Fishing capacity calculation for small scale fisheries at Kuala Stabas Fish Landing Base Krui, West Coast Regency

[1]Darmawan, [2]Amelia R. Yuliandini, [1]Didin Komarudin

[1] Department of Fisheries Resource Utilization, Faculty of Fisheries and Marine Science, IPB University, 16680 Bogor, West Java, Indonesia; [2] Capture Fisheries Technology and Management Study Program, Faculty of Fisheries and Marine Science, IPB University, 16680 Bogor, West Java, Indonesia. Corresponding author: Darmawan, darmawan@apps.ipb.ac.id

Abstract. Fishing capacity is the ability of a fishing vessel unit to catch fish normally within one year. The value of fishing capacity is needed to determine the condition between fishing capacity and the number of permitted catches. Calculating the value of fishing capacity for a fleet of small fishing vessels is difficult to carry out due to the different dimensions of the vessels and also the techniques for handling or storing fish caught on board. Kuala Stabas Fish Landing Base is located in Krui, West Coast Regency, and has a fishing fleet that can be divided into seven types based on the fishing gear used and the length of the vessel. The research aims to calculate the fishing capacity at Kuala Stabas. Sampling was carried out using a stratification approach based on the type of vessel and fishing gear. The sampling was carried out using the accidental sampling method with a total sample of twenty-three boats and three fish seller's stalls. The results of measurements and calculations of fish storage space on board were analyzed descriptively. Research reveals that fishermen at Kuala Stabas use both Holds and storage boxes as fish storage areas. Fishermen will stop fishing operations if the Hold or storage box is full. Fish storage in the Hold is adjacent to the placement of fishing gear and a storage box. The total fishing capacity value at Kuala Stabas in 2021 was 17,992.275 tons year^{-1}.
Key Words: fishing capacity calculation, small scale fisheries, fish storage practices, under-deck layout.

Introduction. Fishing capacity is the amount of catch a fishing vessel normally produced within one year (Pascoe & Gréboval 2003; FAO 2008). That is, if effort and catch were not constrained by restrictive management measures. Fishing capacity is an important issue in efforts to manage sustainable capture fisheries, especially for policymakers in the capture fisheries sector (Luasunaung & Jaya 2009). Excessive fishing capacity means that the input provided for fishing is not used efficiently. Excessive fishing capacity encourages fishing efforts to be carried out continuously which ultimately encourages overfishing. The FAO (1998) report referred to by Kirkley & Squires (1998) shows that almost all fisheries resources in the world have been fully utilized or experienced overfishing, where 35% have experienced overfishing, 25% have been fully utilized and 40% require serious management attention. Assessed global fish stocks show that overfishing conditions range from 27.21% to 35.4% between 2000 and 2019 (FAO 2023; Ritchie & Roser 2023). Overfishing is a product of over capacity and excess capacity is a key problem in capture fisheries.

Guidelines for sustainable fisheries management (Code of Conduct for Responsible Fisheries) published by FAO (1995) have called on all countries to avoid overfishing and overfishing capacity by implementing measurements of the fishing capacity of their fleets. The results of the calculation of fishing capacity need to be compared with the estimated calculation of the sustainable potential of fish resources in a fishing area. The direction of management of fish resources in the region should ideally be designed based on a balance between the value of fishing capacity and the sustainability resources, which is then determined by the amount of allowable catch (FAO 1998).

The issue of fishing capacity has been discussed for a long time. In 1999, the Food Agriculture Organization (FAO) issued an International Plan of Action (IPOA) regarding Fishing Capacity, which called on world fishing countries to start calculating the size of their fishing capacity. The size of fishing capacity is an important indicator in efforts to manage fish resources sustainably. Controlling the size of a country's fishing capacity is the key to finding a balance in exploitation when compared to the potential value of its fish resources.

As an archipelagic country, Indonesia has quite abundant fish resources. However, until now, there has been no detailed calculation regarding the actual fishing capacity of the national fleet. The main difficulty in calculating fishing capacity in Indonesia is that 96% of the national fleet consists of small-scale vessels under 10 GT (MMAF 2022), which have very diverse design and construction specifications. Calculations based on approaches to measuring physical variables and economic variables are difficult to carry out due to the large diversity, number and distribution of locations of these fishing units. Another difficult factor is the practice of handling fish on board, which is also very diverse. Not all small vessels have under-deck storage to accommodate the catch. Often, fishermen carry styrofoam boxes or just put their catch on the deck of their boat. Fishing units that have under-deck storage are often not only used as a place to store catches. The overall practices and habits of fishermen in storing their catch on board vary greatly, all of which influence the calculation of fishing capacity for that type of fishing unit. Failure to calculate fishing capacity has resulted in the regulation of capture fisheries not being based on reliable information data. So, in fact, it cannot be ascertained whether the potential of existing fish resources and the number of catches allowed each year are in accordance with the existing fishing capacity.

This research is one part of a series of research to compile measurements of fishing capacity at various small landing bases numbering hundreds throughout Indonesia. It is hoped that the physical measurement calculation model carried out can be implemented in various fishing ports or landings so that the fishing capacity can be calculated systematically and carefully. These calculation techniques and formulations can be tested and developed further for other various small-scale fishing vessels throughout Indonesia and even Southeast Asia, which do not have design and construction standards. This research will also compare the calculation of fishing capacity with statistical data on the number of fish landed in Kuala Stabas during the same year period. This result is done to see how high the success rate of fishermen in catching fish is according to the fishing capacity of the vessel and the fishing gear used.

Material and Method

Study sites and period. The research was conducted at Fish Landing Base (FLB) Kuala Stabas in Krui, West Coast Regency (Figure 1). The research was carried out from September to October 2021.

Research method. The data and information collected consist of three parts, which are:

- the main dimensions of the vessel and the volume of the vessel, as well as the dimensions and volume of the Hold space;
- dimensions and volume of fish storage media other than Holds;
- practices for storing catches on board vessels include the habit of placing fishing gear in the under-deck storage, using ice in storage boxes, and placing the catch on deck when all the storage areas are filled.

The main dimensions of the vessel. The main dimensions of the vessel, namely length over all (LOA), breadth (B) and depth (D), were obtained according to the fishing vessel measurement guide from Nomura & Yamazaki (1977) and Iskandar & Novita (1997). The vessel's gross tonnage (GT) volume was calculated according to Minister of Transportation Regulation Number 45/2021 with the formula:

$$GT = 0.25 \times V$$

where: GT = gross tonnage;
0.25 = a coefficient;

V = the total volume of room below deck (V_1) plus the total volume of closed room above deck (V_2).

