Fishing ground mapping of static fishing gear in Lada Bay waters

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Abstract. Various types of fishing gear operated in Lada Bay waters. Data and information regarding fixed or static fishing gear (SFG) are minimal. This research aims to (1) determine the number and size of SFG; and (2) mapping the fishing ground of SFG in Lada Bay. The census method was conducted from August 2018 to April 2019. The identification of SFG and water characteristics were analyzed descriptively. Map of the fishing ground made with GIS. The number of SFG in Lada Bay was 123 units (45 units of fixed lift net and 78 units of the arrier). The fixed lift net sizes range from 10.6-12.7 m with bamboo and areca trees construction. The leader net of the barrier is 100 m, wings 37.5 m, body 10.5 m, and crib 4x4-4x5 m, with bamboo and nets construction. The fishing ground of the fixed lift net is from Tanjung Lesung to the north of Liwungan Island. While the barrier is from Tanjung Lesung to Ciseukeut River. Water characteristics for fixed lift net are temperature 27.2-29°C, pH 7.7-9, salinity 30-33 ppt, depth 11-16 m, and brightness 2.8-3.8 m. The water condition for barriers is temperature 27.3-30°C, salinity 30-34 ppt, current 0.1-0.3 m/s, and depth 1.3-7.7 m with the substrate of muddy sand and sandy coral.

1. Introduction
Lada Bay waters are one of the capture fisheries centres located in the Pandeglang Regency. It is very strategic because directly facing the Sunda Strait so that the water mass of Lada Bay waters is still directly influenced by the water masses of the Sunda strait [1]. The presence of water input from the Sunda Strait caused the waters of Lada Bay to become fertile and is widely used for fishing activities [2,3]. The types of fisheries activities in the Lada Bay area capture fisheries, marine culture, and green mussel garden [2].

Capture fisheries are the most developed fisheries activities compared to others [2]. Various types of fishing gear operated in the Lada Bay include lift net, sondong, gill nets, hooks and lines, boat seine, and the barrier [4]. Various types of fishing gear operating in the Lada Bay area anchored at three fishing ports, namely Labuan, Panimbang, and Citeureup [5]. Lift net, sondong, gill net, and mini trawl based at Panimbang, lift net and the barriers at Citeureup, and boat seine, hooks and lines, and gill nets at Labuan [4,5].
All of the fishing gears are one-day fishing gear [4,5]. Most of these types of fishing gear have a wide area for fishing operations, even to the waters of Sunda Strait and south of Java [4,6], because their fishing gear can move around, except for fixed lift net and the barrier. After all, it is fixed (static). So far, data and information regarding fixed or static fishing gear such as fixed lift net and the barrier are still very limited [4,6]. Information regarding the fishing ground is also minimal. Until now, there is no data and information regarding how much fixed lift net and the barrier are operating in Lada Bay [4,5,6]. Therefore, this study aims to (1) determine the number, condition, and size of static fishing gear in Lada Bay, and (2) mapping the fishing ground location of stationary fishing gear in Lada Bay, Pandeglang Regency, Banten Province.

2. Material and methods
The research was conducted in August 2018 to April 2019 at Lada Bay, Pandeglang Regency, Banten Province. The study was conducted using the census method [7], where data collection and measurement of all static fishing gears were carried out in the field. The census was carried out by circling the entire waters of Lada Bay by boat to obtain data on the number and condition of fishing gear, the location of the installation, dimensions of fishing gear, the depth of the water was installed.

The number of static fishing gear was observed and marked using the global positioning system (GPS). Depth measurements were carried out with a fish finder. Experimental fishing is also carried out by following a fishing operation and measuring the oceanographic conditions of the fishing gear location (temperature, pH, salinity, brightness, tides, and currents). In-situ measurements of temperature, brightness, salinity, pH, and tides were carried out. The fishing trip is carried out with 10 fixed lift net and 22 the barriers, which are selected with criteria that represent all existing static fishing gear.

The number, condition, dimension, and fishing ground characteristic of static fishing gear were analysed descriptively [8]. The distribution of stationary fishing gear installation location is made in the form of a map using geographic information system [9,10,11].

3. Result and discussion
3.1. The static fishing gear in the Lada Bay waters
The result showed the types of static fishing gear operating in Lada Bay are only fixed lift net and the barrier. The number of static fishing gear is 123 units, consisting of 45 units of fixed lift net and 78 units of the barrier. Two units of fixed lift net are in a damaged condition (damaged nets and rollers), while the other 43 units are still operating correctly. As for the barrier, all of them are in good condition and functioning. Fishers generally have 2 to 3 units of the barriers. The characteristics of the fixed lift net and the barrier are described as follows.

3.1.1. The fixed lift net
The dimension of the fixed life net operating in Lada bay ranges from 10.6 x 10.6 m to 12.7 x 12.7 m with a depth of installation ranging from 11 to 16 m. The fixed lift net operating in Lada Bay has a smaller size when compared to the fixed lift net operating in Banten Bay, which has a size of 11 x 11 m to 16 x 16 m [12]. However, it is bigger than the fixed lift net operating in Makassar waters [13].

