since mainly associated with mangrove ecosystem of an intertidal and subtidal area with the predominantly muddy substrate ([1, 2, 3]. For many Southeast Asia countries, this mud crab is one of high economy fish resources and an important fish resource for coastal fishermen [4, 5, 6, 7, 8].

There are four species of mud crab of the genus *Scylla* spp i.e. *Scylla serrata*, *S. olivacea*, *S. paramamosain*, and *S. tanquebarica*, three species (*S. serrata*, *S. olivacea* and *S. paramamosain*) are found to be harvested by local fisher of Kotania Bay and its vicinity area and *S. serrata* being the dominant species [9, 10].

The mud crab from this area has been harvested for more than 25 years [9, 10, 11]. Some studies have shown that a sign of overexploitation of this mud crab has been taking place [12, 13]. The economic dependency of local mud crab fisher, steady demand, no fisheries management, have caused high intensity in the harvesting of this mud crab which leads to the unsustain condition. General
speaking, most of the local fisher from this area are classified as artisanal fishers. Sustainability of this crab therefore is important for this local fisher since they support the life of this local fisher.

2. Material and Methods

2.1. Objectives and study site
The objectives of this study were to analyze mud crab size distribution, growth pattern, the potency (stock biomass), stock status, sustainability status, and proposed a sustainable management of this fishery. This research was conducted at waters of Kotania Bay of Western Seram District, Maluku Province of Eastern Indonesia (Figure 1) from March to August 2018.

![Figure 1. Study site and sampling station (red square).](image)

2.2. Data collection and analysis
Mud crab samples were collected from local fisher of Wael and Kotania Village on two weeks interval. Mud crab sex determination was based on the abdominal flap morphologic structure [14]. The external carapace with was measured using the vernier caliper to the nearest mm, whilst weight was weighted using 5.0 kg blue LCD blacklight portable digital balance to the nearest gram. Additional historical data on mud crab production was obtained from mud crab collector merchant, interviewed with local mud crab fishermen, and secondary data from marine and fishery agency of Western Seram District.

Length size distribution of mud crab caught during the study period was analyzed using descriptive statistic [15], whilst carapace width-weight relationship was analyzed according to the formula proposed by [16]:

\[ W = aL^b \]

where:  
- \( L \) = carapace width (cm) 
- \( a \) = intercept 
- \( b \) = slope

The \( b \) value is then used to determine growth pattern i.e. isometric growth \((b = 3)\) or allometric growth \((b \neq 3)\) by using \( t \)-Student test [16].
Biomass of the stock was calculated by using Schaefer-Graham dynamic model [17] in [18]

\[
B_{t+1} = B_t + rB_t \left(1 - \frac{B_t}{K}\right) - C
\]

where:
- \(B_{t+1}\) = stock biomass after time \(t\)
- \(B_t\) = stock biomass at time \(t\)
- \(K\) = stock biomass at carrying capacity
- \(r\) = intrinsic growth rate of the stock

Mud crab fishing mortality rate \((F_t)\) was assessed using formula suggested by Quinn and Deriso [17] as follows:

\[
F_t = \frac{C_t}{B_t}
\]

where:
- \(C_t\) = fishing mortality rate at time \(t\)
- \(B_t\) = stock biomass at time \(t\)

The maximum sustainable yield (MSY) was estimated using the following formula [17]:

\[
MSY = \left(\frac{rK}{4}\right)
\]

Stock biomass at MSY \((B_{MSY})\) was calculated using the following formula [17]:

\[
B_{MSY} = \frac{K}{2}
\]

where:
- \(r\) = intrinsic growth rate
- \(K\) = stock biomass at carrying capacity

The sustainability status of mud crab was analyzed using rapid appraisal for fisheries method (Rapfish) according to [19,20] and the sustainability standard attributes were based on attribute proposed by [21, 22]. Data for Rapfish analysis was collected through a questionnaire distributed to local mud crab fisher of Kotania Bay covering the villages of Kotania and Wael as a sampling station. The sustainable management plan for this fishery was based on sensitivity attribute analysis (Leverage analysis) which was derived from Rapfish analysis [19,20]. Sustainable level of mud crab was classified according to ecosystem approach to fisheries management standard [23].

