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Study the Ecological of the Banggai Cardinalfish in the Sea Waters of Banggai Laut Regency, Indonesia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Indonesia is one of the countries with a high level of biodiversity. This is evidenced by the many species of fish and coral in Indonesian waters. The abundance of biodiversity also allows Indonesia to have endemic species, one of which is the Banggai Cardinalfish. Banggai Cardinalfish (P*terapogon kauderni*) is one of the endemic species found in the Banggai Islands-Central Sulawesi-Indonesia. This study aims to see the bio-ecological conditions of the Banggai Cardinalfish. This study was conducted in January-March 2014 in North Banggai District, Banggai Laut Regency, Central Sulawesi Province. The study was conducted using the observation method and monitoring the population of Pterpogon kauderni at predetermined stations and measuring the quality of marine waters at each station. Population monitoring was carried out using the Belt transect method. The data obtained were then analyzed using population density analysis. The water quality data obtained were then compared with the seawater quality standards according to

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PP No. 22 of 2021. Based on the research results, it is known that the population of Banggai Cardinalfish and associated biota from each location is generally low, only at station III which has the highest population. Water quality conditions are generally optimal only at salinity parameters that tend to be very high.

Keywords: Ecology; endemic species; banggai cardinalfish; populastion; water quality.

1. INTRODUCTION

Indonesia is part of *The Coral Triangle region*, which is a region that has a very high level of biodiversity and is the center of marine biota diversity [1–3]. This high level of biodiversity allows for endemic marine biota species only found in Indonesian waters. Banggai Cardinalfish (*Pterapogon kauderni* Koumans, 1933) is a species endemic to the Banggai Islands-Central Sulawasi and one of Indonesia's Endemic Coral Fish Species [4,5]. This species has a distribution area of 5,000 km ^{2} with a potential habitat area of 20-24 km ^{2}, and it's primary habitat is coastal areas containing coral reefs and seagrass beds with a depth of 0-5 m [6].

The current existence of *Pterapogon kauderni* has experienced a decline in population numbers due to human activities, such as both due to fishing, land use and so on. The United States and the European Union claim that the exploitation of Banggai Cardinalfish for export has been over-harvested and unsustainable [7]. In addition, there are concerns about the taking of associated biota from Banggai Cardinalfish by coastal communities, as a food source [8]. In 2016, 17th CITES CoP, Appendix II, categorized *Pterapogon kauderni* as an endangered species. This decision requires Indonesia to ensure the preservation of this species by carrying out conservation and sustainable management [7–9].

The Indonesian government, through the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia, has issued decision Number 49/KEPMEN-KP/2018 concerning the Determination of the Limited Protection Status of the Banggai Capungan Fish (*Pterapogon kauderni*). Along with the Decree of the Minister of Maritime Affairs and Fisheries Number 53/KEPMEN-KP/2019 concerning coastal conservation and the Banggai Small Islands, Banggai Sea, Banggai Islands and the surrounding waters of Central Sulawesi Province. To maintain the preservation of *Pterapogon kauderni* in its natural habit.

Based on monitoring in 2019, the population status of *Pterapogon kauderni* at eight monitoring locations in the Bokan Islands showed a decline in the population of *Pterapogon kauderni* and its associated biota (sea urchins and sea anemones) [10]. Based on the results of previous population monitoring, it is necessary to re-monitor the Pterapogon kauderni population in different locations in the Banggai Islands. The waters of North Banggai District, Banggai Laut Regency, are one of the areas where *Pterapogon kauderni lives,* and have been designated by the Decree of the Minister of Maritime Affairs and Fisheries as part of the coastal and small island conservation area in Central Sulawesi Province. This area is also a beach tourist attraction in Banggai Laut Regency.

