Assessing stock status of grey sharpnose shark
(*Rhizoprionodon oligolinx* Springer, 1964) in Java Sea

Wijopriono* and T Ernawati

1Center Research for Fisheries, Ministry of Marine Affairs and Fisheries, Ancol, Jakarta, Indonesia
2Research Institute for Marine Fisheries, Indonesian Institute of Sciences, Bogor, Indonesia

*E-mail: wijopriono@yahoo.com

**Abstract.** Increasing demand for shark products leads to over fishing of these species in many areas, damaging their population. Grey sharpnose shark (*Rhizoprionodon oligolinx*) is caught mostly by gillnet fleet in Java Sea. The objective of the study was to discuss the current stock condition of grey sharpnose shark in Java Sea. Research on shark resources has been conducted by placing enumerators at the main landing base in PPN Pekalongan. Biological parameters of *R. oligolinx* were estimated based on commercial landings data recorded by enumerators from 2014-2015. The growth parameters of grey sharpnose shark such as *L*∞, *K*, *t*0, values were 96.1 cm, 0.47 year−1, and -0.78 year, respectively. Moreover, total mortality rate (*Z*) were estimated at 1.82 year−1 with fishing mortality and natural mortality rates (*F* and *M*) were 1.04 year−1 and 0.78 year−1, respectively. Stock status of grey sharpnose shark in Java sea from view point of gill nets fisheries is still in the sustainable utilization status with biological reference point more than 30% SPR and level of exploitation rate (E) is 0.57.

**Keywords:** Java Sea, gill nets, *Rhizoprionodon oligolinx*, stock status

1. Introduction

Increasing demand for shark products has led to a rapid increase in the exploitation of shark resources in various fishing areas. Global production recorded that there has been a significant increase in shark production since the 1980s (Lack and Sant 2006). It was estimated that shark resources have been exploited in the range between 6.4% and 7.9% of the total population each year, while their rebound rate was 4.9% per year. Accordingly, the global population of shark declined less than 10% from the baseline level (Baum et al 2003, Worm et al 2013). In coastal habitats, sharks would experience more fishing pressure due to increased rates of exploitation and habitat degradation.

Indonesia is the world’s largest shark producer, contributing approximately 13% of total world production. Even though sharks are generally non-target species (caught as by catch from variety of fishing gears), exploitation of this commodity has showed indication an increasing trend since the 1980s. Shark catch data showed a significant upward trend between 1975 and 2011 and fluctuated in
the following years (DGCF 2016). A decrease in shark production volumes in Indonesia became apparent for several shark species that are commonly captured, such as Alopiidae and Carcharhinidae.

Sharks are the top predators in their respective environment. The changing of shark abundance can have an impact to population (Myers et al 2007) and ecosystem at various trophic levels (Worm and Branch 2012). On the other hand, monitoring and managing the impact of other fisheries on shark species is not easy because most sharks are caught as by-catch or come from illegal fishing (Bonfil 1994). Fishing pressure for sharks will continue to increase impacting shark stocks. Therefore the information of species-specific data is needed as a basis for their management (Worm and Branch 2012).

Sharks have become the main fishing target for small-scale gillnet fisheries. The fishing gear used material of monofilament with 3.5-5.0 inch stretched mesh sizes and operated by boat of less than 30 GT. Total catch of shark from gillnet fisheries showed an increasing trend since 2012 (DGCF 2016). Monitoring on catches of shark caught from Java Sea has been done in Pekalongan fishing port, one of main fish landings for gillnet fishery in the north coast of Java. This paper discusses current stock condition of grey sharpnose shark in Java Sea.

2. Materials and methods

Length frequency data for of *R. oligolinx* was collected monthly from 2014 to 2015 at Pekalongan fishing Port (figure 1). Total length (TL) and body weight of each shark were measured and weighted to the nearest cm (centimeters) and g (grams) using a measuring tape and a weighing balance. A number of 809 of *R. oligolinx* specimens were collected and used for analysis.

![Figure 1. Location of Pekalongan landing site and the Java Sea fishing area (●).](image)

Growth parameters i.e. asymptotic length ($L_\infty$) and growth coefficient ($K$) were estimated following von Bertalanffy’s growth model (von Bertalanffy 1938) and calculated using FISAT I subroutine which incorporated in the FISAT II software program (Gayanilo et al 2005). Using estimated growth parameters back calculated on von Bertalanffy’s growth equation was done to estimate age at length zero ($t_0$). Pauly’s equation (Pauly, 1983) was used to estimate longevity ($L_{max}$). The length-weight relationship of *R. Oligolinx*, was obtained following formula of Le Cren (1951), $W = aL^b$, where, $W$ and $L$ denoted weight of the shark in g and the total length in cm while $a$ and $b$ were the intercept and slope of the regression curve, respectively. Length converted catch curve method (Pauly 1983) was employed to estimate the total mortality rate ($Z$). Natural mortality rate ($M$) was estimated using the empirical formula of Pauly (1983). Fishing mortality rate ($F$) was obtained by subtracting natural mortality rate ($M$) from $Z$. The current exploitation rate ($E_{cur}$) was defined as a ratio between fishing
mortality rate and total mortality rate (Ricker 1975), \( E = F/Z \). Length at first capture (\( L_{50} \)) was estimated by regressing probability of capture of each length class using logit curve (Pauly 1987). Calculation of both growth and mortality parameters was done using FISAT II software program (Gayanilo et al 2005).

