

Red snapper *Etelis* sp. feeding behavior in Sario waters, Manado city, North Sulawesi, Indonesia

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Abstract. This study is aimed at providing the legal size, fishing technique, and fishing season in relation with feeding period, bait type, and correct fishing grounds for red snapper *Etelis* sp.. The study utilized explorative method through direct observations and interviews. During the study, 1,650 individuals of red snappers were caught, 879 individuals in morning operation and 771 in afternoon operation. On monthly basis, there were 270 fish caught in July, 215 fish in November, 165 fish in February and the rest was distributed in other months. The best bait for red snapper fishing was squid and caught 806 fish. Red snappers *Etelis* sp. were caught mostly at 04:30-05:00 in the morning and 17:01-17:30 in the afternoon. The fish catches consisted of size range of < 1 kg (166 ind), 1.1-2.0 kg (661 ind), 2.1-3.0 kg (598 ind), and > 3 kg (225 ind). Five fishing ground positions were detected with the highest catches in area 2 (492 ind) and area 4 (358 ind).

Key Words: bait, catch, feeding periodicity, fishing ground.

Introduction. Snappers are one of the most important components of artisanal fisheries in many tropical countries and become the target of commercial fisheries (Allen 1985). Export volume of snapper from Indonesia is estimated around 1.5 to 2.7 thousands metric tonnes per year to the United States, EU countries, Japan, Hongkong, Taiwan, Singapore, Malaysia, South Korea, Australia, Thailand and Middle East as main markets (MMAF 2011) in the form of frozen boneless fillet, but this volume is not enough to meet the market demand (Anggraeni 2012) due to stock decline in the seawater of eastern Indonesian and northern Australia (Blaber et al 2005). This fish is also utilized for fishing recreational sites (Haight et al 1993).

Snappers (Lutjanids) belong to 21 genera and have strong variation in habitat preferences from shallow to deeper waters up to 500 m below the surface, in which the species of the genera *Etelis* and *Aphareus* live in waters up to 500 m below the surface (Newman & Williams 1996). *Etelis* spp. can be found at about 105 m depth in Manado Bay waters and at the depth range of 50-300 m in Ambon waters (Matrutty 2011; Katimpali et al 2012; MMAF 2013). In Konawe waters, demersal fishes live at water temperature of 30.25°C, mean salinity of 33.27‰, pH of 7, current condition of 34.12 m sec⁻¹ (Wa Ode et al 2017). According to Froese & Pauly (2013), genus *Etelis* has 4 species, deep water red snapper *E. carbunculus* G. Cuvier, 1828, deep water longtail red snapper *E. coruscans* Valenciennes, 1862, queen snapper *E. oculatus* Valenciennes, 1828, and pale snapper *E. radiosus* W. D. Anderson, 1981. These groups, in general, inhabit stony bottom with major food of small fishes, large crustaceans, and squids (Allen 1985; Wakefield et al 2020).

Optimization of fishing operations, especially line and hook fishing, needs good knowledge of feeding time of the target fish, besides fish resources condition, habitat, and technology (Simbolon 2011). The dynamic of ocean conditions can also influence fish behavior, distribution, abundance, and availability of fish resources. Environmental parameters are also relating one and another. Change in one parameter can affect the other in the environment (Yulianto et al 2016). For this, the ecological approach is highly needed in order to predict the fishing ground that the role of the technology can be better in fish resources utilization.

Snappers are classified as demersal fish and occur near the sea bottom. Based on the bottom habitat type, demersal fish can be grouped as coral fishes that part of their life occur around the coral, and non-coral fishes that are found far from the coral ecosystem (Fahmi & Adrin 2002; Yulianto et al 2016). Coral fishes can be caught using several types of gears, such as bottom fishing line, mini long line, bottom gill net (Sudirman 2012). According to Nurulludin et al (2017), weather conditions, such as extreme waves and wind, are constraints in fishing operations. In Molucca Sea, the effective time for fishing the red snappers occurs only in 4 months (August-November), and the fish size vary from 30 to 91 cm total length (TL) (Matrutty 2011). Deep sea snapper (*Etelis radiosus*) is one of the importantly economic demersal fish resources in Indonesia, but information on this species is still very rare (Russell et al 2016).

