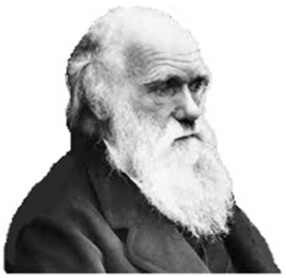
Available online at www.worldnewsnaturalsciences.com



World News of Natural Sciences

An International Scientific Journal

WNOFNS 24 (2019) 89-99 EISSN 2543-5426

Analysis of Stingray Catches which Landed in Fish Landing Site of Labuan Bajo, West Manggarai Regency of East Nusa Tenggara

Helena Asut*, Herman Hamdani, Junianto and **Lantun Paradhita Dewanti**

Faculty of Fisheries and Marine Science, Padjadjaran University
Jl. Raya Bandung Sumedang Km 21, Jatinangor 45363, West Java, Indonesia

*E-mail address: helenaasut@gmail.com

ABSTRACT

The purpose of the study was to determine the sustainability status of Stingray capture to determine the feasibility of catching Stingray in the waters of West Manggarai Regency. The research method used is the survey method, and this was conducted in July 2018 until mid-September 2018. The parameters studied included the type of Stingray, size and sex ratio. The results showed that the Stingray species found were *A. narinari, D. kuhlii, H. granulata, H. uarnak, P. sephen,* and *T. lymma,* with species diversity still stable (H' = 1,4). The average size of Stingray species caught makes it, however, not worth catching. Comparison of the Stingray sex ratio shows that *T. lymma* and *H. granulata* species were unbalanced, thus they should not be caught. *D. kuhli* and *H. uarnak* are still in balance so they can still be harvested. Based on conservation status in IUCN, the stingray that had the most severe threat status was *H. granulata* and *H. uarnak,* thus, these should not be harvested at all.

***Keywords*:** Stingray, Stingray Type, Stingray Size, Sex Ratio, *Taeniura lymma, Himantura granulata, Himantura uarnak, Dasyatis kuhlli, Pastinachus sephen, Aetobatus narinari*

1. INTRODUCTION

The data available for Stingray is still very minimal in West Manggarai Regency. Based on information from the Central Nusa Tenggara Statistics Agency (2018), only Stingray production data is available in 2015 and 2016. The 2015 Stingray production was 9.85 tons and in 2016 as many as 15.29 tons. Other data, such as data on species and size of fish caught are

(Received 10 March 2019; Accepted 28 March 2019; Date of Publication 29 March 2019)

still not available. Minimal Stingray data will make it difficult to monitor Stingray's fishing activities. Less fishery data will cause inaccuracies in deciding and implementing capture fisheries policies. According to Sudarso (2007), Stingray is an elasmobranch fish with slow sex growth and maturity and low fecundity. The Stingray reproductive cycle produces 1-2 children (Novariani 2014). The reproductive abilities of Stingray are very slowly vulnerable to overfishing. Stingray size data need to be available to prevent catching fish of unfit size. Fishing activities against Stingray must be sustainable because Stingray has an important role.

Stingray has an important role as a consumption fish and ecosystem balance. According to Abubakar *et al*. (2015), Stingray has an ecological role as a predator benthic in the waters. Stingray as the top predator or peak position in the food chain (Aditya and Al-Fatih, 2017).

Stingray has many species that are spread in nature and have been listed on the IUCN (International Union for Conservation of Nature) red list. Stingray manta (Manta birostris and Manta alfredi) have been categorized as vulnerable to extinction in the IUCN. The Indonesian government has issued a full policy on manta Stingray through the decree of the Minister of Marine Affairs and Fisheries No. 4 / KEPMEN-KP / 2014 in 2014.

The realization applied in fishing activities is still not in accordance with the provisions that have been set. Government Policy No.4 / KEPMEN-KP / 2014 is still not optimal. Amanda *et al*. (2016) stated that most people still do not care about the type, size and biological and morphological aspects of fish caught. Stingray manta species that have been protected are still caught. Stingray manta which caught almost 900 of around 17,000 fishes that live every year in Indonesia (Aditya and Al-Fatih, 2017). Stingray is a renewable resource, but if there is no good management, the benefits cannot be enjoyed. Therefore, through an analysis of catch surveys, Stingray can determine the feasibility of fishing results and whether or not Stingray species can be captured in West Manggarai Regency, East Nusa Tenggara.

