

Abundance and Diversity of Coral Fish in Border Water of Unarang Reef, Nunukan, Kalimantan Utara Province

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Abstract. Nunukan regency, North Kalimantan Province is one of the outermost regions adjacent to the neighboring country Malaysia, both land and water borders. Some of the district is still subject of a claim by Malaysia. One strategic area is Unarang Reef, a coral reef formations situated in the territorial border. The most important natural resources of the region were fisheries and coral reefs. The research objective was to determine the diversity of species of coral fish in the Coral Unarang. Besides, it was also to identify the environmental factors, especially, the coral reefs, turbidity, salinity, pH, flow etc. Sampling of coral fish was conducted using transect technique. The line transect was determined following the permanent sampling points that have been installed under water column permanently. The method used was Underwater Visual Census (UVC), where the fish found at a distance of 2.5 meters on the left and right along the transect lines 25 m were recorded both the species name of fish and amount. Data analysis were diversity and evenness indices. The observation shows that there are about 21 species of coral fish in the waters. The species diversity belong to small, particularly compared to fishes in Bunaken which reached 181 species. The most common species of fish were Pullers, Damselfish, Anemone fish and butterfly fish. Analysis of fish diversity index of H' were between 1.5 to 1.8. The value were likely to be small. This indicated that the stability of the environmental conditions tend to be low, mainly due to the fishing pressure and environmental factors. Environmental factors affected were turbidity, pH, flow and quality of the reef. The quality of the fish should be managed through introducing fish apartment well as protection of the environments. This can be done through mangrove conservation and sea weed culture. Coral will greatly support the preservation of the availability of fish catch for fishermen. The existence of fishermen on the territorial boundary can also be empowered to strengthen border patrol, so that the neighboring countries would be reluctant to claim territory

Introduction

Nunukan regency, North Kalimantan Province is one of the outermost regions adjacent to the neighboring country Malaysia, both land and water borders. Some of the district is still subject of a claim by Malaysia. One strategic area is Unarang Reef, a coral reef formations that are situated in the territorial border. The most important natural resources of the region were fisheries and coral reefs (DKP Nunukan, 2013). The quality of fisheries is strongly influenced by the quality of coral reefs (Dahuri et al, 2004, Supriharyono, 2004). Some or all of the life cycles of the marine fish will be placed on coral reefs. Because of the high occurrence of fish, the reef becomes subject fishing (exploitation). Coral fish is a group of fish that associated with coral reefs, striking its presence and found in various micro-habitats on coral reefs (Setiawan et al, 2013). Coral

fish live and forage in the area of the coral reef, so if the reef is damaged therefore they do so, the reef fish will lose their habitat (Dahuri et al, 2004). As fauna that life associated with coral reefs, the destruction of coral reefs will affect the diversity and abundance of reef fishes (Bengen, 2000). The aim of the study was to determine the diversity of species of coral fish in the Coral Unarang. Besides, it also to identify the health conditions / level of coral damage as well as environmental factors, especially factors salinity, turbidity, depth, dissolved oxygen (DO) and pH of waters. Results were used as input of management especially in border waters in such way provide benefits to community and border management policy

Methodology

Research was done in Oktober 2013 situated in surrounding Unarang reef, Sebatik Strait,

Kabupaten Nunukan, Kalimantan Utara Province. Research station was shown as below:

