Multi years catch composition and abundance of Parrotfish landed at Makassar Fisheries Port

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Abstract. Parrotfishes have an important ecological role in the coral reef ecosystem of the Spermonde Islands. The Spermonde Islands is located in the Makassar Strait, who was Wallace's line trajectory. The Spermonde Islands consist of 120 islands, which have an area of around 2,500 km², consisting of 50 vegetated islands and 70 non-vegetated sand dunes. Vegetated islands were inhabited around 50,000 people. The ecological role and economic value of Parrotfishes place Parrotfishes in a paradoxical situation. Economically, Parrotfishes are an important protein resource for coastal and highlands communities. The Socio-economic contribution of Parrotfish can be overlooked, especially after the call not to eat Parrotfishes. For this reason, it necessary to overview the species composition and abundance of the Parrotfishes catch in Spermonde Islands by a monthly sampling of Parrotfish landed at Makassar Fisheries Port. The study aims to analyze the species composition and abundance for two different sampling periods (2014 and 2018) and to analyze their annual similarities. The study was expected to provide a preliminary description of the Parrotfishes. The number of species found in 2014 was 31, and in 2018 was 34. The similarity index between 2014 and 2015 was 0.912. The similarities indexes for monthly catches were lower. It was between 0.423 (May) and 0.680 (December). The catch was randomly distributed; this result shows that there were no target species in the catch of Parrotfish; the fishermen caught whatever Parrotfish they found. The sample conditions prove that large-sized Parrotfish were captured using the spear, whereas the medium and small size of Parrotfish seems to be captured using the net. The net use was quite worrying because the net was generally not selective. In order to maintain a balance between Parrotfish's ecological role and socio-economic functions, regulations should be made regarding the prohibition on parrotfish catch with nets. It is recommended that Parrotfish should only be caught using the spear regularly and orderly so as not to damage the coral reefs.

1. Introduction

Parrotfishes are reef fish of Scaridae families that have around 90 species. Parrotfishes are herbivores that live in tropical and subtropical regions of Indo-Pacific waters[1]. Parrotfishes are generally solitary fish[2] that can live from shallow waters to depths of up to 25 m.
As herbivorous fish, Parrotfishes have an important ecological role in maintaining ecosystem balance in the coral reef ecosystem[1]. Parrotfishes can maintain the balance of marine aquatic plant community structures in the coral reef ecosystem. Parrotfish resource management that does not pay attention to sustainability aspects can cause a shift in the community from coral to macroalgae because macroalgae can hinder recruitment and coral growth[3]. Therefore, Parrotfishes as target fish that have important economic value must be managed by regarding ecological role. Overfishing can reduce the ecological contribution of Parrotfishes to the coral reef ecosystems[4].

Overfishing is one of the main problems in coral reef ecosystems management[5]. Several studies on the coral reef ecosystem of the Pacific Islands reveal that fishing pressures on reef fish populations were significant[6]. Overfishing can increase the vulnerability of coral communities[7]. This vulnerability can be exacerbated by global warming, which continues to increase[8].

Parrotfishes that caught in the Spermonde Islands waters were generally landed on the Makassar Fisheries Port. The Spermonde Islands are located in the Makassar Strait region, which is one of the fishing ground in South Sulawesi[9]. The Spermonde Islands is an archipelago that consists of 120 islands, which have an area of around 2,500 km$^2$, consisting of 50 vegetated islands and 70 non-vegetated sand dunes[10]. The vegetated island was inhabited around 50,000 people[11].

The ecological role and economic value of Parrotfishes place Parrotfishes in a paradoxical situation. Economically, Parrotfishes are an important protein resource for coastal and highlands communities. Parrotfishes are generally traded in traditional markets in highlands areas as dried fish. Although it is not yet supported by previous studies, Parrotfishes are thought to contribute to reducing iodine deficits in highlands communities. This socio-economic contribution can be overlooked, especially after the call not to eat Parrotfishes. For this reason, it necessary to overview the species composition and abundance of the Parrotfishes capture in Spermonde Islands as one of the important fishing areas in Wallace's line by a monthly sampling of Parrotfish landed at Makassar Fisheries Port. This study aims to analyze the variation of species composition and abundance for two different periods (2014 and 2018) and to analyze their annual similarities. This study was expected to provide a preliminary description of the Parrotfishes capture at one of the important fishing areas in the area of Wallace’s line.