2. MATERIALS AND METHODS

2. 1. Time and Location of Research

This research was carried out at the Labuan Bajo Fish Landing Site (TPI) in West Manggarai Regency, East Nusa Tenggara in July 2018 until mid-September 2018.

2. 2. Tools and Materials

The tools and materials used in this study are meters, scales, identification books, cameras, stationery and Stingrays as research objects.

2. 3. Research Methods

This research was conducted by using a survey method with data sources used including primary data as main data and secondary data as supporting data.

2. 4. Parameter Observed

The observation parameters that have been observed in this study are:

1) Type of Stingray

Stingray captured by fishermen landed in TPI Labuan Bajo is identified by species using a Stingray identification guide and its conservation status is determined based on the 2008 IUCN data.

2) Size of Stingray
Stingray captured is measured as Standard Length (SL), Disc Width (DW), and body weight using meters and scales.

3) Gender
Stingray's gender is being observed by seeing the presence of a clasper in Stingray. Stingray which have a clasper are male Stingray, while the female Stingray does not have a clasper.

2. 5. Data Analysis

Data on Stingray's catches in the form of data on type, size, and sex of Stingray were analyzed descriptively and presented in the form of tables and graphs. Comparison of male and female Stingray sex ratios was done by chi-square test with an error rate of 95% ($\alpha = 0.05$) if the ratio between male and female is not 1:1.

The captured Stingray is counted species diversity by using the Shannon-Wienner Diversity (H') Index (Effendie, 2002) with the formula as follow:

$$H' = -\sum (Pi)\,(In\ Pi)$$

where:

H' = Shannon-Wiener Diversity Index
Pi = ni/N
ni = number of individual genus-i
N = total number of individuals.

Batoide sex ratio is calculated using the following formula (Omar *et al*., 2014):

$$NK = \frac{\sum J}{\sum B}$$

where:

NK = Gender ratio
∑J = Number of male Stingray
∑B = Number of female Stingray.

The balance between the number of male Stingray and female Stingray in a population uses the chi square test (χ^2) (Omar *et al*., 2014):

$$\chi^2 = \sum_{i=1}^{k} \frac{(Oi-Ei)^2}{Ei}$$

where:

χ^2 = *chi-square* value
Oi = value of observations of male and female fishes
Ei = the value expected to occur in male and female fishes.

3. RESULTS AND DISCUSSION

3. 1. Overview of the Research Sites

West Manggarai Regency is one of the districts on the island of Flores, East Nusa Tenggara Province. This regency consists of 4 sub-districts, namely Komodo, Boleng, Lembor Selatan, and Macang Subdistricts. The area of West Manggarai Regency has an area of 9,450 km^2 and 64% is an area of water used for the fisheries sector.

Geographically located between 08º14' South Latitude - 09º00' South Latitude and 119º21' East Longitude – 120º20' East Longitude with northern boundaries bordering the Flores Sea, southern part with Sawu Sea, western part with Sape Strait and parts East is bordered by Manggarai Regency.

3. 2. Captured Stingray Types

Stingray landed in Labuan Bajo FAS, West Manggarai Regency, consists of 56 individuals belonging to 2 families, 5 genera and 6 species with a total catch of 96,4 kg (**Table 1**). The catch is being dominated by *Taeniura lymma* species and the least is *Pastinachus sephen* and *Aetobatus narinari*.

Table 1. Stingray Captured at TPI Labuan Bajo During Research

Family	Species	Number of Individuals	Total (kg)
Dasyatidae	*Taeniura lymma*	24	20
	Himantura granulata	11	58.1
	Himantura uarnak	12	12
	Dasyatis kuhlli	7	4.2
	Pastinachus sephen	1	0.6
Myliobatidae	*Aetobatus narinari*	1	1.5
Total	**6**	**56**	**96.4**

T. lymma is found the most ofter because it has the ability to reproduce faster than other Stingray species that are caught because it reaches adult size faster. White *et al*. (2006) stated that *T. lymma* could reach body widths of 35 cm, adult male rays about 21 cm in size, and female immature Stingray in size 24 cm, while *A. narinari* had a body size that could reach 330 cm in size, with adult male Stingray 110-120 cm. *P. sephen* has a body width that can reach

180 cm, with the width of the body of an adult male Stingray at a size of 96-100 cm. *A. narinari* and *P. sephen* are Stingrays which have longer growth compared to other Stingray spores that are captured.