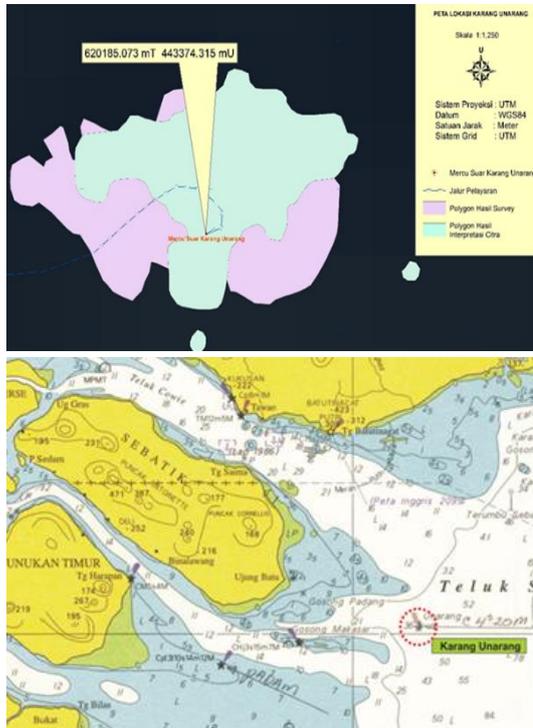


Figure 1. Location of Unarang reef, Kabupaten Nunukan, Kalimantan Utara Province

Sampling of coral fish was conducted using transect technique. The research location was set to be four stations, according to the wind direction out of lighthouse building (Mercusuar), ie south, west, north and east sides of the lighthouse. The method used was the method of Underwater Visual Census (UVC) (Ctitic LIPI, 2009 in Manuputy et al 2006), where the fish were found at a distance of 2.5 meters on the left and right along the transect lines 25 m recorded species of fish and amount. Data were analyzed using community structures of Shnnon-Wiener (H') diversity index (Shannon and Wiener, 1963; Magurran, 1988). The formula of the index were as follows:

$$H' = -\sum p_i \ln p_i$$

In which:

- H' = Diversity index of Shannon-Wiener
- Pi = proporsion of individual abundance of given species of i (ni/N)
- ni = total individual of a species
- N = total individual of all species

Based on the stability of H' index there were 3 categories as mentioned in Table 01. i.e:

Tabel 1. Quality of diversity and its category (Odum 1993)

Diversity Index (H')	Category
H' < 2,0	Low
2 < H' < 3	Moderate
H' > 3	High

Evenness Index (e)

Evenness index (e) is a value that indicates the level of species uniformity which is balance in a division of the number of individuals of each species. The formulas are as follow,

$$e = \frac{H}{\ln S}$$

Where:

- E = Evenness Index
- H = Shannon-Wiener index
- S = total of species

Environmental quality data were analyzed using descriptive comparative mainly to water quality standards for sea water. Coral communities observed through underwater dives using Scuba Diving at depths between 9-15 m. Coral data collection was done by using a sampling technique through Transec Intercept Point (PIT) (English et al, 1997). Quality of coral was determined using the criteria of Brown (1996) as mentioned in Table 02.

Tabel 2. Criteria for coral cover that represent a quality and condition of coral

No	Coral covers (%)	Condition category
1	0,00 – 24,9	Bad
2	25,0 - 49,9	Slightly good
3	50,0 – 74,9	Good
4	75,0 - -100	Very good

Research result

Based on the surveys of reef fish abundance at the sites, it was found 21 species of fishes. When compared with coral fish research in Bunaken (Setiawan et al (2013),

Barranglompo (Rani 2012) or Karimunjawa (Marsaoli, 1998), such number was still very low. It was associated with the wide of the area of coral reefs which was relatively narrow only a 1.8 ha. It was also affected by the environmental stress. Karimunjawa have higher number of coral fish diversity which reached at least 181 species. This area covered coral reef area about 6,800 km² (Marsaoli, 1998). Rani (2013) observed higher number of 52 species in coral reef Barranglompo, South Sulawesi. Narrow regions provided limitation in activities, especially with the territoriality behaviour in some reef fishes. Besides, the abundance and diversity of fish was also associated with environmental factors, especially turbidity, pH, DO, depth and salinity. Instant transparency measurement quantitatively was still clear up in the bottom waters (the depth of 5 m). However, transparency is dramatically changed by the new turbid water column of about 14 NTU. Turbidity directly interfered to the life of the fish though gill disturbance, but indirectly also covers and killing down living reefs, home of fish. Therefore destruction of corals will indirectly cause a decline in fish populations. Observations result of coral fish identification of Unarang can be seen in the following table.

Table 3. Abundance and diversity of Unarang reef (per 125 m²)

General name	Latin Name	Local Name	South st	North st	West st	East st
Target						
Squerrelfishes	Holocentridae	Ikan biji rante	2	-	1	-
Rock cods	<i>Ephinephelus</i> spp (Serranidae)	Ikan Kerapu	-	-	-	2
Spinecheeks	Nemipteridae	Ikan kembayan	-	-	2	1
Sweetlips	Haemulidae	Ikan bibir tebal	-	-	-	4
Snappers	Lutjanidae	Ikan Kakap	3	-	1	-
Fusiliers	Caesionidae	Ikan ekor kuning	25	-	15	-
Emperors	Lethrinidae	Ikan Lencam	-	-	-	4
Goatfishes	Mulidae	Ikan Janggut	3	-	-	-
Baltfish	Ephippidae	Ikan plataks	-	-	-	1

