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Research Article

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Monofilament Gillnet Selectivity for *Hampala Barb* (*Hampala macrolepidota*) Management at Ir. H. Djuanda Reservoir-West Java

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ABSTRACT

Native species from Citarum River and introduce new species caused high fish biodiversity in this reservoir and one of them is Hampala barb (*Hampala macrolepidota*) and it's economical species. Hampala barb is one of dominant species was captured at Ir. H. Djuanda Reservoir but wasexperience decreasing of population by overfishing. The objective of this research were to known gillnet selectivity and length at first mature for hampala barb (*Hampala macrolepidota*) at Ir. H. Djuanda Reservoir. The information will be used as base determination of gillnet mesh size and legal size for sustainability fisheries management (Silvanoet al., 2009). The research was done at February-September 2017 with experimental fishing used gillnet with mesh size between 1.0-3.0 inch with intervals 0.5 inch. Total length hampala barb with highest captured probability for gillnet with mesh size 1.0; 1.5; 2.0; 2.5 and 3.0 inch were 11.0; 17.0; 22.5; 28,0 and 33.5cm respectively. Length at first mature of hampala barb for female and male were 14.2 and 13.8 cm respectively. Based on the information, the minimum total length for exploitation was 19 cm using gillnet with mesh size > 2.0 inch.
Keywords: gillnet, selectivity, total length, hampala barb

1. Introduction

Ir. H. Djuanda Reservoir located at Purwakarta Regency, West Java Province is a multifunction reservoir and was used for captured fisheries activity. The Jatiluhur Reservoir was built with the damming Citarum River and native fish from this river was entry and inhabits the reservoir. Introduction new species like milk fish caused increasing of fish species in this reservoir (Hedianto and Purnamaningtyas, 2011). Its caused this reservoir have high fish biodiversity. Result of the result from Putri and Purnamaningtyas (2011) shown 15 species were captured by experimental fishing using gillnet and one the species is hampala barb. Hampala barb (*Hampal macrolepidota*) is economical value of native species. Its one of dominant species was captured but now experience population decreasing is caused overfishing (Kartamihardja, 2008). The overfishing has caused significant changes in of fish population. Therefore, to achieve sustainable fisheries, management should conserve the age and spatial structure in addition to spawning biomass (Hsieh et al., 2010). Effective management of fisheries resources depends on the fishing gear selectivity, fishing effort control and biology aspect of target species (Kindsvater et al., 2017).

The fishing gear was used at Jatiluhur Reservoir by fisherman including hook, lift net, cast net, trap and gillnet as dominant fishing gear. Gillnets was used for the commercial harvest and the assessment tool of fish population with highly selective for certain size of fish. The size selectivity for fish exploitation therefore needs to be known to effectively regulate its commercial use (Svedang and Hornborg, 2014; Vainikka and Hyvarinen, 2012). Information on the fish reproductive is required in order to advise on management measures to protect the reproductively active part of the population. Such measures could involve the introduction of a minimum mesh size and closed

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season and/or area (Kuparinen et al., 2016). Proper fisheries management requires that fishing gear harvest large mature fish while allowing the small juveniles to escape. This property of fishing gear is called gear selectivity (Dincer and Bahar, 2008).

Fisheries management based on biology parameters and fishing gear selectivity prevent recruitment over fishing (Jarvis et al., 2014). If length at first harvest is correctly determined, a stock is more likely to be sustained and yield optimized (Ratz et al., 2015). The regulation of minimum gillnet mesh size for nile tilapia exploitation was enforcement in El-Bahr El Faraouny Canal, Egypt (El-Kasheif et al., 2015). Determine of reference point for fish exploitation have some objective include to ensure the long sustainability and risk minimize of fish resources exploitation (Olin et al., 2017). The objective of this research were to known gillnet selectivity and length at first mature for hampala barb (*H. macrolepidota*) at Ir. H. Djuanda Reservoir. The information will be used for based of determination of gillnet mesh size and legal size for sustainability fisheries management.

