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Population dynamics of dominant demersal fishes caught in Tambelan Islands waters, Riau Archipelago Province

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ABSTRACT

Yonvitner, Fahmi. 2012. Population dynamics of dominant demersal fishes caught in Tambelan Islands waters, Riau Archipelago Province. Biodiversitas 14: 200-204. The population of demersal fishes tends to be decline in the last few decades. The decline was due to the increased of intensive catches, fishing effort and illegal fishing practices. This study aimed to examine aspects of population dynamics such as mortality, recruitment, opportunity capture and population estimation. The study was conducted in six locations at Tambelan waters, on 4-16 November 2010. Collected data included the fish species, size and biomass catch. The analyses performed included mortality, recruitment, opportunity capture and population estimates (VPA). The data indicated that the Genus of *Nemipterus* and *Lutjanus* possess the highest total mortality rate that was respectively 1.62 and 2.55. The highest recruitment presentation of the population which has an annual period as *Pentapodus* was 16%. Catch opportunities tend to be higher than actual fishing, while the alleged biomass of steady state conditions reached 12.2 tons/yr.

Key words: demersal, fish, Tambelan, Natuna Sea, Riau Archipelago

INTRODUCTION

Fishing area located in the Natuna Sea waters are very diverse both ecosystems and fish resources. In terms of ecosystems, the Natuna Sea waters possess coastal fisheries, offshore fishing, shallow water fishing, deep sea fishing and reef fishing. In terms of fisheries resources, there is an area dominated by one particular species but also many fishing areas inhabited by various species.

Multi-species fishery may cause the existence of three kinds of interactions, i.e. biological, technical, and economical interactions. The biological interaction may be both intra-and inter-species in the form of predation (prey-predator relationships, including cannibalism), and the competition in terms of food or space. Technical interactions occur because of fisheries on a stock as a target always cause mortality in other stocks, namely in the form of by catches.

Demersal fisheries in Tambelan waters, the Natuna Sea is one of fisheries resources where fishing pressures occurred. Tambelan waters are relatively open to fishing pressure either by local and foreign fishermen. Usually fishing activities are carried out by using trawl fishing gear (bottom nets). The declining of demersal fish stocks caused by high fishing pressure has led to decrease in stocks and fish stocks in Tambelan waters. Capture diminishing size, small fish catches getting more frequently, lower percentage of recruitment as well as the percentage of low yield per recruit may be the indicators of the declining of stock levels.

Based on the above conditions, it requires a study on the dynamics of the pattern of demersal fish stocks of which includes the more frequent small fishes catch, the lower the percentage of recruitment as well as the percentage of yield per recruit. The results of this study were expected to be used as a basis for formulating management plans and resource utilization of demersal fish from the Tambelan waters. Therefore, in the long period the stocks are maintained and remain sustainable.

MATERIALS AND METHODS

Site sampling

The study of demersal fish in Tambelan Islands waters, Natuna Sea, Riau Archipelago Province, Indonesia, was carried out on November 4 to 16, 2010. Fish samples were collected using a bottom trawl nets (trawling) with a swept area method. The equipments were operated on the Research Ship Baruna Jaya VIII. Fish sampling using trawl was conducted between 11 pm to 5 am.

Location of sampling stations were set as six spots in the south, east and north of Menggirang Island, west and north of Benua Island, and east of Tambelan Island. The sampling sites are presented in Table 1.

Table 1. Position and description of each location of the trawl operation in Tambelan waters, November 2010.

	ST1	ST2	ST3	ST4	ST5	ST6
Location	South of Menggirang Besar Is.	East of Menggirang Besar Is.	North of Menggirang Besar Is.	West of Benua Is.	North of Benua Is.	East of Tambelan Is.
Time (WIB)	3.45-4.45	4.30-5.30	4.15-5.15	4.50-5.50	22.05-23.05	4.34-5.58
Setting	N 01° 02,257' E 107° 26,390'	N 00° 53,163' E 107° 35,160'	N 00° 54,255'' E 107° 31,478'	N 00° 54,804' E 107° 25,258	N 01° 00.599' E 107° 26,253'	N 00° 59,765' E 107° 37,788'
Hauling	N 00° 59,805' E 107° 29,062'	N 00° 55,850' E 107° 38,208'	N 00° 56,434' E 107° 34,385'	N 00° 58,669' E 107° 22,242'	N 01° 03,779 E 107° 27,818'	N 01° 02,789' E 107° 35,134'
Velocity (kt)	3.5	3.2	3.2	3.3	2.8	2.8
Depth (m)	33-34	44-45	32-34	37-39	37-42	37-63

Procedures

The measurement of fishes caught were included the length (mm) and weight (grams). Measurements were performed on the Baruna Jaya ship using a ruler (precision 0.005 cm) and OHAUS scales (accuracy 0.0005 g). The collected data were subsequently analyzed with the size structure using statistical approach (average and deviation analysis), analysis of mortality, the percentage of recruited (Pauly 2004), the opportunity of the captured size, and the level of population change (yield per recruit) (Pauly 1999; FAO 2005).

