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Original Paper

SELECTIVITY OF *Decapterus macarelus* (SCAD) DRIFT GILLNET IN KAYELI BAY MALUKU BY KITAHARA'S METHOD

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ABSTRACT

To study the gear selectivity on scad Decapterus macarelus fishing experiments using drift gill net with differents mesh sizes were conducted in Kayeli Bay Buru Island Maluku. To obtain data of fork length size composition, drift gillnets were operated at fish agregation devices along night time. The selectivity of drift gillnets for scad were estimated with Kitahara's method. Mesh selectivity by a drift gillnet used for scad Decapterus macarelus shows a peaked curved with the efficiency at the peak of mesh selectivity increasing in proportion to the mesh size. The optimum size selectivity (fishing efficiency) of scad are ratio of 185 mm fork length class and 38 mm mesh size, 225 mm and 45 mm mesh size, and 255 mm and 51 mm mesh size.

Keywords: drift gillnet, selectivity, *Decapterus macarelus* (scad), 'Kitahara's method'

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INTRODUCTION

Small-scale fisheries are of primary social and economic importance to Maluku. They operate mainly with beach seines, gillnets, lines, traps, lift net and the number of boats involved in 2005 was 34 553. Their total catch was 113 134 tons, representing some 80.8% of the total Maluku marine catch. The number of fishermen involved was 39 651 representing 95% of the total number of Maluku fishermen (Statistik Perikanan Laut Indonesia, 2009). These figures do not include those related to the fishery with boats engine horsepower less than 15 HP. The boats involved in the small-scale fisheries are generally small (90% of the boats are less than 9 m long) and operate mostly at a distance from the coastline of less than 2 miles. The crew per boat usually ranges from one to three fishermen.

Despite the social and economic importance of the Maluku small-scale fishery, there has not previously been a comprehensive analysis of its major features (e.g. catch species composition, length frequency distributions and selectivity estimates of the main species caught). In the present study, the optimum probabilities of capture for *Scad* (*Decapterus macarelus*), the most valuable small pelagic species in Maluku waters especially in Kayeli Bay Buru Island caught in drift gillnets of three mesh sizes namely 38, 45 and 51 mm, are estimated.

Many methods of estimating gillnet selectivity have been reported. These have been classified by Hamley (1975) into five categories. Using this classification, the method of comparing fish size compositions captured by two or more mesh sizes is included with the indirect methods. Many researchers use this method because estimates of selectivity can be obtained from the catch data without having to make strict assumptions on fish population distribution or having to carry out complex calculations. Almost all methods are based on the geometrical similarity theory of Baranov, which assumes that selection is a function of the ratio of fish body size and mesh size. Holt (1957) developed an early estimating method based on this theory. A similar method was proposed by Ishida (1962) and Kitahara (1971) in Japan during the same period. The methods of Ishida and Kitahara assume that the fishing intensity of each mesh size in a fleet of gillnets consisting of different mesh sizes are equal. This means that there is an equal chance of a fish encounter at any mesh size and also that the gear efficiency of each mesh size is equal. Fujimori *et al* (1996) expanded the method of Kitahara to take into account the differences in the gear efficiency of each mesh size. These methods can on be applied to data sets in which the catch effort at each mesh size is the same or to data sets that have been standardized by catch effort, at each mesh size. In such experiments, the gillnets are fished two or more times for a certain length of time and usually the aggregated data is used to analyze the gillnet selection. For that in this paper to apply of this method to study drift gillnet selectivity for *scad* as the implications of its management in Kayely Bay Buru Island Maluku.

MATERIALS AND METHODS

Nets

*S*cad drift gillnets artisanal fishermen were interviewed in order to obtain details on the design and operation of the nets used in Kayeli Bay and a representative design was then chosen. The technical specifications of the experimental gillnets are presented in **Table 1.** Inside mesh size was measured between opposite knots when fully stretched, taking a sample of 25 randomly chosen meshes, using a steel ruler and light manual force to stretch the mesh. All nets were made of a polyamide monofilament light twine with a diameter of 0.25 mm. Floatation was given by 24 rubber sponge floats (93 gf) in each panel. These were approximately 12 m long and 280 meshes height. The hanging ratio of these nets was 0.55 on the float rope and 0.57 on the lead rope.

