



Feeding habit track point mapping of red snapper (*Etelis* sp.) in Sario waters, Manado Bay, North Sulawesi

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Abstract. Fishing ground determination of economic fish is one of the important steps in fishing operation optimization. Demersal fish exploration is relatively limited compared with pelagic fish. Red snapper (*Etelis* sp.) has high economic value and its demand is sufficiently high in domestic or export market. Red snapper resource potency in the coastal waters of Sario, Manado, can become fishing spot for tourists to support marine tourism promotion in Manado city. This study aims to gather information on legal size, fishing technique and season in relation with feeding periodicity, bait type, and definite fishing ground geographic position of the species. Explorative method used direct observation, fishing ground survey, and indirect observation through interviews with the fishers. Number of catches during one-year fishing were 879 fish, with the highest in July, 143 fish, November, 111 fish, and February, 100 fish. Bait mostly preferred was squid. Furthermore, the red snapper was mostly caught at 04:30-05:00 am. The highest number of fish caught was > 1.0-4.0 kg body mass. Fishing location position was separated by 5 areas, and the highest catch was area 5 and 2.

Key Words: red snapper, fishing ground, geographic position, coastal waters of Sario.

Introduction. Determination of economic and profitable fishing ground is one of the crucial steps in fishing operation optimization. This process, according to Simbolon (2011), needs 3 major parameters to be considered, fish resources, aquatic environment (habitat), and technology. Fish behavior, distribution, abundance, and fish resources conditions are highly influenced by the dynamics of environmental aspects, and even change in one of those can affect other parameters. Therefore, ecological approach is required to predict the fishing ground, so that the role of technological aspects can be better in fish resources utilization (Yulianto et al 2016).

Demersal fish are a solitary one and occur in deep water column down to the sea bottom. This group consists of various species, in either large or small group. Based on water column as fish habitat, demersal fish can be grouped into reef fishes since they are found in coral reef area. Their exploitation can be done using bottom handline, mini longline, and bottom gill net (Sudirman 2012).

Demersal fish exploration is still relatively limited compared with that of pelagic fish (Murahman et al 2019). This group covers fusilier (*Caesio* sp.), emperor (*Lethrinus* sp.), grouper (*Epinephelus* sp.), snapper (*Lutjanus* sp.), and red snapper (*Etelis* sp.) (Allen 1985). These fish groups, including red snapper, have high economic value and their demand is sufficiently high in export or domestic markets due to restaurant business development for seafood and fishing spots for tourists (Fahmi & Adrin 2002).

Red snappers have many species and not all of them are identified. They can be found in Manado Bay waters, Maasing waters, and Tuminting waters around 105 m depth (Katimpali et al 2012; MMAF 2013). *Etelis* spp. can be found in Ambon

waters at the depth range of 50-300 m and 90-300 m with the size range of 70-110 cm total length (TL) (Matrutty et al 2011). In Konawe Regency waters, demersal fish live at water temperature of 30.25°C and mean salinity of 33.27 ppt, pH of 7, and current speed of 34.12 m sec⁻¹ (Wa Ode et al 2016). 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. *Etelis* sp. can reach maximum longevity of 56 years and age at 50% maturity for females and males of 527 mm fork length (FL) and 456 mm FL, respectively at 4-5 years old (Wakefield et al 2020). Nevertheless, according to Martines (2003) in Matrutty (2011), red snapper of *Etelis* sp., can only reach longevity of 25 years, maturity at 3 years old, with 3 months of reproductive cycle, and maximum size > 80 cm TL, with minimum legal size of 63 cm TL.

According to Nurulludin et al (2017), fishing season does not occur along the year due to weather conditions, such as wave and wind. The effective time to have good fishing production was only four months, August–November. The individual body length ranged from 29 to 108 cm TL. Deep sea snapper (*E. 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). In Indo-Pacific, this species is distributed from Sri Lanka to Samoa, north to the Ryukyu Islands, south to Australia, whereas *E. carbunculus* is distributed from East Africa to the Hawaiian Islands, north to southern Japan, south to Australia, and recorded in Three Kings Island, New Zealand (Allen 1985).