2. Material and Methods

2.1. Study sites

The hampala barb were collected from February-September 2017 at Ir. H. Djuanda Reservoir, West Java using monofilament gill nets mesh size 1,0-4,0 inch with intervals 0,5 inch. Experimental fishing was done at six stations include Cihonje-Cibadak, Cikayanyan, Cirirp, Cihonje, Pasirkole and Cilalawi (Figure 1). The nets were made from white monofilament polyester twine with diameter size 0.25 mm. The length of each gill nets was 40 m with the number meshes in depth was 100.

The experimental gillnets with seven mesh size were used simultaneously at the same area with the depth from 6,0-18 m. The gillnets were set at 04:00 am and hauled at 07:00 pm. After hauling, the catch was remove and separated according the mesh size and the total length of each fish was measured to the nearest 0,1 cm using measure board. Secondary data of hampala barb total length was used got from Research Institute for Fisheries Conservation (Balai Riset Pemulihan Sumber Daya Ikan) Jatiluhur.

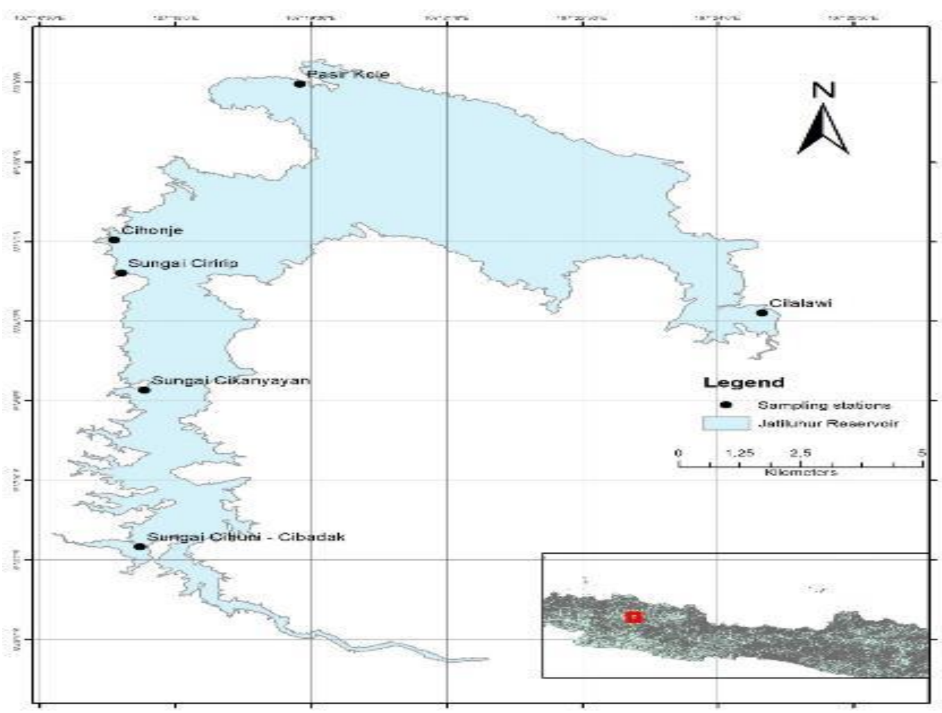

Figure 1. Sampling stations using experimental gillnet

The data was collected at 1985 and 1986.Measurenment of opercular or Head (G_H) and maximum girth (G_{max}) for hampala barb according Ozekinci (2005).

The maturity scale used for determination of sexual stages according Legendere and Ecoutin (1989). That scale includes seven stages: Stage 1: immature; Stage 2: beginning mature; stage 3: maturation; Stage 4: advanced maturation; Stage 5: ripe. The mature of females and males if they had reached gonad stage 3 or higher.

2.2. Data analysis

Optimum mesh size for hampala barb exlpoitation decided by optimum length (Lc) with length at first mature (Lm) (Lc>Lm) (Makmur et al., 2014). The L_m defined as the mean length at which gonadal development advanced to at least stage 3 of individual. The determination of Lm was estimated using logistic curve (King, 2007). The logistic equation used is as follows:

$$P = 1/(1+\exp[-r(L-Lm)$$

Where:

P = The proportion of mature fish gonad (%)
Lm = Length at first maturity (cm)
L = Total length (cm)
R = Slope

Curve linear constant of a relationship between the proportion of fish mature with a number of examples of the same length class can be used to determine the value of r and Lm where r = -b and Lm = a/r.

