



World Scientific News

An International Scientific Journal

WSN 182 (2023) 133-142

EISSN 2392-2192

The Productivity of Seine Nets Fishing Gear at Several Fish-Catching Areas in Indonesia

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ABSTRACT

Seine nets are a type of fishing gear that resembles a large pocket and is operated at the bottom of bodies of water, with a focus on targeting demersal fish in particular. The primary issue with this type of fishing gear is that it often results in the capture of non-targeted fish, including many small fish that are not yet of sufficient size to be harvested, leading to a high rate of bycatch. This research method involves a literature review of various sources, such as scientific journals and previous theses. The bycatch obtained from seine net fishing gear exceeds the main catch in number across the three locations where seine nets operate: North Java Waters, Tegalsari Fisheries Port, and Tinggi Island, Bangka Belitung. This indicates that the seine net fishing gear has low selectivity and requires additional management and monitoring to promote sustainable fishing practices.

Keywords: fishing gear, fish catches, Indonesian waters, seine nets

1. INTRODUCTION

Indonesia is an archipelagic country that has extensive territorial water. Indonesia has around 17,500 islands, with a coastline of 81,000 km, and 62% of its territory consists of seas as confirmed by KKP data. Utilization and management of Indonesia's substantial marine

wealth potential need to be a major concern in its goal for the Indonesian people's welfare. The fishing industry is one of the primary means of harnessing the potential of fishery resources. Seine nets are a type of fishing gear made of nets that form pockets and are capable of catching large quantities of fish by trapping schools of fish inside. Out of the approximately 1.177 million fishing gear units operated in Indonesian waters, around 1.66% or 19,544 units belong to the seine net type.

Fishermen typically operate seine nets and other types of fishing gear to catch various species of fish. Therefore, it is important to recognize the landed seine net's fish catch composition and comprehend the fishing gear's productivity. The production rate of capture fisheries activities can be determined by the extent of fishing effort exerted. The dimensions of fishing gear, vessels, the number of operation days, and the fishing technology applied all influence the fishing effort.

This paper aims to assess the productivity of seine net fishing gear and the fish caught by fishermen across various Indonesian waters. The review paper intends to offer valuable information, knowledge, and insight, along with preliminary data, about the productivity of seine nets and the catches made by fishermen in Indonesian waters.

2. METHODS

The method used in this research is a literature review. A literature review involves examining academic articles, books, and other materials relevant to a particular subject, field of study, or theory, with the purpose of describing, summarizing, and critically evaluating these works. In this study, a range of sources, such as articles, organizational and government websites, published surveys, reports, and papers, were analyzed to evaluate research methodologies and instruments used for seine nets employed by local fishermen. The search was conducted using structured keyword searches in several databases, including Elsevier Science Direct, Google Scholar, and various university repositories which were published in the period 2016-2020. To ensure relevance, the criteria used for source selection included scientific research, research articles, theses, and articles published in both Indonesian and English. The findings were then categorized into different groups, including fishing gear and seine net types. The research was conducted as a study desk in June 2022 - January 2023.

3. RESULTS AND DISCUSSION

The capture fisheries industry is recognized as a major contributor to the decline in fish stocks, primarily due to fishing mortality and the selective targeting of certain sizes of fish. Indonesia's capture fisheries are characterized by a diverse array of fishing gear, reflecting the variety of available resources. These resources, typical of tropical fisheries, are multi-species and exist within complex ecological systems. Unfortunately, the lack of control over the use of fishing gear has led to unregulated fishing activities that have resulted in significant pressure on marine fish populations, leading to declines in both catch numbers and the quality of the ecosystem that supports these resources. One of the key issues in the utilization of fish resources is the lack of selectivity in fishing gear, which often leads to environmental degradation. In fisheries management, individual size is a crucial indicator of both age and reproductive

biology, and is one of the four main types of data required for effective management. It is essential to ensure that fishing activity is appropriate in terms of size to maintain the sustainability of fish populations. To fully utilize the high potential of fisheries, it is important to adopt good utilization principles, including the use of eco-friendly fishing technologies.

