Spatial pattern of fishing activities at Yogyakarta waters (case study: fishers at Depok beach, Parangtritis village, Bantul regency)

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Abstract. Capture fisheries are one form of fishery resource utilization by fisher in the waters. With open access, fishers are free to catch fish in the waters. Yogyakarta waters are one of the waters with capture fisheries activities that continue to develop until now, especially on Bantul Regency. Fishers on Depok Beach are the largest and most developed communities in Bantul Regency. Sustainable fisheries resource management is formed in Yogyakarta waters by analyzing fishers' behavior on Depok Beach in fishing activities. Survey methods and participatory mapping were carried out to obtain fisher's characteristics, water conditions, fishing grounds locations, and fish catch variation. Statistical descriptive analysis, map overlays, and correlations are used in this study. The fishing community on Depok Beach is dominated by migrant fisher who come from Cilacap. Fishing activities are still very dependent on water conditions both during high and low seasons. Fishing grounds can be up to 10 miles in the high season, while the low season tends to be closer to land. The type of fish catch varies each month, dominated by demersal fish. Beltfish (Trichiurus lepturus) is a fish caught commodity during high and low seasons. Meanwhile, white pomfret (Pampus argenteus), banana prawn (Penaeus merguiensis), scalloped spiny lobster (Panulirus homorus) are mostly found in the high season, and mackerel tuna (Euthynus affinis) in the low season.

1. Introduction
Capture fisheries is an activity of exploiting resources in the form of fishing by fishers in the waters. Resources used jointly by user groups are known as Common Pool Resources (CPR) [1]. The characteristics of these resources lead to competition among users in utilizing resources. In this case, fisher as resource users will continue to compete with other fishers in catching fish in the waters.

Research on fisher in fisheries is considered an important field because it relates to fisheries resource management [2]. Small-scale capture fishers dominate Indonesian fishers. These fishers are generally characterized as having households considered poor, marginalized, and vulnerable to social and economic shocks [3]. This situation makes fishers very dependent on fish resources to meet their daily needs. Fishers of this type are also free from fisheries management regulations [3] even though the waters have open access to freely catch fish in the waters.

Several studies emphasize that it is necessary to understand fisher's spatial behavior to manage fish resources [4] [5]. Spatial behavior is described as a series of conscious or unconscious processes related to the selection or change of human life location [6]. In the case of capture fisheries, fishers' spatial
behavior is regarding the selection of fishing grounds. There will be the most significant space competition in coastal waters by small fishing vessels [7]. Small-scale capture fishers use small boats.

In the practice of small-scale capture fisheries, it will depend on water conditions [8]. Indonesian waters are affected by the movement of the monsoon wind. This movement causes two seasons, namely the west monsoon wind and the east monsoon wind. The characteristics of each season will influence catch and fishing activity [9].

Thus, the study will discuss the spatial behavior of fishers in fishing activities based on seasons. This behavior is in the form of choosing the location of fishing grounds and fish catch variation.

2. Materials and methods

2.1. Study area

Yogyakarta waters are one of Indonesia's tropical region waters, located in the south of Java, Yogyakarta. The waters of Yogyakarta are located between 109°55'–110°47' E and 7°52'–8°11' S (see figure 1.). Fishing communities use these waters on the south coast of Yogyakarta for capture fisheries activities, which are still growing up to now [10]. The fishing community is spread across Kulon Progo, Bantul, and Gunung Kidul Regencies. In 2018, Bantul Regency had the highest capture fishery production value compared to these two districts [11]. Kretek District is the sub-district with the highest contribution to capture fisheries in Bantul Regency, where there are fishing communities on Depok Beach [12].

![Figure 1. Study area](image)

Yogyakarta waters are affected by the movement of monsoon winds [13]. With the movement of monsoon winds, it will significantly impact capture fisheries activities. During the west monsoon and transition winds, fishers on Depok Beach will experience "musim berlimpah" (high season). However, when entering the east monsoon winds, fishers will experience "musim paceklik" (low season).

2.2. Data collection

Field survey activities were carried out in April (high season) and August (low season) 2020 at Depok Beach, Parangtritis Village. Data collection was carried out by filling out questionnaires and
participatory mapping assisted by a resident. Interviews with the head of the fisher were also conducted to validate research data. Supporting data in journals and data from related agencies will be used to add research results and validation.

In the process of filling out the questionnaire, fishers will be selected by random sampling. The questionnaire deals with fisher's characteristics, weather conditions, waters, fishing activities, and fish caught variation during high and low seasons. At this stage, 34 fishers were found. Fishers who have the role of ship leader will continue with participatory mapping.

Participatory mapping was carried out to show fishing locations in Yogyakarta waters. The map covers 545 km² with a scale of 1:105,000, which is made as like original appearance of the coastal waters. Fishers will be directed to mark points on fishing locations in high and low seasons on the map. Labeling of fishing grounds can be in the form of points, lines, polygons [14]. In this process, 17 fishers were found to be the fishing boat's head on Depok Beach.