Table1. Technical parameters for the experimental gillnets

Mesh Size	38 mm	45 mm	51 mm
Net length (no. meshes)	575	485	428
Net height (no. meshes)	280	280	280
Float line length (m)	12	12	12
Lead line length (m)	12.5	12.5	12.5

Fishing trials and fishing area

Overall, three selectivity experiments were conducted at 12 stations in the Kayeli Bay Buru Island Maluku (**Fig. 1**) in April 2005 with a chartered artisanal fish aggregation devices (rumpon). The adopted soak time was that used by the artisanal fishermen, corresponding to setting the nets in the night time during 2 hours

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and their replication again at each station to 2 hours before morning time.

Data collection

After hauling, the catch was removed separately for each mesh size experiment. Along experiment, a total of 822 scad specimens were caught. The number of specimens and the fork length were recorded, where all fish were measured (fork length) to the nearest millimeter.

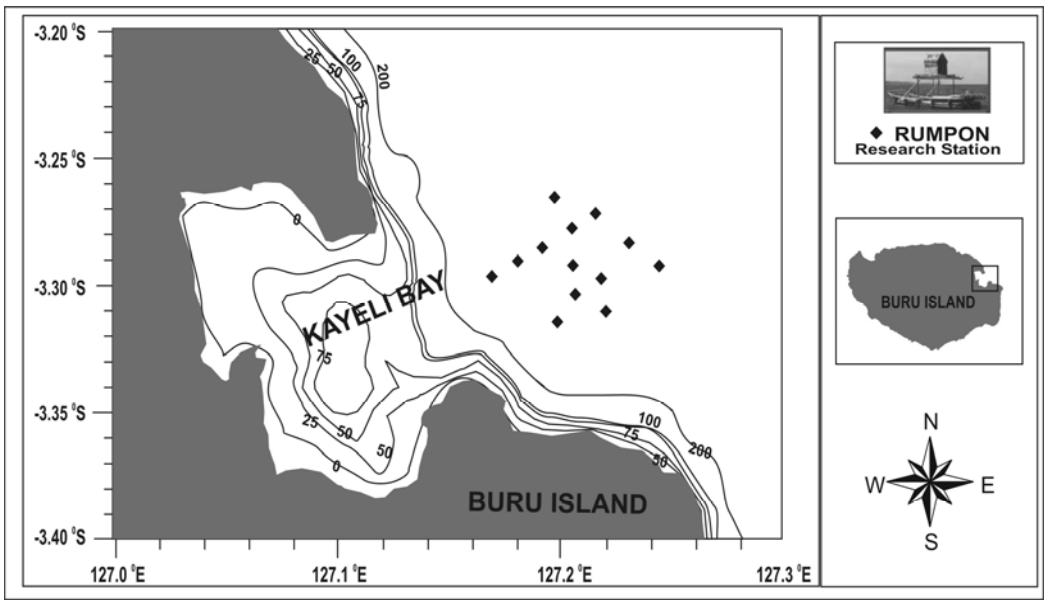

Fig 1. Map showing locations of drift gillnet experiment.

Estimation of mesh selectivity curve

The mesh selectivity curve was therefore estimated by using the method of Kitahara (1971). The catch per unit effort C, of scads at j-th length class l_i with i-th mesh size m_i is expressed as Eq. (1)

$C_{ij}=s(l_j/m_i)qdj$ ………………... (1)

taking its logarithm

$\log C_{ij} - \log s(l_i/m_i) + \log qdj$ ………. (2)

where $s(m_i/l_j)$ is the mesh selectivity (i.e. a function of the relative efficiency (max = 1) against the body length), of mesh size m_i to length l_j, q denotes the efficiency at the peak of the mesh selectivity curve and is assumed to be ordinarily constant (q = 1) if relative efficiency is considered, and d_j is the relative population density of fish at length l_j. Eq. (2) was used and the width of a length class was treated as 10 mm in calculation. The mesh selectivity was approximated by a polynomial curve to the plots taken from Eq. (2) using the least squares method. The master curve of mesh selectivity is expressed as follows (Fujimori and Tokai, 1999):

$\log s(R) = (a_nR^n+a_{n-1}R^{n-1}+a_{n-2}R^{n-2}-2 \ldots +a_0)/s_{max}$ (3)

taking the exponent

$s(R) = exp\{(a_nR^n+a_{n-1}R^{n-1}+a_{n-2}R^{n-2}-2 \ldots +a_0) - s_{max} \}$………………………….. (4)

Where R is equal to l/m and s_{max} is the maximum value of the approximated curve.