The level of eco-friendliness can be assessed based on the selectivity of fishing gear using three indicators: the proportion of main catch to by-catch, the proportion of catch size utilized, and the proportion of discard (wasted catch). The Code of Conduct Responsible Fisheries (CCRF) provides nine criteria for eco-friendly fishing gear, including selectivity, ease of operation, safety for fishermen, ability to produce high-quality catches, non-detrimental to the habitat, low by-catch, minimal biodiversity impact, not capturing protected organisms, and considered acceptable by society.

3. 1. History and Development of Seine Net

The seine net, which was previously known as *cantrang* in Indonesia, is a fishing gear commonly used for catching fish. In Indonesia, there exists a variety of terminology for fishing gear utilized in different regions. In the Lamongan area, for instance, seine nets are referred to as *payang* and *dogol* by the fishermen, despite the gear being largely identical. However, other regions such as the Malacca Strait and several areas in Java still refer to this equipment as a seine net. The term "seine net" originated from the Mediterranean and was introduced to England, the Netherlands, France, Germany, and other European countries in the 16th century to improve fishing efficiency. In Dutch, a seine net is called a Schrol net. Although the original shape of the seine net differed from the current design, it has undergone various modifications and improvements over time.

The seine net can be categorized based on its location of operation, such as:

1) Beach or coastal seine, which is a seine operated on the beach.

Beach seines are also called *krakats*. In addition, various regions in Java refer to this equipment with different names such as *puket*, *kriket*, and *kikis*. Beach seine as a type of seine net used to catch both pelagic and demersal fish found on the shore. The beach seine fishing gear is a large type of seine commonly used on the north coast of Java. Pangandaran Bay is home to at least 27 beach seine units that are actively operated by local fishermen. Beach seine operated in Cilacap and also operated in Madura. Beach seines are known to mainly catch *Parapenaeopsis sculptilis*, *Trichiurus lepturus*, and anchovies, while also resulting in significant by-catch including Leiognathidae, *Johnius carouna*, Indian mackerel, Narrow-barred Spanish mackerel, squid, *Caranx ignobilis*, *Cynoglossus lingua*, *Atule mate*, and other mixed species of fish. This high level of by-catch suggests that beach seines have low selectivity, a fact supported by Wiyono [16] who noted that traditional capture fisheries, which are typically carried out by fishermen with collective organizations, lack sophisticated equipment that would improve selectivity. Moreover, limited fishing facilities mean that resource utilization in coastal areas is constrained. With a catch rate value of 8.01 kg/hour, beach seines provide an indicator of the productivity of the fishing gear and its effectiveness in increasing efficiency and effectiveness of fishing strategies.

2) The midwater seine net operates in offshore locations, away from the coastline. This type in Indonesia consists of:

a) Payang

Pelagic fish species, which are typically found on the water's surface, are generally caught using *payang* fishing gear. *Payang* is classified as a type of seine net, as noted by BSN, and is operated using a single fishing boat. *Payang* is operated in several regions in Indonesia. Nusantara Fisheries Port (PPN) Palabuhanratu as part of South Java area is the home base for 39 *payang*. *Payang* also operated in North Java area such as Karawang, Tegal, Madura.

The use of *payang*, a traditional fishing gear with many variations in mesh size, length of net, and size of Fish Aggregating Devices, is prohibited by Ministerial Decree Number 2 of 2015. However, this regulation has not been widely accepted by fishing communities, and the government has delayed its implementation. While *payang* has been passed down from generation to generation, there are concerns that some variations do not meet the criteria for sustainable fisheries.

The gear's main catches include flying fish (*Decapterus macrosoma*), mackerel (*Rastrelliger* sp.), and skipjack tuna (*Katsuwonus pelamis*).

b) Dogol

Dogol is a type of fishing gear that has pockets to hold the catch and is constructed from warp ropes and wing straps. Its shape is similar to *payang*, although it is smaller in size. *Dogol* operated in several areas in Indonesia such as Cilacap, Aceh, Banten, Lamongan, Demak, Indramayu, Tegal, Pangkep, Sulawesi, Bengkulu, Kutai, Kalimantan.

The regulation set forth by the Minister of Maritime Affairs and Fisheries (Regulation Number 2 of 2015) prohibits the use of *dogol* fishing gear as it falls under boat or vessel seines. This type of fishing gear is deemed to have low selectivity and can potentially damage the swept area it passes through.