Based on the information from the fishermen, *T. lymma* was mostly caught because *T. lymma* was found in the area around the coast and fishing gear operated in Western Manggrai on average operated in the area around the coast. Captured fishing fleets only consist of boats without motorcycles and motorboats of <5 GT size which are only capable of operating around the coast. According to Kinaskesti and Wahyudewantoro, (2017), *T. lymma* often migrates to shallow sandy areas around the coast during high tide to look for food such as worms, mollusks, shrimp and crabs. White *et al*. (2006) stated that *T. lymma* has a distribution area and habitat around the coral reef and coastal waters to a depth of 20 m.

A. narinari and *P. sephen* are Stingrays with the fewest catches but are fish that have high economic value compared to *T. lymma* which is less economical. West Manggarai fishermen provided information that at least fish *A. narinari* and *P. sephen* were caught because the rate of exploitation of these two species was much higher while the ability to reproduce was very slow. The high rate of exploitation that is not in accordance with the ability of fish to reproduce causes a decrease in catch results.

Fishermen in general will prioritize catching fish that have high economic value compared to fish that are not economical. According to Hutabarat in Rahmawati *et al*. (2013), fisheries resources are renewable resources, but in renewing them they run slowly. Exploitation of fish that far exceeds the ability of resources to reshape themselves, resulting in non-renewable resources.

3. 3. Stingray Species Diversity

The Shannom-Wiener Stingray index value is H = 1,4. The diversity of the Stingray species in West Manggarai Regency is quite stable in its natural habitat. Effendie (2002) states that if the diversity index value of species 1 < H’ < 3 indicates a moderate level of diversity.

3. 4. Protection and Conservation Status of Stingray

Stingray species caught by West Manggarai fishermen are classified as unprotected fish so they can be exploited. The Indonesian government only issued full protection against species *M. birostris* and *M. alfredi* through the decision of the Minister of Marine Affairs and Fisheries No.4/ KEPMEN-KP/2014. The manta rays on the International Union for Conservation of Natura (IUCN) list have been categorized as animals in the "vulnerable" category (Adytia and Al-Fatih, 2017).

Stingray from fish catches based on IUCN has different threatening status (**Table 2**). Wijayanti *et al*. (2018) stated that the species included in the “Vulnerable” category proved to meet the criteria in IUCN. One reason is because there is a reduction in population size that occurs in a vulnerable time of 10 years. *H. uarnak* and *H. granulata* fall into the vulnerable category. The arrest of H. uarnak and H. granulata had to pay attention to the size and number of people who could be arrested. The aim is to prevent a decline in population that is rising and extinction in nature. The decline in the Stingray population in nature can be caused by the biological nature of Stingray. Stingray has low fecundity while fishing activities are higher, not selective and not balanced with Stingray's ability to reproduce.

Captures of *H. uarnak* and *H. granulata* need to be stopped to create sustainable fisheries. "near threatened" Stingray (Table 2) has entered the status of almost threatened so it is necessary to control and supervise fishing activities so as not to have the potential to over-exploit. The catches of *P. sephen* and *A. narinari* which were only found one during the study were taken into consideration to further monitor fishing activities.