To determine the status of \( R. \) oligolinx in terms of their reproductive potential, estimation using Length-Based Spawning potential ratio (LB-SPR) (Hordyk et al. (2015a) was done. \( M/k, L_\infty \), the coefficient of variation of the maximum length (\( CV_{L_\infty} \)), as well as size-at-maturity were used for input parameters. R software of LB-SPR package of The Barefoot Ecologist’s Toolbox Length-Based Spawning Potential Ratio was used for the analysis (Prince et al 2015a).

3. Results and discussion

3.1. Length-Weight Relationship

Samples consisted of females 61.1\% (\( n = 452 \)) and males 38.9 \% (\( n = 290 \)), and 67 unsexed specimens. The size of \( R. \) oligolinx females ranged between 29.5 and 86.0 cm, while the size of the males ranged between 28.5 and 80.0 cm. The minimum size of \( R. \) oligolinx observed in this study was somewhat larger than those found in northwest coast of India waters (27.0 cm) (Purushottama et al 2017). On the contrary the minimum size was smaller than that all reported from Kuwait waters (45 cm) (Moore et al 2012).

The length-weight relationships \( R. \) oligolinx was expressed by \( W = 0.001021 L^{3.38875} \) (\( R^2 = 0.929, n=176 \)) for females, and \( W = 0.002773 L^{3.0978} \) (\( R^2 = 0.877, n=141 \)) for males. The relationship based on pooled data showed that the growth of \( R. \) oligolinx was positive allometric (figure 2)

![Figure 2. Length weight relationship of \( R. \) oligolinx.](image)

3.2. Growth and mortality parameters

Using von Bertalanffy’s growth equation, the asymptotic length (\( L_\infty \)) of \( R. \) oligolinx was estimated at 96.10 cm with growth coefficient (\( K \)) 0.47 year\(^{-1} \) (figure 3). Back calculated to the equation using these values resulted in the estimated age at length zero (\( t_0 \)) of -0.78 year. Growth parameters of \( R. \) oligolinx found in this study were comparable with those found in the waters of northwest coast of India (Purushottama et al 2017). However, when it was compared to the growth parameters of the species from same genus \( R. \) acutus, the value of growth coefficient (\( K \)) of \( R. \) oligolinx was smaller (Sen et al 2017).
The growth curve of *R. oligolinx* reconstructed using estimated growth parameters showed that the shark grows with different growth rates throughout its life cycle (figure 3). High growth rates occurred in the first and second years of their lives and then getting slower in subsequent years. The length of birth (*L₀*) was estimated at 29.5 cm and *t_max* was estimated reaching to 6.4 years.

The length at birth (*L₀*) of *R. oligolinx* in this study was found to be close to the same species caught from the north-west coast of India (Purushottama *et al.* 2017). The maximum length (*L_max*) observed in the present study was 91.3 cm and found to be lower than those found in north-west coasts of India, which reached to approximately 93.0 cm (Sen *et al.* 2017).

Analysis using empirical formula of Pauly (1983) suggested that natural mortality rate (*M*) for *R. oligolinx* was 0.78 year⁻¹, while total mortality rate (*Z*) estimated using length converted catch curve resulted a value of 1.82 year⁻¹. Thus, based on *Z* and *M* values it can be estimated that the fishing mortality rate (*F*) for *R. oligolinx* was 1.04 year⁻¹ (figure 5). It can be stated that of the total mortality, 43% reduction of the stocks contributed by natural mortality and 57% mortality due to fishing activities. From the values of mortality parameters, it can be obtained the current exploitation rate (*E*)
was 0.57, indicating the exploitation of *R. oligolinx* resource stock has been in the limit of sustainable utilization.

Probability of capture derived from length converted catch curve suggested that 50% of *R. oligolinx* become vulnerable to gillnet fishing (*L*$_{50}$) at the total length of 44.88 cm. White (2007) stated that *R. oligolinx* in Indonesia is mature at a total length of 43-45 cm, accordingly it can be ascertained that the gillnets used by fishers in Java sea will not threat sustainability of *R. oligolinx* resource.

The results showed that stock of *R. oligolinx* in Java Sea was 36 % of SPR (figure 6). Mace and Sissenswine (1993) suggested that a recruitment overfishing limit is ≥ 20% SPR, but for sharks which have lower productivity, its require the higher SPR value. For fish with unknown stock-recruit relationships, Mace (1994) recommended SPR value not less than 40 %. According to the SPR limit recommendation, it can be stated that *R. oligolinx* resource in Java Sea was still in the sustainable utilization status with biological reference point is > 30% SPR and level of exploitation rate (E) is 0.57.

Figure 5. Length converted catch curve for *R. oligolinx* (Left) and its probability of capture (*L*$_{50}$) (right).

Figure 6. Spawning Potential Ratio (SPR) of *R. oligolinx*.

4. Conclusion

Stock status of grey sharpnose shark from gill nets fisheries in Java sea is still in the sustainable utilization status with biological reference point more than 30% SPR and level of exploitation rate (E) is 0.57.
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