The existence of aquatic biota populations cannot be separated from the quality conditions of the waters. Water quality can be broadly interpreted as physical and chemical factors that influence the life of fish and other aquatic organisms, either directly or indirectly [11]. Monitoring water quality aims to maintain ecosystems and aquatic habitats because decreased water quality quickly affects these two components [12]. Therefore, this research aims to determine the population density of *Pterapogon kauderni* and water quality in Banggai Utara District, Banggai Laut Regency.

2. MATERIALS AND METHODS

2.1 Time and Place

The research was carried out from January to March 2024 in Banggai Utara District, Banggai Laut Regency, Central Sulawesi Province. With four data collection station points, namely; (1) Station I Popisi Village: E123^{o}30.908' and S01^{o}29.956'; (2) Station II Tolisetubono Village: E123^{o}29.966' and S01^{o}31.520'; (3) Station III Bonebaru Village: E123^{o}29.643' and S01^{o}31.916'; (4) Station IV Bonebaru/Bongo Village: E123^{o}28.911' and S1^{o}32.422'. This area is included in the conservation area designated by the Decree of the Minister of Maritime Affairs and Fisheries in PERMEN KP Number 53/KEPMEN-KP/2019. The data collection location can be seen in Fig. 1.

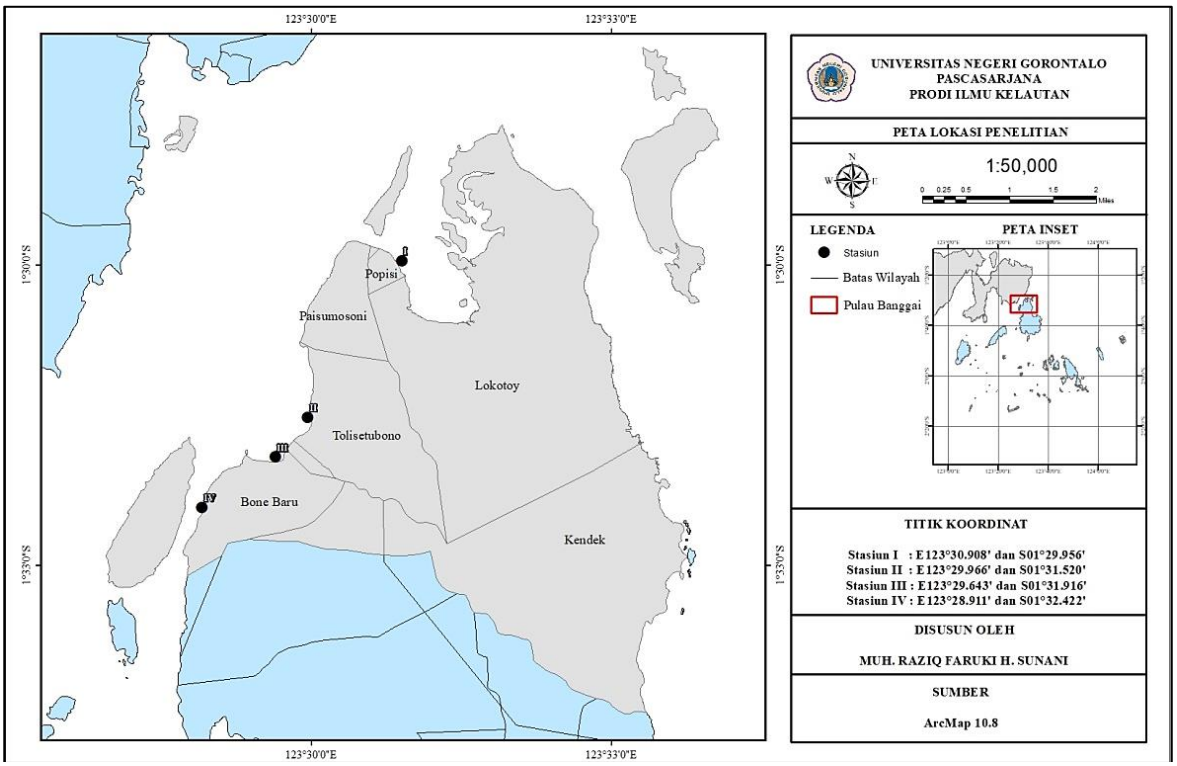

Fig. 1. Research location

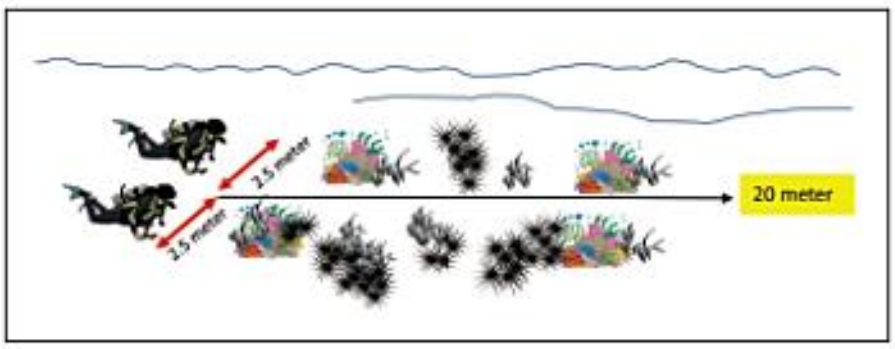

Fig. 2. Population survey *of Pterapogon kauderni* using the *belt transect method* [13]

2.2 Tools and Materials

The tools and materials used in this study were Stationery for data recording, TR-LE-731 Portable for collecting Temperature, pH and DO data, Refracto meter for measuring Salinity, Meter Roll for transect measurements.

2.3 Research Methods

The research was conducted using survey methods and direct observation at predetermined locations. Data was collection by monitoring the population number of *Pterpogon kauderni* at predetermined stations and measuring the quality of sea waters at each station. The technique for collecting data on population numbers and water quality can be seen below.