Table 2. Conservation Status of the Stingray Catches Based on IUCN

Species	Conservation Status
Taeniura lymma	NT (*Near Threatened*)
Himantura granulata	VU (*Vulnerable*)
Himantura uarnak	VU (*Vulnerable*)
Dasyatis kuhlii	NE (*Not Evaluated*)
Pastinachus sephen	NT (*Near Threatened*)
Aetobatus narinari	NT (*Near Threatened*)

3. 5. Size Distribution of Stingray Catches [18-25]

The size of the Stingray species caught was very varied except *A. narinari* and *P. sephen* because only one fish was found. *P. sephen* has a Standard Length (SL) size of 20 cm and a Disc Width (DW) of 26.1 cm with a weight of 0.6 kg. *A. narinari* has a size of SL 27.5 cm and DW 49.6 with a weight of 1.5 kg. *A. narinari* and *P. sephen* are classified as immature. *A. narinari* caught has a length of clasper less than the length of the pelvic fin so that it is classified as immature. The size of SL and DW of Stingray *A. narinari* caught is a size that is not worth catching.

T. lymma has an SL size of the interval between 15-17 cm to an interval of 30-32 cm. The highest catch is at intervals of 18-23 cm. DW size ranges from intervals of 14-16 cm to intervals of 28-30 cm. Most catches are at intervals of 19-21 cm. *T. lymma* caught in this size range is still not suitable for capture except for 21 cm male Stingray. According to White *et al*. (2006), *T. lymma* has a body width that can reach 35 cm in size; adult male rays 21 cm while female Stingray at 24 cm are recorded as immature. Therefore, most of the captured *T. lymma* is still not mature in size so it is still not feasible to catch.

H. granulata has an SL size with intervals ranging from 28-33 cm to intervals of 52-57 cm. Most catches are in the range of 46-51 cm. DW sizes range from intervals of 28-33 cm to intervals of 52-57 cm with the most catches in the 46-51 cm interval. According to White *et al.* (2006), *H. granulata* has a size of DW that can reach 141 cm in size with a birth size of 28 cm so that it is indicated that *H. granulata* caught is still immature and even found newborn fish caught.

D. kuhlii has a distribution of SL sizes from intervals of 13-16 cm to intervals of 25-28 cm. The most catches are in sizes with intervals of 13-16 cm. DW sizes range from 19-22 cm to intervals of 31-34 cm. The highest catch is at DW size of 19-22 cm with a percentage of

71%. *D. kuhlii* which was caught still found a size that was not suitable for capture with a body width of less than 22 cm and according to White *et al*. (2006), *D. kuhlii* adult males measuring 22-23 cm.

H. uarnak has a distribution of SL sizes from intervals of 22-23 cm to intervals of 28-29 cm with the most catches being in sizes 24-27 cm. DW size ranges from intervals of 24-25 cm to intervals of 32-33 cm with the highest number of catches dominated by sizes 30-31 cm. All of *H. uarnak's* catches are classified as unfit because the size of the body caught is still in the juvenile phase. This statement is reinforced by the statement of White *et al.* (2006) that *H. uarnak* has a body width that can reach more than 150 cm and the size of adult male rays is 82-84 cm while the birth size is 21-28 cm.

3. 6. Stingray Gender Composition

The catch of Stingray species is dominated by female fish with a percentage of 52% and male 48%. The male Stingray is dominated by immature Stingray. Male Stingray is not yet 39% and only 9% are adults. The male and female sex ratios of each Stingray species caught showed different results based on the *chi-square* test (**Table 3**). *P. sephen* and *A. narinari* have not been able to know the ratio of sex ratios in nature because the amount of data obtained during the study is limited; only one was found for each of *P sephen* and *A. narinari*.

Stingray species that were caught had male and female sex proportions with a ratio of not 1: 1 so that a square test was performed (Table 3). The *chi-square* test shows that if the value of χ^2 Calculation > χ^2 Table means that there is a significant difference between male and female fish (unbalanced), whereas if the value of χ^2 Calculation < χ^2 Table means there is no significant difference between male and female sex (balanced).

Table 3. Sex Ratio of Stingray Species

Species	Sex Ratio		Chi-square Test		Conclusion
	♂	♀	χ^2 Calculation	χ^2 Table	
Taeniura lymma	1.7	1.0	6.25	3.84	Unbalanced
Himantura granulata	1.0	2.7	20.66	3.84	Unbalanced
Dasyatis kuhlii	1.0	1.3	2.04	3.84	Balanced
Himantura uarnak	1.0	1.4	2.78	3.84	Balanced

T. lymma and *H. granulata* have significant or unbalanced differences in sex ratio between male and female genitalia in nature. *D. kuhlii* and *H. uarnak* have a comparison that are still balanced or ideal in nature. *T. lymma* has a greater number of males than the number of female Stingray so it is not ideal to maintain its sustainability, or it will tend to become extinct.

