CORAL REEF COVER CONDITION AND ABUNDANCE OF REEF FISH OF THE POMACENTRIDAE FAMILY IN THE WATERS OF PAGANG ISLAND, PESISIR SELATAN REGENCY, WEST SUMATRA

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ABSTRACT

Coral reefs play a crucial role in maintaining marine biodiversity by providing habitat and resources for various aquatic organisms, including reef fish from the Pomacentridae family. This study aims to determine the condition of coral reef cover, the abundance of reef fish from the Pomacentridae family, and the relationship between coral reef cover and the abundance of reef fish from the Pomacentridae family in the waters of Pagang Island. The study used the Underwater Photo Transect (UPT) method for coral cover analysis and the Underwater Visual Census (UVC) method for fish abundance data collection. The results showed that the average percentage value of coral reef cover at a depth of 5 m was 22.18%, and at a depth of 7 m was 12.80%, indicating a poor category for the percentage value of coral reef cover. Data collection was carried out at three different stations. The highest percentage of coral reef cover was found at station III at a depth of 5 m at 46.74% and at a depth of 6 m at 28.81%, while the lowest value was at station I at a depth of 5 m at 11.67% and at a depth of 7 m at 2.41%. The abundance of Pomacentridae reef fish varies between stations, with the highest abundance observed in areas with higher coral cover. Regression analysis showed a positive correlation between coral reef cover and fish abundance, indicating that declining coral reef conditions can have a negative impact on fish populations. These findings highlight the importance of coral reef conservation efforts to maintain marine biodiversity and ecosystem balance.

Keywords: Coral Reef Cover, Fish Abundance, Pomacentridae, Pagang Island.

1. INTRODUCTION

Pagang Island is located in the administrative area of Koto XI Tarusan District, Pesisir Selatan Regency, West Sumatra Province. Pagang Island is one of the main tourist attractions in the area, and you can tour Mandeh. The island's white sand and clear water become the main power pull for the Pagang Island. Activity tourism carried out by tourists can impact the ecosystem waters negatively if not appropriately managed. According to Nirwan et al[1]., activities such as snorkeling and diving can damage reef coral, where diving can step on and break coral, and boat-wasteful tourism anchors in a careless way

around reef coral. Mutahari et al.[2] also said that area tourism and non-tourism have different environments, especially in ecosystems, such as reef coral, where the level of damage tends to be higher in the area tourist compared to non-tourist areas. Indrabudi & Alik[3] stated that cover reef coral experiences a decline in areas of activity development, its anthropogenic impact, and so on.

According to Hadi et al.[4], the condition of coral reefs in Indonesia has decreased. Living coral cover conditions globally have decreased compared to the previous year, resulting in bleaching. In Indonesia, the last bleaching phenomenon occurred in 2015 and

2016 in several areas. The southern and western regions (especially western Sumatra) have relatively poor coral conditions due to the extreme environmental conditions, namely, facing directly onto the Indian Ocean.

One of the resources in the coral reef ecosystem is reef fish. Reef fish allegedly have a very close relationship with the ecosystem, reef coral, which can influence each other between the reef coral and the abundance of coral fish. Based on the role of coral fish, shared into 3, namely target fish, which are fish as consumption targets, the families Seranidae, Lutjanidae, Kyphosidae, Lethrinidae, Acanthuridae, Mulidae, Siganidae, Labridae, and Haemulidae. Indicator fish, namely fish as determinant fertility reef coral that is the Chaetodontidae family, and major fish or commonly known as ornamental fish that is family Pomacentridae, Caesionidae, Scaridae, Pomacanthidae, Labridae, Apogonidae[5].

Coral fish are often found in the reef coral area, a family of coral fish. Pomacentridae, one of the major fish groups, has a small and living bodyand colonizes the ecosystem of the reef coral. Most major fish, such as ornamental fish, are commercially important[6]. The most common types of ornamental fish found on reefs, from the group Pomacentridae, are anemonefish and angelfish, which have beautiful colors. Abundance species, tall individuals, and patterns of various colors make this group of fish a Power Pull tour nautical dive.

Pomacentridae, or damselfish in general, are herbivorous fish that play an important role in looking after the system of reef coral because they influence the growth and diversity of algae and change the structure of the coral community. Family Pomacentridae is an easy reef fish recognized because it is often found in the area, especially in the flat reef (flat reefs). Fish from the family are also easy to count because generally found in numbers that are not so numerous and solitary in the area, coral and rocky[7].