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RESULTS AND DISCUSSION

Results

The fork length distribution of the catch, expressed in numbers of scads caught per three nets, is shown in (**Fig. 2**). The 45 mm mesh size of drift gillnet had the highest catch while for nets of 51 mm mesh size was lowest. Scads were caught in the same size range from 180 to 250 mm fork length by all mesh sizes. The length of fish caught appeared to increase with mesh size (**Fig. 2**). The modal length class of 38 mm mesh size of net was 180 - 190 mm, 230 – 240 mm for 45 mm net and 250 – 260 mm for 51 mm net, respectively.

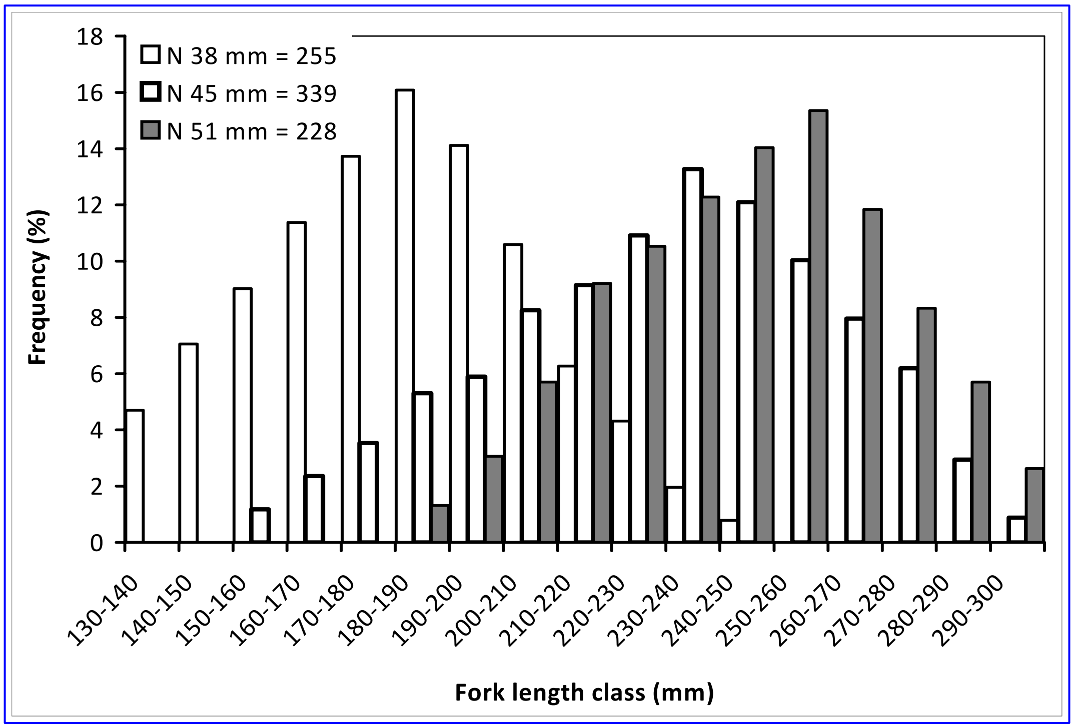

Fig 2. Length frequency distributions of Scads *Decapterus macarelus* caught in gill nets. N 45 mm is number of fish caught in the 45 mm mesh size gill net, etc.