Sario waters, Manado city, have the potential of demersal fish resources, but exploitation of these fish groups is only done by artisanal fishermen. Tourism development program of North Sulawesi Province is marine ecotourism. The availability of the fish resources is an opportunity to promote the marine tourism destination to this province, especially for the visitors who have sport fishing hobby, but as a result, sustainable and environmental friendly fishing activities need to be implemented to maintain the fish resources. Knowledge on habitat distribution, feeding behavior with time, food type, fishing technique, and fishing ground are important in fishing operations (Baskoro & Effendi 2005).

This study was conducted for one-year in order to obtain good information on the fish resources to be easily accessible to the fishermen and sport fishing adventurers. This study is aimed at providing information on fishing time in relation with feeding period, bait type, and correct fishing grounds for red snapper.

Material and Method. This study was carried out for one year, from August 2020 to July 2021. Fishing operations were conducted twice a day at 03:30-07:30 and 15:30-19:30, 20 trips a month at the depth of approximately 80-100 m. Direct observations covered fishing ground, GPS-based geographic position, depth detection using fish finder (Garmin FF 350 plus), time the fish were caught, number of catches per trip, fish size, weather condition at fishing operation, and current, salinity and visibility measurements. Water currents were measured using a floating ball and stopwatch, whereas water salinity and temperature measurements used Horiba. These measurements were done once a week. Interviews with 24 fishers were done to gain fishing line construction, fishing technique, bait type, fishing time, and water depth.

Data collection process. Research activities started with fishing preparation to set the fishing equipment, bait, and Global Positioning System (GPS). Sampling used 16 traditional fishing boats. Each boat went to the fishing ground as far as 1-5 sea miles from the beach. When the sea condition supported for data collection, the anchor was lowered down and fishing was started.

The fishing line with bait was jigged at the desired water depth. When the bait got the fish bite, the data were recorded while pulling it up on board. The data cover time caught, fish length, width, weight. Besides, measurements on current direction, speed, salinity, water brightness, geographic position, and wind direction and speed were accomplished. After data collection, the boats went back to the base

camp to discuss the data collection activity, handle the fish catches, and make preparation for the next trip.

Results and Discussion

Catches. Fishing operation caught a total of 1,650 individuals of red snapper *Etelis* sp. consisting of 879 individuals at morning operation and 771 individuals at afternoon operation with monthly catches presented in Figure 1.

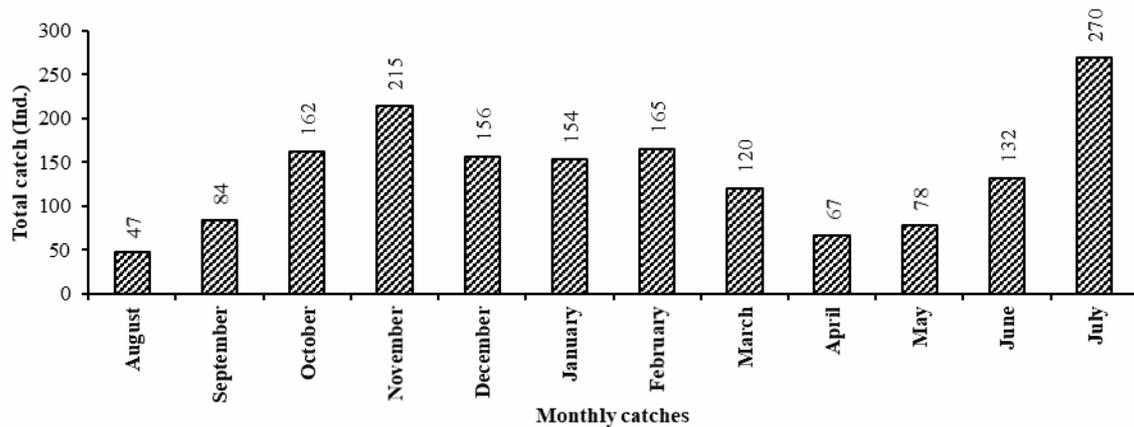


Figure 1. Distribution frequency of red snapper *Etelis* sp. catches during the study.