2. Methods
Parrotfishes sampling was done throughout 2014 and 2018 at Makassar Fisheries Port, South Sulawesi, Indonesia (Figure 1). Long-term sampling was intended to obtain the species composition and abundance of Parrotfishes caught in Spermonde Islands, South Sulawesi, Indonesia.

![Figure 1. Map of the Makassar Strait, Spermonde Archipelago, and Makassar Fisheries Port Location.](image-url)
The parameters observed were species names and the number of each species. Identification of species names refers to[12,13] Abundance is described in the number of individuals for each species. Abundance is compared in percentage value. 

The similarity index was calculated based on the similarity index formula with reference to[14], namely:

\[
Si = \frac{c}{a + b + c}
\]

where Si was a similarity index; a was the number of species found only in Month or Year A; b was the number of species found only in Month or Year B, and c was number of species found both in Month or Year A and B

3. Results

The number of species found in 2014 was 31, and 2018 was 34, of which 31 species were found together for both years. The similarity index between 2014 and 2015 was 0.912. The similarities indexes for monthly catches were lower. The similarities index for the same month for in 2014 and 2018 were lower, which is between 0.423 (May) and 0.680 (December).

The number of species found in January 2014 and 2018 was 18 and 18. The number of species found together in January 2014 and 2018 was 14. The similarity index for both months was 0.636. The five highest abundance were Chlorurus capistratoides, Scarus flavipectoralis, Scarus forsteni, Scarus niger, and Scarus chameleon (Figure 2).

![Figure 2](image)

**Figure 2.** The percentage of presence of all species of Parrotfish in the sampling of January 2014 and 2018.

The number of species found in February 2014 and 2018 was 19 and 17. The number of species found together in February 2014 and 2018 was 13. The similarity index for both months was 0.565. The five highest abundance were Chlorurus capistratoides, Scarus niger, Scarus schlegeli, Scarus chameleon, and Scarus flavipectoralis(Figure 3).

![Figure 3](image)

**Figure 3.** The abundance of Parrotfish in the sampling of February 2014 and 2018.
The number of species found in March 2014 and 2018 was 15 and 18. The number of species found together in March 2014 and 2018 was 13. The similarity index for both months was 0.435. The five highest abundance were *Scarus flavipectoralis*, *Scarus schlegeli*, *Chlorurus capistratoides*, *Scarus chameleon*, and *Scarus niger* (Figure 4).

![Figure 4. The abundance of Parrotfish in the sampling of March 2014 and 2018.](image)

The number of species found in April 2014 and 2018 was 17 and 26. The number of species found together in April 2014 and 2018 was 10. The similarity index for both months was 0.536. The five highest abundance were *Hipposcarus longiceps*, *Scarus flavipectoralis*, *Scarus rivulatus*, *Chlorurus sordidus*, and *Scarus quoyi* (Figure 5).

![Figure 5. The abundance of Parrotfish in the sampling of April 2014 and 2018.](image)

The number of species found on May 2014 and 2018 was 17 and 20. The number of species found together in May 2014 and 2018 was 15. The similarity index for both months was 0.423. The five highest abundance were *Scarus flavipectoralis*, *Scarus ghobban*, *Calotomus spinidens*, *Scarus festivus*, and *Scarus schlegeli* (Figure 6).

![Figure 6. The abundance of Parrotfish in the sampling of May 2014 and 2018.](image)
The number of species found in June 2014 and 2018 was 14 and 18. The number of species found together in June 2014 and 2018 was 11. The similarity index for both months was 0.600. The five highest abundance were Chlorurus capistratoides, Scarus flavipectoralis, Scarus niger, Scarus ghobban, and Chlorurus bleekeri (Figure 7).