In calculating the selectivity parameters and selection curve of nets using indirect method (Holt, 1963), in which selectivity parameters are estimated form catches taken by slightly difference mesh size. The natural logarithms of caught number per length class, C_1 and C_2, by two slightly difference mesh size, m_1 and m_2, are linearly related to fish lengths:

$$\ln (C_b/C_a) = a + bL$$

where:

L = lenght class of caught fish (cm)
a = intercept
b = Slope

The optimum length (Lc_a and Lc_b) for mesh sizes c_a and c_b

$$L_{ca} = -2[am_a/b(m_a + m_b)]$$

$$L_{cb} = -2[am_b/b(m_a + m_b)]$$

Selection factor (SF) and standard deviation (SD) of the gillnet were then estimated using the following equation:

$$SF = -2a/b(c_a+c_b)$$

$$SD = ((-2a(c_b-c_a)/b(c_a+c_b))^{1/2}$$

Selection factor (SF) and standard deviation (SD) of experimental gillnet using more than two mesh sizes, the common selectivity factor will be calculated as follows (Sparre et al., 1989).

$$SF = -2 \sum\left[\left(\frac{ai}{bi}\right)(mi + mi + 1)\right] / \sum[m1 + mi + 1)^2]$$

$$SD = \{1/n - 1)\sum[2a(m_{i+1} - m_i)]/bi^2(m_i + m_{i+1})]\}^{1/2}$$

The probability of capture (P) for a given a length (L) in a gill nets with mesh sizes (m) was determined from the following equation:

$$P = \exp[-(L-Lc)^2/(2SD)^2]$$

The optimum length (corresponding to a 100% of probability of retention) for each mesh size was obtained:

$$Lc = SF \times m$$

Relationships between fish total length and G_H and G_{max}were estimated by linear regression analysis (Kurkilahti et al., 2002):

$$y = a + bL,$$

where :

a = intersept
b = slope

3. Result and Discussion

3.1. Length distributions and length at first mature

A total of 823 individuals of hampala barb (*H. macrolepidota*) specimens were captured during the sampling period. The total length distribution of hampala barb caught using experimental gillnets with five mesh size in Ir. H. Djuanda Reservoir are shown at Fig 2. The total length of fish of caught ranged around 5,0-34,0 cm and increases according increasing of gillnet mesh size. The length frequency distribution of hampala barb each mesh size followed normal distribution with specific mesh size. The modal of total length of hampala barb captured with experimental gillnets increased namely 10.5; 15.5; 20.5; 26.5 and 29.5 cm for mesh size 1.0; 1.5; 2.0; 2.5 and 3.0 inch respectively. Hampal barb was not captured at gillnet with 3.5 and 4.0 inch mesh size.