Figure 1 shows that the highest catches occurred in July, 270 individuals, and the lowest in August, only 47 fish. This finding indicates catch fluctuation in that the peak of fish season occurs in July and drastically declines in August, then rises in September to November, and slightly declines in December and January. The fish catches rise again in February and gradually decline in March to April, then rise again in the next months. This condition could result from many factors, one of which fish distribution in Sario waters is affected by the oceanographic conditions, such as sea storms that prevent the fishing operations, and dissimilar number of fishermen going the fishing activities every month. Our observations also found that not all fishers got the fish catch or the same number of catches.

In Lease Islands, Moluccas, red snapper fishing activities start at the end of east wind period, May to August, transitional season in September to October, early west wind in November to December, every year, with 4 effective fishing seasons, August to November (Matrutty 2011), whereas in Manado Bay, the effective fishing season occurred in July, November, and February (Figure 2).

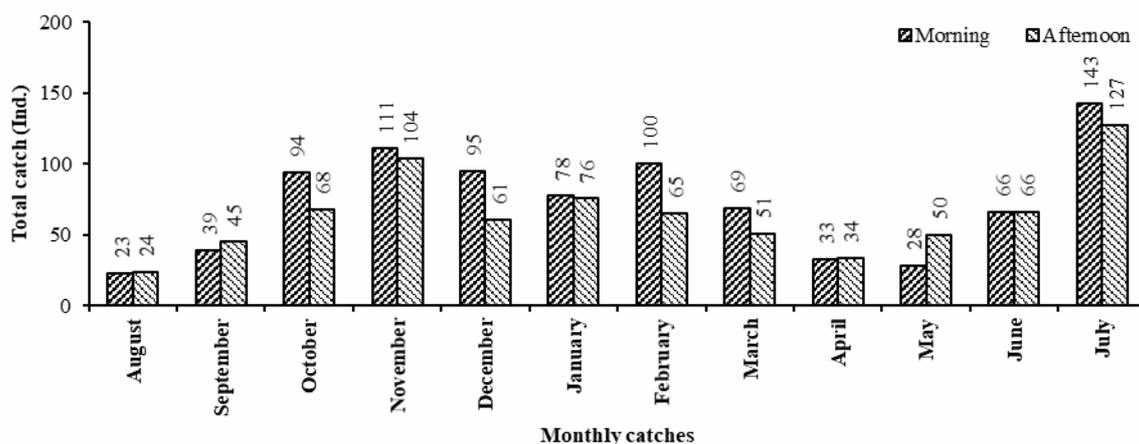


Figure 2. Fishing time-based red snapper *Etelis* sp. catches during the study.

Feeding periodicity. Fishermen did the fishing operations from dawn to morning and from afternoon to evening. Feeding habit was separated in 10 time ranges (Table 1). Fishing time division was done in relation with feeding behavior in space and time. The red snappers caught in the set time are related with feeding time as presented in Figure 3. The red snappers were mostly caught at the time range of 04:30-05:00 in the morning, 398 fish, and at 17:01-17:30 in the afternoon, 302 fish, indicating that the red snappers mostly actively feed at both time ranges. Low red snapper catches before 04:30 am could result from that the fish are on migratory trip to the feeding ground, and low catch before 16:30 could be due to the fish in full condition or on the way to the feeding ground. It is indicated with relatively shorter feeding time (± 3 hours) in the afternoon than that in the morning (> 3 hours). After 18:31, the fish catches fell down very low. This feeding behavior is similar to that in Lease Islands (Matrutty 2011), even though the present study did not fish at night for red snappers. This condition asserts that red snappers *Etelis* sp. in Indonesian waters have the same feeding time due to similar oceanographic condition.