3. Results and Discussion

The total number of mud crab sampled during the study was 592 individuals consisting of 304 males and 288 females. The size distribution of male and female mud crab range from 7.80 to 23.50 cm carapace width with the average size caught being 13.68 (±2.25) cm. For male mud crabs, size range from 8.20-23.50 cm with an average size of 13.45 (±2.13) cm, whilst female mud crabs size range from 7.80 to 20.10 cm with an average of 13.92 (±2.34) cm. The size distribution for both sexes was no different throughout the study period with size most frequently caught being 11.50 cm.

Figure 2 shows the size frequency distribution of mud crab caught during the study period. The study in Bangladesh [24] on the same species shows size frequency distribution between 47.0 and 130 mm carapace width for male mud crab and between 32 and 110 mm for female which is smaller compared to this study. The size distribution of mud crab from Segara Anakan, Central Java range from 3.5-12.25 cm [26] and from Kutai National Park range from 5.0-14.3 cm and from 4.5-15.5 cm for male and female respectively [27], whilst from Mayangan Subang, West Java range from 4.3-14.3 cm [28].
Test of significant differences between carapace width-weigh relationship of male and female mud crabs shows no statistically different ($t_{(2),0.05}$), therefore both male and female data were combined for the analysis. Figure 3 shows the carapace width-weight relationship of mud crab *S. serrata*. A high relationship was found between carapace width and weight ($r = 0.9405$). Study on the same species at Balungun District of North Kalimantan [29], Pulicat Lake, Tamilnadu, India [30], and Coringa Wildlife Sanctuary, Andhra Pradesh, India [31] also shows a strong relationship with the $r$ value range from 0.9274 – 0.9592.

Table 1 shows carapace width-weight relationship in mud crab *S. serrata* which shows a high correlation throughout the study period. The b value varies over time both for male and female mud crab. Test of b coefficient for growth pattern of shows an isometric growth pattern ($t_{calc} < t_{a(2),0.05}$) throughout the study period. The same result was also found at Western Seram waters except for September and November [25]. A variation on the growth pattern of the same species has been
reported in some studies. An isometric growth for male and negative allometric for female mangrove crabs was reported from Khulna, Bangladesh [31]. On the contrary, a negative allometric was reported for both male and female mud crab from Mayangan, Subang West Java [26].

Tabel 1. Carapace width-weight relationship, the correlation coefficient and t-student test for b coefficient during the study period

| Study period | Carapace width-weight relationship | Correlation Coefficient (r) | Test of b coefficient |
|--------------|-----------------------------------|----------------------------|-----------------------|
|              | Male | Female | Male | Female | t<sub>calc</sub> | t<sub>α(2)0.05</sub> | t<sub>calc</sub> | t<sub>α(2)0.05</sub> |
| 1.           | $y = 0.210x^{3.007}$ | $y = 0.266x^{3.011}$ | 0.993 | 0.994 | 0.0003 | 2.010 | 0.0036 | 2.018 |
| 2.           | $y = 0.161x^{3.171}$ | $y = 0.152x^{3.165}$ | 0.982 | 0.990 | 0.0455 | 2.005 | 0.0074 | 2.020 |
| 3.           | $y = 0.084x^{3.295}$ | $y = 0.160x^{3.019}$ | 0.989 | 0.978 | 0.0694 | 2.003 | 0.0056 | 2.007 |
| 4.           | $y = 0.118x^{3.133}$ | $y = 0.139x^{3.182}$ | 0.982 | 0.986 | 0.0440 | 2.018 | 0.0497 | 2.017 |
| 5.           | $y = 0.167x^{3.057}$ | $y = 0.086x^{3.277}$ | 0.986 | 0.986 | 0.0164 | 2.023 | 0.0908 | 2.012 |
| 6.           | $y = 0.110x^{3.211}$ | $y = 0.179x^{3.011}$ | 0.968 | 0.987 | 0.0543 | 2.008 | 0.0038 | 2.015 |