Some study about cover reef coral and abundance of reef fish has several times done in between by Sirait et al.[8] about condition cover reef coral and image common coral fish on the island Pagang, South Coast, West Sumatra, Rafli et al.[9], about condition cover reef coral and abundance of reef fish family Pomacentridae in the waters Kalimantung Island Regency Central Tapanuli, North Sumatra Province, by Sitohang et al.[10], about connection closed reef coral against reef fish family Pomacentridae and Phytoplankton on the Kasiak Island West Sumatra Province, and by Amrullah et al.[11], about coral fish condition Chaetodontidae family area conservation Island Pieh and the sea surrounding the core zone and other zones. However, there is no study about the condition of the reef coral and the reef fish family Pomacentridae on the Pagang Island Regency, South Coast of West Sumatra Province, so a study is needed.

Purpose of the study: To know the condition of reef coral in the waters, to see the abundance of coral fish family Pomacentridae in the waters, and to learn the connection between the cover of reef coral life and the abundance of coral fish family Pomacentridae in the waters of Pagang Island.

2. RESEARCH METHOD
Time and Place

This study was implemented in February 2025 in Pagang Island, Regency South Coast, West Sumatra waters (Figure 1).
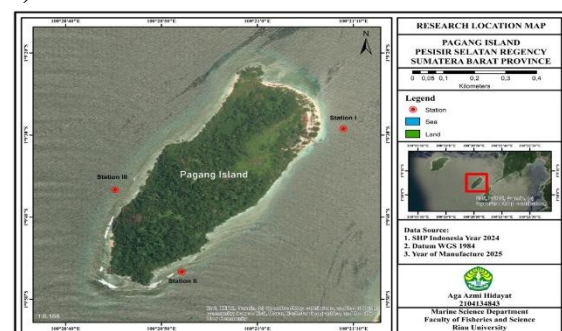

Figure 1. Map of research location

Method

Determination of research stations was carried out using purposive sampling. That is a determining point station considering certain conditions while in the field. To determine the point station, the former observation was conducted using the free-swimming method, which aims to obtain a general description of the distribution of coral and the abundance of coral fish found in the waters of Pagang Island. Observation is done using skin diving equipment. Station I is in the direction east of the island with anthropogenic influence activity that becomes dock main, station II is located in the direction south of the island with anthropogenic influence activity, station III is located in the far west direction of the island from the activity man.

On every station, two transects at depths of 5 m and 7 m, transects installed parallel with the coastline following the station's location, that has set with a long transect of 50 m. After that, data collection with the method dive using equipment such as a self-contained underwater breathing apparatus (SCUBA) is done.

Procedures
Cover Data Capture Coral reefs.

Reef data collection techniques, coral use method, underwater photo transect (UPT) passes use equipment, self-contained underwater breathing apparatus (SCUBA), and underwater photo shoot using an underwater digital camera. Field data collection only takes underwater pictures, which are done with a photo shoot using an underwater digital camera. The following photos stored in the memory camera were moved to the laptop to be more regular before analyzing the photo with the Coral Points Count with Excel Extension (CPCE) application.

Observation of Coral Fish Types and Abundance

Reef fish data were collected using the UVC (Underwater Visual Census) method. Moment taking Coral fish data was collected by two divers, namely 2.5 m on the left side of the transect and 2.5 m on the right side of the transect. Figure 3 has a wide 250 m2. Observations were made on the same line transect to collect coral reef cover data.

Calculating and recording the number and types of fish family Pomacentridae use system stakes on the slate (underwater slate) prepared previously. Identification of the kinds of coral fish is done directly in the field, and documentation is used. The fish family Pomacentridae has been recognized directly on slate, whereas some types of fish that have not been recognized are identified, referring to Allen[12]; White et al.[13].
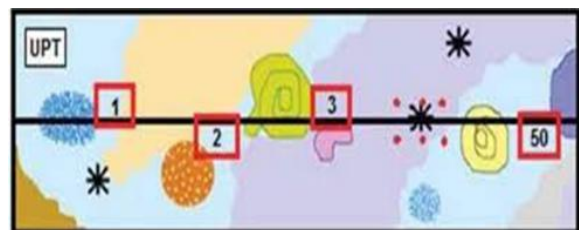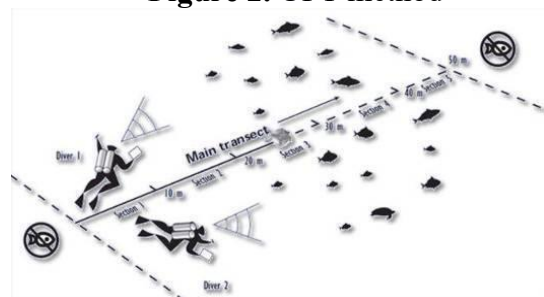