The formula used in the domestic GT measurement method to calculate the volume below deck (V_1) is:

$$V_1 (m^3) = L \times B \times D \times f$$

where: V_1 = volume below deck;

f = factor determined according to the shape and type of vessel (a. 0.85 - barge; b. 0.70 - motor boat; c. 0.50 - sailboat/motorboat.

The vessels at Kuala Stabas do not have space above deck (V_2), so the GT calculation will only use the volume of space below deck (V_1).

The volume of the catch storage (Hold)

a. Calculation of the volume of the catch storage (Hold) is adjusted to its shape using the Simpson's I method.

Calculate the area of the vertical side using Simpson's I formula:

$$A (m^2) = 1/3 \times h(y0 + 4y1 + 2y2 + 4y3 + 2y4 + 4y5 + y6)$$

where: A = boat's waterplane area;

h = common interval between ordinate;

y = length of ordinate.

After the value of the area of the transverse side is obtained, the Hold volume can be calculated using the formula:

$$V\ Hold (m^3) = A \times P$$

where: P = length of Hold (m)

b. Calculation of the volume of fishing gear and storage boxes.

Calculate the volume of a storage box (fiber box) using a simple mathematical formula:

$$V\ box (m^3) = V\ outer\ wall (m^3) - V\ inner\ wall (m^3)$$

c. Calculation of fishing capacity/vessel type.

Fishing capacity = vessel load capacity:

$$FC (ton) = Net\ Hold\ volume (m^3) \times density\ of\ fish (ton\ m^{-3})$$

Calculation of fishing capacity/vessel type/year:

$$FC (ton\ year^{-1}) = Net\ Hold\ volume (m^3) \times \rho\ fish (ton\ m^{-3}) \times E \times V$$

where: FC = catching capacity (ton $year^{-1}$);

ρ fish = density of fish (0.423 ton m^{-3});

E = average number of days at sea in one year;

V = number of vessels.

Direct observations in the field were carried out to directly calculate the number of existing fleets, including the number of storage boxes used (other than under-deck storage). In-depth interviews were conducted to understand fishermen's customary practices in storing catches and practices of placing or storing other cargo in Holds or catch storage boxes. Other information obtained is about the behavior of fishermen when their Holds and containers are full.

In-depth interviews were also used to obtain information regarding the estimated number of catches per season, the length of each fishing trip, the number of trips per year or the average number of days at sea fishermen per fishing season in a year. As a comparison, statistical data on the number of fish landed was used, which is officially recorded by the West Coast Regency Maritime Service.

The fishing capacity of one type of fishing gear will be obtained by calculating the net volume of fish storage media (Holds, storage boxes, vessel decks), the average number of days at sea for fishermen per fishing season in a year, the number of similar

vessels and the constant value of converting volume to weight correspond to the density value of fish and ice. The density of fish uses a value of 0.423 ton m^{-3}.

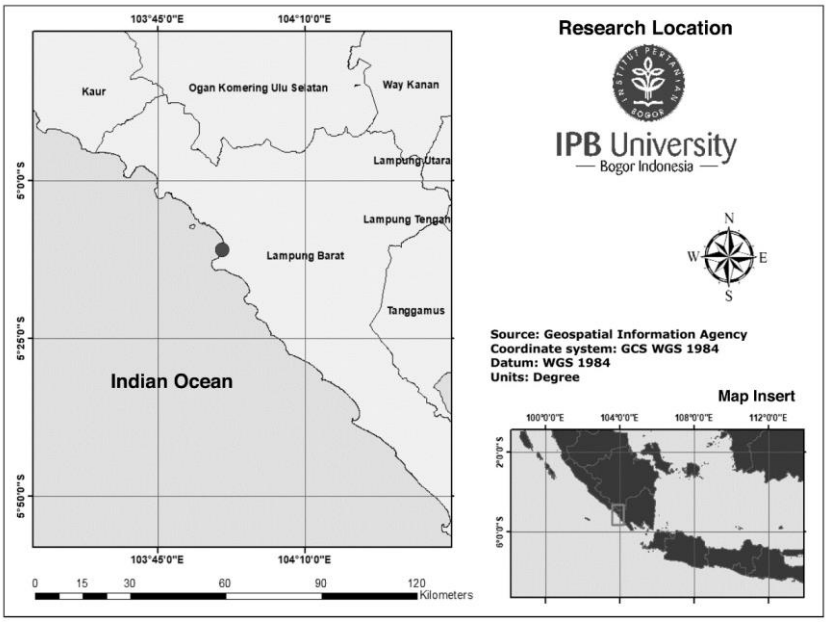

Figure 1. The location of Kuala Stabas in Krui, West Coast Regency, Indonesia.

Results

Dimensions of fishing vessels. FLB Kuala Stabas has seven types of one-day fishing units totaling one hundred and seventy-three (173) vessels with three lengths ranging from six, seven, to nine meters. The fishing gear used was a mini purse seine, handline and rampus net with outboard motor drives varying between 6.5 and 15 horse power (HP) (Table 1). Rampus net is the local name for bottom gillnet fishing gear.

Table 1

Capture fleet at FLB Kuala Stabas

No	*Capture fleet*	*Vessel length (m)*	*Size of fishing gear (m)*			*Total*	
			Mini purse seine	*Handline*	*Rampus net*	*Ship*	*Sample*
1	Mini purse seine	9	200-250	-	-	2	2
2	Handline	9	-	25-50	-	4	1
3	Rampus net	9	-	-	100	1	1
4	Mini purse seine and handline	9	200-250	25-50	-	65	7
5	Mini purse seine and handline	7	100	25-50	-	76	8
6	Handline and rampus net	7	-	25-50	40-100	12	2
7	Handline and rampus net	6	-	25-50	30-100	13	2

The measurement sample was set at 10%, referring to the opinion of Gay & Diehl (1992) that descriptive research can take a 10% sample from the total of each type of fishing unit using convenient/accidental sampling data collection techniques (Sugiyono 2017). These are vessels that are not at sea. The results of measurements of the main dimensions of vessels, fishing gear and GT size of sample vessels for each fishing fleet at FLB Kuala Stabas are presented in Table 2.