From an interviewed with local fisher, mud crab tradesman collector, and from biomass stock analysis it was found that the products tend to decline from years to years. Mud crab estimated production in 2000 was 28,800 t, decreased to 17,850 t in 2018. The fishing unit varied over time with increasing tendency. This analysis also shows that mud crab CPUE also declined over time (Figure 4). A sign in mud crab production decline was also reported from mud crab of Pelita Jaya, Western Seram. Mean weight of mud carb harvested at Pelita Jaya Village in 2012 was 565.22 g ind<sup>-1</sup> [33] decreased to 495.55 g ind<sup>-1</sup> in 2014 [34] and decreased to 477.22 g ind<sup>-1</sup> in 2016 [36]. The same condition has also been reported from Sorbay Bay of Southeast Maluku [35].

Figure 4. Estimated Bt, effort and catch per unit effort (CPUE) of mud crab

Figure 5 shows the trajectory of mud crab fishery in Kotania Bay from 2000 to 2018. Estimated of stock biomass reveals that Bo at carrying capacity ($K$) of this fishery was 130,000 ton with MSY of 22,425 t yr<sup>-1</sup> and $F_{MSY} = 0.1725$. The analysis also shows that the fishery starts to enter a cautious zone at 2008 shown by $F_{(2008)} = 0.2168 > F_{MSY} = 0.1725$ and by 2013 entering the over-exploited zone.
Figure 5. Trajectory of mud crab *S. serrata* from 2000 to 2018

The Rapfish analysis for ecology sustainability status of mud crab from Wael and Kotania Village was 60.74% and 73.37% (stress = 0.1398; R² =0.9514) respectively from 100% sustainable scale (Figure 6A). In term of the ecosystem approach to fisheries management [23], Wael’s mud crab fishery from ecology domain was considered fair sustain whilst Kotania’s was considered sustain. Test for goodness of fit shows all stress value was < 0.25 explain the high validity of the test [36]. This was also shown by Monte Carlo scatter plot (Figure 6B) where anchor and reference did not move during ordination. Overall sustainability of mud crab fishery was 46.92% (less sustain) with institutional dimension being the lowest one (Table 2). Study on the same species at Pelita Jaya village also shows unsustainable condition with overall sustainability status was less sustain [12,13,34].

Figure 6. Rapfish ordination for sustaianability analysys (A) and Monte Carlo scatter plot ordination stability (B)
Table 2. Sustainability level (%), stress value and square correlation in Rapfish ordination of mud crab *S. serrata*

| Dimension        | Kotania | Wael | Stress | R²     | Kotania | Wael | Sustainable level          |
|------------------|---------|------|--------|--------|---------|------|-----------------------------|
| Ecology          | 73.37   | 60.74| 0.1398 | 0.9514 | Sustain | Fair Sustain                |
| Social           | 43.81   | 45.96| 0.1488 | 0.9422 | Less sustain | Less sustain |
| Economy          | 37.81   | 37.56| 0.1401 | 0.9465 | Not sustain | Not sustain |
| Technology       | 58.66   | 49.40| 0.1657 | 0.9144 | Less sustain | Less sustain |
| Ethic            | 45.30   | 51.69| 0.1531 | 0.9295 | Less sustain | Less sustain |
| Institutional    | 23.89   | 34.85| 0.1440 | 0.9376 | Not sustain | Not sustain |
| Mean             | 47.14   | 46.70| 0.1486 | 0.9369 | Less sustain | Less sustain |
| Overall sustainability | 46.92 |      |        |        | Less sustain |       |

Analysis of sensitivity attribute towards mud crab sustainability (Figure 7) shows that two most sensitive attribute from ecology, social, economy, technic, ethic, and institutional dimension were caught before maturity (RMS = 5.75), consumer attitude towards sustainability (RMS = 4.82), other source of income (RMS = 4.05), gear side effect (RMS = 2.86), just governance (RMS = 4.87), and government quality (RMS = 4.82) respectively. The previous study in Pelita Jaya Village shows that about 98.04% of female mud crab caught was berried female at various gonad maturity index ([12, 33, 37]. A study in Pelita Jaya Village shows 58.64% of mud crab caught was in the size less than 15 cm carapace width [33] and 49.90% in this present study, the size according to Ministry of Marine and Fishery Affairs of The Republic Indonesia is not allowed [38].