Table 1

Time of fishing operation of the red snapper

Fishing time		
Morning		Afternoon
< 04:30		< 16:30
04:30-05:00		16:30-17:00
05:01-05:30		17:01-17:30
05:31-06:00		17:31-18:00
06:01-06:30		18:01-18:30
> 06:31		> 18:31

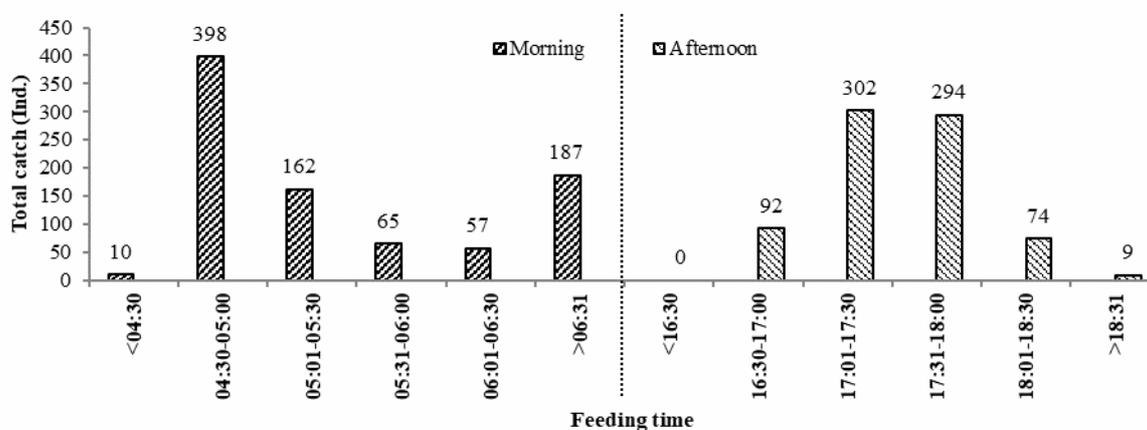


Figure 3. Feeding time-based catches of the red snapper.

Food habit. Food type of fish varies with species, including the red snapper, such as small fish, squids, crustacean, and Polychaeta (Baskoro & Effendi 2005). In fishing activities, this knowledge is important for bait preparation, either natural or artificial baits, in order for effective fishing. Red snapper fishing in Sario waters, Manado city, often uses natural food as fish bait, such as scad mackerel, bonito, anchovy or squid. Figure 4 demonstrates that the red snapper *Etelis* sp. prefers feeding on squid and yields a total catch of 806 individuals, followed by scad mackerel (548 ind), anchovy (217 ind), and bonito (79 ind).

The same finding is also reported by Matrutty (2011) and Onthoni et al (2017), squid and scad baits are the best bait to use in snapper fishing because they could stand longer in the water than other bait types. However, the present finding indicates that only fresh baits are taken by the red snappers *Etelis* sp.

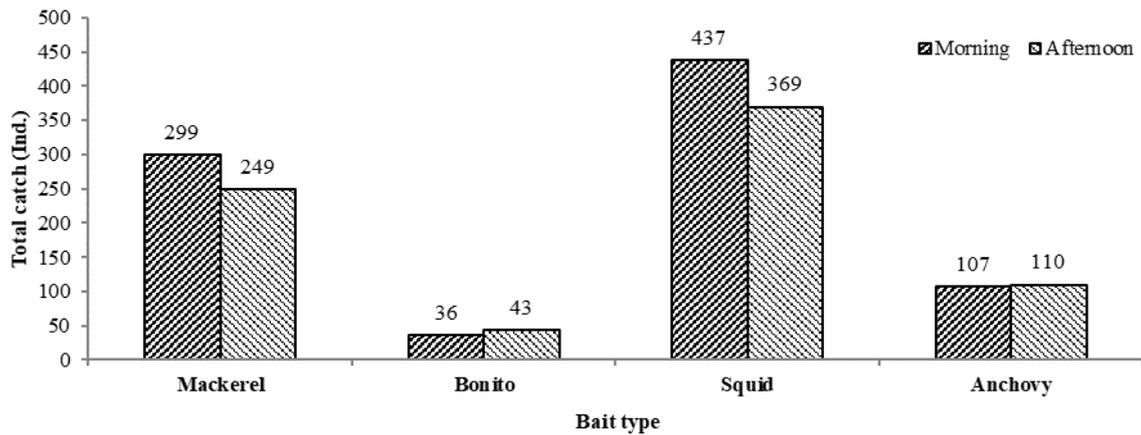


Figure 4. Bait type-based catches of the red snapper.