Figure 2. UPT method

Figure 3. UVC method

Measurement Quality Waters

The parameters measured in this study consist of four parameters: temperature, salinity, brightness, and current speed. The time of data collection was the same as the data collection of coral reefs and reef fish at each station on the water surface, with three repetitions of data collection.

Percentage Cover Coral reefs.

Taking pictures results in a photo shoot underwater at every 1 m interval of the transect line, and the data is analyzed to get quantitative data like percentage cover of coral and biota. To obtain quantitative data based on taking underwater pictures generated from the Underwater Photo

Transect (UPT), data analysis is carried out on every frame using the random sample point method. This technique is used to determine random use of as many as 30 points for every frame, which is already representative for suspect percentage cover category and substrate.

Based on the mark percentage cover, coral life can determine the condition of reef coral, like grouping carried out by the Research Center Oceanography – Institute of Science Indonesian Knowledge (Puslit Oceanography – LIPI), according to Giyanto[14], as seen in Table 1.

Table 1. Criteria percentage cover coral life

Parameter		Standard Criteria for Damage to Coral Reefs (%)	
Percentage Area Cover Living Coral Reef	Damaged	Bad	0 – 24.9
		Currently	25 – 49.9
	Good	Good	50 – 74.9
		Good Very	75 – 100

Abundance of Coral Fish Family Pomacentridae

The abundance of coral fish shows that the number of individuals will unite widely at the research location. According to Sudarmaji & Efendy[15] , fish can be counted with the use of equality :

$$N = \frac{n}{A}$$

Information:

N : Abundance of individual fish (ind/m^2)

n : Number of individual fish (ind)

A : Area of observation (m^2).

The assessment criteria for fish abundance on coral reefs according to COREMAP II LIPI[16] can be seen in Table 2.

Table 2. Categories include an abundance of major reef fish

Amount Individual	Category
< 50	A little
50 – 100	Lots
> 100	Overflowing

Connection Cover Coral Reef with Abundance of Coral Fish Family Pomacentridae

The analysis used to see the relationship between coral reef cover and the percentage of reef fish family Pomacentridae is a simple linear regression analysis using the Microsoft Excel program, with the formula Tanjung[17], as follows:

$$Y = a + bX$$

Information:

Y = Variable dependent (abundance of coral fish)

x = Variable free (coral reef cover)

a = Constant

b = Coefficient regression

The correlation coefficient (r) relationship criteria, according to Tanjung[17], can be seen in Table 3.

Table 3. Correlation coefficient

Criteria	Connection coefficient correlation (r)
Connection Weak	0 – 0.25
Medium Relationship	0.26 – 0.50
Connection Strong	0.51 – 0.75
Very Strong Relationship	0.76 – 1.00

3. RESULT AND DISCUSSION
Water Quality

Pagang Island is one of the islands in the administrative area of Koto XI Tarusan District, Regency South Coast, West Sumatra Province. In general, it is geographically located at 01°09′34″ South Latitude and 100°20′55″ Longitude east. Adjacent north bordering Pasumpahan Island and Sikuai Island. The highest

temperature is found at stations I and III with a value of 31 ºC, and the lowest is located at station II with a value of 28 ºC. The highest salinity value waters of Pagang Island were found at station I with a value of 32‰, followed by station III with a value of 31‰, and the lowest was located at station II with a value of 30‰. Brightness in the waters of the Pagang Island is classified as category Good with an average of 6 m. The speed is currently the highest on the Pagang island located at station III with a value of 0.43 m/s, followed by station I with a value of 0.13 m/s, and the lowest at station II with a value of 0.09 m/s.

Table 4. Results of quality parameter measurements

Station Research	Coordinate		Parameter			
	LS	BT	Temperature (ºC)	Salinity (‰)	Brightness (m)	Current speed (m/s)
I.	01°9'25,128"	100°21'50"	31	32	6	0.13
II.	01°9'43.77"	100°20'56"	28	30	6	0.09
III.	01°9'28.8"	100°20'50."	31	31	6	0.43
Average			30	31	6	0.21

Percentage Cover Coral reefs.

