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# Analysis of biological aspects of Scottish seine net catches in Mamuju waters, West Sulawesi

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**Abstract.** The decree of the Minister of Maritime Affairs and Fisheries No. 2 of 2015 has disturbed many fishermen in Indonesia, including Scottish seine fishermen. In that decree, the government concludes that the Scottish seine is not selective in catching fish and tends to disrupt the sustainability of small pelagic fish resources. This study aimed to analyse the biological aspects of fish caught with Scottish seine nets during the west monsoon season in the waters of Mamuju, South Sulawesi, Indonesia. The study was carried out from January to March 2016 with a case study of 1 unit during 30 fishing trips. The data collected included the type of fish caught, the weight and length of each fish by species. Data on fish taxa and size were analysed graphically and descriptively. The composition of the fish caught during the study was: shortfin scads (38%), bigeye scads (18%), sardines (14%), mackerel tuna (9%), Indian mackerel (7%), torpedo scads (6%), white trevally (3%), and other species (5 %). The length of shortfin scads, bigeye scads, sardinella, and mackerel tuna ranged from 9.9 - 18.2 cm; 8.5 - 19.5 cm; 10 - 12.5 cm; and 10-15 cm, respectively. In general, the fish caught were still classified as immature and not suitable for capture. To support sustainable fishing, it is necessary to limit fishing in the period from January to March.

## 1. Introduction

The Scottish seine net is a type of fishing gear commonly used in small pelagic fisheries in the Makassar Strait, Indonesia. By the Decree of the Minister of Marine Affairs and Fisheries Number 02 of 2015, the Scottish seine net was included as an illegal fishing gear [1]. This prohibition of Scottish seine nets was not accepted by most fishing communities. As a result, the Indonesian Government delayed the implementation of the regulation.

The Scottish seine net is the dominant pelagic fishing gear in Majene and Mamuju Regencies in East Sulawesi Province [2]. This is a traditional fishing gear that has been derived from gears used in the past and is still evolving now. This fishing gear has many variations, including in the mesh size used (especially in the cod end section), the net length, and the size of FADs used. Among the many variations in use, it is feared that some do not meet the criteria for sustainable fisheries. Purse seines have been used in Mamuju Regency for the past 5 years but have not succeeded in competing with the existing traditional fishing gear [2]. There is even a tendency for more young fish to be caught in purse seine nets compared to Scottish seine nets.