The exploitation of this fish group along Manado Bay is based on local wisdom or fishing experience generated from the parents. The main constraints of this exploitation is very limited information on fishing ground, including feeding periodicity, food habit, and moon cycle-based habitat distribution. In addition, fishing technique is very crucial to know in order to be one of the objects to promote marine tourism development in North Sulawesi.

In these regions, red snappers have supported sport fishing, and therefore, in the fishing season, local fishermen and fishing adventurers will come to Manado Bay waters for fishing. The potency of demersal fish resources in the coastal waters of Sario, Manado city, can become a fishing spot for the tourists who want to do fishing adventures, and therefore, there is necessity to have sustainable and environmental friendly fishing system that the demersal fish fishing ground could be maintained.

Factors need to be considered to support the sustainable fishing of this fish group are (1) availability of information on minimum legal size; (2) fishing technique with environmental friendly supporting fishing apparatus; (3) bait type dominantly preferred by red snapper; (4) fishing season related to feeding periodicity; and (5) geographic position of the fishing ground. Therefore, this study was conducted to obtain accountable data and could be easily accessed by local fishermen and fishing communities.

Material and Method. This study was conducted for one year, January to December 2020 employing an explorative method as a research design that gives direction to problem formulation. Data collection was carried out using open interviews, literature search, and direct observations. Direct observations covered fishing ground, GPS-based geographic position, depth detection using fish finder, time the fish were caught, number of catches per trip, fish size, gonad maturity, weather condition at fishing operation, and current, salinity and visibility measurements. Interviews with fishers were done to gain fishing line construction, fishing technique, bait type, fishing time, and water depth.

The study started with fishing preparation through discussion on technical operations, fishing line preparation, bait and fishing boat. Besides, oceanographic measurement apparatus, such as water current, temperature, salinity, fish finder, and GPS were also prepared for in situ measurements. Fishing operations were done as far as 1-5 sea miles from the coastline at 04.00-07.00 am at about 80-100 m depth. Fishing

activities were conducted using vertical bottom handline, a fishing line facilitated with hook and bait moved up and down. All fish caught were brought on board and recorded the length, width, and weight. During the fishing activities, current direction and velocity, salinity, water brightness, geographic position, wind direction and speed were also recorded. When fishing operation had finished, all fishing teams went back to the base camp. Then a Focused Group Discussion (FGD) was formed to discuss the field activities and sample handling and plan the next field activities.

Data collection. This activity started with preparations in the base camp, such as fishing line, boat, oceanographic apparatus, and data documentation. Fishing boats went to the fishing grounds together about 1-5 miles from the shore. This study has set 5 fishing grounds following fishermen's experiences as presented in Figure 1. Observations were then conducted on local situation and possible positions for data collection.



Figure 1. Map of fishing location.

Bottom handline was operated at the certain depth after the baits had been set. The fishing line was set by moving up and down. When the line gets strike, the fish were taken up on board and measured, such as total length, width, weight, gonad maturity, and species identification. While fishing, water current direction, speed, salinity, visibility, geographic position and wind speed were recorded. After fishing operation, the fishers went back to the base camp to discuss the data collection, catches, and plan the next data sampling.

Data analysis. One year-red snapper catch data collected were grouped into measured parameters, feeding time, bait types, fishing point, and individual size, and then presented in histogram and tables.

Results and Discussion

Catch. During one-year fishing survey, there were 879 red snapper caught (Figure 2). Figure 2 demonstrates that the highest catch occurs in July, 143 individuals, then November, 111 individuals, and February, 100 individuals, respectively. The lowest catch occurred in August, only 23 individuals. The catch rose again up to November, then declined again until January. In March to June, number of catches was averagely low. Overall, number of catches varied with month, in which there were 3 catch peaks. It could result from fish school distribution in Sario coastal waters influenced by oceanographic factors and dissimilar number of red snapper fishers with month.

Red snapper fishing in the bay waters of Lease of group of islands, Moluccas province, occurs at the end of east season (May-August), transitional season 1

(September-October) to early west season (November-December), and the fishing effectivity is only four months, August to November every year (Matrutty 2011). In Sario waters of Manado Bay, there is similarity in number of effective fishing seasons, October to December, and July.