a. Number of Populations of *Pterpogon kauderni* refers to [13]

1) Observations were carried out by placing transects parallel to the coastline at a depth of 1.5-3 m where Banggai Cardinalfish are generally found. However, it will have to be adjusted to tidal conditions.

2) Observations were made using the *belt transect method.* The size of the transect is 20 m long and 5 m wide (transect area 100 m^2), namely 2.5 m wide on the right and 2.5 m on the left (Fig. 2).
3) Two divers collected data, each dividing the task of collectingfish data. Each on the left and right of the transect.
4) Each sampling station was conducted 6 times. The Banggai Cardinalfish found were recorded based on the fish size category (Recruit :< 1,8 cm, Juvenile 1,8 to 3,5 cm, Adult >3,5 cm).

b. Water quality

1) Water quality measurement is carried out in-situ including temperature parameters (°C), pH, DO (ppm), salinity (ppt).
2) Sampling is carried out once for each parameter. Water sampling is carried out in a composite manner between the bottom of the water and 30 cm from the water surface.

2.4 Data Analysis

Data from *the Pterapogon kauderni population survey* and associated Biota were analyzed to determine the density of fish at each location and size category using a density formula based on the following monitoring guidelines from the Ministry of Marine Affairs and Fisheries:

$$Density\ Population\ (individu/m^2) = \frac{\frac{total\ fish\ individuals}{100}}{} \quad [13]$$

Water quality measurement data is analyzed by comparing with quality standards based on PP No. 22 of 2021 concerning sea water quality standards.

3. RESULTS AND DISCUSSION

3.1 Population Conditions of *Pterapogon kauderni*

Fig. 3 presents the *Pterapogon kauderni* population survey results. The most numerous *Pterpogon kauderni* population is at station III, which is dominated by the very high presence of Juveniles, reaching 12.60 Individuals/m^2, then Adults 2.18 Individuals/m^2 and Recruitment 1.14 Individuals/m^2.