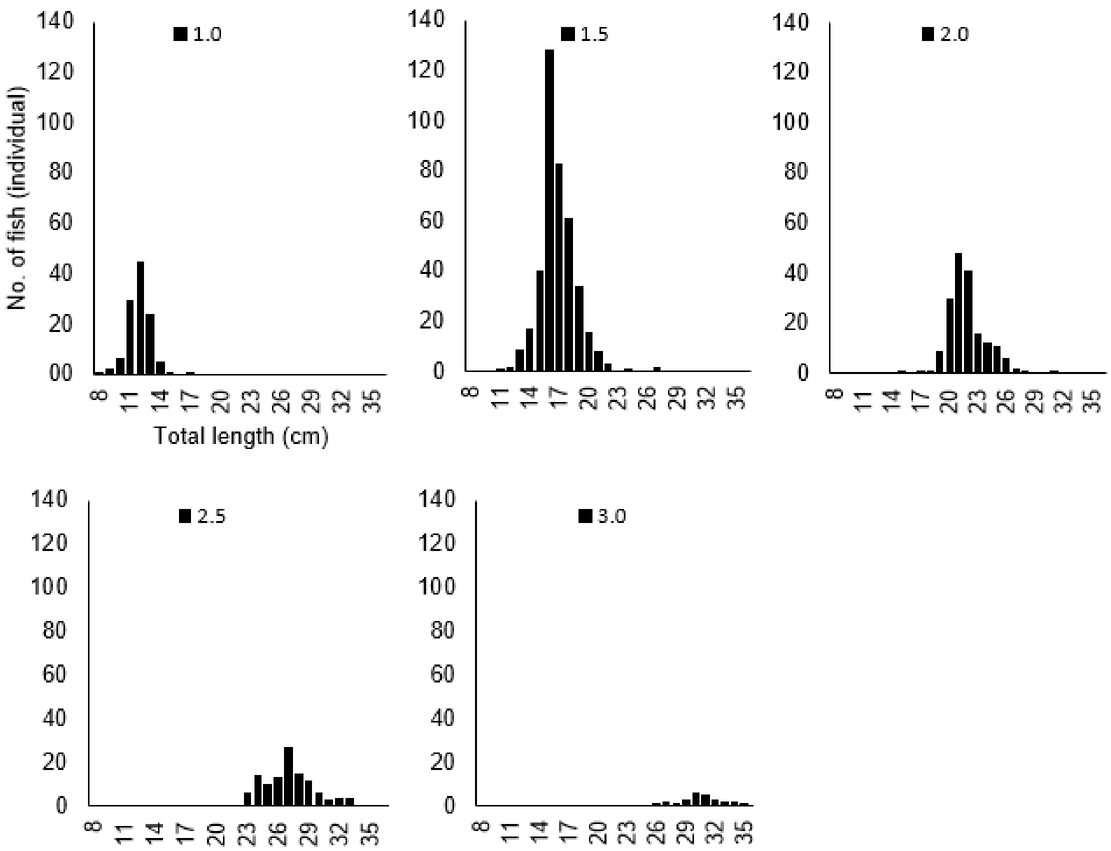

Figure 2. Length frequency distributions of hampala barb caught for each mesh size

The total length of hampala barb was captured at Jatiluhur Reservoir smaller than Lake Ranau around 9.7-33.3 cm (Makmur et al., 2014). Procentage of total length bigger than length at first mature (Lm) for 1.0; 1.5; 2.0; 2.5 and 3.0 inch were 0.0; 16.0; 91.7; 98.2 and 100% respectively. The mesh size > 2.0 inch would captured the hampala barb longer than Lm with proportion > 90%. Use of this mesh size ensures that at least 85% of the barbs harvested by the commercial gillnet fishery are large adults as their size at maturity is much smaller than their size at capture (de Graaf et al., 2003).

Fishes resources management can be done with determination the fishing season and location, the number of catches and the minimum fish size that can be captured (Andersenet al., 2018) which its was greater than the value of Lm (Tesfaye et al., 2016; Teame et al., 2018). There is a potential for immature individuals being caught at mesh size < 2,0 inch.

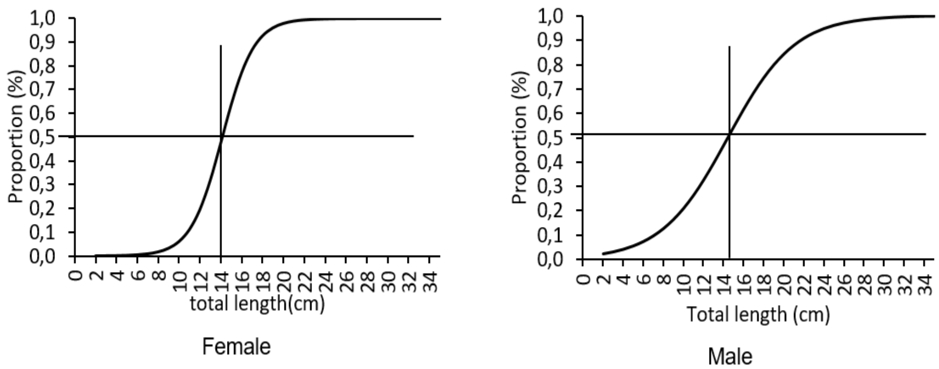

Figure 3. The size at first maturity of female hampala barb in Ir. H. Djuanda Reservoir

Length at first mature (Lm) for female and male of hampala barb at Ir. H. Djuanda Reservoir were 14.2 and 13.8 cm respectively and Its smaller than another research result. The length at first mature (Lm) for female and male of hampala barb in Lake Zoo Nagara, Kuala Lumpurwere is 15,0 and 18,0 cm respectively (Abidin, 1986) and 16,0 cm for female in Lake Kenyir (Zakaria et al., 2000). Lm can be considered as minimum permissible size for first capture (Amarasinghe and Pushpalatha, 1997) and reduce the risk of overexploitation of specific spawning component (Van Overzee and Rijnsdorp, 2015). Restriction of size for exploitations is a fisheries resources management efforts before there are restrictions on efforts or the number of fish biomass that can be exploited (Davies et al., 2009) and its also a sustainable fisheries management (Garcia et al., 2016).