The data of the eight length classes (175–255 mm) were used for the estimation of selectivity curve to avoid the use of the length class with a zero catch as much as possible. The estimated mesh selectivity curve is shown in Fig. 3 and its equation is shown as

$s(R) = \exp\{ (0.06R^3 - 2.32R^2 + 18.37R – 38.12) - 3.62\}$……………………… (5)

where *R* is equal to ratio of length and mesh size, *l*/*m*.

This equation curve has a peak at 5.0 relative lengths, *R* (**Fig 3**). The mesh selectivity curve has a shape that is resemble with normal curve. The peak of curve, R be equal with ratio of fork length class 255 mm and 51 mm mesh net (fishing efficiency 1.00), ratio of fork length class 225 mm and 45 mm mesh net (0.99), and ratio of fork length class 185 mm and 38 mm mesh net (0.98), respectively.

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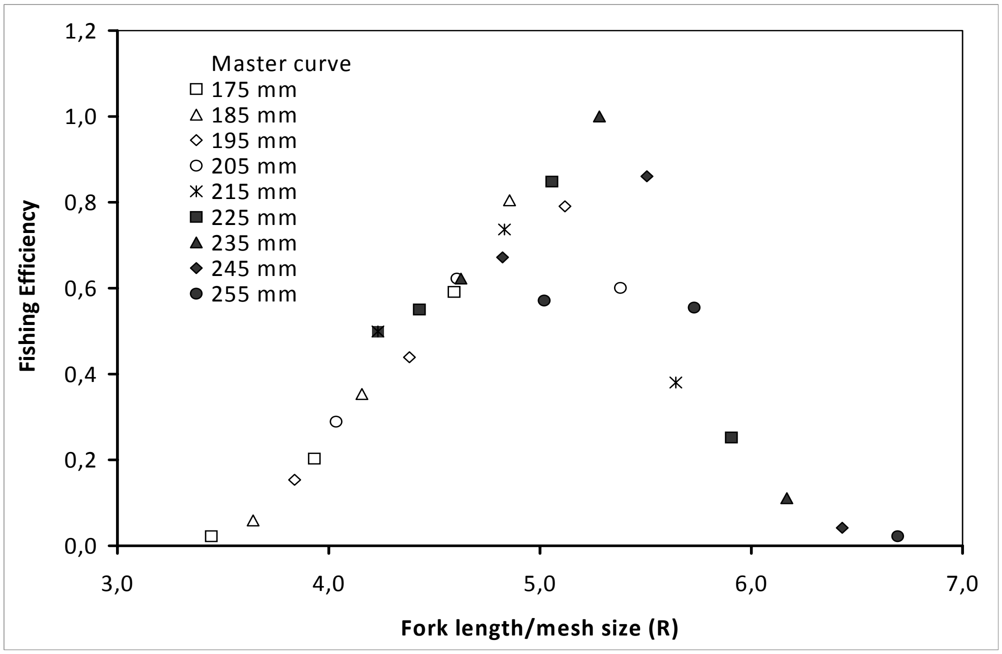

Fig 3. Master curve of mesh selectivity of the drift gillnet for scad in Kayeli Bay, using Kitahara's method. The mark of 175 mm is fork length class, etc.

Discussion

One of the priorities of the Law of the Republic of Indonesia number 31 of 2004 concerning fisheries is the limitation of net mesh size and fish size. Gill nets are highly size-selective gears that generally catch a relatively narrow size range consisting of few or no fish with lengths 20% less than or 20% greater than the optimum length of a particular mesh size (Hamley, 1975). The widespread use of minimum mesh sizes in fisheries management has meant that gill net selectivity has received considerable attention, with numerous studies worldwide (Petrakis and Sergiou, 1994; Fujimori *et al.*, 2001; Carlson and Cortes, 2003; Santos *et al.*, 2003; Chang *et al.*, 2004).

Scad is commonly caught by small purse seine in Maluku, except in Kayeli Bay it is captured by drift gillnet. The present study is one of the few concerning gill net selectivity for the *Decapterus macarelus* (Scad). It was caught in the same narrow size range by all three mesh sizes used in the fishing trials. The catch size distributions clearly showed that there was size selectivity, with an increase in mean size with greater mesh size. The estimated size at maturity would contribute to the goals of conservation and sustainability of fishing (Dos Santos *et al.*, 2003). Information about size new maturity of scad in this area is not identified clearly yet, but the present study can acquire implication to minimum mesh size of scad drift gillnets.