Table 2

Main dimensions of vessels, fishing gear, and GT of each fishing fleet

No	Vessel name	Fishing gear	Fishing gear size (m)					Main dimension (m)			GT
			Mini purse seine		Rampus net		Handline				
			L	H	L	H	L	LOA	B	D	
1	Sumber Rejeki	Mini purse seine	250	20	-	-	-	9.20	1.03	0.80	1
2	Putra Jaya		200	18	-	-	-	9.11	0.93	0.75	1
3	Anugrah	Handline	-	-	-	-	50	9.25	1.03	0.70	1
4	Eramas	Rampus net	-	-	100	2	-	9.10	0.93	0.70	1
5	Arjuna Laut	Mini purse seine and handline	250	15	-	-	25-50	9.20	1.02	0.70	1
6	Dolpin		250	15	-	-	25-50	9.20	0.97	0.75	1
7	King Fish		250	15	-	-	25-50	9.25	1.03	0.75	1
8	Ayu Pargastu		200	18	-	-	25-50	9.25	1.03	0.75	1
9	Kapten Muda		250	18	-	-	25-50	9.10	0.93	0.75	1
10	Nusantara 02		200	18	-	-	25-50	9.20	1.02	0.75	1
11	Romantika 12		200	18	-	-	25-50	9.22	0.98	0.75	1
12	Baruna	Mini purse seine and handline	100	2	-	-	25-50	7.05	0.63	0.56	0.43
13	Cendrawasih		100	2	-	-	25-50	7.06	0.66	0.60	0.48
14	Cari Berkah		100	2	-	-	25-50	7.20	0.62	0.60	0.46
15	Berkah Laut		100	2	-	-	25-50	7.37	0.67	0.56	0.48
16	Mitra Karya		100	5	-	-	25-50	7.20	0.62	0.60	0.46
17	Perwira Muda		100	2	-	-	25-50	7.37	0.63	0.56	0.45
18	Harapan Baru		100	2	-	-	25-50	7.05	0.55	0.56	0.38
19	Ridho		100	2	-	-	25-50	7.20	0.62	0.60	0.46
20	Lemuru 07	Handline and rampus net	-	-	100	2	25-50	7.06	0.66	0.60	0.48
21	Merpati		-	-	30	2	25-50	7.40	0.67	0.56	0.48
22	Anak Laut	Handline and rampus net	-	-	40	2	25-50	6.05	0.59	0.50	0.31
23	Lima Muakhi		-	-	100	2	25-50	6.50	0.69	0.55	0.43

Note: L = length; H = height; LOA = length overall; B = breadth; D = depth.

The FLB Kuala Stabas fishing boat does not have buildings or closed spaces on board, so the vessel's GT calculation is carried out using only the volume of space below the deck. The GT size of a vessel with a length of 9 m is 1 GT, while for vessels with a length of 6 and 7 m, the size is 0.31-0.43 GT and 0.38-0.48 GT respectively.

Fisherman's habits in handling the catch. FLB Kuala Stabas fishermen are fishermen who carry out fishing operations for no more than one day (one day fishing). Generally, fishermen leave for sea at 02.00-05.00 WIB, then return to FLB Kuala Stabas at 11.00-17.00 WIB. Fishing vessels use outboard motors with a power of 6.5 HP and 15 HP. Furthermore, FLB Kuala Stabas fishermen use Holds and storage boxes to accommodate their fish catch. Mini purse seine vessels with vessel lengths of 7 and 9 m, rampus net vessels with vessel lengths of 6, 7 and 9 m and fishing vessels with vessel lengths of 6 and 7 m each only use Holds to accommodate fishing gear and catch in sequence as in Figure 2, Figure 3 and Figure 4. This condition is because the vessel carried out fishing operations around FLB Kuala Stabas. Meanwhile, hand-line fishing vessels measuring 9 m long use a Hold and one storage box as auxiliary media in accommodating fishing gear and storing the catch. This condition is because hand-line fishing vessels usually carry out fishing operations in the fishing areas located 18-40 miles away. The storage box used by the 9 m longline fishing vessel uses 10 kg of ice, which maintains the quality of the fish.

The results of interviews with fishermen show that fishermen use Holds and storage boxes as fish storage media. Fishermen also put fishing gear and storage boxes in the Hold. Fishermen will try to fill the Hold with fish during operations and stop fishing operations when the Hold is full.

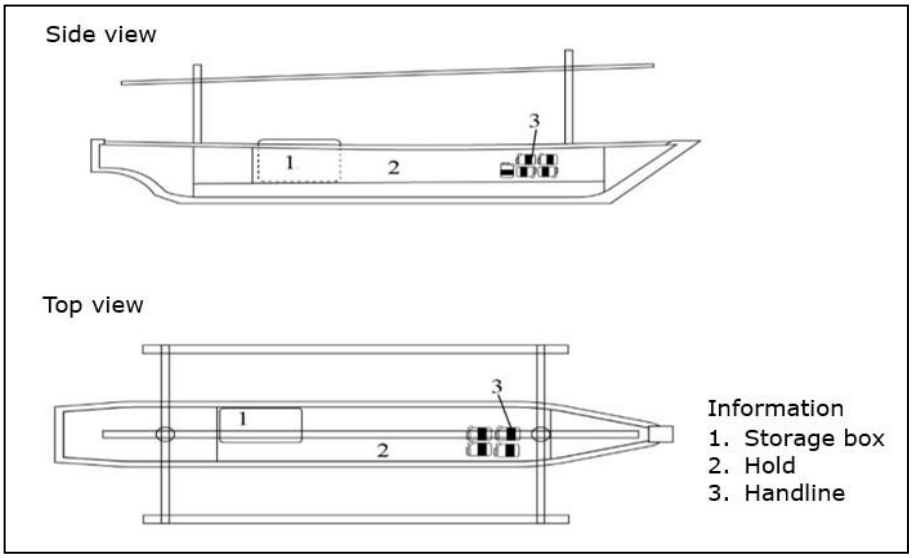

Figure 2. Illustration of placing a handline and storage box in the Hold.