3.2. Gillnet Selectivity

The calculations of selectivity parameters based on the net pairs 2.54-3.81; 3.81-5.08; 5.08-6.35; 6.335-7.62 cm. The regression constant (slope and intercept) coefficient for optimum lengths and selectivity parameters were assessed from length frequency distribution for each mesh size combination (Table 1). That's values were used to estimate the common selectivity factor, standard deviation and optimum selection length for mesh size respectively. The generally of selectivity factor and standard deviation were 4.3805 and 3.467, respectively.

The selection curve of monofilament gillnets for hampala barb obtained with the probability of capture (P) equation and shown in Figure. 2. The optimum selectivity length were 11.0; 17.0; 22.5; 28,0 and 33.5 cm for gillnet 2.54; 3.81. 5.08; 6.35 and 7.62 cm mesh size respectively. Fishing gear selectivity as importance instrument for fisheries management (Zhenlin et al., 2014; Jorgensen et al., 2009) cause diminished non target catches (Kalayci and Yesilcicek, 2014).

Table 1. The selectivity parameters of monofilament gillnet with different mesh size

m_1	m_2	a	b	n	R^2	L_1	L_2	SF	SD
2.54	3.81	-28.8900	2.400	3	0.9250	9.6	14.5	3.79	1.41
3.81	5.08	-16.7890	0.9010	4	0.9984	16.0	21.3	4.19	2.43
5.08	6.35	-17.9690	0.7390	6	0.9655	21.6	27.0	4.25	2.70
6.35	7.62	-4.2686	0.1316	3	0.9494	30.0	35.5	4.66	6.72

n=Number of point used in the regressions, L_1 and L_2=estimated catch lengths (cm) for nets of mesh size m_1 and m_2 respectively, SF= selection factor, SD= Standard deviation

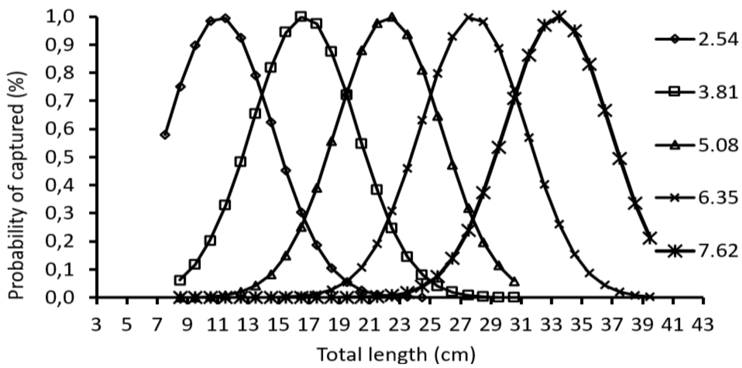

Figure 3. Selectivity curve for experimental gillnets of hampala barb

The selectivity can serve for fisheries management with minimizing bycatch and fishing impact for fish structure (Laurence and Marie-Joelle, 2016). Determination of mesh size for fishing activity is more efficient because it is minimize catches of unwanted species and minimize capture of certain size (Breen et al., 2016; Laurence and Marie-Joelle, 2016; Dineshbabu et al., 2012). Gillnet with mesh size > 2,0 inch could be safely, as they allow the target resources to attain Lm before vulnerable to fishing. The increasing size-selectivity could increase yield and juveniles captured avoiding and its provide an opportunity to reproduce at least once before they are harvested (Garcia et al., 2012). The results have important management for protecting juvenile and mega-spawners of target species (Tesfaye et al., 2016). Appropriate mesh size is thus one way of establishing an appropriate Lc for target species and as basis of regulation for specify the minimum mesh size (Emmanuel and Chukwu, 2010; Saberin et al., 2013). The effect of exploitation pattern for fisheries resources depend on selectivity of the gear relative to the available fish size (Rochet et al., 2011). Nile tilapia (*Oreochromis niloticus*) fisheries resources management at Amerti Reservoir, Ethiopia was done with determination of gillnet mesh size for fish captured bigger than Lm (Hailu, 2014).