Analysis results on the device soft *CPCe* project cover coral with type diverse growth (*lifeform*) and some cover category waters others, namely *Acropora Branching (*ACB*), Acropora Digitate (*ACD*), Acropora Encrusting (*ACE*), Acropora Submassive (*ACS*), Acropora Tabulate (*ACT*), Coral Branching (*CB*), Coral Encrusting (*CE*), Coral Massive (*CM*), Coral Millepora (*CME*), Coral Mushroom (*CMR*), Coral Submassive (*CS*), Non coral* (NC), *Dead coral with algae* (DCA), and *Recently dead coral* (RDC). In addition to coral reefs, other algae and fauna such as *Zoanthids* (ZO), *Macro Algae* (MA), *Turf Algae* (TA), *Halimeda* (HA), and abiotic factors such as *Sand* (S), *Rubble* (RB) were also found. In comparison, the results analysis can be seen in Table 5.

Table 5. Percentage cover of reef coral in the waters of Pagang Island

Station	Depth (m)	Live Coral Cover (%)	Category
I	5	11.67	Bad
	7	2.41	Bad
II	5	8.13	Bad
	7	7.2 0	Bad
III	5	46.74	Currently
	7	28.81	Currently
Average		17.49	Bad

Analysis results show the variation in the percentage of reef coral on the Pagang island between stations and depth. At station I, the cover reef coral recorded 11.67 % at a depth of 5 m and 2.41 % at a depth of 7 m. At station II, each cover's value is 8.13 % at a depth of 5 m and 7.20 % at a depth of 7 m. Station III shows the highest percentage, namely 46.74 % at a depth of 5 m and 28.81 % at a depth of 7 m. The average percentage of cover reef coral in the third station is 17.49%, indicating that reef coral is in the category bad. An increase in nutrients triggers the explosion of this algae population until the threshold is critical, a temporary decline in the number of herbivorous fish, and the consequence of an excessive reduction in the control experience against algae. As a result, the balance reef shifts from domination by coral to algae dominance, decreasing Coverage and diversity of coral[18-19].

Types of Coral Fish Family Pomacentridae

Observation and census results from the on-site study of the coral fish family Pomacentridae, 17 species were found.

Species that originate from eight genera, namely Pomacentrus, Dascyllus, Chrysiptera, Neopomacentrus, Chromis, Abudefduf, Amphiprion, and Amblyglyphidodon, can be seen in Table 6.

Table 6. Type and quantity of individual fish

Genus	Species	St. I		St.II		St. III		Total (ind)
		Depth						
		5	7	5	7	5	7	
Pomacentrus	*P. amboinensis*	5	0	2	0	2	2	11
	P. chrysurus s	2	0	1 0	7	1 2	9	40
	P. coelestis	2	0	0	0	4	3	9
	P. molucensis	12	5	3	5	35	22	82
	P. burroughi	2	0	6	0	4	8	20
Dascyllus	*D. trimaculatus*	0	0	13	4	8	10	35
	D. reticulatus	0	0	0	0	4	7	11
Chrysiptera	*C. talboti*	0	4	7	11	6	15	43
Neopomacentrus	*N. nigroris*	0	0	0	0	6	2	8
	N. melas	2	0	3	5	11	7	28
	N. azysron	0	0	12	5	5	3	25
Chromis	*C. atripectoralis*	3	0	0	0	3	2	8
Abudefduf	*A. septemfasciatus*	4	2	6	3	5	3	23
	A. vaigiensis	14	3	8	5	13	11	54
Amphiprion	*A. ocellaris*	0	3	8	7	0	0	18
	A. sandaracinus	0	0	0	3	4	9	16
Amblylyphidodon	*A. leucogaster*	0	0	8	3	5	3	19
Amount		46	17	86	58	127	116	450

Based on the results of observations in each station research in the waters of Pagang Island, the total number of individual fish is 450, with a distribution per depth range between 17 and 127 individuals. The most abundant species is *Pomacentrus moluccenesis,* totaling 82 individuals, while the least abundant species found is *Chromis atripectoralis* and *Neopomacentrus nigroris,* eight individuals each. Locations with the most significant number of individuals are station III at a depth of 5 m, with a total of 127 individuals, while the lowest amount recorded is at station I at a depth of 7 m, totaling 17 individuals.