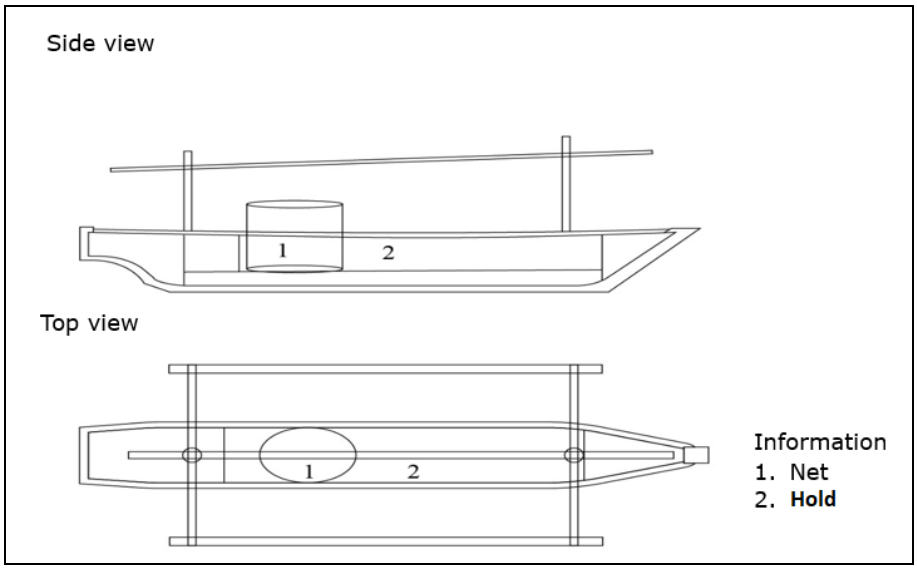

Figure 3. Illustration of placing a mini purse seine in the Hold.

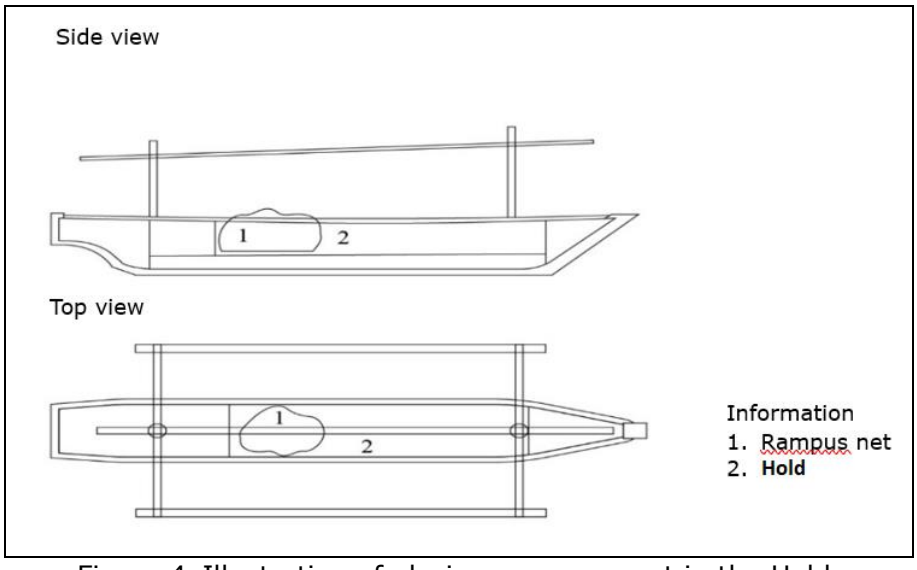

Figure 4. Illustration of placing a rampus net in the Hold.

Handline fishermen with vessels 9 m long with Holds and storage boxes as fish storage media carry out different practices. If the storage box is full, the fisherman will continue the fishing operation. The next catch will be stored in the Hold. Then, mini purse seine fishermen with a boat length of 9 m use the Hold and top of the boat as a fish storage medium. However, the use of these vessels is rare because if the holds are full, fishermen will stop carrying out fishing operations. If there is an excess of fish, such as during the peak season, fishermen will transfer fish loads so as not to endanger the condition of the vessels and maintain the quality of the fish. The transfer of fish is carried out to other similar vessels. However, in this study, it was not investigated further, so the influence on the calculation of fishing capacity was ignored.

The catch of fishermen from mini purse seine vessels with a vessel length of 9 m is stored in the vessel's Hold. If the catch in the Hold is not filled, the fishermen will continue the fishing operation. Fishing operations are stopped when the catch has filled the Hold. Storing the catch in the Hold is adjacent to the placement of the mini purse seine fishing gear. The same Hold situation also occurs on mini purse seine vessels with a vessel length of 7 m, rampus net vessels measuring 9, 7 and 6 m, and handline fishing vessels measuring 7 and 6 m. What is different from hand-line fishing vessels with a length of 9 m is that when using hand-line fishing gear, the catch is first stored in a storage box, and the fisherman continues the fishing operation. The catch obtained is then stored in the vessel's Hold. Storing the catch in the Hold is adjacent to the placement of hand-line fishing equipment and a storage box.

The results of interviews with fishermen regarding the number of days at sea in a year showed that during the peak season, fishermen made 27 trips or 27 days per month. Meanwhile, during the transition season, fishermen make 26 trips, and during the lean season, they only make 24 trips. So, in total, fishermen carry out fishing operations 300 days per year. When fishermen are on holiday or not at sea, generally, the boats will be on the beach. Then, fishermen will inspect and repair damaged fishing gear and driving machines.

The volume of catch storage media. The results of interviews and direct observations of fishermen explained that FLB Kuala Stabas fishermen used Holds and storage boxes (fiber boxes) together to store their catch. The Hold design on each fishing fleet is not specifically designed but rather follows the shape of the vessel's body. However, none of the Holds are insulated. Apart from being used to store fish, Holds are also used to store fishing gear and storage boxes. There are four cargo layout positions in the Hold according to the type of fishing gear. Therefore, the calculation of the net volume and load capacity of the storage media uses four variations, namely layout 1, where the Hold contains mini purse seine fishing gear; layout 2, where the Hold contains rampus net fishing gear (Figure 5); layout 3, where the Hold contains handline fishing gear (Figure 6); and layout 4, where the Hold contains handline fishing gear and a storage box (Figure 7).

a. Net Hold volume layouts 1 and 2 for mini purse seine and rampus net:

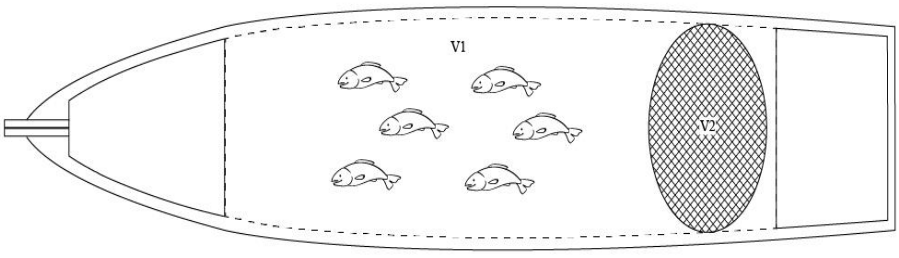

Figure 5. Layouts 1 and 2 are for mini purse seine or rampus net.