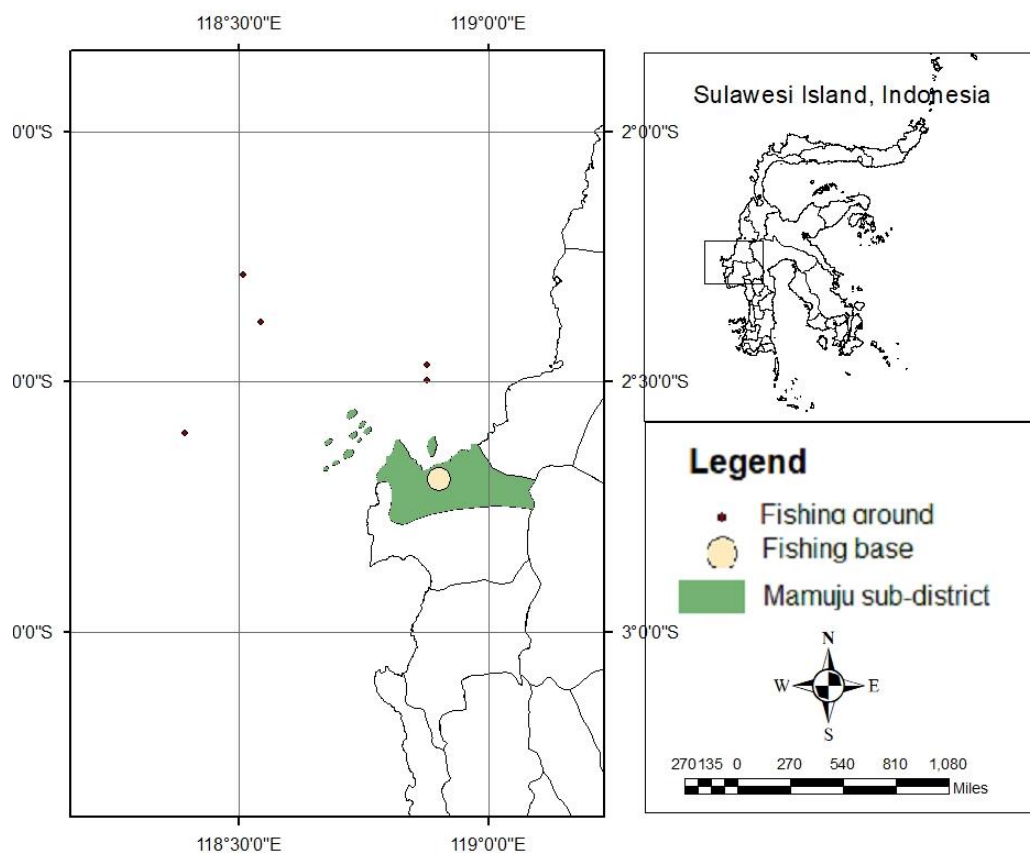
There is a lack of research on fish caught as a basis for evaluating the environmental friendliness of fishing gears toward fish resources. Possibly, as a traditional fishing gear, the Scottish seine net seems less attractive to researchers; whereas its contribution to the rate of exploitation of small pelagic fish species is quite high [3,4]. Research on this gear is urgently needed to provide basic data and benchmarks for the implementation of the code for responsible fisheries.

Responsible fishing is an international issue that should have been applied in the field [3]. In principle, the code or responsible fisheries requires the governing body to maintain existing fisheries resources so that they can be sustainably used. Attention to this directive is still minimal in the field. The reality is that resource exploiters freely modify the size of fishing gear, including net mesh sizes. As a result, small fishes, which in a responsible management scenario it is not feasible to catch, also become a main target of exploitation [4,5]. The lack of information regarding the level of sustainability of the Scottish seine fishery in terms of the fish caught is considered a strong reason for conducting this research.

To address the problems outlined above, as a preliminary research step, a case study was carried out on the catch of a Scottish seine net unit in Mamuju, West Sulawesi. This study aimed to analyse the biological aspects of fish caught with Scottish seine net during the west monsoon season at this research location.

## 2. Materials and methods

This research was conducted from January to March 2016, following a Scottish seine net unit operating in the Makassar Strait. The fishing base was in Mamuju District, Mamuju Regency, West Sulawesi Province, Indonesia (Fig 1).