The high population at station III is likely due to the many associated biota and coral reefs there. *Pterapogon kauderni* can be found in seagrass and coral reef ecosystems, including fringing reefs and reef flats [7]. Coral reefs provide a place for fish to shelter, spawn and feed.

The lowest population density was found at station II, with the number of recruit 0.06 individuals/m^2, juveniles 0.44 individuals/m^2, and adults 0.96 individuals/m^2. The low population of *Pterapogon kauderdi* at station II is likely due to the lack of associated biota at that location. The absence of an ecosystem supporting this species and its associated biota can affect its population density. *Pterapogon kauderni* does not have a self-defense mechanism, so it needs associated biota to avoid predators. It is known that for most of its life, it coexists with biota; its leading associations are sea urchins, soft corals, and sea anemones [7,10,14].

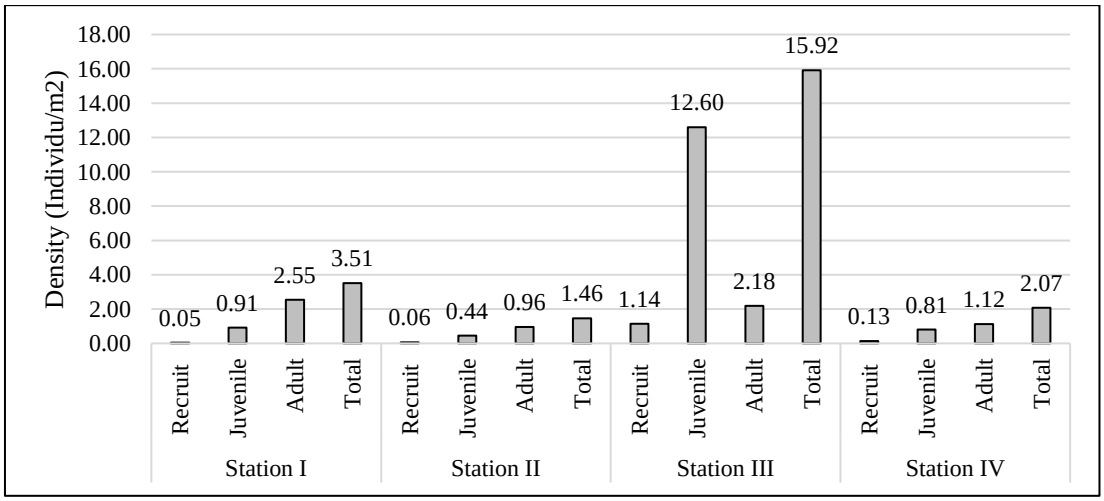

Fig. 3. Population Density of *Pterpogon kauderni*

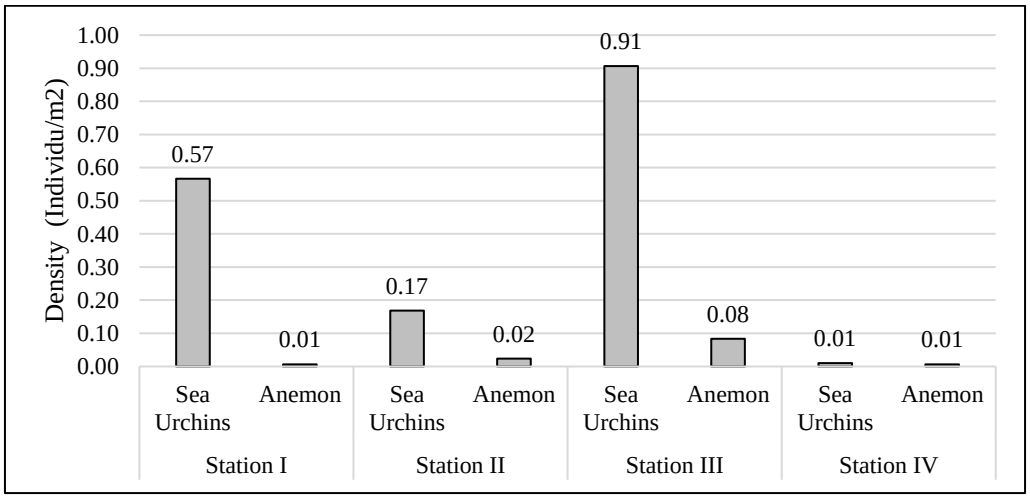

Fig. 4. Association biota population

Table 1. Water quality at the research location

Parameter	Location				Quality Standards (PP No. 22 of 2021)	Note.
	Station I	Station II	Station III	Station IV		
Temperature (°C)	29.8	29.9	29.3	31.8	28 to 32 °C	Optimal
pH	8.06	8.08	8.01	8.19	7 to 8.5	Optimal
DO (ppm)	7.9	11.04	8.1	11.04	> 5 ppm	Optimal
Salinity (ppt)	35	34	41	36	33 to 34 ppm	Bad

3.2 Condition of Association Biota

Based on Fig. 4. The population of associated biota (sea urchins and anemones) is most abundant at station III, with a density of sea urchins of 0.91 individuals/m ^{2} and anemones of 0.08 individuals/m^2. Meanwhile, the lowest was at station IV with a density of both associated biota, namely 0.01 individuals/m ^{2}.

It is strongly suspected that the associated biota at Station IV exists because it is captured for consumption by the local community. Tourist activities can also be the cause of the reduction in sea urchins in the area. As is known, this area is a tourist spot for local people on Banggai Island. The loss of associated biota is caused by habitat degradation caused by human activities and climate change [7,10].

3.3 Water Quality

Water quality conditions at each research location can be seen in Table 1.

Based on the research results, it is known that the water quality conditions for temperature, pH, and DO at each station are still optimal for seawater biota. The water temperature at the research location ranges from 29.3 to 31.8 °C. Optimal water conditions will have a good impact on marine biota. These conditions will support the metabolic processes of fish so that they can support growth, survival and reproduction.