Demersal fish are commonly caught using the *dogol* fishing gear as they prefer habitats with a substrate of sandy silt or mud. Studies have shown that demersal fish are typically found at depths of 20-40 meters. Benthic biota in waters with a depth profile of less than 100 meters are predominantly comprised of various types of crustaceans and fish from the Sciaenidae and Trichiuridae families, which are demersal fish groups. The use of *dogol* fishing gear has resulted in a decrease in fish resources and is one of the reasons why it has been banned. There are abundant fish resources in shallow waters, including spawning, feeding, and nursery grounds.

This is demonstrated by the significant numbers of juvenile fish that are also caught using *dogol* fishing gear. The by-catch of *dogol* fishing gear includes several types of demersal fish, such as *Trichiurus lepturus*, pony fish (Leiognathidae), flatfish (Pleuronectiformes), and *Johnius carouna*. The high proportion of by-catch to the main catch is attributed to several factors, such as the active pursuit of fish targets by the trawl as it is towed by boats, resulting in the capture of fish that are not the main catch. Furthermore, shallow waters serve as feeding, spawning, and nursery grounds, making them a place for fish to find food and grow. The bottom of the water has a relatively sloping surface because it is a shelf area and has a muddy substrate which is a habitat for demersal fish species.

3. 2. Design and Operational Principles

The seine net comprises wings, a body, and a pocket (cod-end), and is cone-shaped. It also consists of buoys, weights, a head rope, a ground rope, and a warp rope, but it does not have any net mouth opening mechanism. Seine nets are encircled and then hauled onto a stationary fishing vessel to catch demersal fish or schools of pelagic fish.

3. 2. 1. Seine Net Component

Payang

Payang is a type of pelagic fishing gear made from durable nylon nets. The fishing gear comprises several components, which are illustrated in Figure 1.

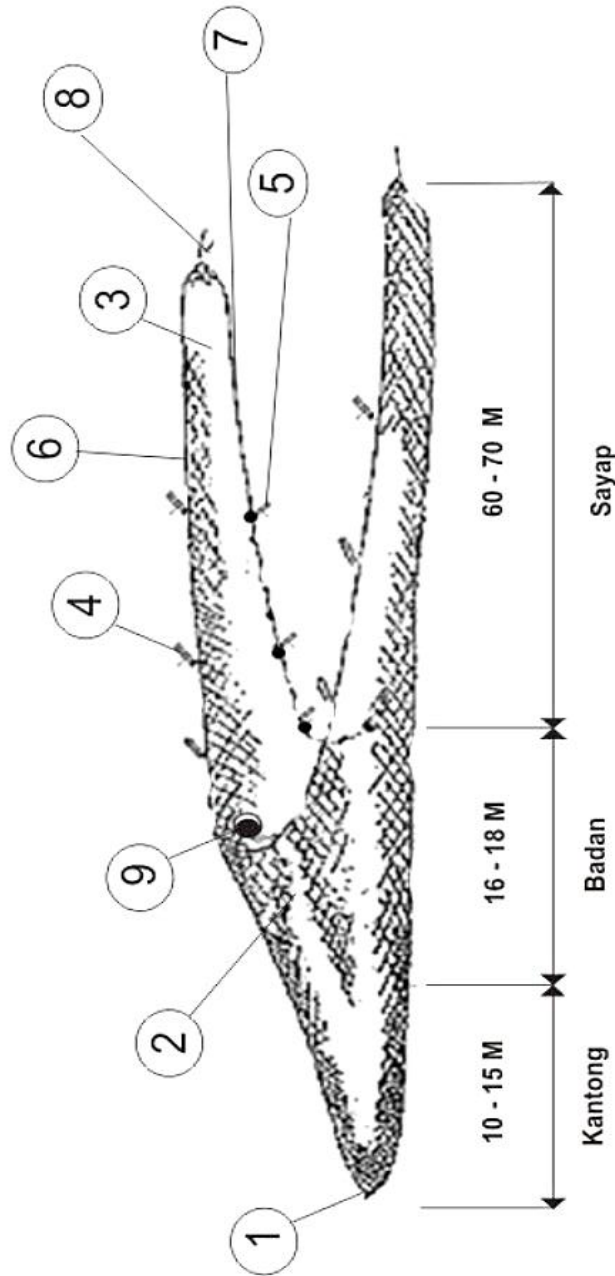


Figure 1. *Payang* fishing gear components (1. pocket; 2. body; 3. wing; 4. buoy; 5. sinkers; 6. head rope; 7. ground rope; 8. warp rope; and 9. Middle buoy) [43]