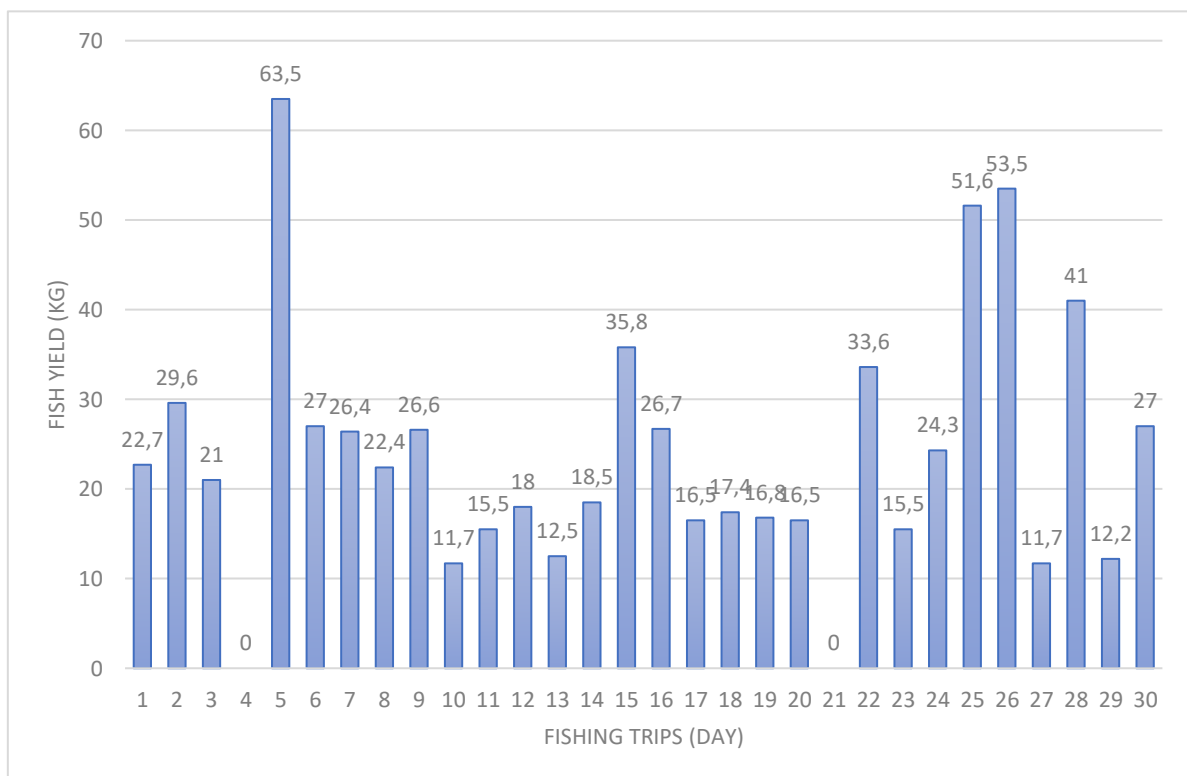


**Figure 1.** Map of the research location

The equipment and materials used in this study included one Scottish seine net unit, a fish ruler, digital scales, a global positioning system (GPS), digital cameras, and stationery. The case study method followed the fishing operations of a Scottish seine net for 30 trips during January - March 2016. The fishing operations were conducted in the early morning around the fish aggregation devices indicated by points in the map (Fig 1). Fishing operations were not conducted every day due to the changeable weather conditions. Fishing operations were conducted whenever the weather condition was considered safe for fishing; otherwise, there would be no fishing and the fishermen stayed at home. During each fishing trip, the data collected included the number and species of fish caught. For four dominant fish species, the fork length of each fish was also measured, using a fish ruler. The data were analysed descriptively, displayed in graphical form and compared with the results of previous studies.

### 3. Results and discussion

The Scottish seine net could only be operated for 30 trips from January to March, as fishing operations depended on the weather. The catch was very variable (Fig. 2). The yield ranged from 0 to 63.5 kg, with the minimum fish yield occurring in the 4<sup>th</sup> and 21<sup>st</sup> fishing trips, while the maximum yield occurred in the 5<sup>th</sup> fishing trip.



**Figure 2.** Scottish seine net yield from 30 fishing trips during January to March 2016

The fish yield during the research period was categorized as low, since the fishing conditions were generally poor. The west monsoon is typically windy, with rough seas from December to March in the this fishing location. During this period, the fishermen suffer from low catches and correspondingly low incomes. However, the fishermen also felt that they had to go fishing whenever the weather conditions made it feasible, as there was no livelihood option for these fishermen other than fishing.

The data in Table 1 show that 10 fish species were caught by the Scottish seine net, mostly small pelagic fish species. This indicates that the Scottish seine net had low selectivity in terms of fish species. However, there were 5 dominant fish species, all classified as small pelagic schooling fishes.