![Figure 7](image_url)

**Figure 7.** The abundance of Parrotfish in the sampling of June 2014 and 2018.

The number of species found in July 2014 and 2018 was 19 and 16. The number of species found together in July 2014 and 2018 was 12. The similarity index for both months was 0.458. The five highest abundance were Scarus quoyi, Scarus ghobban, Scarus festivus, Scarus flavipectoralis, and Scarus niger (Figure 8).

![Figure 8](image_url)

**Figure 8.** The abundance of Parrotfish in the sampling of July 2014 and 2018.

The number of species found in August 2014 and 2018 was 18 and 18. The number of species found together in August 2014 and 2018 was 11. The similarity index for both months was 0.565. The five highest abundance were Scarus flavipectoralis, Scarus ghobban, Scarus festivus, Chlorurus bleekeri, and Chlorurus capistratoides (Figure 9).

![Figure 9](image_url)

**Figure 9.** The abundance of Parrotfish in the sampling of August 2014 and 2018.
The number of species found in September 2014 and 2018 was 17 and 23. The number of species found together in September 2014 and 2018 was 14. The similarity index for both months was 0.538. The five highest abundance were *Scarus flavipectoralis*, *Scarus schlegelii*, *Scarus quoyi*, *Scarus ghobban*, and *Chlorurus sordidus* (Figure 10).

![Figure 10. The abundance of Parrotfish in the sampling of September 2014 and 2018.](image)

The number of species found in October 2014 and 2018 was 19 and 24. The number of species found together in October 2014 and 2018 was 17. The similarity index for both months was 0.654. The five highest abundance were *Scarus flavipectoralis*, *Chlorurus bleekerii*, *Scarus niger*, *Chlorurus sordidus*, and *Scarus quoyi* (Figure 11).

![Figure 11. The abundance of Parrotfish in the sampling of October 2014 and 2018.](image)

The number of species found in November 2014 and 2018 was 20 and 17. The number of species found together in November 2014 and 2018 was 13. The similarity index for both months was 0.542. The five highest abundance were *Calotomus carolinus*, *Chlorurus capistratoides*, *Scarus schlegeli*, *Scarus niger*, and *Scarus ghobban* (Figure 12).

![Figure 12. The abundance of Parrotfish in the sampling of November 2014 and 2018.](image)
The number of species found in December 2014 and 2018 was 19 and 23. The number of species found together in December 2014 and 2018 was 17. The similarity index for both months was 0.680. The five highest abundance were *Chlorurus capistratoides*, *Chlorurus bleekeri*, *Scarus flavipectoralis*, *Scarus chameleon*, and *Scarus niger* (Figure 13).

![Figure 13. The abundance of Parrotfish in the sampling of December 2014 and 2018.](image)

4. Discussion

The catch was randomly distributed. This shows that there were no target species in the catch of Parrotfish. Of the 24 sampling periods, it was found that 15 species had performed at least once as the five highest abundance in the sampling (Figure 14), namely *Scarus flavipectoralis*, *Scarus niger*, *Chlorurus capistratoides*, *Scarus ghobban*, *Scarus schlegeli*, *Scarus quoyi*, *Chlorurus bleekeri*, *Scarus chameleon*, *Chlorurus sordidus*, *Scarus festivus*, *Scarus rivulatus*, *Scarus forsteni*, *Hippocaruss longiceps*, *Calotomus carolinus*, and *Calotomus spinidens* (Table 1). The abundance of Parrotfish in the sample seems to have something to do with the availability of food [15] at the location where it was caught. If the food is abundant, then the catch is abundant too.

The Parrotfish catch was not selective, so it can be concluded that the fishermen did not choose the target species, the fishermen caught whatever Parrotfish they found. Based on the condition of the sample obtained, it can be proven that large-sized Parrotfish were captured using the spear, the large-sized of Parrotfish have wounds or holes in their body. Whereas the medium and small size of Parrotfish seems to be captured using the net, in small fish, the scales on the head were peeled off (Figure 15). Scales on the head are usually peeled off when the fish is released from the net.