Dogol

The components of dogol fishing gear typically include pockets, legs, rigging, buoys, and weights, which are illustrated in Figure 2.

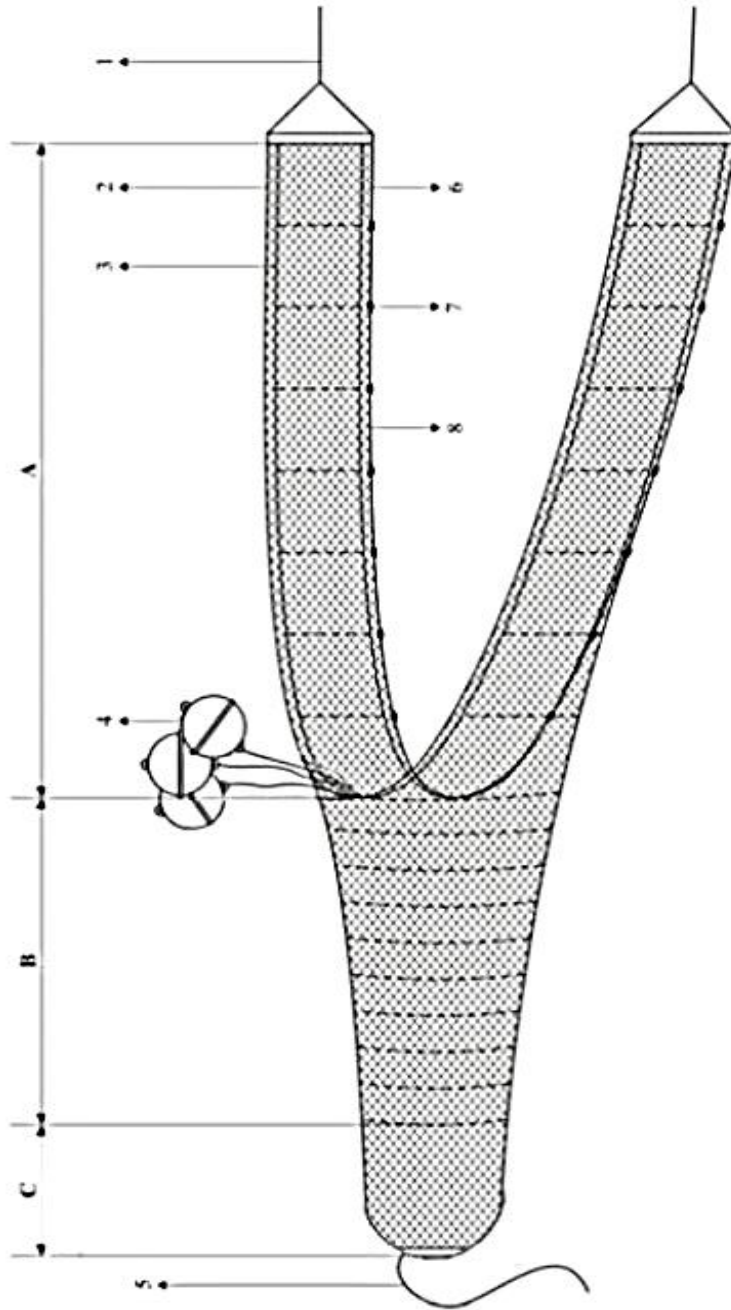


Figure 2. Dogol fishing gear components (A. Wing; B. Body; C. Pocket; 1. Warp rope; 2. Buoy rope; 3. Head rope; 4. Buoy (PVC); 5. Pocket opening and closing rope; 6. Ground rope; 7. Sinker; 8. Sinker rope [44].

