The characteristic of neritic tuna fisheries in the Java Sea and adjacent water

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Abstract. Neritic tuna is an important fishery commodity in the Java Sea, however, the availability of data and information on the fisheries characteristics is still limited. The study was conducted in 2018. Data was collected by researchers with the help of enumerators who monitoring and collecting data from the fishermen. The method used is direct observation at the study site and interviews with fishermen. This study aims to analyze information fisheries characteristics in catch, catch per unit effort (CPUE), catch composition, fishing grounds, fishing season. The results show that neritic tuna in Java Sea caught by purse seine, mini purse seine, drift gillnet, and encircling gill net. The annual catch and CPUE of neritic tuna are still fluctuating. This tuna neritic fishery condition was showed that has not been overfishing. Catch composition of purse seine and mini purse seine dominated by small pelagic seine while catch composition drifts gill net and encircling gill net dominated by neritic tuna. The fishing ground around west of Karimun island, while purse seine from west of Bawean, Masalembu and around Matasiri island. Fishing seasons are April to May and October to December.

Keywords: CPUE; fishing season; Java Sea; neritic tuna

1. Introduction
The Java Sea is shallow water that part of the Sunda Shelf with a depth of fewer than 130m and an average of 50 m, and has many small islands. These waters have potential fish resources, especially small pelagic fish and large pelagic fish. The catches from the Java Sea are landed in several landing sites such as Tegal, Pekalongan, Juwana-Pati, Rembang, and Brondong. Pekalongan is one of the main landing sites of fishing vessels operating in the Java Sea. In the Pekalongan neritic tuna fish such as kawakawa (Euthynnus affinis), longtail tuna (Thunnus tonggol), and figate tuna (Auxis thazard), and bullet tuna (Auxis rochei) are caught by purse seine, mini purse seine, drift gillnet, and encircling gill net.

The main catch commodities in the Java Sea are small pelagic fish such as Indian scad (Decapterus spp.), Indian mackerel (Rastrelliger spp.), bigeye scad (Selar spp.), and gold stripe sardinella (Sardinella spp.) [1]. The exploitation of small pelagic fish carried out since the 1980s [2]. The catch mainly using purse seiner, 90% of purse seine catches consist of small pelagic fish such as Indian scad (Decapterus russelli), Shortfin Scad (Decapterus macrosoma), mackerel scad (Decapterus
macarellus), bigeye scad (*Selar crumenophthalmus*), India mackerel (*Rastrelliger kanagurta*) and gold stripe sardinella (*Sardinella gibosa*), while neritic tuna is caught in a small percentage [3]. Large pelagic fish such as neritic tuna was are being exploited intensively as main target since the 2000s.

Uncontrolled fishing can cause a decrease in the population or fish stock in certain waters. The importance of knowing the status of a fishery due to fishing pressure is the basis for its management. Information about fishery characteristics including catch, catch per unit effort (CPUE), fishing season is needed to know the condition/status of the stock. This study aims to analyze the development of CPUE, the catch composition, the fishing season in the Java Sea. It is hoped that the resulting data and information can be used as input for the management of neritic tuna fisheries in the Java Sea.

2. Materials and methods

2.1. Location and time of research

The research was carried out at the fish landing site in Pekalongan, Central Java, during period April to December 2018.

2.2. Data collection

Data was collected by researcher and helped by the enumerator. The catch data of neritic tuna obtained from daily landing monitoring fishing vessels that operating in Java Sea and adjacent water. Daily catch recording data including name of vessel, type of fishing gear, species composition of fish caught, number of catches, and the number of days of operation (trip), etc.

2.3. Data analysis

CPUE was provided information to understand the abundance trend and level of utilization status of fishery resources that exploited in a water. CPUE calculated from total catch divided by total fishing effort [4]:

$$\text{CPUE} = \frac{\sum C_i}{\sum F_i}$$  \hspace{1cm} (1)

where:

- CPUE : catch per unit effort (kg/trip);
- $C_i$ : total catch from year $i$ (kg/ton);
- $F_i$ : total fishing effort from year $i$ (trip).

To analyze fishing season indices, average percentage method based on time series analysis (Spiegel 1961) was applied. The calculation is as follows.

Calculation of monthly CPUE use the following formula:

$$\bar{U} = \frac{1}{m} \sum_{i=1}^{m} U_i$$  \hspace{1cm} (2)

where,

- $\bar{U}$ : average of monthly CPUE in a year (kg/trip)
- $U_i$ : monthly CPUE (kg/trip)
- $M$ : number of months in a year (12)

Calculation of $U_p$ which is the ratio of $U_i$ towards $\bar{U}$ (in percent):

$$U_p = \frac{U_i}{\bar{U}} \times 100\%$$  \hspace{1cm} (3)

where,

- $U_p$ : average CPUE ratio (%)
Calculation of fishing season indices (FS):
\[ FS_i = \frac{1}{Y} \sum_{i=1}^{Y} U_p \]  

where,
\( FS_i \): the indices at particular season (i)
\( Y \): number of year calculated

Fishing season occurred when the index is higher than 1 (above 100% or above average), and low of fishing season when it is lower than 1 (below 100%). \( FS_i = 1 \) (100%) is equal to monthly average price, meaning that the condition is normal or balanced.