$$V \text{ net Hold } (m^3) = V1 - V2$$

where: V1 = total volume of vessel Holds (m^3);
V2 = volume of mini purse seine or rampus net (m^3).

b. Net Hold volume layout 3 for handline:

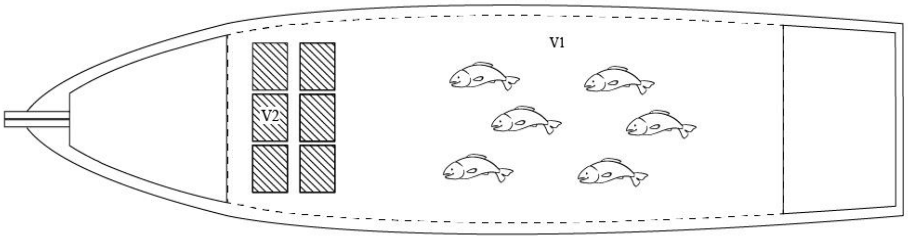

Figure 6. Layout 3 for handline fishing gear.

$$V \text{ net Hold } (m^3) = V1 - V2$$

where: V1 = total volume of vessel Holds (m^3);
V2 = volume of fishing line (m^3).

c. Net Hold volume layout 4: handline with storage box:

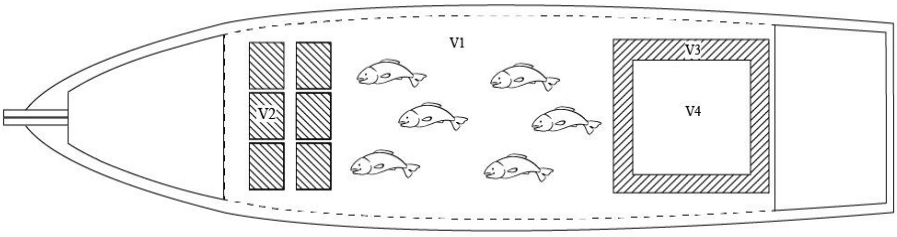

Figure 7. Layout 4 for handline with one storage box.

$$V \text{ net Hold } (m^3) = V1 - (V2 + V3 + V4)$$

where: V1 = total volume of vessel Holds (m^3);
V2 = volume of handline (m^3);
V3 = storage box wall volume (m^3);
V4 = volume of block ice (m^3).

The results of measurements and calculations of the volume and loading capacity of fish storage media are presented in Table 3.

Placing fishing gear in a Hold reduces the Hold's loading capacity. The volume of mini purse seine fishing gear on vessels measuring 9 m in length reaches 0.83 m^3, 9 m longline fishing vessels 0.31 m^3, 9 m long net vessels 0.51 m^3, mini purse seine and handline vessels 9 m 0.83 m^3 and 0.30 m^3 respectively, mini purse seine and hand fishing vessels 7 m 0.22 m^3 and 0.17 m^3 respectively, 7 m 0.24 m^3 and 0.19 m^3 rampus nets and fishing line vessels as well as 6 m^3 and 6 m handline fishing vessels 0.18 m^3 and 0.14 m^3. The average storage box used is 0.30 m^3. Storage boxes are generally used by handline vessels measuring 9 m in length. Handline fishing vessels place fishing gear and a storage box in the Hold in a longitudinal position (Figure 5). Its position adjusts to the width of the Hold, thus affecting the Hold volume. Table 3 explains the total volume and net volume of fish storage media on each sample of vessels from each fishing fleet.

The fishing fleet that uses one fishing tool, namely the mini purse seine, has a Hold space volume of 1.62-2.26 m^3. The hand-line fishing fleet has a Hold space volume of 1.85 m^3, and the rampus net fishing fleet has a Hold space volume of 1.69 m^3. Furthermore, the fishing fleet that uses two fishing gear, namely mini purse seine and handline, has a Hold space volume of 1.70-2.10 m^3 for a vessel length of 9 m and 0.59-0.90 m^3 for a vessel length of 7 m. Fishing fleets with handlines and nets with a vessel length of 7 m have a Hold space volume of 0.83-0.90 m^3, and vessels with a vessel length of 6 m have a Hold space volume of 0.55-0.62 m^3. Vessels that have two fishing gears use just one fishing gear per trip.

The vessel's Hold volume above is the total Hold volume or the Hold volume when it is not filled with fishing gear and storage boxes. Thus, the mini purse seine fishing fleet, namely the Sumber Rejeki vessel (number 1), is the vessel that has the largest Hold volume, namely 2.26 m^3. In contrast, the two-seine fishing fleet, namely the Anak Laut vessel (number 22), has the smallest Hold space volume, namely 0.55 m^3.

Furthermore, storage boxes are generally used by longline fishing vessels measuring 9 m. This storage box has an internal size of 0.81 × 0.52 × 0.57 m. The size of the storage box used by each handline fishing vessel is the same, so it has the same volume, namely 0.24 m^3.

Net volume calculation varies according to layout (4 layout types). Layout is the position and placement of fish, fishing gear, and storage boxes in the Hold. The mini purse seine fishing fleet has a type 1 layout with a net Hold volume of 0.79-1.43 m^3. The handline fishing fleet has a type 4 layout with a net Hold volume of 1.41 m^3. The Rampus fishing fleet has a type 2 layout with a net Hold volume of 1.18 m^3.

A fishing fleet that uses two fishing gears uses a two-layout arrangement. The mini purse seine and handline fishing fleet with a vessel length of 9 m uses type 1 and 4 layouts, with each type having a net Hold volume of 0.87-1.27 m^3 and 1.27-1.67 m^3 respectively. The mini purse seine and handline fishing fleet with a vessel length of 7 m have a net Hold volume of 0.37-0.68 m^3 and 0.42-0.73 m^3 respectively.

The fishing fleet for handlines and rampus nets with vessel lengths of 7 and 6 m uses type 2 and 3 layouts. The net Hold volume of a 7 m vessel is 0.59-0.66 m^3 and 0.64-0.71 m^3 respectively, and the net volume of the Hold 6 m vessels is 0.37-0.44 m^3 and 0.41-0.48 m^3 respectively.