3. 2. 2. Operational Principles

Fishermen carry out seine net operations by encircling schools of pelagic or demersal fish, which are the target catch. This fishing gear can be operated with or without a fishing boat. The fishermen pull the seine net towards the ship, which is anchored or pulled ashore using warp ropes on two sides of its wings. The operation of this fishing gear is performed on the water surface or at varying depths, depending on the type of seine net used. The gear is typically used to catch both pelagic and demersal fish species.

Beach seine is operated in coastal/shore areas to catch pelagic or demersal fish that inhabit coastal waters. Fishermen use beach seines to catch all types of fish, whereas *payang* is typically deployed from the surface to the water column and used to target pelagic species. Fishermen operate beach or shore seine gear in coastal areas to catch pelagic and demersal fish that inhabit the region. On the other hand, fishing gear such as *dogol*, *cantrang*, *bottom lampara*, and pocket dragnets are operated at the bottom of the sea and generally used to catch demersal fish.

The operation of this fishing gear involves several stages, which are outlined below:

A) Preparation. Fisheries activities are typically conducted during the daytime, particularly in the morning when adequate sunlight is available. The fishermen begin to prepare for the fishing operation by examining the fishing gear parts and tying the warp rope with the wings of the net after they have determined the fishing ground.

B) Settings. Before scattering the nets, the fishermen must first consider the wind and current direction. They need to measure these two factors because the wind direction affects the boat movement, while the current affects the fish movement and fishing gear. Fish usually move against the current, so the fishermen must oppose the fish movement with the net opening. To achieve the largest possible area, they form a circle with the netting and spread the net from the ship's hull. This stage begins by lowering the sign buoy, which facilitates the retrieval of the warp rope during hauling. After lowering the flag buoy, the fishermen lower the right-side warp rope, followed by the right wing, then the right side of the body, and continue lowering the pocket. Next, they lower the left side of the body and the left wing. Fishermen then wrap one end of the left side warp rope, which is not tied to the wing, around the left axle. When setting, they move the ship in a circle toward the buoy mark

C) Hauling. After completing the setting process, the net is left for about 10 minutes to allow the warp rope to reach the bottom of the water. During hauling, the fishermen continue to move the ship at a slow speed. This is done to ensure that the ship does not move backward due to the weight of the net when it is pulled. To assist in withdrawing the fishing gear, an axle is used, which conserves more energy. Additionally, the balance between the right and left sides of the ship's hull is guaranteed by completing the dragging speed of the rope at the same time. With this retraction process, the two towing lines and wings move closer to each other and distress the fish, which herds them into the net pocket.

After estimating that the warp rope has reached the bottom of the water, the fishermen carry out hauling immediately. First, they raise the sign or mark buoy onto the ship and then wrap the right warp rope, which has been heaved by the end, around the right axle. After that, they switch on the axle engine simultaneously with the main propulsion engine, causing the ship to move gradually. At that point, the fishermen start to retract the net, roll the warp rope properly after lifting it above the boat, raise the wing of the net onto the ship, turn off the axle engine, and move the left side of the net to the right side of the boat. Then they pull the net onto

the boat and lift the body of the net and the pocket containing the catch onto the fishing boat. The fishermen complete the hauling process by raising the catch and re-arranging the net to its original state. This ensures that no difficulties will be encountered during the next setting stage.

3. 3. Fish Catch Productivity

Many factors influence fish catch, including production factors such as the length of net withdrawal time, net hauling speed, net lifting time, warp rope length, ship tonnage, crew number, and engine power. Factors such as fish resources, including their survival and mortality rates, can also influence the fish catch. Fishermen focus on catching the main catch, while the by-catch includes marine organisms that are not their primary target. The maximum sustainable yield for the catch resources allowed using seine net fishing gear is determined to be 80%, as reported by Harlisa.

The seine net main catch consists of small pelagic fish, such as *Decapterus* spp., *Selaroides leptolepis*, *Rastrelliger* spp., *Sardinella lemuru*, *Sardinella fimbriata*, *Dussumieria acuta*, and others. The fishing effort significantly affects fish production in a region, which in turn impacts the biological condition of fish resources. Unregulated and unmonitored utilization of fishery resources can lead to overfishing, reduced quality, and decreased productivity.