2.3. Data processing
In the questionnaire results, each fisher answer will be entered into the SPSS software. The data will be processed and presented tabularly to answer research questions. The data presented in the form of data on the characteristics of fishers and fish caught variation.

The results of participatory mapping will be processed using ArcGIS 10.1 software. The dots that have been affixed by fishers during high and low seasons will be digitized and overlaid with a 750 m² hexagon grid. A hexagon-shaped grid is considered more appropriate when faced with non-linear geographic shapes such as coastlines [15]. The data presented is a map of fishing grounds during high and low seasons.

2.4. Data analysis
Fisher's characteristic data analyzed using descriptive statistics. Spatial data from water conditions and fishing grounds analyzed using map correlation and overlays analysis during high and low seasons. For fish catch data during the high and low season, analyzed descriptively.

3. Result and discussion

3.1. Fisher's characteristics
In general, Depok Beach fishers come from outside the Bantul Regency (see table 1.). These fishers generally come from various Indonesian regions such as Cilacap, Kebumen, Medan, and Kediri. Fisher, who comes from Cilacap, are fishers with the largest number of origins in Depok Beach. This condition was because the Cilacap fishers were the first fisher to land on Depok Beach so that other Cilacap fisher also headed to Depok Beach, and some decided to stay.

The boats used by fishers on Depok Beach are all outboard motorboats. This type of "jukung" fiberglass ship with a length of between 10-13 meters. An outboard motor supports the ship with a power of 10-15 pk (see table 1.). For ship ownership, the balance between private property and non-private property.

For fishing gear, fishers on Depok Beach generally use gill nets of various sizes. The size varies from 2-7 inches and is adjusted to the fish type that will be caught. Each fisher will carry between 30-80 pieces of the net (see table 1.). Some fishers also have additional handline and bottom longlines in addition to fishing nets.

| Fisher's Characteristics | Mean   | Std. Deviation | N   |
|--------------------------|--------|----------------|-----|
| Age (years)              | 41.21  | 9.87           | 34  |
| Origin                   | Outside Bantul Regency | -    | 34  |
| Education Level          | Elementary School       | -    | 34  |
| People in Household      | 3.65   | 1.13           | 34  |
Experience (years) & 15.82 & 6.15 & 34 \\
Boat Length (m) & 10.71 & 1.29 & 34 \\
Boat Engine (PK) & 13.97 & 2.05 & 34 \\
Number of Gear Used & 38.47 & 11.85 & 34 \\
Fishing Days/Week (High Season) & 4.85 & 0.99 & 34 \\
Fishing Days/Week (Low Season) & 2 & 0.71 & 9 \\
Fishing Hours/Day (High Season) & 8.29 & 1.06 & 34 \\
Fishing Hours/Day (Low Season) & 5.33 & 0.5 & 9 \\
Kg Fish/Day (High Season) & 84.71 & 24.4 & 34 \\
Kg Fish/Day (Low Season) & 47.22 & 7.95 & 9 \\

3.2. Waters condition on seasonal variation
The waters of Yogyakarta are famous for their fast currents and waves because of their location in the south of Java, which is adjacent to the Indian Ocean. These waters are affected by the movement of the monsoon wind. The movement of monsoon winds will cause fishing season for fishers on Depok Beach, namely high and low seasons. The water condition that fishers can pass to the sea is usually called "musim berlimpah" (high season). It occurs in the west monsoon and transitional winds.
Meanwhile, the water conditions that are difficult for fishers to pass are called "musim paceklik" (low season) that occurs in the east monsoon winds (June-August). Usually, fishers on Depok Beach can go to sea in wave conditions up to a height of 1.5-2 meters. At an altitude of 1.5 meters, usually, some fishers have decided not to go to sea.

Figure 2. Water Condition around Java Island a) on 4 Mar 2020 at 6 a.m.; b) on 11 Aug 2020 at 6 a.m. from (http://tides.big.go.id/las/UI.vm)
When the research was conducted in the high season, the fishers considered the water conditions to be less than satisfactory. This condition is due to the unpredictable wave heights every day. The wave height in that month is in the range of 0.6-2.6 meters based on the data. The best conditions in that month are in the range of 0.6-1 meter (see figure 2.).

In the low season, the water conditions, according to fishers, are high waves. Based on the data, the wave height is in the range of 0.8-3.3 meters. With a daily wave height exceeding 1.5 meters. The worst of the month is around 2.1-3.3 meters (see figure 2.).

3.3. Fishing activities
Capture fisheries activities on Depok Beach are still relatively new. It is known from the coastal communities in Yogyakarta Province that they do not have a history and are highly dependent on marine fish [10]. Only around 1995, especially the people of Depok Beach, became interested in fishing. The decline in the productivity of agricultural land in Parangtritis Village caused this interest [16]. The success of the Cilacap fishers in landing on Depok Beach also started fishing activities using boats.