Rabbit fishes	Siganidae (<i>Siganus</i> spp)	Ikan Baronang	-	-	4	-
Surgeons	Acanthuridae	Ikan Butana	7	-	-	-
Pelagics	Carangidae	Ikan Bobara	-	-	-	8
Indicator						
Butterflyfishes	<i>Chaetodon serratus</i> (Chaetodontidae)	Ikan kepe-kepe	8	6	10	
4						
Parrotfishes	Scaridae	Ikan kakatua	-	-	5	-
Major						
Anemonefishes	Amphiprion sp	Ikan Badut	12	5	9	6
Humbugs	Dascyllus		7	3	5	-
Pullers	<i>Chromis</i> sp (Pomacentridae)	Betok Laut	75	20	75	46
Damselfishes	Chrysiptera		50	25	50	35
Wrasses	Labridae		8	3	10	5
Devilfishes	Choridactylinae	Ikan Lepu Batu	-	1	-	-
Boxfishes	Ostracidae	Ikan Buntal		1		

Source: Survey, 2013

Among the common fish species found were Pullers, Damselfish, Anemone fish and butterfly fishes. This was consistent with studies of Setiawan et al (2013) who reported that these species were always present on the coral reef habitats. *Pomacentrus* sp is the dominant species, as in the waters of the coral island Rubiah NAD (Pandiangan, 2009). Family Pomacentridae and Labridae were the most dominant fish on coral reef ecosystems, especially in the tropics (Setiawan et al, 2013). The highest abundance of the family Pomacentridae found on the south station. Cause of high abundance of fish of the family Pomacentridae particularly of species *Chromis ternatensis*, and *Pomacentrus smithi*. This indicates that conditions of coral reefs were still quite good (Table 03) so as to provide more micro-habitats and biotic associations as a food. According to Allen, (2000), in the coral reef ecosystem, trophic level of fish families, Pomacentridae is a species of plants eaters (herbivores) occupied the first level in the food web in the coral reef ecosystem (Bawole, 1998). Pomacentridae has individuals number more abundant than in the upper trophic levels such as fish families Serranidae (carnivores). Important fish species which was not well established, namely parrotfish, where they found beyond a small plot in least abundance.

Unarang coral environmental quality in general also tend to be less suitable for fish lifes, especially from the abundance of fish indicators Caetodontidae which was found only 15 individuals while in Makassar can reach the abundance of 34 fish / 50 m³ (Rani et al, 2012)

Stability of the community.

Results from the analysis of Shannon Wiener diversity index (H') showed a range of values between 1.56 to 1.80. These various level of diversity of reef fish at this location include to low (H' <2.0). The value of the index, as criteria Odum (1993), including weak in stability. This indicates that environmental conditions are tend to disturb both naturally or anthropogenic. The pressure of the environment will significantly affect fish communities. In this case of instability was caused at least by turbidity (4-12 NTU), acidity level (4,4 – 4,6) and quality of coral reefs. Results of the analysis of coral reef structure of Unarang reef can be seen in the following table:

Table 04. Number of individuals, number of species, diversity index and evenness index of coral fish in Unarang reef.

category	South st.	North st	West st	East st
Total individual	200	64	187	116
Total species	11	8	12	11
Diversity Index (H')	1,80	1,56	1,75	1,69
Evenness Index (e)	0,75	0,75	0,74	0,75

Source: Survey 2013

Results of the diversity index analysis in coral reef fish was 0.75 categorized as even (0.75 <E <1). According to Odum (1993) low diversity is associated with many disorders primarily by human activity. Common human activity in that area was fishing, especially unfriendly fishing. Oceanographic disturbances may also occur, due to big waves which often break or even dismantle the coral reefs provoking resuspension of turbidity (Nybakken 1993). Indications of such disturbances was abrasion which was found on the along nearest coast, namely the east coast of the Sebatik island. The current

strength during the storm reached 1.7 knots, which is less suitable for the life of the reef which is only about 0.77 knots.