Total length estimation of fish captured was estimated based on mesh size selectivity value for a gillnet because its have high selectivity (Oginni et al., 2006). Relationship between optimal length (Lopt, cm) and mesh size (MS, inch) can be shown with linier regression (Jawad et al., 2009) as follows:

$$Y = 3.622MS + 1.5$$

$$R^2 = 0.9925$$

The formula shown that fish with total length smaller than length at the first mature would be dominant caught at gillnet with mesh size 1.5 inch while the gillnet with mesh size > 2 inch would be dominant caught fish ≥ 19 cm (L>Lm).

The relationship between head girth (G_H) and maximum girth (G_{max}) versus total length (L) of hampala barb shown the equations as follows:

$$L = 1.6456G_H + 4.2627 \qquad R^2 = 0.8311$$

$$L = 1.3757G_{max} + 3.2109 \qquad R^2 = 0.8753$$

Head girth and maximum girth for hampala barb with 19 cm total length were 9.0 and 11.5 cm, respectively. Its dominant captured on gillnet with mesh size ≥ 2.0 inch with ratioof head girth and maximum girth were 0.9 and 1.1. Its same with experimental gillnet where is hampala barb with 19 cm of total length dominant caught at gillnet with mesh size ≥ 2.0 inch. Significant variation in the selectivity parameters was explained by simple shape descriptors such as percent girth, suggesting that these descriptors might be used as a preliminary tool to describe gillnet selectivity for fish species (Carol and Garcia-Berthou, 2007).

4. Conclusions

Legal size for hampala barb exploitations was ≥ 19 cm by used gillnet with mesh size > 2.0 inch. Its bigger than length at first mature of female and male were 14.2 and 13.8 cm respectively. These information could be used for sustainability management for hampala barb resource at Ir. H. Djuanda Reservoir

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References

Abidin, Z. A. 1986. The reproductive biology of a tropical cyprinid, *Hampala macrolepidota* (Van Hasselt), from Zoo Negara Lake, Kuala Lumpur, Malayasia. J. Fish. Biol. 29: 381-391.

Amarasinghe, U. S., Pushpalatha, K. B. C. 1997. Gillnet selectivity of *Ompok bimaculatus* (Siluridae) and *Puntius Dorsalis* (Cyprinidae) in a small-scale riverine fishery. Journal of the National Science Foundation of Sri Lanka 25(3): 169-184

Andersen, K.H., Marty, L., Arlinghaus, R. 2018. Evolution of boldbess anf life-history in response to selective harvesting. Canadian Journal of Fisheries and Aquatic Sciences, 75(2): 271-281.

Breen, M., Graham, N., Pol, M., He, P., Reid, D., Suuronen, P. 2016. Selective fishing and balanced harvesting. Fisheries Research 184: 2-8.

Carol, J., Garcia-Berthou, E. 2007. Gillnet selectivity and its relationship with body shape for eight freshwater fish species. Journal of Applied Ichthyology 23: 654-660.

Davies, T.E., Beanjara, N., Tregenza, T. 2009. A socio-economic perspective on gear-based management in an artisanal fishery in south-west Madagascar. Fisheries Management and Ecology16: 279-289.

De Graaf, M., Machiels, M.., Wudneh, T., Sibbing, F. A. 2003. Length at maturity and gillnet selectivity of Lake Tana’s *Barbus* species (Ethiopia): implication for management and conservation. Aquatic Ecosystem Health & Management 6(3): 325-336.

Dincer, C., Bahar, M. 2008. Multifilament gillnet selectivity for Red Mullet (*Mullus barbatus*) Eastern Black Sea Coast of turkey, Trabzon. Turkish Journal of Fisheries and Aquatic Sciences 8: 355-359.

Dineshbabu, A. P., Muthiah, C., Sasikumar, G., Rohit, P., Bhat, U. S. 2012. Impact of non selective gears on kingseer, *Scomberomoruscommerson f*ihsery in Karnataka. Indian Journal of Geo-Marine Sciences 41(3): 265-271.