Station III, at a depth of 5 m with a mark percentage covering reef coral, also has the highest number of individual fish from the family Pomacentridae, the highest from every station. In contrast, it is at station I, with a depth of 7 m, with the lowest percentage of reef coral cover, many individuals from the fish family, and few pomacentridae. According to a previous study, the structure microhabitat coral heavily influences abundance and diversity of Pomacentridae. Pratchett et al.[20] found that index diversity and abundance of coral fish increase along with increasing complexity of surface reefs, because more Lots gap shelters and source food are distributed evenly.

According to Almany et al.[21], habitat simplification due to degradation of coral branching can lower the abundance of dependent species, including *N. nigroris*. Thus, scarcity of the second species at station II reflects declining coral, but also affirms the importance of diversity of coral life forms as a determinant of the spatial distribution and abundance of coral fish.

Abundance of Coral Fish Family Pomacentridae

Based on calculations, the average abundance of coral fish of the Pomacentridae family in each Pagang Island water station shows different values. Estimates of abundance individuals per hectare (ind /ha), obtained by converting abundance data on sampling area units to unit hectares, are presented in Figure 4.
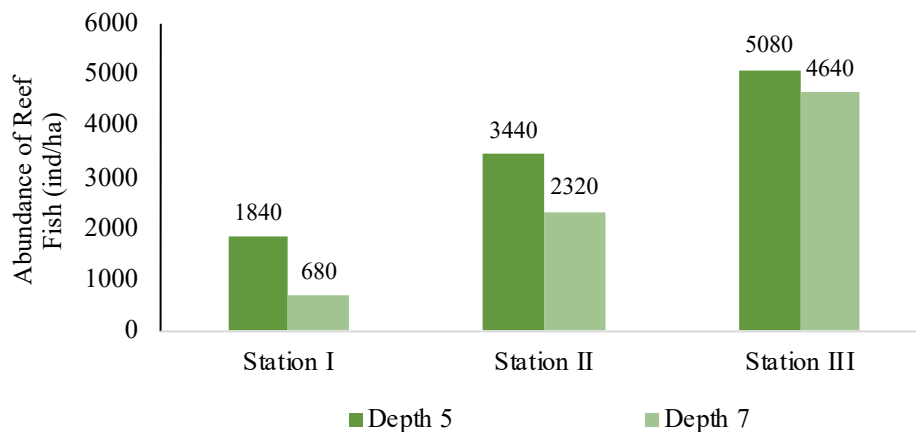

Figure 4. Abundance of coral fish (ind /ha)

The abundance of fish family Pomacentridae in every station research at a depth of 5 m and 7 m ranges between 680 - 5080 ind / ha, with an average of 3000 ind / ha. At station I, 1840 ind / ha was recorded at a depth of 5 m and 680 ind / ha at a depth of 7 m. Station II, respectively, 3440 ind / ha at a depth of 5 m and 2320 ind / ha at a depth of 7 m. Station III shows the highest mark, namely 5080 ind / ha at a depth of 5 m and 4640 ind / ha at a depth of 7 m. Accumulation of sediment reduces water transparency and covers the gaps between branch coral, hindering turf algae growth and narrowing the place to take shelter for Pomacentridae. Presumptive factor, additional reinforcement difference between station covering overflow land that increases turbidity and decreases water quality at stations I and II, limitations connectivity reefs that reduce the supply of fish larvae in the waters near beaches[22], as well as level heterogeneity, more substrate low so that microhabitat for juvenile fish to become limited.

Relationship between Coral Reef Cover and Fish Abundance Coral Family Pomacentridae

An analysis of the connection between percentage cover reef coral and abundance of reef fish family Pomacentridae was done with simple linear regression using Microsoft Excel. The analysis results are presented in the picture under Figure 5.