![Figure 14. The abundance of Parrotfish in the sampling of 2014 and 2018.](image)

The presence of the large numbers of small-size at each sampling proves the nets use to catch small fish. The nets use quite worrying because it is generally not selective; it can capture all sizes of fish that exist. Therefore, ecologically, the use of spears is safer because it is selective and targets large-sized fish, so it has a smaller contribution to overfishing. Urbanization and population growth within the Spermonde Islands region were the complex problems that have an impact on the management of Parrotfish. In the future, Parrotfish resource management needs to be continually improved because...
population growth and urbanization have been shown to increase pressure on the Parrotfish population[4]. The importance of Parrotfish resource management is not only to catch purposes but also to improve coral reef recovery [16].

In order to maintain the balance between Parrotfish's ecological functions and socio-economic functions, regulations should be made regarding the prohibition on parrotfish capture by using the nets. It is recommended that Parrotfish should only be caught using the spear regularly and orderly so as not to damage the coral reefs. Parrotfish catch by using the spear needs to be regulated because fishing activities and other human activities in the coral reef ecosystem have an impact on the ecological role of Parrotfish[7].

Table 1. The fifteen species that have ever appeared as the five highest abundance of Parrotfish in the sampling of 2014 and 2018.

| Species          | Abundance | 2014 | 2015 | Average | J | F | M | A | M | J | A | S | O | N | D | Σ | %  |
|------------------|-----------|------|------|---------|---|--|--|--|---|---|---|---|---|---|---|---|---|
| Scarus flavipectoralis | 14.5      | 14.7 | 5    | 7      | 14.66 | 2 | 5 | 1 | 2 | 2 | 4 | 1 | 1 | 1 | 3 | 11 | 91.67 |
| Scarus niger     | 8.58      | 6.90 | 7.74 | 4      | 2 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 9 | 75.00 |
| Chlorurus capistratoides | 11.6     | 7    | 9.03 | 10.35 | 1 | 1 | 3 | 1 | 5 | 2 | 1 | 7 | 58.33 |
| Scarus schlegeli | 8.25      | 4.96 | 6.61 | 2      | 4 | 2 | 2 | 4 | 5 | 6 | 5 | 0.00 |
| Scarus quoyi     | 8.62      | 5.78 | 7.20 | 3      | 2 | 5 | 3 | 3 | 4 | 3 | 3 | 33.33 |
| Scarus chameleon | 6.06      | 6.01 | 6.03 | 5      | 1 | 3 | 5 | 6 | 4 | 4 | 3 | 33.33 |
| Chlorurus sordidus | 6.91    | 4.19 | 6.03 | 5      | 4 | 2 | 2 | 2 | 4 | 3 | 3 | 33.33 |
| Scarus festivus  | 4.96      | 4.61 | 4.79 | 5      | 4 | 4 | 4 | 4 | 3 | 2 | 5 | 25.00 |
| Scarus rivulatus | 3.90      | 4.92 | 4.41 | 4      | 5 | 4 | 3 | 3 | 2 | 5 | 25.00 |
| Scarus forsteni  | 1.22      | 4.96 | 3.09 | 4      | 3 | 3 | 3 | 2 | 5 | 3 | 25.00 |
| Hipposcarus longiceps | 3.17  | 3.91 | 3.54 | 3      |    | 1 |    |    |    |    |    | 8.33 |
| Calotomus carolinus | 3.98    | 2.44 | 3.21 | 3      |    | 1 |    |    |    |    |    | 8.33 |
| Scarus flavipectoralis | 4.67   | 1.05 | 2.86 | 1      |    | 1 |    |    |    |    |    | 8.33 |
| Scarus niger     | 0.24      | 3.88 | 2.06 | 1      | 1 | 1 | 1 | 1 | 1 | 1 | 8.33 |
| Chlorurus capistratoides | 0.04 | 3.95 | 2.00 | 3      |    | 1 |    |    |    |    |    | 8.33 |