Fishing ground. The success of fishing operations is influenced by several factors, one of which is fishing ground that is related with feeding migration. Local fishermen use vertical hand line to catch the red snapper in Sario waters, in certain areas. The present study established 5 fishing grounds marked as area 1 to area 5 (Figure 5).

The fishing operations found catch variations in number of catches with fishing ground. In the morning, the highest number of catches was recorded in area 5, namely 237 fish, and the lowest in area 4 - 94 fish. In afternoon fishing operation, the highest number of catches was found in area 2, namely 273 fish, and the lowest in area 3, only 38 fish. Among these fishing grounds, area 2 produces the highest number of catches, 492, followed by area 4 - 358 fish, area 5 - 339 fish, and area 1, with 286 fish. The lowest fish catches were found in area 3 - 175 fish.

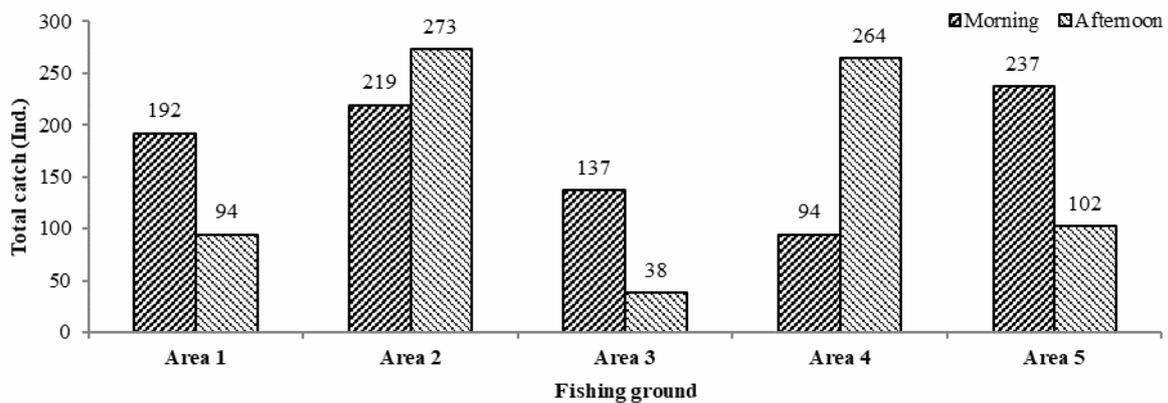


Figure 5. Fishing ground-based catches of the red snapper in Manado Bay.

The depth range was 100-105 m in area 1, 95-100 m in area 2, 90-95 m in area 3, 85-90 m in area 4, and 110-120 m in area 5, so that the depth of the red snapper fishing ground in Sario waters, Manado Bay ranged from 85 to 120 m. The distribution of red snapper *Etelis* sp. in Manado Bay is similar to that reported in Lease islands, Moluccas province (Matrutty et al 2013). The environmental conditions of the fishing ground had water currents of 32.45-34.15 m sec⁻¹, temperature of 28.31-29.65°C, and salinity of 34.2-34.5‰. For demersal fish fishing ground in Konawe, Wa Ode et al (2017) found the water condition has mean temperature of 30.25°C, salinity of 33.27‰, and current speed of 34.12 m sec⁻¹. It means that the environmental conditions for demersal fish distribution could vary with species.