3. Results and discussion

3.1. Results
3.1.1 Fleet and fishing gear. The fishing of neritic tuna in the Java Sea is carried out using purse seine, mini purse seine, drift gillnet, and encircling gill net. The vessel used is made of wood, has to vary tonnage. The number of purse seine fleets in Pekalongan is 119 units, while the Mini Purse Seine is 33 units. The difference between the purse seine and mini purse seine, in general, is the size of the vessel. Purse seine size about 39-180 GT, has 15-20 crew. number of sea days 5-6 days. while the mini purse seine is 12-30 GT, has 30 crew. number of sea days 50-60 days.

There are 82-unit drift gillnet fleets in Pekalongan. This Gill netter has a size of 2-10 GT, the number of sea days is an average of 7 days. Besides, in recent years the encircling gillnet fleet has developed using 15-29 GT vessels. The fishing gear uses a rectangular net like a wall that just like a gillnet with a mesh size in the codend 4 inches, but this net is operated encircling the fish schooling, then enclosed the bottom of net by pulled the purse line, from the fishing technique it is like purse seine.

3.1.2 Fishing ground. The fishing ground for mini purse seine, drift gillnet, and encircling gill net based in Pekalongan is concentrated in the waters north of Pekalongan to the west of the Karimun Islands, while the purse seine area is spread from east of Bawean, Masalembu to the east of Matasiri Island. This fishing ground can be seen in figure 1.

Figure 1. Fishing ground of neritic tuna from several fishing gears in the Java Sea and adjacent water (note: MPS: mini purse seine; GN: drift gill net; PS: purse seine; EGN: encircling gill net).
3.1.3. Catch composition. The purse seine catch composition is dominated by small pelagic species about 86%, it consists Indian scad (Decapterus russelli) 32%, Shortfin Scad (Decapterus macrosoma) 20%, mackerel scad (Decapterus macarellus) 2%, bigeye scad (Selar crumenophthalmus) 3%, Indian mackerel (Rastrelliger kanagurta) 14% and gold stripe sardinelle (Sardinella gibosa) 1%, while longtail tuna (Thunnus tonggol) 3% and kawakawa (Euthynnus affinis) 4% (figure 2). The catch composition of mini purse seine is dominated by small pelagic species about 78% consist of Indian scad (Decapterus russelli) 39%, Shortfin Scad (Decapterus macrosoma) 8%, mackerel scad (Decapterus macarellus) 2%, bigeye scad (Selar crumenophthalmus) 4%, India mackerel (Rastrelliger kanagurta) 2% and gold stripe sardinelle (Sardinella gibosa) 22%, while kawakawa (Euthynnus affinis) 4% and longtail tuna (Thunnus tonggol) 1% (figure 3).

Drift gill net catch composition is dominated by large pelagic species which is longtail tuna (Thunnus tonggol) 47%, kawakawa (Euthynnus affinis) 29%, Spanish mackerel (Scomberomorus commerson) 9%, barracuda (Sphyraena putnaamae) 7%, moonfish (Mene maculata) 3%, Indo-Pacific sailfish (Istiophorus platypterus) 1%, common dolphinfish (Coryphaena hippurus) 1% (figure 4).
Encircling gill net catch composition is dominated by longtail tuna (*Thunnus tonggol*) 85%, kawakawa (*Euthynnus affinis*) 11%, common dolphinfish (*Coryphaena hippurus*) 1%, Spanish Mackerel (*Scomberomorus commerson*) 1%, Indo-Pacific sailfish (*Isthioporus platypterus*) 1%, Marlin (*Makaira mazara*) 1% (figure 5).

![Figure 4. Catch composition species of drift gillnetter in the Java Sea.](image)

![Figure 5. Catch composition species of encircling gill netter in the Java Sea.](image)

3.1.4. Annual catch. The are several species of neritic tuna caught in Pekalongan consists of longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis*), fregat tuna (*Auxis thazard*), and bullet tuna (*Auxis rochei*). The total catch of neritic tuna in the Java Sea landed at Pekalongan show a fluctuation trend amount 1988 ton in 2015 to 2302 ton in 2019. The trend of catches kawakawa and longtail tuna still fluctuates. The catches of fregat tuna and bullet tuna are not too high but show the same trend. The graph shows that catches of neritic tuna longtail tuna are the largest about 69% followed by kawakawa 30%, fregat tuna, and bullet tuna. has very little proportion of less than 1% (figure 6).

Neritic tuna fisheries landed in the Pekalongan, that fishing in the Java Sea and adjacent water caught by purse seine, mini purse seine, drift gillnet, and encircling gill net. From 2009-2012 the catch
of neritic tuna produced 57% by encircling gill netter, purse seiner 34%, gill netter 7%, and mini purse seiner was contributed 3% (figure 7).

![Figure 6](image1.png)

**Figure 6.** Development annual catch of neritic tuna in the Java Sea landed in Pekalongan (Note: LT: longtail tuna; KW: kawakawa; FG: frigate tuna; BT: bullet tuna).