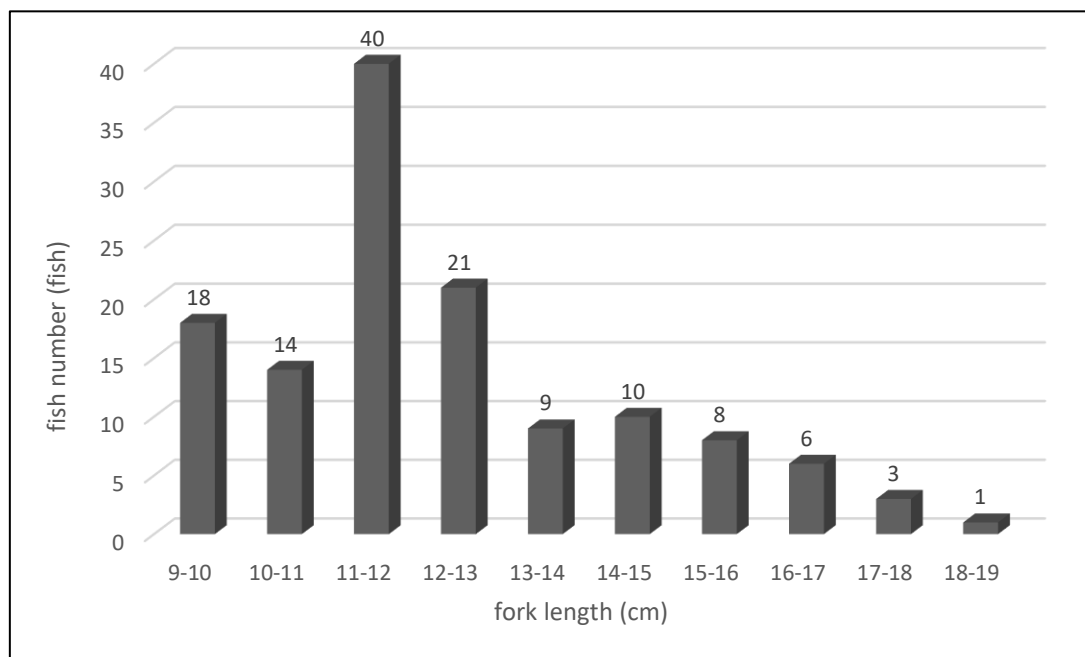
The selectivity of fishing gear is very important in reducing pressure on fish populations in the sea. If the fishing gear is not selective and the number of fishing gear is not limited, the fish population will experience greater pressure [6]. Climate change is also affecting fishing activities and the yield of many fishing gears [7].

**Table 1.** Total yield (in kg) of the Scottish seine net over the study period by fish species

Number	Fish Species	Fish Yield (kg)	Percentage (%)
1	Shortfin scads ( <i>Decapterus macrosoma</i> )	255.8	35.74
2	Bigeye scads ( <i>Selar crumenophthalmus</i> )	126.9	17.73
3	Sardine ( <i>Sardinella fimbriata</i> )	103.3	14.43
4	Mackerel tuna ( <i>Euthynnus affinis</i> )	67.4	9.42
5	Indian mackerel ( <i>Rastrelliger kanagurta</i> )	50.4	7.04
6	Torpedo scads ( <i>Megalapsis</i> sp.)	44.1	6.16
7	White trevally ( <i>Caranx</i> sp.)	23.9	3.34
8	Leather jackets ( <i>Scomberoides</i> sp.)	19.2	2.68
9	Rudder fish ( <i>Kyphosus</i> sp.)	13	1.82
10	Almaco jack ( <i>Seriola</i> sp.)	11.5	1.61
Total		715.7	100

### 3.1. Shortfin scads (*Decapterus macrosoma*)

The fork length of the shortfin scads *Decapterus macrosoma* caught during the 30 trips catch in Mamuju waters is shown in Figure 3. The fork length of the shortfin scads caught in the seine during the study in the waters of Mamuju was in the range of 9-20 cm.