$y = 86.216x + 1491.8$
$R^2 = 0.7425$
$r = 0.8617$
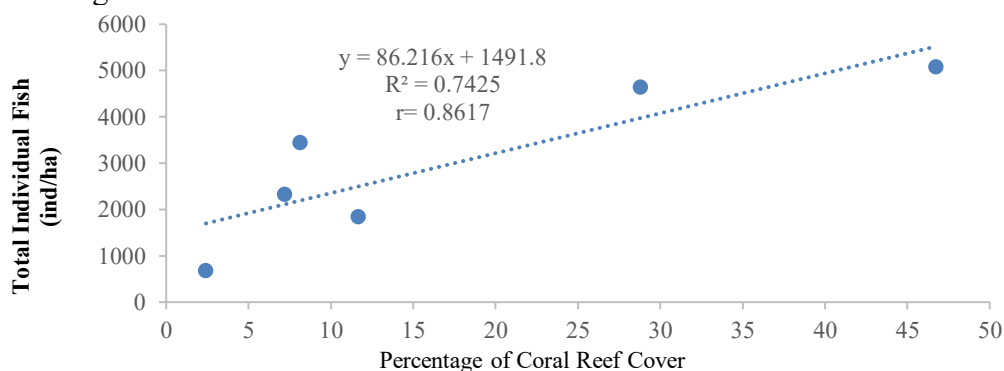
Figure 5. Relationship percentage covers coral life to the abundance of the coral fish family Pomacentridae

Based on the analysis of simple linear regression, the obtained coefficient determination (R^2) of 0.7425, which shows that the percentage cover of coral life can explain 74.25% of the variation in abundance of the coral fish family Pomacentridae, while other factors influence 25.75%. The coefficient correlation (r) of 0.8617 indicates a strong relationship between the second variable. Besides that, the value of the F significance of 0.027 ($p < 0.05$) confirms that the regression model is statistically significant. Thus, the percentage of coral life covered strongly influences the abundance of the coral fish family Pomacentridae in the waters of Pagang Island[17].

Fish from the family Pomacentridae play a vital role in maintaining a balanced ecosystem of reef coral by eating algae and plankton, which helps hinder algae dominance on the substrate coral[23]. The abundance of Pomacentridae in areas that cover coral branching shows that the habitat supports recruitment and a continuous population. On the other hand, disturbances from human activity, such as snorkeling, anchoring ships, and sedimentation, negatively impact the structural physique of reefs, so that lower Power support habitat[24-25].

4.   CONCLUSION

Based on the research that has been conducted, it can be concluded that in the waters of Pagang Island, the condition of live coral reefs is in the poor category. However, the abundance of fish from the Pomacentridae family is relatively high, especially at a depth of 5 meters. The study shows a strong relationship between the percentage of live coral reef cover and the abundance of individual Pomacentridae fish, indicating that coral reef damage can have a negative impact on the population of these fish.

REFERENCES

1. Nirwan, N., Syahdan, M., & Salim, D. Studi kerusakan ekosistem terumbu karang di kawasan wisata bahari Pulau Liukang Loe Kabupaten Bulukumba Provinsi Sulawesi Selatan. *Marine Coastal and Small Islands Journal-Jurnal Ilmiah Ilmu Kelautan*, 2017; 1(1): 11-22

2. Mutahari, A., Riyantini, I., Yuliadi, L. P. S., & Pamungkas, W. Analisis Kondisi Terumbu Karang Kawasan Pariwisata dan Non Pariwisata di Perairan Gugus Pulau Kelapa Kecamatan Kepulauan Seribu Utara. *Jurnal Perikanan Kelautan*, 2019; 10(2): 43-49.

3. Indrabudi, T., & Alik R. Status Kondisi Terumbu Karang di Teluk Ambon. *Widyariset*, 2017; 3(1): 81-94

4. Hadi, T.A., Gyanto, P. Bayu, M. Hafidzt, B. Agus., & Suharsono. Status Terumbu Karang Indonesia. *Pusat Penelitian Oseanografi*. LIPI: Jakarta. 2018.

5. Rembet, U.N., Boer, M., Bengen, D.G., & Fahrudin, A. Struktur Komunitas Ikan Target di Terumbu Karang Pulau Hogow dan Putus-Putus Sulawesi Utara. *Jurnal Perikanan dan Kelautan Tropis*, 2011; 7(2): 60-65

6. Edrus, I.N., & Hadi, T.A. Komunitas Ikan Karang di Perairan Karang Pulau Weh, Sabang, Provinsi Aceh. *Depik*, 2020; 9: 56-67.

7. Nainggolan, N. Keragaman Ikan Karang Famili Pomacentridae di Perairan Pulau Panjang Kabupaten Aceh Singkil. Universitas Sumatera Utara. 2019.