Rapfish analysis attributes used in the study can foster or inhibit sustainability dimensions of the resource [23]. Sustainable management plan of mud crab fishery will be based on the most sensitive attribute obtained from leverage analysis. Table 3 summarized management strategy for mud crab sustainable management at Kotania Bay.

Table 3. Summary of management strategy proposed for sustainable mud crab fishery management at Kotania Bay.

| No. | Sensitive attribute                  | Management strategy                                                                 |
|-----|-------------------------------------|-------------------------------------------------------------------------------------|
| 1.  | Catch before maturity               | Law enforcement, employing of mud crab pot with escape gap for small size mud crab. |
| 2.  | Consumer attitude towards sustainability | Training and workshop on fisheries sustainable principles (Ecosystem Approach to Fisheries Management). |
| 3.  | Other source of income              | Exploring the other fish resources and market potency analysis.                      |
| 4.  | Gear side effect                    | Designing mud crab pot with escaping gap.                                           |
| 5.  | Just governance                     | The inclusion of local fisher in fishery management through community based in fishery management. |
| 6.  | Government quality                  | Empowering of government personal on ecosystem approach to fisheries management.      |
4. Conclusion.
Totally there were 592 samples of *S. serrata* collected during the study period with the range between 7.8 and 23.5 cm carapace width. There is a strong correlation between carapace width-weight relationships with isometric growth pattern. The fishing rate was higher than fishing at MSY and the stock was under over-exploitation. Overall sustainability of this fishery was considered less sustain.
recommendation proposed for sustainable management covers: law enforcement, education, and training on ecosystem approach to fisheries management, deploying mud crab pot with escape gap, community-based fishery management as well as enacting monitoring and reporting in mud crab fishery management.

Acknowledgement.
The authors want to thank DP2M DIKTI Indonesia for funding research through SKIM STRANAS for 2018. We would like to thank Ivana Nha and Saen from Faculty of Fishery and Marine Science of Pattimura University and Tiara Wattimury for their technical assistance in data collection.