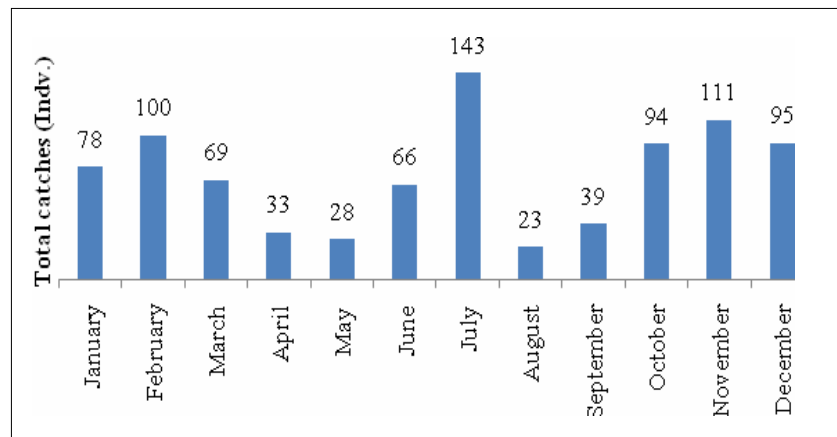


Figure 2. Total red snapper catches in one-year.

Feeding habit. Fishing operations were done from dawn to morning during the study. To know the feeding habit of the red snappers, feeding time was separated into 6 different times, A (before 04:30 am), B (04:30-05:00 am), C (05:01-05:30 am), D (05:31-06:00 am), E (06:01-06:30 am), and F (after 06:31). It could result from the different feeding habit of the fish with space and time. The time-related feeding habit of the red snapper is shown in Table 1.

Table 1 show that red snappers are mostly caught at 04:30-05:00 am, followed with after 06:31 am, and 05:01-05:30. It indicates that red snappers actively feed at 04:30-05:00 am along the year. The lowest feeding activity occurs before 04.30 am. This time could result from the fish migration to the feeding ground, since this fish group can move from area to the other for their living needs.

Table 1

Feeding habit related with time

Month	Feeding time (no. ind)						Total
	A	B	C	D	E	F	
January	0	33	19	7	2	17	78
February	0	38	20	9	13	20	100
March	3	35	13	4	1	13	69
April	0	14	3	3	1	12	33
May	0	16	4	0	3	5	28
June	0	38	5	4	0	19	66
July	6	78	12	5	14	28	143
August	0	11	3	1	1	7	23
September	1	17	6	0	5	10	39
October	0	40	26	7	4	17	94
November	0	41	24	17	9	20	111
December	0	37	27	8	4	19	95
Total	10	398	162	65	57	187	879

Note: A (before 04.30 am); B (04.30-05.00 am); C (05.01-05.30 am); D (05.31-06.00 am); E (06.01-06.30 am); F (after 06.31 am).

This feeding time is rather similar to that in Lease group of islands, Moluccas, 05.00-09.00 am and 16.30-20.30 pm (Matrutty 2011), even though this study does not conduct night fishing operations targeting on this species. This condition confirms that red snapper *Etelis* sp. in Indonesia waters has similar feeding time migration, and may be caused by similar oceanographic conditions.

Food habit. Food habit is related with food sorts preferred by the fish, including the red snapper. Therefore, to catch one of the fish species, food habit needs to be known, and thus, it is related with bait preparation, either natural food or artificial one. Red snapper fishing using bottom handline in the coastal waters of Sario, Manado, often used natural food, such as scad, mackerel tuna, anchovy and squid. Table 2 demonstrates that the highest catch was obtained in squid bait, and then scad bait.