El-Kaheif, M. A., Authman, M. M. N., Al-Ghamdi, F. A., Ibrahim, S. A., El-Far, A. M. 2015. Biological aspect and fisheries management of Tilapia Fish *Oreochromis niloticus* (Linnaeus, 1758) in Al-Bahr El Faraouny Canal, Al-Minufiya Province, Egypt. Journal of Fisheries and Aquatic Science 10(6): 405-444.

Emmanue, B. E., Chukwu, L. O. 2010. Evaluating the selective performance of gillnet used in a tropical low brackish lagoon south-western, Nigeria. Journal of American Scinece 6(1): 49-52.

Garcia, S. M., Kolding, J., Rice, J., Rochet, M. J., Zhou., Arimoti, T., Beyer, J. E. 2012. Reconsidering the consequences of selective fisheries. SCIENCE 335: 1045-1047.

Garcia, S.M., Rice, J., Charles, A. 2016. Bridging fisheries management and biodiversity conservation norms: potential and challenges of balancing harvest in ecosystem based frameworks. ICES Journal of Marine Sciences73(6), pp.1659-1667.

Hailu, M. 2014. Gillnet selectivity and length at maturity of nile tilapia (*Oreochromis niloticus*) in a tropical reservoir (Amerti: Ethiopia). Journal of Agricultural Science and Tecnology 4: 135-140.

Hedianto DA, Purnamaningtyas SE. 2011. Penerapan kurva ABC (Rasio kelimpahan/biomassa) untuk mengevaluasi dampak introduksi terhadap komunitas ikan di Waduk Ir. H. Djuanda. *Dalam* Kartamihardja ES. Rahardjo MF, Purnomo K (Edts). Prosiding Nasional Pemacuan Sumberdaya Ikan III: 1-11.

Holt, S.J. 1963. A method for determining gear selectivity and its application. ICNAF Special Publication, 5, 106-115.

Hsieh, Chih-hao., Yamauchi, A., Nakazawa, T., Wang, W.F. 2010. Fishing effect on age and spatial structures undermine population stability of fishes. Aquatic Science 72: 165-178.

Jarvis, E. T., Gliniak, H. L., Valle, C. F. 2014. Effect of fishing and the environmental on the long-term sustainability of the recreational saltwater bass fishery in southern California. California Fish and Game 100(2): 234-259.

Jawad, L. A., McKenzie, A., Al-Noor, S. S. 2009. Relationship between opecular girth, maximum girth and total length of fishes caught in gillnets in the estuarine and lower river sections of Shaat al-Arab River (Basrah Province, Iraq). J. Appl. Ichthyol. 25: 470-473S.

Jorgensen, C., Ernande, B., Fiksen, O. 2009. Size-selective fishing gear and life history evolution in the Northeast Artic cod. Evalutionary Applications 2(3): 356-370.

Kartamihardja, E.S. 2008. Perubahan komposisi komunitas ikan dan faktor-faktor penting yang mempengaruhi selama empat puluh tahun umur Waduk Djuanda. *Jurnal Iktiologi Indonesia 8(2)*: 67-78.

Kindsvater, H.K., Reynolds, J. D., de Mitcheson, Y.S., Mangel, M. 2017. Selectivity matters: Rules of thumb for management of plate-size, sex-changing in the live reef food fish trade. Fish and Fisheries 18(5): 821-836.

Kurkilahti, M., Appelberg, M., Hesthagen, T., Rask, M. 2002. Effect of fish shape on gillnet selectivity: a study with Fulton's condition factor. Fisheries Research 54: 153-170.

Kuparinen, A., Boit, A., Valdovinos, F. S., Lassaux, H., Martinez. 2016. Fishing-induced lif-history changes degrade and destabilize harvested ecosystems. Scientific Report 6: 1-8.

Laurence, F., Marie-Joelle, R. 2016. Fishing selectivity as an instrument to reach management objectives in an ecosystem approach to fisheries. Marine Policy 64: 46-54

Legendre, M., Ecoutin, J.M. 1989. Suitability of Brackish water tilapia species from the Ivory Coast for Lagoon aquaculture. 1 – Reproduction. Aquatic Living Resources 2: 71-79.