Reference
[1] Keenan C P 1999 The Fourth Species of Scylla. In Keenan, C.P. and Blackshaw, A. (eds.), Mud Crab Aquaculture and Biology: Proc. of an Int. Sci. For. Darwin, Australia, 21–24 April 1997. ACIAR Proceedings No. 78. Australian Centre for International Agricultural Research. Canberra. 48–58
[2] Hay T, Gribble N, de Vries C, Danaher K, Dunning M, Hearnden M, Caley P, Wright C, Brown I, Bailey S and M. Phelan 2005 Methods for Monitoring the Abundance and Habitat of the Northern Australian Mud Crab Scylla serrata. Fisheries Research and Development Corporation. Fishery Report No. 80. 80. 112
[3] Albert-Hubatsch H, Lee S Y, Jan-Olaf M, Diele K, Nordhaus I and Wolff, M 2016 Life history, movement, and habitat use of Scylla serrata (Decapoda, Portunidae): current knowledge and future challenges. Hydrobiologia, DOI 10.1007/s10750-015-2393-z. 763, 5-21
[4] Overton J L and Macintosh D J 2002 Estimated size at sexual maturity for female mud crabs (Genus Scylla) from two sympatric species within Ban Don Bay, Thailand. J Crust Biol, 22, 790-797
[5] Le Vay L, Lebata M J H, Walton M E, Primavera J, Quinitio E, Lavila-Pitagogo C, Parado-Estena F, Rodribuez E, Ut V N, Nghia T T, Sorgeloos P and Wille M 2008 Approaches to stock enhancement in mangrove associated crab fisheries. Rev Fish Sci. doi.org/10.1080/10641260701727285. 6 1-3, 72-80
[6] Walton M E, Le Vay L, Lebata M J H, Binas J and Primavera J H 2006 Seasonal abundance, distribution and recruitment of mud crabs (Scylla spp.) in replanted mangroves. Estuar, Coast Shelf Sci. doi.org/10.1016/j.ecss.2005.09.015. 66, 493-500
[7] Islam M S Kodama K and Kuokura H 2010 Ovarian development of the mud crab Scylla paramomocain in tropical mangrove swamps, Thailand. J Sci Res. DOI: 10.3329/jsr.v2i2.3543. 2(2), 380-389
[8] Fox N Y and Mangubhai M 2016 A preliminary assessment of mud crab stocks in mangrove forests in Bua Province, Fiji. Wildlife Conservation Society, Suva, Fiji. p 9
[9] Van Bulouw D 2016 The fishery of mangrove mud crab (Scylla sp.) of Kotania Village, Western Seram: utilization effort and management. M.Sc. Thesis. Marine Science Study Programe. Pattimura University. p 94 (in Indonesian)
[10] Tetelepta J M S, Natan Y, Ongkers, O T S and Pattikawa J A 2018 Some population biology aspects of edible orange mud crab Scylla olivacea (Herbst, 1796) of Kotania Bay, Western Seram District, Indonesia. AACL Bioflux. 11(4). 1203-12
[11] Tetelepta J M S, Khouw A S, Natan Y and Ongkers O T S 2017 Some biological aspects of mud crab Scylla serrata (Forskal) Fisheries at Pelita Jaya Bay, Western Seram Regency, Indonesia. Int J Fish Aquat Stud. 5(5), 272-277
[12] Ayhuwan S M 2013 Study on some biological aspects and sustainability status of mud crab Scylla serrata for their management at Pelita Jaya Village, Western Seram District. B.Sc. Thesis. Department of Aquatic Resources Management Pattimura University p 68 (In Indonesia)
[13] Bugis R Q 2013 The assessment of social, economy and institutional sustainability of mud crab Scylla serrata fishery at Pletita Jaya Village, Western Seram District. B.Sc. Thesis. Department of Aquatic Resource Management Pattimura University p 73 (In Indonesia)

[14] Anonymous 2013 Fisheries fact sheet: mud crab. Government of Western Australia, Departement of Fisheries. ISSN. 18349382. 4

[15] Nichols J 2006 Introduction to Descriptive Statistics. Mathematics Learning Center (NSW: University of Sydney) p 38.

[16] Pauly D 1984 Fish Population Dynamic in Tropical Waters: a manual for use with programmable calculators. ICLARM Studies and Reviews 8, (Manila Philippines: ICLARM) p 325

[17] Quinn T J and Deriso R B 1999 Quantitative Fish Dynamics. (New York: Oxford University Press) p 542

[18] Syuhada I and Damora A 2015 Harvest Control Rules Protocols. WWF Indonesia p 15 [In Indonesia]

[19] Pitcher T J and Preikshot D 2001 RAPFISH; a rapid appraisal technique to evaluate sustainability status of fisheries Fisheries Research. 49(3) 255-270.

[20] Kavanagh P and Pitcher T J 2004 Implementing microsoft excel software for rapfish: a technique for the rapid appraisal of fisheries status. University of British Columbia. Fisheries Centre Research Report. 12:2, 75. ISSN 1198-6727

[21] Rapfish Group 2006 Standard Attributes for Rapfish analysis Evaluation Field for Ecological, Technological, Economic, Social and Ethical Status. Fisheries Center. University of British Columbia p 5

[22] Pitcher T J, Lam M E, Ainsworth C, Martindale A, Nakamura K, Perry R I. and Ward T 2013 Improvements to Rapfish: a rapid evaluation technique for fisheries integrating ecological and human dimensions. J Fish Biol. 83 865–889. doi:10.1111/jfb.12122

[23] Pitcher T J, Kalikoski D, Short K, Varkey D and Pramoda G 2009 An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries. Mar Pol. 33 223 – 232

[24] Ali M Y, Kamal D, Hossain S M H, Azam M A, Sabbir W, Murshida A, Ahmed B and Azam K 2004 Biological studies of the mud crab Scylla serrata (Forskal) of the Sundarbans mangrove ecosystem in Khulna Region of Bangladesh. Pakistan J Biol Sci. 7(11). 1981-87