For *H. granulate*, although the number of male and female sex comparisons is not balanced but can still maintain its sustainability. According to Wahyuono *et al.* (1983), in Sudarso (2007) the comparison of male and female sex that is balanced or the number of

females more than the number of male fishes can be interpreted that the number of the population is still ideal for maintaining sustainability. Conversely, if more males than females, the population is not ideal for maintaining sustainability or tend to become extinct.

Differences in the number of one sex in the population can be caused by differences in growth patterns, differences in age, size of the first gonad mature, and the addition of new fish species in an existing population (Nikolskiy in Omat *et al*., 2015). While according to Effendie (2002), sex composition in nature is not absolute but is influenced by food availability, population density and food chain balance. Fishing activities also have a large influence on the sex ratio of fish in nature. Palungan *et al*. (1995) in Omar *et al*. (2015), high capture pressure can cause an imbalance in the number of male and female fish. Dharmadi *et al*. (2011) said that differences in fishing techniques and selectivity of fishing gear also affected the comparison of sex of male and female fish.

3. 7. Capability of Capture of Male Stingray

The average male Stingray catch is dominated by immature fish (**Figure 1**). Adult males have a clasper length (CL) less than the length of the pelvic fin (PF). Adult males have a longer classification than the length of the pelvic fin. The immature yield of male Stingray reaches 81% of the total male Stingray catch. Adult male Stingray is only 19%.

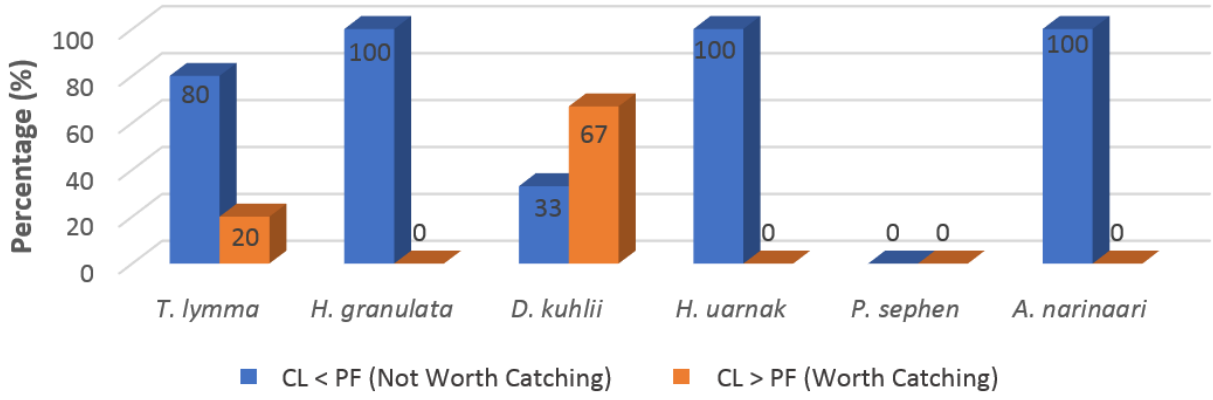


Figure 1. Percentage of "Not Worth Catching" and "Worth Catching" of Male Stingray Based on the C lasper's Length Size

The catch of male capturing Stingray is dominated by *D. kuhlii* with a percentage of 67% while other species dominated by male fish are not worth catching (Figure 1). The catches of *H. granulata* and *H. uarnak* are 100% not worth catching while *T. lymma* is 80% not worth catching. The capture of immature fish indicates that fishing activities in West Manggarai Regency still do not pay attention to the sustainability of fish resources. Stingray in West Manggarai Regency is very vulnerable to extinction. The fishing activities carried out by fishermen are classified as poor. Fishermen caught Stingray without considering the size of Stingray which is worth cathing or not. Long size data and Stingray catches based on information from the Head of the Catching Division of West Manggarai Regency are still not available. Unavailable data results in the capture of immature fish because there is no reference