These operating fixed lift nets are those owned by fishermen from the Citeureup and Panimbang areas. There are differences in the fixed lift net of the two regions, which makes the fixed lift net characteristic, namely the support section. The fixed lift net from Citeureup uses bamboo, while the fixed lift net from Panimbang uses the areca tree. Bamboo has good properties to be utilized, among others, its stems are strong, ductile, straight, hard, flat, easy to split, easy to shape and light, so it was easy to transport [14].

The fixed lift net operation is usually from February to December. The installation of a fixed lift net is generally carried out in February, and after that in mid or late February or early March fishing operation will begin. The peak season for anchovy fishing using a fixed lift net based on information from fishermen rangers from July to August. The peak season of anchovy occurs from April, June to
August [3]. So the installation of fixed lift net by fishers starting February or March has adjusted to the peak season for anchovy season.

3.1.2. The barriers
The barriers operate in Lada Bay consist of leader net, wing, body, and crib. The leader net has an average length of 100 m, wings of 37.5 m, and 10.5 m of body. The crib section measures 4 x 5 m and 4 x 4 m. The crib size 4 x 5 m is usually found in the barriers installed in the outermost areas.

In construction, the barrier which operates in Lada Bay is different from the barrier in Banten Bay. The barrier on the north coast of Serang consist of five parts, namely leader net, wings, body, stomach, and crib [15]. The barrier, according to Minister of Marine Affairs and Fisheries Decree No. 6/2010 is a fixed fishing gear operated in coastal areas to catch migratory fish by utilizing tides. The barriers take advantage of the influence of tidal currents using a tool that shrinks so that fish can be dragged in and trapped in.

The barriers construction uses a combination of bamboo and nets. Bamboo is used as a frame, with the length criteria ranging from 7-9 m. The nets are installed stretching to follow the bamboo frame to form a netting wall with bamboo poles 2-3 m apart. The nets used are made of polyethylene multifilament with a mesh size of 1.5 inches (some are 3 inches). For the crib, a waring is used which is tied to the top four sides, so that when it is lowered into the water, it will form like a pocket.

The barrier operation is divided into three stages. The first is set, which is done by lowering the crib into the water. The crib net has a rope tied to the bottom end of the waring on all four sides and hooks it to the bottom of the bamboo so that when it is pulled, it forms a pocket. The setting process is carried out every day at 7.00 WIB. The second stage of towing, namely immersion of the crib, was carried out for 24 hours. The last step of hauling, namely the process of lifting the crib and taking the catch, usually done every day at 6.00 WIB. The rope ties that are connected to the corners of the lower crib are released, then the crib is lifted by pulling the upper side slowly so that the sides of the crib are raised. Fish are usually collected on one side of the crib net to make it easier to scoop the fish. After the hauling is finished, the crib net is lowered back to the water (setting), and after that, the fishermen go back home.

All the barriers operating in Lada Bay are installed in a position perpendicular to the coast. It aims to block the fish that enter the beach and at low tide can lead the fish to enter the barrier. The position of the barrier opening facing the beach results in trapping the fish and making it difficult to find a way out. The behaviour of fish that migration towards the beach at high tide and return to the sea at low tide. This condition is the basis for installing the barrier in the waters, namely by utilizing tides. Fish whose movement is obstructed or towards the proponent will continue to enter the barrier until finally, they are trapped and have difficulty finding a way out [16].

3.2. The fishing ground mapping of static fishing gear in Lada Bay
The location for the installation of a fixed lift net and the barriers in Lada Bay is presented in Figure 1. The site for the installation of a fixed lift net is more concentrated on the west and southwest side of Liwungan Island and the Tanjung Lesung coast with a direction further outside the waters of the bay. Meanwhile, the barriers installation locations are concentrated along the coast of Panimbang to Tanjung Lesung, with a more dominant number on the western side of the bay.

The installation of a fixed lift net in the west and southwest side of Liwungan Island has been done for a long time and continues to this day. Even after the tsunami disaster that occurred in December 2018, fishers returned to sticking their fixed lift net at that location. The determination of this location is based on experience, namely by looking at the number of stars with the position of the moon on the right [17].

The water conditions of fixed lift net location are temperature ranges from 27.2-29°C, pH ranges from 7.7-9, salinity ranges from 30-33 and brightness ranges from 2.8-3.8 m. The water temperature suitable for the fishing ground of fixed lift net ranges from 26-29°C [18]. The sea surface temperature
of Lada Bay ranges from 27.3-28.8°C [19]. It shows that the temperature of Lada Bay waters is still suitable for the fishing ground for a fixed lift net.

![Figure 1. The fishing ground of static fishing gear in the Lada Bay waters.](image)

The depth of the waters, which are the fishing location of fixed lift net ranges from 5-15 m [20]. This depth value is still appropriate because the depth of fixed lift net location ranges from 11-16 m. The depth of the water will affect the strength of the construction and the material used to build the fixed lift net.