Makmur, S., Arfiati, D., Bintoro, G., Ekawati, A. W. 2014. Food habits of hampala (*Hampala macrolepidota*) and its position in food web, food pyramid and population equilibrium of Ranau Lake, Indonesia. Journal of Biodiversity and Environmental Sciences 4(6): 167-177

Oginni, O., Fasakin, E.A., Balogun, A.M. 2006. Gillnet selectivity of chichlidae Sarotherodon Galilaeus (Linne 1758) in Iwo Reservoir, South West Nigeria. Middle-East Journal of Scientific Research1(1): 10-15.

Olin, M., Tiainen, J., Rask, M., Vinni, M., Nyberg, K., Lehtonen, H. 2017. Effect of non-selective and size-selective fishing on perch population in a small lake. Boreal Environment Research 22: 137-155.

Ozekinci, U. 2005. Determination of the selectivity of monofilament gillnets used for catching the annular sea bream (*Diplodus annularis* L., 1758) by length-girth relatioships in Izmir Bay (Aegean Sea). Turkish Journal of Veterinary and Animal Science 29: 375-380.

Putri, M.R.A., Purnamaningtyas, S. E. 2011. Distibusi ikan di Waduk Ir. H. Djuanda. In Simanjutak, C. P. H., Zahid, A., Rahardjo, M. F., Hadiaty, R. K., Krismono., Haryono., Tjakrawidjaja, A. H (Editor). Prosiding Seminar Nasional Ikan VI. Bogor. 401-407.

Ratz, H. J., Casey, J., Holmes, S. J., Lloret, J., Dorner, H., Mitrakis, N., Charef, A. 2015. An alternative reference point in the context of ecosystem-based fisheries management: maximum sustainable dead biomass. ICES Journal of Marine Science 72(8): 2257-2268.

Rochet, M. J., Collie, J. S., Jennings, S., Hall, S. J. 2011. Does selective fishing conserve community biodiversity? Preditions from a length-based multispecies model. Canadian Journal of Fisheries and Aquatic Sciences68: 469-486.

Saberin, I. S., Reza, M. S., Ayon, N. J., Kamal. M. 2013. Estimation of size selectivity of fish species caught by different gears in the old Brahmaputra River. J. Bangladesh Agril. Univ. 11(2): 359-364.

Sparre, P., Ursin E., Venema, S.C. 1989. Introduction to tropical fish stock assessment. Part 1 – Manual. FAO Fish. Tech. Paper 306/1, 204-218.

Silvano, R. A. M., Ramirez, M., Zuanon, J. 2009. Effect of fisheries management on fish communities in the floodplain lakes of a Brazilian Amazonian Reserve. Ecology and Freshwater Fish 18: 156-166.

Svedang, H., Hornborg, S. 2014. Selective fishing induces density-dependent growth. Nature Communication 12(5): 1-6.

Teame, T., Zebib, H., Meresa, T., 2018. Observation on the biology of nile tilapia, *Oreochromis niloticus* L., in Tekeze Reservoir, Northern Ethiopia. International Journal of fisheries and Aquaculture10(7): 86-94.

Tesfaye, G., Wolff, M., Taylor, M. 2016. Gear selectivity of fishery target resources in Lake Koka, Ethiopia: evaluation and management implications. Hydrobiologia 765(1): 277-295

Vainikka, A., Hyvarinen, P. 2012. Ecologically and evolutionary sustainable fishing of pikeperch *Sander lcioperca*: Lake Oulujarvi as an example. *Fisheries Research 113*: 8-20.

Van Overzee, H. M. J., Rijnsdorp, A. D. 2015. Effect of fishing during the spawning period: implication for sustainable managegement. Review in Fish Biology and Fisheries 25(1): 65-83.

Zakaria, M. Z., Jalal, K. C. A., Ambak, M. A. 2000. Length weight relationship and relative condition factor of Sebarau, *Hampala macrolepidota* (Van Hasselt) in Kenyir Lake, Malaysia. Pakistan Journal of Biological Science 3(5): 721-724.

Zhenlin, L., Peng, S., Wei, Y., Liuyi, H., Yanli, T. 2014. Significant effect of fishing gear selectivity on fish life history. J. Ocean Univ. China 13(3): 467-471.