in determining capture fisheries policies and controls. A similar condition was explained by the EAFM Learning Center and the Christian University of Arta Wacana (2016) that fisheries management in West Manggarai received less attention. Data on fish size are not yet available and fishermen do not know fish caught are immature or adult. Knowledge of the size of fish worthy of capture is important to know for the stability of the resources of stingrays in nature. Abubakar *et al*. (2016) stated that fish that had not been able to spawn caught would cause the recruitment process in the fish population to be disrupted and could threaten the preservation of the fish. Fish worthy of capture have a length longer than the length of the first gonad ripe (Jamal *et al*., 2014). The male Stingray that has the size of the first gonad ripens when the length of the class is parallel to the length of the pelvic fin (Utami *et al*., 2014). Female Stingray, to find out the size of the first gonad ripe, must be observed internally.

4. CONCLUSIONS

Stingray has a stable species diversity in the waters of West Manggarai Regency, East Nusa Tenggara (H' = 1,4). *A. narinari, H. granulata, H. uarnak, P. sephen* and those caught were dominated by a size that was not suitable for capture (Not Worth Catching) while *D. kuhlii* was predominantly suitable for capture (Worth Catching).

D. kuhlii has a balanced ratio of male and female sex and has a status of "Not Evaluated" in IUCN. *D. kuhlii* can still be captured in West Manggarai.

A. narinari, P. sephen and T. lymma have "Near Threatened" status in IUCN. *T. lymma* T. lymma has an unbalanced ratio of male and female sex ratios.

H. granulata and H. uarnak have the status of "Vulnerable" (vulnerable to extinction) so that they should not be arrested. *H. granulata* has an unbalanced ratio of sex ratio (unable to maintain sustainability) and *H. uranak* can still maintain sustainability.

References

[1] Abubakar, S., M. Boer, and Sulistiono. 2015. Biological Aspects of Bottle Stingray (Neotrygon kuhlii) in the Sunda Strait. *Journal of Fisheries and Marine Technology*, 6 (2): 129-138

[2] Abubakar, S., M. Boer, and Sulistiono. 2016. Biological Reproductive Aspects of Blentik Stingray Neotrygon kuhlii in the Sunda Strait. *Indonesian Aquaculture Journal*, 15 (2): 189-197

[3] Aditya, Z.F. and S. Al-Fatih. 2017. Legal Protection for Sharks and Stingrays to Maintain the Balance of Indonesian Marine Ecosystems. *Legality*, 24 (2): 224-235

[4] Amanda, D.T., A. Pratomo, and R.D. Putra. 2016. Conservation Status of Stingray Types Landed by Fishermen in May-July 2016. Article. Ocean Sciences FIKP-UMRAH.

[5] East Nusa Tenggara Statistics Agency. 2018. Stingray Production According to Regency Cities in East Nusa Tenggara Province 2015-2016.

[6] Dharmadi, M.T.D. Sunarno, and I. Edrus. 2011. Fisheries and Biological Aspects of Stingray Lampengan, Mobula japonica in South Java Waters. *Bawal,* 3 (6): 369-376

[7] Effendie, M.I. 2002. Fisheries Biology. Nusantara Library Foundation. Yogyakarta: 163

[8] Jamal, M., F.A. Sondita, B. Wiryawan, and J. Haluan. 2014. The Concept of Cakalang Fisheries Management (Katsuwonus pelamis) in the Gulf Bone Region in the Sustainability Perspective. *Journal IPTEKS PSP,* 1(2): 196-207

[9] Kinaskesti, S.M. and G. Wahyudewantoro. 2017. Stingray Type Study (Dasyatidae) in Indonesia. *Indonesian Fauna,* 16(2): 17-25.

[10] EAFM Learning Center and Christian University Arta Wacana. 2016. Report on Assessment of Capture Fisheries Management Performance with EAFM (Ecosystem Approach to Fisheries Management) Indicators at West Manggarai Regency East Nusa Tenggara. 46 p.