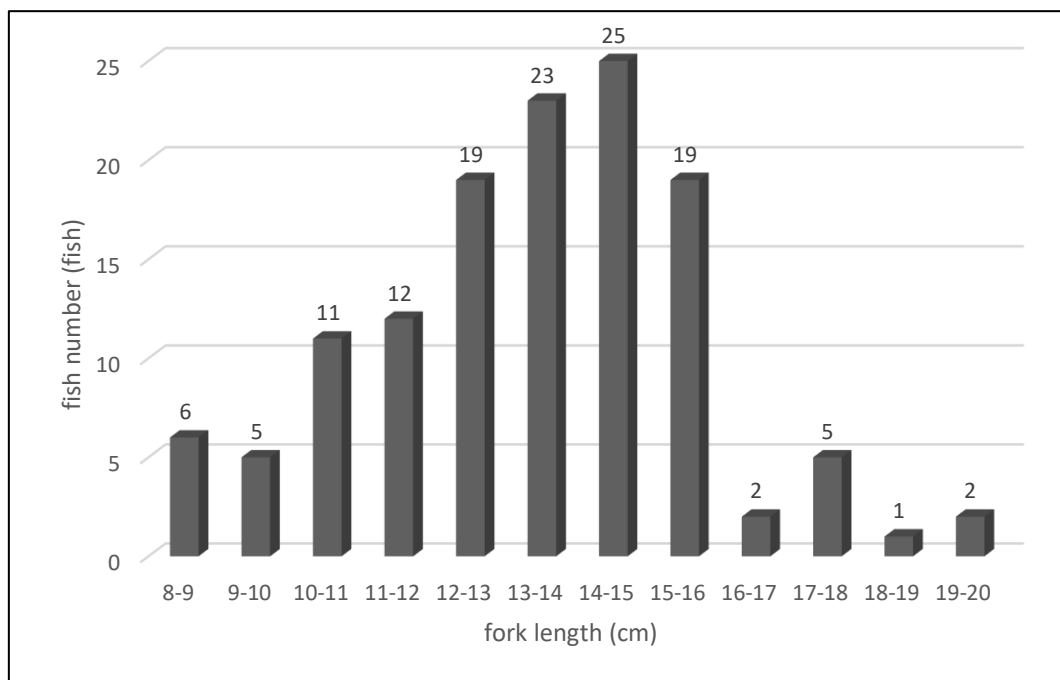


**Figure 3.** Fork length distribution of shortfin scads *Decapterus macrosoma* caught by the Scottish seine net over the study period

The highest shortfin scad frequency was in the class range 11-12 cm fork length (FL) while the lowest frequency was in the class range 18-19 cm FL. Shortfin scads first spawn at fork lengths between 19.8 - 20.3 cm for female fish and 19.6 - 20.1 cm for male fish [2]. Shortfin scads are categorized as juveniles if the total length is 8.2 - 11.1 cm [8]. The size distribution of the fish caught shows that most of the shortfin scads caught in the Mamuju area of the Makassar Strait were still immature (below 18 cm FL) and therefore not worthy of capture.

### 3.2. Bigeye scads (*Selar crumenophthalmus*)

The length of the bigeye scads caught during the 30 trips catch in Mamuju waters is shown in Figure 4. The bigeye scads caught during this study were in the size range 8 - 20 cm FL.