Table 3

Total volume and net volume of fish storage media

No	*Vessel name*	*Fishing gear*	*Total volume of fish storage media (m^3)*		*Net volume of fish storage media (m^3)*			
			Hold	*Box fibre*	*K1*	*K2*	*K3*	*K4*
1	Sumber Rejeki	Mini purse seine	2.26	-	1.43	-	-	-
2	Putra Jaya		1.62	-	0.79	-	-	-
3	Anugrah	Handline	1.85	0.24	-	-	-	1.41
4	Eramas	Rampus net	1.69	-	-	1.18	-	-
5	Arjuna Laut	Mini purse seine and handline	1.70	0.24	0.87	-	-	1.27
6	Dolpin		2.10	0.24	1.27	-	-	1.67
7	King Fish		1.83	0.24	1.00	-	-	1.40
8	Ayu Pargastu		1.83	0.24	1.00	-	-	1.40
9	Kapten Muda		1.74	0.24	0.91	-	-	1.31
10	Nusantara 02		1.70	0.24	0.87	-	-	1.27
11	Romantika 12		2.01	0.24	1.18	-	-	1.58
12	Baruna	Mini purse seine and handline	0.70	-	0.48	-	0.53	-
13	Cendrawasih		0.90	-	0.68	-	0.73	-
14	Cari Berkah		0.72	-	0.50	-	0.55	-
15	Berkah Laut		0.77	-	0.55	-	0.60	-
16	Mitra Karya		0.72	-	0.50	-	0.55	-
17	Perwira Muda		0.70	-	0.48	-	0.53	-
18	Harapan Baru		0.59	-	0.37	-	0.42	-
19	Ridho		0.72	-	0.50	-	0.55	-
20	Lemuru 07	Handline and rampus net	0.90	-	-	0.66	0.71	-
21	Merpati		0.83	-	-	0.59	0.64	-
22	Anak Laut	Handline and rampus net	0.55	-	-	0.37	0.41	-
23	Lima Muakhi		0.62	-	-	0.44	0.48	-

Note: K1 = layout 1 for mini purse seine (PS); K2 = layout 2 for rampus net (JR); K3 = layout 3 for handline (PU); K4 = layout 4 for handline/rampus net & storage box (PU/JR & KP).

Catch load capacity. Using the fish density value of 0.423 ton m^{-3} becomes a conversion factor that shows how many tons of fish can be accommodated in a storage area of one cubic meter (m^3). So for 1 ton of fish, 2.36 m^3 of storage space is needed, or 1 m^3 of storage space can contain 0.423 tons of fish.

The calculation results (Table 4) show that the mini purse seine fleet has a loading capacity of 0.334-0.605 tons, the fishing fleet has a loading capacity of 0.596 tons, and the rampus net fleet has a loading capacity of 0.499 tons.

Fishing fleets that use two fishing gears have varying load capacities depending on the gear they operate. The mini purse seine and handline fleet with a vessel length of 9 m have a loading capacity of 0.368-0.537 tons and 0.537-0.706 tons. The mini purse seine and handline fleet with a vessel length of 7 m have a loading capacity of 0.157-0.288 tons and 0.178-0.309 tons. The fleet of handlines and rampus nets measuring 7 meters in length has a load capacity of 0.250-0.279 tons and 0.271-0.300 tons. Meanwhile, a 6-meter vessel has a loading capacity of 0.157-0.186 tons and 0.173-0.203 tons.

Table 4

Total volume and net volume of fish storage media

No	*Vessel name*	*Fishing gear*	*Fish density (ton m^{-3})*	*Net volume of fish storage media (m^3)*				*Load capacity of fish storage media (ton)*			
				K1	*K2*	*K3*	*K4*	*K1*	*K2*	*K3*	*K4*
1	Sumber Rejeki	Mini purse seine	0.423	1.43	-	-	-	0.605	-	-	-
2	Putra Jaya			0.79	-	-	-	0.334	-	-	-
3	Anugrah	Handline	0.423	-	-	-	1.41	-	-	-	0.596
4	Eramas	Rampus net	0.423	-	1.18	-	-	-	0.499	-	-
5	Arjuna Laut	Mini purse seine and handline	0.423	0.87	-	-	1.27	0.368	-	-	0.537
6	Dolpin			1.27	-	-	1.67	0.537	-	-	0.706
7	King Fish			1.00	-	-	1.40	0.423	-	-	0.592
8	Ayu Pargastu			1.00	-	-	1.40	0.423	-	-	0.592
9	Kapten Muda			0.91	-	-	1.31	0.385	-	-	0.554
10	Nusantara 02			0.87	-	-	1.27	0.368	-	-	0.537
11	Romantika 12			1.18	-	-	1.58	0.499	-	-	0.668
12	Baruna	Mini purse seine and handline	0.423	0.48	-	0.53	-	0.203	-	0.224	-
13	Cendrawasih			0.68	-	0.73	-	0.288	-	0.309	-
14	Cari Berkah			0.50	-	0.55	-	0.212	-	0.233	-
15	Berkah Laut			0.55	-	0.60	-	0.233	-	0.254	-
16	Mitra Karya			0.50	-	0.55	-	0.212	-	0.233	-
17	Perwira Muda			0.48	-	0.53	-	0.203	-	0.224	-
18	Harapan Baru			0.37	-	0.42	-	0.157	-	0.178	-
19	Ridho			0.50	-	0.55	-	0.212	-	0.233	-
20	Lemuru 07	Handline and Rampus net	0.423	-	0.66	0.71	-	-	0.279	0.300	-
21	Merpati			-	0.59	0.64	-	-	0.250	0.271	-
22	Anak Laut	Handline and rampus net	0.423	-	0.37	0.41	-	-	0.157	0.173	-
23	Lima Muakhi			-	0.44	0.48	-	-	0.186	0.203	-

Note: K1 = layout 1 for mini purse seine (PS); K2 = layout 2 for rampus net (JR); K3 = layout 3 for handline (PU); K4 = layout 4 for fishing rod & storage box (PU & KP).

FLB Kuala Stabas fishing capacity. Fishing capacity is a theoretical calculation of a vessel's ability to catch fish normally and bring it back to base within one year. Based on interviews, it is known that, on average, all types of fishing gear operate for three hundred days a year. Fishermen who own two fishing gears use them alternately throughout the year. Therefore, the calculation used is that each fishing gear is operated one hundred and fifty days a year.