Fishers on Depok Beach have time to go to sea in the morning, and some also go to sea in the afternoon. Fishing activities are usually at 05.00 WIB and return to Depok Beach at noon around 13.00 WIB. Fishers who return to sea in the afternoon will go to sea until evening around 22.00 WIB. Meanwhile, during the low season, fishers usually only go to sea at one time. The distribution related to fishing time is the result of mutual agreement. This agreement also applies to unloading and towing ships into the waters carried out in mutual cooperations [17].

Fishing activities in the high season, all fishers will go out to sea. However, fishers will choose not to go to sea waiting for the water conditions to be passed or choose to do other jobs when entering the low season. As many as 73.53% of fishers choose not to go to sea during the low season. This condition indicates that water conditions significantly affect fishers in fishing [8].

In carrying out fishing, usually, fishers will choose the location of the fishing grounds first. Fishers usually choose fishing grounds with low wave heights. The location selection is very dependent on the situation and environmental obstacles, namely water [18]. In determining the location, the fisher will choose the previous fishing grounds that have abundant catches. In this case, the fisher's experience will influence the fishing grounds' location selection [19]. The direction in selecting the fishing grounds' location is usually to the south or the west towards Kulon Progo Regency.

Generally, fishers can choose fishing grounds as far as 10 miles from the coastline in high season. However, in the low season, it only reaches 6 miles. Fishers who continue to go to sea during the low season will usually choose fishing grounds close to land for 1-2 miles. Fishers in this season can go to the coast of Kulon Progo Regency to catch fish (see figure 3.). Indirectly, fishers change the fishing grounds location due to changes in seasons [20].

In the low season, only migrant fishers catch fish. The catch depends on the waters that day so that fishing can be done in the morning or evening. For the choice of fishing grounds location too. The migrant fishers on Depok Beach are generally used to capture fisheries activities, so they decide to sea when they can. This condition is different from local fishers who previously did not utilize marine resources, so they chose to carry out other activities during the low season.
3.4. Fish catch variation

The types of fish caught that are obtained are quite diverse every month during the high and low seasons. Beltfish (Trichiurus lepturus) is a catch fish commodity during high and low seasons. Meanwhile, white pomfret (Pampus argenteus), banana prawn (Penaeus merguiensis), and scalloped spiny lobster (Panulirus homorus) are mostly found in the high season. Mackerel tuna (Euthynnus affinis) become commodity fish in the low season, which can be obtained at night (see table 2.). However, because it is very dependent on water conditions, Mackerel tuna (Euthynnus affinis) are not always caught during the low season. The type of fish caught by fishers in Depok Beach is demersal fish, usually found in coastal waters. This commodity is by the characteristics of a fishing asset like boat and gear, which is still simple and is supported by the harsh conditions of the Yogyakarta waters.

Table 2. Fish catch variation

| Local Fish Name / English Name / Species                  |
|--------------------------------------------------------|
| Bawal Putih / White Pomfret / Pampus argenteus *        |
| Bawal Hitam / Black Pomfret / Formio niger             |
| Tenggiri / Spanish Mackerel / Scomberomorus commerson  |
| Layur / Beltfish / Trichiurus lepturus                   |
| Jahan / Spotted Catfish / Arius maculatus               |
| Teri / Anchovy / Stolephorus sp.                        |
| Udang Jerbung / Banana Prawn / Penaeus merguiensis *    |
| Kakap Cina / Barramundi / Lates calcarifer              |
| Kakap Hitam / Black and White Snapper / Macolor niger   |
| Tongkol / Mackerel Tuna / Euthynnus affinis b           |
| Lobster Pasir / Scalloped Spiny Lobster / Panulirus homorus * |
| Lobster Mutiara / Ornate Spiny Lobster / Panulirus ornatus |

* High season commodity.
4. Conclusion
The fishing community on Depok Beach is dominated by migrant fishers from Cilacap and captured fisheries in Yogyakarta waters. Fishing activities are still very dependent on water conditions both during high and low seasons. Fishing grounds can be further away in the high season, while the low season tends to be closer to the shoreline. Demersal fish dominate the type of catch in coastal waters. Beltfish (*Trichiurus lepturus*) is a fish catch commodity during high and low seasons. Meanwhile, white pomfret (*Pampus argenteus*), banana prawn (*Penaeus merguiensis*), scalloped spiny lobster (*Panulirus homorus*) are mostly found in the high season, and mackerel tuna (*Euthynnus affinis*) in the low season.

Acknowledgments
This research is supported by the PITU research grant of 2020 from Universitas Indonesia with contract number NKB-930/UN2.RST/HKP.05.00/2020. Lastly, thank Bu Dewi Susiloningtyas and Bu Tuty Handayani as this research counselor and the Parangtritis Village Officer for helping the research.

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