8. Sirait, J.P., Siregar, S.H., & Nedi, S. Condition of Coral Reef Cover and Overview of Coral Fish in Pagang Island, South Coast, West Sumatera. *Journal of Coastal and Ocean Sciences*, 2022; 3(1): 1-8

9. Rafli, M., Zulkifli, Z., & Thamrin, T. Kondisi Tutupan Terumbu Karang dan Kelimpahan Ikan Karang Famili Pomacentridae di Perairan Pulau Talam, Kabupaten Tapanuli Tengah, Provinsi Sumatera Utara. *Jurnal Zona*, 2022; 6(2): 99-109

10. Sitohang, M.S.U., Nurrachmi, I., & Thamrin, T. Coral Reef Cover Relationship to Pomacentridae and Phytoplankton Coral Fish in Kasiak Island of West Sumatra Province. *Asian Journal of Aquatic Sciences*, 2021; 4(2): 117-126

11. Amrullah, M.Y., & Rahmat, F.B. Kondisi Ikan Karang Famili Chaetodontidae Kawasan Konservasi Pulau Pieh dan Laut Sekitarnya pada Zona Inti dan Zona Lainya. *Semah Jurnal Pengelolaan Sumberdaya Perairan*, 2024; 8(1): 103-111.

12. Allen, G.R. *Marine Fishes of South East Asian.* Kaleidoscope Pront and Prepress Periplus Edition, Perth, Western Australia. 1999.

13. White, W.T., Last, P.R., Dharmadi, Faizah, R., Chodrijah, U., Prisantoso, B.I., Pogonoski, J.J., Puckridge, M., & Blaber, S.J.M. Market Fishes of Indonesia / Jenis-Jenis Ikan di Indonesia (*Australian Centre for International Agricultural Research*). 2013.

14. Giyanto, M.A., Abrar, M., Siringoringo, R.M., Suharti, S.R., Wibowo, K., Edrus, I., & Zulfianita, D. *Panduan Monitoring Kesehatan Terumbu Karang.* Coremap LIPI, Jakarta. 2014; 71pp

15. Sudarmaji, S., & Efendy, M. Hubungan Persentase Penutupan Karang Hidup terhadap Kelimpahan Ikan Karang di Perairan Pulau Noko Selayar Kabupaten Gersik. *Juvenil*: *Jurnal Ilmiah Kelautan dan Perikanan*, 2021; 2(1): 39-46.

16. Coremap II LIPI. *Penentuan Kriteria Kelimpahan Ikan Terumbu Karang.* Pusat Penelitian Oseanografi-LIPI. Jakarta. 2009.

17. Tanjung, A. *Rancangan Percobaan.* Tantaramesta. Bandung. 2014; 114 pp

18. Lapointe, B.E., Brewton, R.A., Herren, L.W., Porter, J.W., & Hu, C. Nitrogen Enrichment, Altered Stoichiometry, and Coral Reef Decline at Looe Key, Florida Keys, USA: a 3-Decade Study. *Marine Biology*, 2019; 166(8): 108

19. Hughes, T.P., Kerry, J.T., Álvarez-Noriega, M., Álvarez-Romero, J.G., Anderson, K.D., Baird, A.H., & Wilson, S.K. Global Warming and Recurrent Mass Bleaching of Corals. *Nature*, 2017; 543(7645): 373-377

20. Pratchett, M.S., Wilson, S.K., & Baird, A.H. Declines in the Abundance of Chaetodon Butterflyfishes Following Extensive Coral Depletion. *Journal of Fish Biology*, 2006; 69(5): 1269-1280

21. Almany, G.R., Connolly, S.R., Heath, D.D., Hogan, J.D., Jones, G.P., McCook, L.J. & Williamson, D.H. Local Replenishment of Coral Reef Fish Populations in a Marine Reserve. *Science*, 2007; 316(5825): 742–744

22. Harrison, H.B., Bode, M., Williamson, D.H., Berumen, M.L., & Jones, G.P. A Connectivity Portfolio Effect Stabilizes Marine Reserve Performance. *Proceedings of the National Academy of Sciences*, 2020; 117(41): 25595-25600

23. Ceccarelli D.M. Modification of Benthic Communities by Territorial Damselfish: A Multispecies Comparison. *Coral Reefs*, 2007; 26(4): 853–866

24. Wilkinson, C. *Status of Coral Reefs of the World: 2008 Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre.* Townsville. Australia. 2008. 296 pp.

25. Harborne, A.R., Rogers, A., Bozec, Y.M., & Mumby, P.J. Multiple Stressors and the Functioning of Coral Reefs. *Annual Review of Marine Science*, 2017; 9(1): 445-468