[11] Novariani, H., Lubis, and Fahmi. 2014. Biology of Reproduction of Toka-Toka Stingray (Himantura walga, Muller and Henle 1841) who was caught and landed in Cilincing. *BIOMA,* 10 (1): 1-7

[12] Omar, S.B.A., M. Nur, M.T. Umar, M.A. Dahlan, and S. Kune. 2015. Gender Ratio and Size First Time Ripe Gonad Fish Endemic Pirik (Lagusia micracanthus Bleeker, 1860) in Pattunuang River, Maros Regency, and Sanrego River, Bone Regency, South Sulawesi. Semnaskan_UGM, 73-81.

[13] Rahmawati, M., A.D.P. Fitri, and D. Wijayanto. 2013. Analysis of Catches Per Catching Efforts and Seasonal Patterns for Anchovy (Stolephorus Spp.). *Journal of Fisheries Resources Utilization Management and Tecnology,* 2 (3): 213-222

[14] Sudarso, J. 2007. Batu / Mondol Stingray Biology Study (Himantura gerrardi) Famili Dasyatidae Landed in PPN Penjajab, Pemangkat District, Sambas Regency, West Kalimantan. *Journal of Fisheries and Marine Affairs,* 12 (1): 30-35

[15] Utami, M.N.S., S. Redjeki, and N.T. SPJ. 2014. Stingray Biology Study (Dasyatis sp) at FAS Tasik Agung Rembang. *Journal of Marine Research,* 2 (3): 79-85

[16] White, W.T., P.R. Last, P.R. Stevents, G.K. Yearsley, Fahmi, and Dharmadi. 2006. Economically Important Shaeks Rays. 329 p.

[17] Wijayanti, F., M.P. Abrari, and N. Fitriana. 2018. Species Diversity and Conservation Status of Stingray at the Muara Angke Fish Auction Site, North Jakarta. *Journal of Biodjati,* 3 (1): 23-35

[18] Susumu Hagiwara and Kunitaro Takahashi. Mechanism of anion permeation through the muscle fibre membrane of an elasmobranch fish, Taeniura lymma. *The Journal of Physiology* Volume 238, Issue 1 April 1, 1974 Pages 109-127

[19] I.P. Jacobsen and M.B. Bennett. Life history of the blackspotted whipray Himantura astra. *Journal of Fish Biology* Volume 78, Issue 4 April 2011 Pages 1249-1268

[20] Christina A.D. Semeniuk, and Lawrence M. Dill. Anti-Predator Benefits of Mixed-Species Groups of Cowtail Stingrays (Pastinachus sephen) and Whiprays (Himantura uarnak) at Rest. *Ethology* Volume112, Issue1 January 2006 Pages 33-43

[21] T.S. Harmon, T.Y. Kamerman, A.L. Corwin, and A.B. Sellas. Consecutive parthenogenetic births in a spotted eagle ray Aetobatus narinari. *Journal of Fish Biology* Volume 88, Issue 2 February 2016 Pages 741-745

[22] M.S. González-Ramos, A. Santos-Moreno, E.F. Rosas-Alquicira, and G. Fuentes-Mascorro. Validation of photo-identification as a mark–recapture method in the spotted eagle ray Aetobatus narinari. *Journal of Fish Biology* Volume 90, Issue 3 March 2017 Pages 1021-1030

[23] K.I. Flowers, A.C. Henderson, J.L. Lupton, and D.D. Chapman. Site affinity of whitespotted eagle rays Aetobatus narinari assessed using photographic identification. *Journal of Fish Biology* Volume 91, Issue 5 November 2017 Pages 1337-1349

[24] M. Janse, A.L. Kappe, and B.L.M. Van Kuijk. Paternity testing using the poisonous sting in captive white-spotted eagle rays *Aetobatus narinari*: a non-invasive tool for captive sustainability programmes. *Journal of Fish Biology* Volume 82, Issue 3 March 2013 Pages 1082-1085

[25] Susan M. Theiss, Thomas J. Lisney, Shaun P. Collin, and Nathan S. Hart. Colour vision and visual ecology of the blue-spotted maskray, Dasyatis kuhlii Müller & Henle, 1814. *Journal of Comparative Physiology A* January 2007, Volume 193, Issue 1, pp 67–79