Table 2

Number of catches based on bait type

Month	Bait type			
	Scad	Mackerel tuna	Squid	Anchovy
January	24	5	37	12
February	34	7	43	16
March	27	2	31	9
April	11	0	21	1
May	12	0	16	0
June	21	3	37	2
July	52	7	59	25
August	7	0	16	0
September	16	0	22	1
October	28	2	53	11
November	39	7	50	15
December	28	2	52	12
Total	299	35	437	104

The present findings are supported by Onthoni et al (2017) who obtains the highest catch in squid and scad-baited fishing. This could result from strong aroma released by both types of bait and that these types of bait can sustain in the water longer than the others. Similar results are also found in Moluccas waters that among baits of squid, mackerel tuna, and skipjack meat slice, the squid bait catches the highest number of red snapper catches (Matrutty 2011). However, field observation indicates that only fresh meat is preferred by the red snapper.

Fishing ground. Fishing ground is closely related with migrating habit during their life, including feeding migration. To catch one of the fish species, the migrating habit needs to be studied, and it is related with fishing ground. Red snapper fishing in Sario waters was done in certain areas in Manado Bay.

Table 3

Number of catches based on fishing area

Month	Fishing locality				
	Area 1	Area 2	Area 3	Area 4	Area 5
January	13	19	18	12	16
February	22	32	13	8	25
March	15	18	12	8	16
April	2	7	4	4	16
May	0	7	7	4	10
June	12	21	4	7	22
July	49	34	7	8	45
August	0	2	7	4	10
September	0	11	7	6	15
October	30	23	16	5	20
November	23	22	25	19	22
December	26	23	17	9	20
Total	192	219	137	94	237

Table 3 demonstrates that area 5 and area 2 were found with the highest catches of the red snapper. It could result from higher fish concentration in both areas or these areas are feeding migratory route of the species that might affect the number of catches obtained as well.

Fish weight. Individual fish size caught (kg) is very important to know the catch feasibility in relation with sustainable resources. In present survey, the most catches were in the individual size range of 1.1-3.0 kg. However, the individual size below 1.0 kg was also high enough, and it indicates that the fishing ground is not far from spawning and nursery grounds. Based on Table 4, it is apparent that the fish group consists of different individual size classes with the dominance of size 1.1-4.0 kg.

Table 4
Red snapper catch based on individual size (weight)

Month	Weight range (kg)				
	< 1	1.1-2.0	2.1-3.0	3.1-4.0	> 4
January	17	37	20	4	0
February	16	53	21	10	0
March	12	38	13	5	0
April	3	18	8	4	0
May	0	9	11	8	0
June	4	46	13	3	0
July	6	34	61	38	4
August	0	7	11	5	0
September	4	23	10	3	0
October	0	14	43	35	2
November	2	26	52	30	1
December	0	14	46	34	1
Total	64	319	309	179	8

Table 4 shows that red snappers caught comprise the individual of < 1 kg (< 620 mm TL), 1.1-2.0 kg (630-700 mm TL), 2.1-3.0 kg (710-760 mm TL), 3.1-4.0 kg (770-800 mm TL), and > 4 kg (> 81 mm TL), with the highest catch in the range of 630-700 mm TL (36%) and 710-760 mm TL (35%). These size ranges are almost similar to those reported by Matratty (2011) in Lease waters, Moluccas, 610-720 mm TL (24.51%), 730-840 mm TL (23.5%), and 490-600 mm TL (22.55%). Based on Wakefield et al (2020), the red snapper population that enters the fishing ground in Manado Bay belongs to adult individuals with 50% maturity. Fisheries biologists estimate the fish maturity level, in general, employ fish length in order to set the minimum legal size, the fish at the first caught at least have passed one reproductive cycle. Based on Martinez (2003) in Matratty (2011), and Wakefield et al (2020), about 90% of the red snappers *Etelis* sp. caught in the present study could have belonged to the minimum legal size with more than 50% are > 70 cm TL spawners.

Conclusions. This study found that fishing season of the red snapper (*Etelis* sp.) in the coastal waters of Sario, Manado, occurred in July and October to December. The best bait used to obtain high catch was squid. Morning fishing is the best at 04:30-05:00 am. The weight size range mostly caught was 1.1-4.0 kg and categorized as legal size. The best fishing ground occurred in area 5 and area 2. Further studies need to be directed to the biological and reproductive aspects and the influence of oceanographic factors on the fish occurrence in Sario waters, Manado in order to promote their sustainability.

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