Based on the calculation of the load capacity for each type of fishing gear, as stated in Table 5, one load capacity value is determined for each type of fishing gear

based on the average value of the sample capacity calculations. A 9-meter purse seiner vessel is determined using an average fishing capacity value of 0.47 tons, a 9 m handline uses a value of 0.596 tons, and a 9-meter rampus net uses a value of 0.499 tons. The 9-meter-long vessel, which has two types of equipment (purse seine and handline), has a capacity of 0.429 tons and 0.598 tons, respectively. The 7-meter-long vessel, which operates two purse seine and handline equipment, has a fishing capacity of 0.215 tons and 0.236 tons. A 7-meter vessel operating handlines and ramp nets has a fishing capacity of 0.265 tons and 0.286 tons, respectively. A 6-meter vessel using handlines and ramp nets has a fishing capacity of 0.171 tons and 0.188 tons. The total value of the fishing capacity at FLB Kuala Stabas is presented in Table 5.

Table 5

Fishing capacity at FLB Kuala Stabas

No	*Fishing gear*	*Vessel size (m)*	*Fishing capacity (ton)*		*∑ Vessel*	*∑ Fishing day*	*Total fishing capacity (ton year^{-1})*		
1	PS	9	0.4695		2	300		281.700	-
2	PU	9	0.596		4	300	-	715.200	
3	JR	9	0.499		1	300		149.700	-
4	PS & PU	9	0.429	0.598	65	150	4,182.750	-	5,830.500
5	PS & PU	7	0.215	0.236	76	150	2,451.000		2,690.400
6	PU & JR	7	0.2645	0.2855	12	150	476.100		513.900
7	PU & JR	6	0.1715	0.188	13	150	334.425		366.600
Total								17,992.275	

Note: PS = mini purse seine; PU = handline; JR = rampus net.

Vessel with a length of 9 meters*.* Mini purse seine fishermen store their catch and mini purse seine nets in the Hold. The fishing capacity is 0.4695 tons. There are two vessels, each with 300 days at sea in one year. Therefore, the value of the fishing capacity of the 9 m mini purse seine fleet is 281.7 tons.

Handline fishermen store their catch, handline fishing equipment and a storage box in the Hold. The fishing capacity is 0.596 tons. The number of similar vessels in Kuala Stabas is four with 300 days at sea per year. Therefore, the value of the fishing capacity of the handline fishing fleet is 715.72 tons.

Fishermen from the rampus net fleet store their catch and rampus nets in the Hold. The fishing capacity is 0.499 tons. The number of similar vessels is only one, with 300 days at sea per year. So, the total capacity of the 9-meter rampus net fleet is 149.7 tons.

Fishing fleet fishermen who have two types of fishing gear (mini purse seine and handline) use them alternately throughout the year. When operating a mini purse seine, fishermen place their catch and the mini purse seine in the Hold. The fishing capacity is 0.429 tons. The number of vessels is 65 vessels, and the number of operating days a year is 150 days. The total fishing capacity when operating a mini purse seiner with a 9-meter vessel is 4,182.75 tons.

When operating a handline, fishermen use a Hold and a storage box as a medium for storing fish. Then, the fishermen put their catch, line and storage box in the Hold. The fishing capacity for handline fishing with a 9-meter boat is 0.598 tons. The number of vessels is 65 vessels, and the number of operating days a year is 150 days. The total fishing capacity when operating a handline with a 9-meter vessel is 5,830.5 tons.

Vessel with a length of 7 meters*.* All vessels with a length of 7 meters have two types of fishing gear. The fishing fleet with two fishing gears, mini purse seine and hand fishing, has a fishing capacity of 0.215 tons when operating mini purses and a fishing capacity of 0.236 tons when operating handlines. The number of vessels of this type is 76, with 150 sailing days per year each. The fishing capacity when operating a mini purse seine is 2,451 tons, while for hand fishing, it is 2,690.4 tons.

The fishing fleet with two fishing gears, hand fishing and rampus nets, has a fishing capacity of 0.2645 tonnes when operating handlines and a fishing capacity of

0.2855 tonnes when operating rampus nets. The number of vessels of this type is 12, with sailing days each of 150 days per year. The fishing capacity when operating a handline is 476.1 tons, while for rampus nets, it is 513.9 tons.

Vessel with a length of 6 meters. The fishing fleet with two fishing gears, hand fishing and rampus nets, has a fishing capacity of 0.1715 tonnes when operating handlines and a fishing capacity of 0.188 tonnes when operating rampus nets. The number of vessels of this type is 13, with sailing days each of 150 days per year. The fishing capacity when operating a handline is 334.425 tonnes, while for rampus nets, it is 366.6 tonnes.

Based on the calculation of the fishing capacity of each vessel that operates normally 150-300 days per year, the total fishing capacity at FLB Kuala Stabas in 2021 is 17,992.275 ton year^{-1}.

Discussion

Comparison of fishing capacity with fishermen's catch results at Kuala Stabas fish landing base (PPP) 2021. Fishing capacity is a theoretical calculation of a vessel's ability to catch fish normally and bring it back to base within one year. Based on interviews, it is known that, on average, all types of fishing gear operate for three hundred days a year. Fishermen who own two fishing gears use them alternately throughout the year. Therefore, the calculation used is that each fishing gear is operated one hundred and fifty days a year.

Figure 8 shows a comparison between FLB Kuala Stabas fishing capacity values and FLB Kuala Stabas production data in 2021. FLB Kuala Stabas production data was obtained based on the results of interviews with fishermen and fish marketers in 2021, amounting to 6,477.75 tons. It can be seen that fishermen's catch only reaches 36% of their total fishing capacity. Facts on the ground show that fishermen cannot catch fish according to their potential fishing capacity due to various things such as reduced fish resources, limited capacity of small boats, simple fishing technology and their luck (Ramlah et al 2022). Without additional information, which is beyond the scope of this study, it is not easy to interpret fishing conditions at the Kuala Stabas PPP conclusively. However, the catch value of only 36% can indicate an overcapacity condition at the FLB Kuala Stabas.