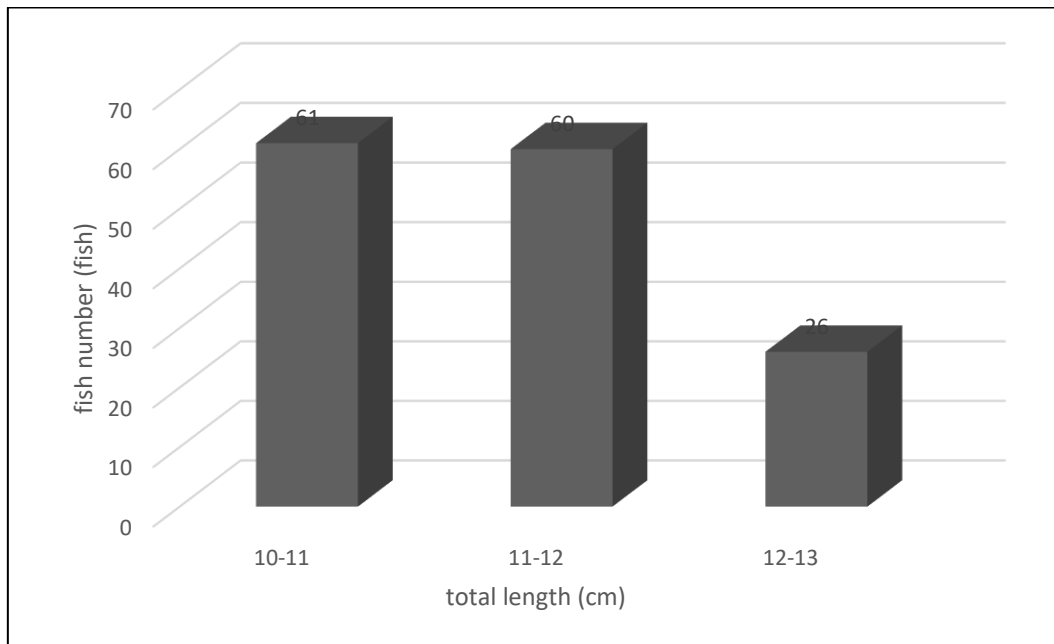


**Figure 4.** Fork length distribution of bigeye scads *Selar crumenophthalmus* caught by the Scottish seine net over the study period

The highest frequency was in the class range 14-15 cm FL while the lowest frequency was in the size class 17-18.4 cm FL. Bigeye scads first spawn at a fork length of 13.5 cm for females and 16.5 cm for males. These fish generally have total length sizes varying between 11.0 and 27.0 cm with a maximum length of 47.0 cm [9]. Mature gonads have been reported at a length of 16.3 cm [10]. Based on the fork length of the fish caught, then some of the fish caught were mature and of a suitable size for capture. However, during February - April high proportions of young fish have been reported, around 75% [11].

### 3.3. Sardines (*Sardinella fimbriata*)

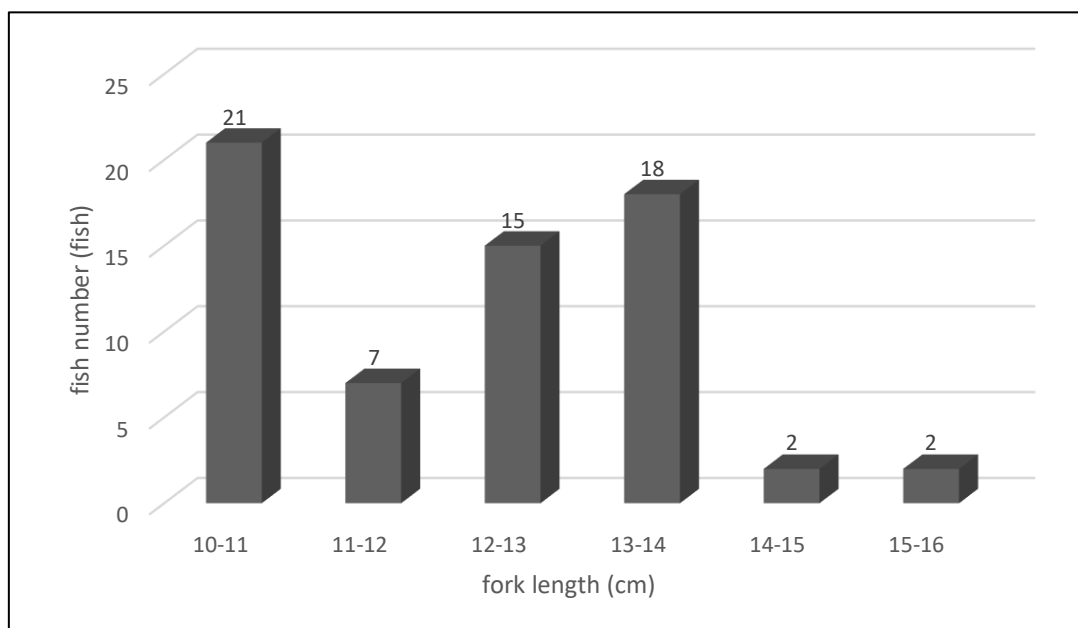
The length of the sardines *Sardinella fimbriata* caught during the 30 trips catch in Mamuju waters is shown in Figure 5. The fork length of sardines caught was fairly uniform, in the class range of 10-13 cm. The highest frequency was in the class range 10-11 cm while the lowest frequency was in the 12-13 cm FL class. The size of sardines at first maturity is reported as 15 cm [12]. Based on the fork length of sardines caught in Mamuju waters, all were still relatively young and immature, and therefore not yet worthy of capture.