![Figure 7](image2.png)

**Figure 7.** Annual catch by gears of neritic tuna in the Java Sea landed at PPN Pekalongan. (Note: PS: purse seine; MPS: mini purse seine; GN: drift gillnet; EGN: encircling gill net).

3.1.5. *CPUE.* The annual CPUE value of four fishing gears is still a fluctuation trend (figure 5). CPUE mini purse seine and gill net show a decreasing trend but CPUE purse seine and the surrounding gill nets show an increase (figure 8).

3.1.6. *Fishing season.* The fishing season of neritic tuna show twice started in March-May, then decreased gradually afterward and started to appear in September then reached its peak season on November (figure 9).
3.2. Discussion

The CPUE information would explain the condition of the stock. In this study CPUE of some fishing gears fluctuate, the trend CPUE of the mini purse seine and the drift gill net tends to decrease while the CPUE of the purse seine and the encircling gill net tends to decrease. The main cause of the decline CPUE of the mini purse seine and the drift gill net because the number of vessels also decreased, while on the other hand number of the vessel of purse seine and the encircling gill net increase its lead to an increase CPUE as well. From this condition, the tuna neritic fishery can be said that has not been overfishing.

The purse seine and mini purse seine catch composition is dominated by small pelagic species; gill net catch composition is dominated by large pelagic species. Purse seine and mini purse seine have similar catch composition which is dominated by small pelagic fish, this is because those gear use fish aggregating devices (FADs) in their fishing operation. FADs are an effective fishing tool to collect fish that make ease in fishing activities [5-8]. This convenience causes fishing operations to be more efficient, can reduce operating time and fuel, and increase the productivity of the catch [9-11].
The use of FADs began when fishermen saw the behavior of groups of tuna and another pelagic fish gathering naturally around floating objects on the sea surface to be used for their livelihoods [12]. [13] believe that fish use fad as a gathering point and socialize with other fish. [14] Concluded that the mechanism of gathering small pelagic fish around FADs tends to be caused by the food chain process, where the colonization of microorganisms that attach to the FADs attractor material forms, the gathering of predatory microorganisms around the FADs, then the gathering of predatory fish which is small pelagic fish. Besides, purse seine and mini purse seine in the Java Sea use lights, together with FADs, this is because pelagic fish are photographic taxis or are attracted to light so they gather around light [15, 16].

The catch composition drifts gillnet and encircling gill net are dominated by large pelagic species which are longtail tuna (Thunnus tonggol), kawakawa (Euthynnus affinis), Spanish Mackerel (Scomberomorus commerson), with various percentages. This is similar to the previous study of the catch composition gill net in the South China Sea and the Java Sea [17, 18]. This is because the longtail tuna, kawakawa, and Spanish mackerel often live in groups to form the same schooling [19]. From the catch composition drift, gillnet and encircling gill net are the main fishing gear that catches neritic tuna.

Fishing seasons are a period where the catch is high which indicates the high abundance of fish in the sea. There are two fishing seasons for neritic tuna in the Java Sea, i.e., during March-June which was the first transitional season to the east monsoon, and during September-December which was the second transitional season to the west monsoon. Fishing seasons, in the Java Sea, occur twice a year i.e., during March-June which was the first transitional season to east monsoon (minor), and during September-December which was the second transitional season to west monsoon (major). The fishing season was affected by monsoon cycle [20, 21]. In transitional season I (March-May) and transitional season II (September-November) the wind and wave speed is moderate-high, sea condition is preferable to fishing activity. On the contrary, during the west monsoons and the east monsoons, the wind speed and waves are high lead to low fishing season. Monsoon wind generate current and wave, in the Java Sea when east monsoon (June-August) surface currents move from the Banda Sea through the Flores Sea and from the Makassar Strait to the Java Sea where there is a lot of upwelling in these waters, make the Java Sea has high chlorophyll-a levels and low SST [22, 23].

The increase in chlorophyll-a concentration indicates high plankton concentration, this causes an abundance of small pelagic fish which are plankton feeder, while small pelagic fish are the prey of neritic tuna. It is suspected has to lead to an increased catch of neritic tuna in this season 2.

According to Adman, Hendiarti et al., Kunarso, and Kunarso et al. [24-27], it can be seen from the increasing concentration of chlorophyll-a which causes increased catch. Gaol and Sadhotomo [28] states that there is a spatial distribution of chlorophyll-a in the eastern Java Sea, a movement of chlorophyll-a concentration that occurs between October to December, and has synchronization with the abundance of pelagic fish, which is a prey of neritic tuna.

4. Conclusion
Annual catch and CPUE of neritic tuna are still fluctuating. This tuna neritic fishery condition was showed that has not been overfishing. The Catch of neritic tuna in the Java Sea, produced 57% by encircling gill netter, purse seiner 34%, drift gillnetter 7%, and mini purse seiner was contributed 3%. From the catch composition drift, gillnet and encircling gill net are the main fishing gear that catches neritic tuna. Fishing seasons, in the Java Sea, occur twice a year i.e. the first the transitional season I (March-May) (minor), and the transitional season II (September-November) (major).

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