[25] Siahainenia L, Natan Y, Khouw, A S and Pattikawa J A 2016 Size distribution, growth pattern and condition factor of mangrove crab Scylla serrata in the coastal waters of Western Seram, Maluku, Indonesia. Int J Fish Aquat Stud. 4(2): 291-296

[26] Sentosa A A and Syam A R 2011 Temporal distribution of condition factor of mangrove crab (Scylla serrata) at coastal waters of Mayangan, Subang Regency, West Java. Jurnal Perikanan (J Fish. Sci.) 13(1):35-43 (in Indonesian).

[27] Wijaya N I, Yulianda F, Boer M and Juwana S 2010 Population biology of mangrove crab (Scylla serrata F.) in mangrove habitat of Kutai National Park, East Kutai Regency. Oseanologi dan Limnologi di Indonesia 36(3). 443-461 (in Indonesian).

[28] Syam A R, Suwarso and Purnamaningtyas S E 2011 Exploitation rate of mangrove crab (Scylla serrata) in Mayangan mangrove area, Subang-West Java. Jurnal Penelitian Perikan Indonesia 17(3). 201-207 (in Indonesian).

[29] Bambang W, Rukisah, Laga A, Hamim A A and Wardianto Y 2017 Carapace length-weight and width-weight relationships of Scylla serrata in Bulungan District, North Kalimantan, Indonesia. Biodiversitas. 8(4). 1316-23. E-ISSN: 2085-4722

[30] Gayathre V, Felix S and Durairaja R 2016 Carapace width -weight relationship of mud crab Scylla serrata (Forskal, 1775) collected from Pulicat Lake, Tamilnadu, India. IRA-Int J App Sci ISSN 2455-4499. 5(1). 29-33
[31] Myla S C, Tirumani V B and Paturi R C G 2017 Body weight, carapace length and width relationship and condition factor of the mud crab *Scylla serrata* (Forskal) in mangrove ecosystem. *Notulae Scientia Biologicae*. ISSN E. 2067-3264. DOI: 10.15835/nsb9310127. 9(3) 338-343

[32] Ali M Y *et al.* 2004. Biological studies of the mud crab, *Scylla serrata* (Forskal) of the Sundarbans mangrove ecosystem in Khulna Region of Bangladesh. *Pakistan J Biol Sci.* 7(11) 1981-1987.

[33] Makatita M 2012 Gonad maturity index, social economy, and institutional aspects for mud crab *Scylla serrata* management at Pelita Jaya waters. B.Sc. Thesis. Department of Aquatic Resources Management Pattimura University p 59 (in Indonesia)

[34] Natan Y, Khouw A S, Tetelepta J M S and Siaila J 2014 The fishery of mangrove crab and community economy empowerment of local fisher, Piru Bay Sub-district: potency, utilization and development Pattimura University Research Intitute p85 (in Indonesia).

[35] Fikri I A and Siahainenia L 2017.Harvest control rules of mud crab (*Scylla* spp.) at Ohoi Evu waters, Kei Kecil, Southeast Maluku District. National Symposium on Sustaianble Crustacean Fisheries. 15-16 May, 2017. Jakarta Indonesia p 15 (in Indonesia)

[36] Clarke K R. and Warwick R M 2001 *Change in Marine Communities: An Approach to Statistical Analysis and Interpretation*. (Plymouth: Marine Laboratory. UK. Primer-E Ltd.) 2nd Edition p 144

[37] Tetelepta J M S and Makatita M 2012 An approach to the management of mud crab *Scylla serrata* through the reproductive status of mud crab and socio-economy and institutional aspектs of the fishermen at Pelita Jaya, Western Seram Distriet. *Jurnal Triton* 8(1). 1-11

[38] PERMEN KP No. 1/Permen-KP/2015. Ministry of Marine and Fishery Affairs of the Republic Indonesia. Harvesting of lobster (*Panulirus* spp.), mud crab (*Scylla* spp.), and portunid crab (*Portunus pelagis* spp.) p 5 (In Indonesia).