Table 05. The results of physico-chemical measurements of environmental in the waters around Unarang Reef

Physico-chemical Parameters	South St	North St	East St	West St
DO (ppm)	5	6,9	6,7	5,1
Temperatur (°C)	29,6	29,6	29,6	29,8
Salinity (ppm)	31,2	31,9	31,8	31,2
pH	4,4	4,6	4,5	4,4
Conductivity	39	47	40	40
Turbidity NTU	4	14	12	5

Based on result, at was appear that among four observation stations there were differences in fish diversities. South station showed a better quality, which was found 200 individual fish species with number reaches 11 species. At the east station known that number of individuals has decreased, although the number of species the same as the southern station. While at the northern station number of species and individuals fell into 8 species and 64 individuals. Such differences are generally associated with different reef quality among 3 locations. Coral on north station has the worst condition, with a life form only 5%. North side was shallower and therefore facing strong current that reach 1,7 knot during heavy storm. In the northern station, reef destruction has took place, There were spot of dead coral formations resulted of high pressure with centrifugal force similar to fish bombs. Conditions of living coral in the east and south stations were better reach a value of 30% (moderate conditions) and 52% (good condition). In the western station reef condition is the best with lifeform reached 73% (good condition). This station is slightly lower and more protected from direct current..

Table 5. Quality and condition of coral reef organisms Coral Unarang

No	Station	Coral Life Form (%)	Coral Condition
1	South	52	good
2	East	30	Moderate
3	North	5	bad
4	West	73	good

In term of local issue, Unarang Coral reefs can be stated performing decrease in fish population, particularly reef fish on the north station. This can be managed at least similar or approaching the southern station. A mechanism to recover (rehabilitation) can be done by various methods; among others were establishing coral ball, fish apartments and implantation of coral. Besides, indirect manner this was also to reduce further destruction of coral; especially destructive fishing. Institutionally, it was also can be anticipated by developing environment concerned groups. In regional of East and north Kalimantan waters are very vulnerable to contamination from the mainland, especially the mining and plantation activities. Supervision of these two activities should be intensified by environment board (BLHD). Potential contamination entering into public waters can be controlled at the water edges, both river and beach, which is done by conservation of the mangrove. Mangrove stands in location is still good, although there were tends to be depleted. Mangroves are a natural accumulator both through mechanical (depositing sediments) manner (bind physically onto sludge) and chemically manners (absorption). This stand must be protected, especially from plunder of farmers and timber thieves. Destruction on mangrove communities must be balanced with rehabilitation, both the coastal (mangrove) species and woody plants on the mainland. Against water enrichment and contamination, it can also be done through the cultivation of seaweed. According to information DKP Nunukan (2013), seaweed farming is currently develop very aggressively and will continue to the next few years. Seaweed is economically very profitable, and ecologically also suppressed the excess of fertility (eutrophication) of the sea water. Seaweed also provides habitat and natural food that is good for some fish (herbivore). This fish however is technically does not considered to be pest to the

seaweed cultivation, which is proven by people which did not develop pest control mechanisms. Generally the presence of seaweed is very favorable for Unarang waters, ecologically, socially and economically

Unarang reef area situated near the boundary demarcation of marine waters of NKRI, which is also suffer to illegal fishing from abroad, such as Malaysia and the Philippines. Politically this is suffer from territorial claims by Malaysia. According to local fishermen of Sebatik island, they are reluctant to fish in these waters because of security sensitive. To attract fisher comes, the Government was also already build artificial fish apartment near coral Unarang. However such effort were still less attract to the community to come which is evidenced by decreasing the number of structures. If the quality of the fish catch improved and better security, there will be more fishermen operating and thus can simultaneously functioned to patrol (by public) in the border area

Conclusion

There were 21 species of fishes associated with coral of Unarang reef that must be conserved to strengthen ecological, social and political aspects. The mostly found species was puller (*Chromis* spp) followed by damselfish (*Chysiptera* spp), fusilier, clown fish (*Amphiprion* spp), and butterflyfish (*Chaetodon serratus*).

The diversity of coral fishes were vary from 1,80 – 1,75, qualified as small to moderate stability which is affected by fishing and environmental factors, including coral with lifecover percentage of 5 to 75% qualified as bad to good lifeform.

Reccomendation

The improvement of fish population should be done immediately by growing fish apartment surrounding the areas to attract more fish and fishermen in Nunukan and the last is potentially to be empowered to participate in border patrol.

It requires action in suppressing turbidity factor at least by mangrove forest

conservation both seed re-planting or old plant conservation so that the mud structure of stand becomes sedimented on the mangrove forest floor, reduce current and precipitate dissolved particles and not floating toward coral reef. Besides that, also by massive seaweed planting on beach water so that local current becomes slower and water becomes clearer.

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