**Figure 5.** Fork length distribution of sardines *Sardinella fimbriata* caught by the Scottish seine net over the study period

### 3.4. Mackerel tuna (*Euthynnus affinis*)

The length of the mackerel tuna *Euthynnus affinis* caught during the 30 trips catch in Mamuju waters is shown in Figure 6. The fork length of mackerel tuna *Euthynnus affinis* caught was in the range 10-15 cm FL. The highest frequency was in the 10-11 cm FL class while the lowest frequency was in the 14-15 cm FL class. The size of mackerel tuna at first maturity is reported as 31.08 cm [13]. This indicates that all the *Euthynnus affinis* caught in the waters of Mamuju were juvenile fish and should not be considered catchable.



**Figure 6.** Fork length distribution of mackerel tuna *Euthynnus affinis* caught by the Scottish seine net over the study period

In general, fish caught by the Scottish seine net over the study period in the Makassar Strait (Mamuju waters) were dominated by juvenile fish. These fish were unsuitable for harvesting because they were still below the size at first maturity (and hence first spawning). It has been reported that the size of fish caught in Mamuju waters tends to peak in June - September while in December - February is a low season where many of the fish caught are still relatively small [2]. Reports of larger sized fish in the peak season call for further research in different seasons, especially in the peak season, to verify whether the catches obtained in the peak season and low season by Scottish seine net gear show the same patterns as reported in [2].

The prohibition on the use of trawls and seine nets in Indonesian territorial waters under Minister of Agriculture Regulation Number 2 /2015 is related to environmental friendliness. This regulation was made because these gears can have a significant negative impact on marine ecosystems, especially through habitat damage. In fact, the operation of Scottish seine nets in the waters of Mamuju is carried out in surface waters with a net depth ranging from 20-30 meters from the surface in waters with a depth of 250-350 meters. This means that, unlike some trawl and seine gear types, the Scottish seine does not affect the benthic habitat (e.g. corals and other benthic organisms) or affect water quality (e.g. by disturbing sediment) [2,14].

Uncontrolled fishing and fishing equipment have a great potential for disrupting the sustainability of fisheries resources [5,14,15]. It should be noted that the Scottish seine net is operated on the surface of the waters, hence preventing habitat damaged. However, the fish caught are still relatively young, so selectivity is still problematic. The main principle is to increase the selectivity of fishing gear so that only the target fish are caught [5, 6, 14]. Even though it was realized that the fishing season at the time the research took place coincided with the season when many fish are still small, it is still considered that modifications should be made to reduce the proportion of juvenile fish caught.

Net selectivity is closely related to the size of the mesh used. Improved selectivity can be achieved through the use of larger mesh sizes, particularly in the cod end [16]. The net mesh sizes in the wings and the main body of the Scottish seine net were quite large but in the cod end the mesh size they were around 1 cm so that the small fish also remain caught. To increase its selectivity, the net mesh size in the cod end needs to be enlarged. The same principle has been applied to increase the selectivity of trawlers [5,16].

#### 4. Conclusion

There were many fish species caught by Scottish seine net and the catch was heavily dominated by immature fishes unsuitable for capture. The dominant types of fish caught with the Scottish seine net were shortfin scads, bigeye scads, sardines, mackerel tuna, Indian mackerel, torpedo scads, and white trevally. Based on biological aspects, the Scottish seine net as currently used can be categorized as an unsustainable fishing gear. The size selectivity of this gear could be improved through the use of larger mesh-size, especially in the cod end.

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