The pH of the water ranges between 8.01 to 8.19, which is still in optimal conditions. Water pH can affect the physiology of marine biota, including inhibiting growth, biota will be very sensitive to bacteria and parasites, and the water will be toxic to fish. Changes in pH that are very acidic or alkaline will disrupt the survival of aquatic organisms because they disrupt the respiration process [13].

The DO condition of the research location waters ranges from 7.9 to 11.04 ppm, which is very good. The DO of waters greatly determines the survival of marine biota. Water conditions that contain dissolved oxygen. Oxygen levels can affect the decomposition, reproduction and growth processes. The need for dissolved oxygen in fish is influenced by age, activity and water conditions. The oxygen content influences organic and inorganic materials' oxidation and reduction processes [15].

Salinity at the research location ranges from 34 to 41 ppt, this value is quite high and can be dangerous for the existence of marine biota. Seawater salinity influences the distribution, abundance and growth of aquatic biota as well as their density in a body of water [16]. Suboptimal salinity can cause osmoregulation disorders for biota. The water's high salinity is likely due to the very high evaporation level. The cause of the high salinity is also thought to be due to the data collection being carried out in sunny and cloudless conditions. One of the factors that influences salinity is evaporation. The greater the level of seawater evaporation in an area, the higher the salinity, and vice versa in areas with low levels of seawater evaporation [17-20].

4. CONCLUSION

[Based on the research results, it is known that the population of Banggai Cardinalfish from each location is generally low, only at station III which has the highest population. The population of associated biota is also low, only at station III which has a high population. Water quality conditions are generally optimal only when the salinity parameter tends to be very high.

Efforts to carry out in-situ conservation need to pay attention to environmental conditions, especially salinity, so that conservation can be carried out optimally.

APPENDIX

Appendix available in this link:
https://journalajfar.com/media/Appendix-2024_AJFAR_122650.pdf

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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