Fish weight. The legality of fish size is related with fish weight for sustainable resources utilization. In the present study, the individual weight of the red snappers *Etelis* sp. ranged from 1.1 to 4.0 kg. The highest catch was found at the size range of 63-70 cm TL (40%), followed with that of 71-76 cm TL (36%), 77-80 cm TL (14%), and then < 62 cm TL (10%). The fish < 63 cm TL have a body weight below 1.0 kg, 63-70 cm TL are in the range of 1.1-2.0 kg, 71-76 cm TL in the range of 2.1-3.0 kg, 77-80 cm TL in the range of 3.1-4.0 kg, respectively (Figure 6). The size of fish caught in the morning and afternoon was almost similar, < 63-76 cm TL, but the size range of 77-80 cm TL was more caught in the morning than that in the afternoon (Figure 6). It could explain the distribution patterns of *Etelis* sp. population in Manado Bay in relation with feeding behavior.

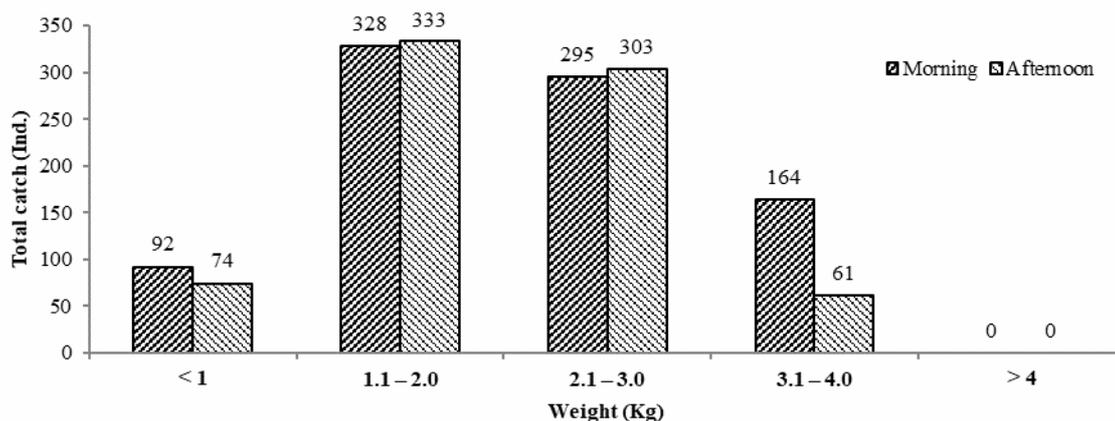


Figure 6. Weight-based catches of the red snapper.

Moreover, the size of *Etelis* sp. in Manado Bay is averagely bigger than that reported in Lease islands waters, 30-91 cm TL, and Cendrawasi Bay, 22-108 cm TL (Nurulludin et al 2017). Martinez-Andrade (2003) gives size of different adult red snapper species of subfamily Etelinae (Table 2) as comparison with those reported in recent studies.

Table 2
Size variety of red snapper (Etelinae subfamily)

No.	Species	Location	Source	Lmax (cm)	Lm (cm)
1	<i>Etelis corbunculus</i>	Hawaii	Everson (1984)	104	55.5
		Hawaii	Smith & Kostlan (1991)	76.2	41.9
		Tonga	Langi & Langi (1987)	114	57
2	<i>A. rutilans</i>	North Marianas	Ralston & Williams (1988)	141.4	72.2
			Froese & Pauly (1987)	110	58.3

Lmax = maximum length; Lm = length at first maturity.

Table 2 demonstrates the size of adult red snapper *Etelis* sp. from different localities. The present study in Manado Bay found that 90% of the fish catches had the size range of from 63 cm to 80 cm TL, so that the red snappers caught in Manado Bay are above the legal minimum size and has supported the sustainability of the red snapper population in this area.

Conclusions. This study concluded that the fishing peak of red snapper *Etelis* sp. in Sario waters occurred in the morning at 04:30-05:00 and in the afternoon at 17:01-18:00. Morning fishing had higher catches than afternoon one, both caught the same individual size range. This peak occurs in July with squid as the best bait. The fish size belonged to adult individuals and legal size. The best fishing ground was in area 2. This finding is expected to be able to give important information for fisheries

development, red snapper resources management, and fishing recreation development in Sario waters, Manado Bay.

Conflict of interest. The authors declare that there is no conflict of interest.

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