Previous studies on scad with used Holt method that the optimum fork length classes are 215 mm for 45 mm, 245 mm for 51 mm and 175 mm for 38 mm mesh size of net (Tupamahu and Tawari, 2005), but the present

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study is more than them. The difference of selectivity methods because of Holt method is based upon standard linear regression, however, it is restrictive as it assumes the normal curve as the selection model and this selection model does not conform to the principle of geometric similarity (Hovgard and Lassen, 2000). While estimation methods of Kitahara where selection is estimated by graphically adjusting catches from individual length groups to fit a common master selection curve. The modes of the estimated selectivity curves were same as the length frequency distributions of the catch, for the 38 and 51 mm mesh sizes, except for 45 mm. This is probably due to the fact that the Baranov principle of geometric similarity (i.e. that modal lengths are proportional to mesh size) is observed for all net fitted using the MS excel problem solver software.

CONCLUSION

The result of this study indicated that fishing efficiency of scad drift gillnet in Kayeli Bay are 255 mm, 225 mm and 185 mm mean size length class for 51 mm, 45 mm and 38 mm mesh size of net, respectively. Implication of minimum mesh size of net must be proposed to fisheries management. For that reason, 51 mm mesh size of net is minimum legal size for it.

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REFFERENCES

Carlson, J.K. and E, Cortes., 2003. Gillnet selectivity of small coastal sharks off the southeastern United States. *Fish. Research*., 60: 405–414.

Chang , D., P., Eui, C., Jeong., J.K., Shin., H., Chun An and Y. Fujimori., 2004. Mesh selectivity of encircling gill net for gizzard shad *Konosirus punctatus* in the coastal sea of Korea. *Fish. Research*., 70: 553-560.

Fujimori, Y., T. Tokai., S, Hiyama., S.K, Matuda., 1996. Selectivity and gear efficiency of trammel nets or kuruma prawn (*Penaeus japonicus*). *Fish. Research* 26: 113–124.

Fujimori, Y and T, Tokai., 2001. Estimation of gillnet selectivity curve by maximum likelihood method. *Fish. Sci*., 67: 644-654.

Hamley, J.M., 1975. Review of gillnet selectivity. *J. Fish. Res. Board Can.*, 32: 1943–1969.

Holt, S.J., 1957. A method of determining gear selectivity and its application. *ICNAF-ICES-FAO Joint Set.Meeting Paper*.

Hovgard, H and H, Lassen., 2000. Manual on estimation of selectivity for gillnet and long line gears in abundance surveys. FAO Series Technical Paper., 397: 89 pp.

Ishida, T., 1962. On the gill-net mesh selectivity curve. *Bull.Hokkaido Reg. Fish. Res. Lab.*, 25: 20–25.

Kitahara, T., 1971. On selectivity curve of gillnet. *Bull. Jap. Soc. Sci. Fish.*, 37: 289–296.

Petrakis, G and K.I., Stergiou., 1995. Gill net selectivity for *Diplodus annularis* and *Mullus surmuletus* in Greek waters. *Fish. Research*. 21: 455-464.

Santos, M. G., C.C, Monteiro., and K, Ersini., 2003. Gill net selectivity for European hake *Merluccius merluccius* from southern Portugal: *Implications for fishery management*. *Fish. Sci.* 69: 873–882.

Tokai, T and Y. Fujimori., 1999. Estimation of Gill Net Selectivity Curve By Kitahara' s Method With Solver on MS Excel. *In*: T. Arimoto and J. Haluan (Eds). The 3rd JSPS International Seminar Sustainable Fishing: 93-97.

Tupamahu, A dan R, Tawari., 2005. Selectivity of *Decapterus macarelus* (Scad) drift gillnet in Kayeli Bay Buru Island. *In*: (Eds). Proceedings of Agriculture Technology Innovation of Friendly Agribusiness Seminar to Support Islands Agricultural. Agricultural Ministry, Study Center of Socio-Economic Agriculture: 257-461.