Researchers have conducted several studies using different ship sizes. For instance, in the research conducted in the North Java Sea, they used a ship with a length (LoA) of 23 m, width (B) of 5 m, and depth (D) of 1.2 m or 64 GT, powered by a 360 HP propulsion engine. In another study conducted at the Tegalsari Coastal Fishing Port (CFP), the seine net vessel ranged from 60-200 GT. Throughout the March–April 2022 research period, 121 seine net vessels arrived at Tegalsari CFP. Fishermen using seine nets on Tinggi Island, South Bangka Regency, used boats with an average size of 3 GT, which is appropriate for catching their target species.

The measurement of fishing productivity pertains to the production capacity of fishing gear in terms of fishing effort units. Assessing fishing productivity involves examining the relationship between the duration of catch acquisition and the quantity of catch. The fishermen utilizing seine net fishing gear who arrived at Tegalsari CFP During one month attained a total catch of 435,555 kg of fish, comprised of 23 distinct species (9 main catch species and 14 non-target catch species). The seine net caught mainly unintended catch, which was not part of the main catch, totaling 339,200 kg, while the main catch was only 96,355 kg. These results suggest that seine nets are less selective in catching fish in the ocean.

A trial of seine net fishing gear for one month in September and identified as many as 72 species (46 families) of fish, shrimp, crabs, squids, cuttlefish, and other invertebrates caught during the research. The highest number of commodities originated from *Leiognathus splendens*, which reached 192.5 kg (61.78%). Fishermen using seine nets caught as many as seven fish species. The most common unintended catch was *Leiognathus aquulus* with catches ranging from 200–250 kg and a composition value of 20.5%. The following Table 1 shows data on production commodities caught by seine net fishing gear in several regions in Indonesia. Based on Table 1, we can see that the number of commodities caught in the northern waters of Java is higher compared to those caught in Tegalsari CFP and Tinggi Island, South Bangka. This suggests that the seine net fishing gear has lower selectivity and results in a higher volume of an unintended catch than the main catch in all three locations. Two types of by-catch exist, namely high economic value and low economic value. Fishers can sell or trade the former for consumption, while the latter cannot be utilized or sold due to their small size or other factors.

To decrease unintended catch, fish-catching time can be controlled through alternative management strategies, such as regulating trawl fishing grounds for small-scale shrimp trawling fisheries and installing suitable by-catch reduction devices (BRD) for small-scale demersal fisheries using fishing technology.

Table 1. Commodities produced by seine net catches

No.	Commodity		
	North Java Seas	Tegalsari CFP	Tinggi Island, Southers Bangka
1.	Squids	<i>Leigognathus</i> sp.	Shrimps
2.	Rays	<i>Nibea soldado</i>	<i>Nemipterus nematophorus</i>
3.	Crabs	<i>Glossogobius giuris</i>	<i>Selaroides leptolepis</i>
4.	Cuttlefish	Squids	<i>Leigognathus</i> sp.
5.	<i>Leigognathus</i> sp.	Shrimps	<i>Hippocampus</i> sp.
6.	<i>Nibea soldado</i>	Cuttlefish	<i>Tetraodon</i> sp.
7.	<i>Glossogobius giuris</i>	<i>Upeneus sulphureus</i>	<i>Alectis indica</i>
8.	-	<i>Nemipterus nematophorus</i>	-
Total main catch (kg)	119	96,355	5
Total by-catch (kg)	203	60,900	227

4. CONCLUSION

The seine net is a conically-shaped fishing net that comprises a pocket, a body, two wings, and warp ropes. Fishermen use seine nets to enclose a school of pelagic or demersal fish, which are the primary targets for catching fish using this method.

They can operate seine nets with or without a fishing boat. However, based on the operational locations of seine nets (North Java Seas, Tegalsari Coastal Fishery Harbor, and Tinggi Island, Southern Bangka), this study concludes that fishermen using the seine net catch a greater volume of by-catch compared to their main target catch. This indicates that the seine net fishing gear has low selectivity. As a result, stakeholders must take measures to reduce the amount of by-catch.

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