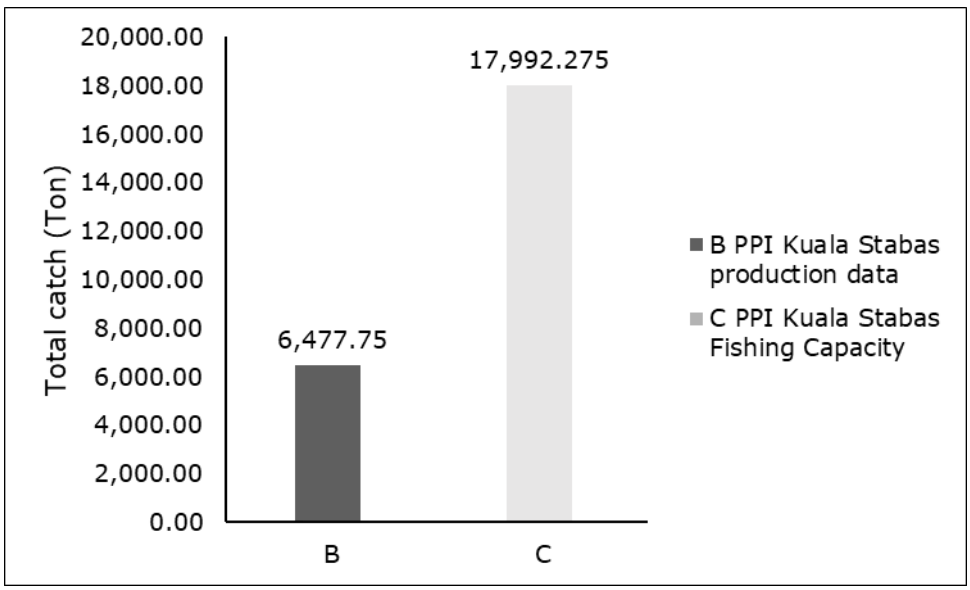

Figure 8. Comparison of production data with fishing capacity.

Conclusions. A mini purse seine vessel with a vessel length of 9 m has dimensions of overall vessel length (LOA) of 9.11-9.20 m, vessel width (B) of 0.93-1.03 m and vessel height (D) of 0, 75-0.80 m. Mini purse seine fishermen put the catch in the Hold. If the

Hold is filled, the capture operation will be stopped. Placing the catch in the Hold is adjacent to the placement of the mini purse seine fishing gear. The total fishing capacity of the mini purse seine fishing fleet is 281.72 ton year^{-1}.

A hand-line fishing vessel with a vessel length of 9 m has dimensions of overall vessel length (LOA) of 9.25 m, vessel width (B) of 1.03 m and vessel height (D) of 0.70 m. Hand-line fishermen put their catch in a Hold and a storage box. The catch is first placed in a storage box, and the fisherman continues the fishing operation. Then, the next catch is placed in the Hold. Placing the catch in the Hold is side by side with placing the fishing line and a storage box. The total fishing capacity of the handline fishing fleet is 715.72 ton year^{-1}.

A rampus net vessel with a vessel length of 9 m has dimensions of overall vessel length (LOA) of 9.10 m, vessel width (B) of 0.93 m, and vessel height of 0.70-0.75 m. Rampus net fishermen put their catch on Hold. If the Hold is filled, the capture operation will be stopped. Placing the catch in the Hold is adjacent to the placement of the rampus net fishing equipment. The total fishing capacity of the rampus net fishing fleet is 149.74 ton year^{-1}.

Mini purse seine and fishing line vessels with a vessel length of 9 m have dimensions of overall vessel length (LOA) of 9.10-9.25 m, vessel width (B) of 0.93-1.03 m, and vessel height (D) of 0.70-0.75 m. Mini purse seine and handline fishermen place their catch in Holds and storage boxes. If the Hold is filled, the capture operation will be stopped. Placing the catch in the Hold is adjacent to the placement of mini purse seine fishing equipment and handlines as well as storage boxes. The total fishing capacity of the mini purse seine and handline fishing fleets is 4,182.75 and 5,830.5 ton year^{-1} respectively.

Mini purse seine and fishing line vessels with a vessel length of 7 m have dimensions of overall vessel length (LOA) of 7.05-7.37 m, vessel width (B) of 0.55-0.67 m, and vessel height (D) of 0.56-0.60 m. Mini purse seine and handline fishermen place their catch in the Hold. If the Hold is filled, the capture operation will be stopped. Placing the catch in the Hold side by side with the placement of mini purse seine fishing equipment and handlines. The total fishing capacity of the mini purse seine and handline fishing fleets is 2,451 and 2,690.4 ton year^{-1} respectively.

Hand-line fishing vessels and rampus nets with a vessel length of 7 m have dimensions of overall vessel length (LOA) of 7.06-7.40 m, vessel width (B) of 0.66-0.67 m, and vessel height (D) of 0.56-0.60 m. Fishermen with handlines and nets put their catch in the Hold. If the Hold is filled, the capture operation will be stopped. Placing the catch in the Hold is side by side with placing the fishing gear of handlines and rampus nets. The total fishing capacity of the handline and rampus net fishing fleets is 476.1 and 513.9 ton year^{-1} respectively.

Hand-line fishing vessels and rampus nets with a vessel length of 6 m have dimensions of overall vessel length (LOA) of 6.05-6.55 m, vessel width (B) of 0.59-0.69 m, and vessel height (D) of 0.50-0.55 m. Fishermen with handlines and nets put their catch in the Hold. If the Hold is filled, the capture operation will be stopped. Placing the catch in the Hold is side by side with placing the fishing gear of handlines and rampus nets. The total fishing capacity of the handline and rampus net fishing fleets is 334,425 and 366.6 ton year^{-1} respectively.

The total fishing capacity at FLB Kuala Stabas is 17,992,275 tons. The method and technique for calculating the fishing capacity of small and non-standard vessels is to measure the main dimensions and Holds of the vessel, fish handling practices, and catch processing practices on board. Next, estimate the number of trips or days at sea each year.

Recommendations. It is necessary to collect data on fishermen's catches and record the catches landed at FLB Kuala Stabas. Further research needs to be carried out regarding fish quality based on fishermen's habits in handling catches at FLB Kuala Stabas. Research needs to be carried out regarding the calculation of fishing capacity at other fishing ports.

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

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Authors:
Darmawan, Department of Fisheries Resource Utilization, Faculty of Fisheries and Marine Science, IPB University, 16680, Bogor, West Java, Indonesia, e-mail: darmawan@apps.ipb.ac.id
Amelia Riska Yuliandini, Capture Fisheries Technology and Management Study Program, Faculty of Fisheries and Marine Science, IPB University, 16680, Bogor, West Java, Indonesia, e-mail: ameliariskaay@gmail.com
Didin Komarudin, Department of Fisheries Resource Utilization, Faculty of Fisheries and Marine Science, IPB University, 16680, Bogor, West Java, Indonesia, e-mail: didinkomarudin@apps.ipb.ac.id

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