The conditions that are good for waters suitable for fishing ground are near the coast, bay areas, or waters that are safe from currents, winds, and waves, as well as clean waters [21]. Based on these criteria, the waters on the west side of Liwungan Island are still suitable for the fixed lift net. The bottom substrate also influences the location selection. The primary substrate of Lada Bay in the form of soil and sand [22,23], and around the waters of Liwungan Island has a mud substrate [2].

The installation distance between the fixed lift net ranges from 50-100 m and is relatively close to each other. The area of fixed lift net is 1 ha, which means that in 1 ha there is only one embedded fixed lift net. The distance between the fixed lift net that is too close together will affect the effectiveness of fishing; this is because the use of the fishing lamp is less effective so that it will affect the catch [24]. The higher the density of the fixed lift net, the higher the competition that occurs in getting the catch. The density of the fixed lift net significantly affects the productivity of fishing gear. The higher the density will be resulting in decreased fishing gear productivity [25].

Installation of the barriers starting from Tanjung Lesung to the mouth of the Cisekeut river at Panimbang. The largest number was on the west side of Lada Bay, namely those close to Tanjung Lesung with 63 units, while those on the east side were 15 units. The location of the barrier in the
waters is varied. If the distance from the beach to the barrier is measured, the site ranges from 140 m to 2 km. The closest distance between the barrier is 49 m, and the farthest is 1,064 m. Almost all the barriers are installed with a mud sand substrate, except in Tanjung Lesung which has a sandy coral substrate, because it is easier to stick bamboo in the muddy bottom of the water, as presented in Figure 2.

Figure 2. The distribution of the barrier location and its substrate characteristics of the fishing ground.

Based on the distance and the water substrate, the barrier installation location can be divided into several categories: the west side of Lada Bay is close to Tanjung Lesung with a muddy sand substrate, and the distance of 100-550 m from the beach is found 38 units of barriers, in the range of 550-1,800 m from the coast, 24 units of the barriers were found. One unit of the barrier is located on a sandy reef with a distance of 200 m from the beach. The rest is near the estuary of the Cisekeut river with a muddy sand substrate and 15 units of the barrier from the coast range from 1,300-2,100 m.

For the installation location suitable substrate is in the form of mud, sand, or a mixture of both, so that the coast of Lada Bay is still ideal for the barrier fishing ground. Lada bay forms a curved beach, with a sloping coastal area, and the coast is sand and mud deposits [26].

The number of the barrier in a location far from the coast is less because the waters have more massive currents, making it less suitable for the barrier (shortening the service life of the barrier). The criteria for the barrier fishing ground are water depth ranging from 1-10 m, the substrate in the form of muddy sand of mud and sand, located in the estuary area with a distance of approximately 200-250 m from the river, water currents in the range 0.05-0.4 m/s, high tide with a range of 0.5 m, not in a polluted area, good accessibility, and a water temperature range from 26-35°C [27,28]. The barrier can be installed in a water depth of up to 10-15 m, depending on the size of the barrier [29].

The current speed at the barrier fishing ground ranges from 0.1-0.3 m/s with the direction of the current going in the bay. The west side blocked by Tanjung Lesung has a lower current than the open area to the east. The fishing ground that meets the requirements for the installation of the barrier with a maximum current of 1.029 m/s because the effect of current on the structure and the catch of the barrier are quite large. Installation of the barrier should be done in waters that have weak currents. If the current in the water is too large, it will cause the shape and position of the net to be unstable and can change and can cause the fishing gear to be damaged quickly [30].

From the result of the mapping of the fishing ground location of the fixed lift net and the barrier, recommendations for future management can be given as follows: (1) it is necessary to adjust the
distance for the installation of the fixed lift net. It is needed to be done because it will affect the effectiveness of using lights. (2) For the barrier, (a) it is necessary to adjust the distance for the barrier installation, this needs to be done because it will affect the ease of operation of the boat when going to and leaving the barrier. (b) the time of hauling needs to be done by taking into account the tidal condition. (c) the height of the barrier, especially the crib, needs to be made at least as high as the water at the highest tide so that the fish that are already trapped in the crib will not come out or run away when the tide occurs.

4. Conclusion
The types of static fishing gear in the Lada Bay are fixed lift net and the barrier. There are 45 units of fixed lift net and 78 units of the barrier. The size of the fixed lift net varies from 10.6 to 12.7 m. The fishing ground location of the fixed lift net is on the west side of Liwungan Island with water characteristics are temperature 27.2-29°C, pH 7.7-9, salinity 30-33 ppt, depth 11-16 m, and brightness 2.8-3.8 m. The barrier fishing ground starts from Cisekeut river at Mekarsari village to the coast of Tanjung Lesung with water characteristics are temperature 27.3-30°C, salinity 30-34 ppt, current 0.1-0.3 m/s, depth 1.3-7.7 m, with the bottom substrate in the form of muddy sand and sandy coral.

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