Figure 15. The condition of the hole in the body of Parrotfish allegedly caused by a spear (top) and the condition of several scales on the part of the head that was released due to the net (bottom). Scale: 5 cm.
5. Conclusion
Parrotfish fishing on Spermonde Island was not patterned to certain species, the Parrotfish catch was not selective, so it can be concluded that the fishermen did not choose the target species, the fishermen caught whatever Parrotfish they found. The sample conditions prove that large-sized Parrotfish were captured using the spear, whereas the medium and small size of Parrotfish seems to be captured using the net. The use of nets is quite worrying because the net is generally not selective; it can capture all sizes of fish that exist. In order to maintain a balance between Parrotfish's ecological functions and socio-economic functions, regulations should be made regarding the prohibition on parrotfish captured with nets. It is recommended that Parrotfish should only be caught using a spear.

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References
[1] Bellwood D R, Hoey A S and Choat J H 2003 Limited functional redundancy in high diversity systems: resilience and ecosystem function on coral reefs *Ecol. Lett.* 6 281–5
[2] Streelman J T, Alfaro M, Westneat M W, Bellwood D R and Karl S A 2002 Evolutionary history of the parrotfishes: biogeography, ecomorphology, and comparative diversity *Evolution (N. Y.)* 56 961–71
[3] Hoey A S and Bellwood D R 2009 Limited functional redundancy in a high diversity system: single species dominates key ecological process on coral reefs *Ecosystems* 12 1316–28
[4] Aswani S and Sabetian A 2010 Implications of urbanization for artisanal parrotfish fisheries in the Western Solomon Islands *Conserv. Biol.* 24 520–30
[5] Pandolfi J M, Bradbury R H, Sala E, Hughes T P, Bjorndal K A, Cooke R G, McArldle D, McClanachan L, Newman M J H and Paredes G 2003 Global trajectories of the long-term decline of coral reef ecosystems *Science (80-. ).* 301 955–8
[6] Aswani S and Allen M S 2009 A Marquesan coral reef (French Polynesia) in historical context: an integrated socio-ecological approach *Aquat. Conserv. Mar. Freshw. Ecosyst.* 19 614–25
[7] Bellwood D R, Hoey A S and Hughes T P 2011 Human activity selectively impacts the ecosystem roles of parrotfishes on coral reefs *Proc. R. Soc. B Biol. Sci.* 279 1621–9
[8] Zaneveld J R, Burkepile D E, Shantz A A, Pritchard C E, McMinds R, Payet J P, Welsh R, Correa A M S, Lemoine N P and Rosales S 2016 Overfishing and nutrient pollution interact with temperature to disrupt coral reefs down to microbial scales *Nat. Commun.* 7 11833
[9] Kantun W, Mallawa A and Tuwo A 2018 Reproductive pattern of yellowfin tuna Thunnus albacares in deep and shallow sea FAD in Makassar Strait. *AACL Bioflux* 11 884–93
[10] Kench P S and Mann T 2017 Reef island evolution and dynamics: Insights from the Indian and Pacific oceans and perspectives for the Spermonde Archipelago *Front. Mar. Sci.* 4 145
[11] Glaeser B 2019 Sustainable Coastal Management for Social-Ecological Systems—A Typology Approach in Indonesia *Coastal Management* (Elsevier) pp 61–77
[12] Allen G 1999 *Marine Fishes of South-East Asia: A field guide for anglers and divers* (Tuttle Publishing)
[13] Kuitter R H and Tonozuka T 2001 *Pictorial guide to Indonesian reef fishes* (Zoonetics)
[14] Yue J C and Clayton M K 2005 A similarity measure based on species proportions *Commun. Stat. Methods* 34 2123–31
[15] Rotjan R D and Lewis S M 2006 Parrotfish abundance and selective corallivory on a Belizean coral reef *J. Exp. Mar. Bio. Ecol.* 335 292–301
[16] Burkepile D E 2012 Context-dependent corallivory by parrotfishes in a Caribbean reef ecosystem *Coral Reefs* 31 111–20