Data analysis

Analysis of natural mortality (M) according to Pauly (2004) derived from empirical data that is ln (M) =-0.0152-0279 ln (L ∞) + 0.6543ln (K) + 0463 ln (T), where L ∞ (infinity length), K (growth rate coefficient and T (average temperature of the waters). While the mortality due to fishing was evaluated using model approach from the linear relationship between the numbers of fish in length of-i with the time needed to grow as follows:

$$\ln(N_i/Dt_i) = a + b \cdot t_i$$

Where, Ni: is the number of fish in length class i, Dti: is the time required for fish to grow in length to the class, ti: is the age (or the relative age, calculated) in accordance with the value of mean of class-i, and where b (negative sign) is as an estimate value of Z (mortality).

Analysis of recruitment percentage was conducted using length frequency data analysis approach used on the approach of regression analysis of the relationship of Gausian distribution model (with a normal distribution curve approaches is maximum (Moreau and Cuende 1991). Fisheries analysis includes descriptive analysis of production data and the size of the capture, while analysis of fishing opportunities using the approach curve to approach the selection of data length and weight in the interpolation of the catch curve and compare with the actual number of catches caught by fishermen. Length parameters with the estimation success rate (%) i.e. (L25, L50, L75), which was evaluated from (i) using a logistic curve, which assumes that the selection will be symmetrical or nearly between the actual catch by logistic curve interpolation; (ii) using a moving average of each class and the interpolation of the parameters of selection. The function of the logistic curve (Pauly 1999; FAO 2005) i.e.

$$\ln((1/P_L)-1) = S1-S2 \cdot L \quad ....(1)$$

Where, P_L is catch opportunity of length data of fish catch (L).

$$L_{25} = (\ln(3)-S1)/S2 \quad ....(2)$$

$$L_{50} = S1/S2 \quad ....(3)$$

$$L_{75} = (\ln(3)+S1)/S2 \quad ....(4)$$

Function of average is:

$$P_{L,i(new)} = (P_{L,i-1}+P_{L,i(old)}+P_{L,i+1})/3, \quad ....(5)$$

Population analysis to reconstruct the population (estimated population) which describes the maximum number to obtain the calculated amount of catch, population, fishing mortality and biomass amount which available in a state of equilibrium (steady state). Steady state conditions may include the circumstances that have not been under pressure of arrest or arrests have been under pressure, but the population is spread more uniformly. The model used was based on the model curve analysis approach to measure the length of the curve with the linear model. VPA analysis begins with the evaluation of estimated population

$$N_t = C_t \cdot (M + F_t)/F_t$$

Where, Ct catch point (i.e. the number of catches taken from the largest length class). Then the value of Nt is determined from the movement of the curve F (fishing) to solve the equation

$$C_i = N_{i+}N_t \cdot (F_i/Z_i) \cdot (\exp(Z_i \cdot Nt_i)-1)$$

Where,

$Nt_i = (t_{i+1}-t_i)$, and

$t_i = t_o-(1/K) \cdot \ln(1-(L_i/L\ \ ))$

and whereas length of population (N_i) calculated from $N_i = N_{i+}N_t. \exp(Z_i)$

Last two equations are used as an alternative to population size and mortality due to fishing for all groups of predetermined length. ELEFAN analysis assisted with analysis tools in the program I Fisat 1.2.2 series. In the analysis of fish size structure, all fish samples were used. While frequency distribution analysis, age group and the growth were measured from the dominant fish caught.

RESULTS AND DISCUSSION

Mortality

Mortality describes fish mortality rates either due to fish catch, or natural deaths. Natural death is a process of life cycle of many populations which are influenced by the environmental factors. While deaths due to fishing is a death caused by fishing activities and use of destructive fishing gear. The results of analysis of dominant fish mortality rates are presented in Table 2.

The results showed that the highest total mortality rate in the group *Lutjanus lutjanus*, then *Nemipterus* sp and *Saurida grandisquamis*. *Pentapodus* group has a low mortality rate. From these results it can be concluded that the Tambelan waters was very supportive to life and the development of *Pentapodus setosus*, *Selaroides leptolepis* and *Upeneus asymmetricus*. Mortality of siganid fishes from the Luwu waters (M = 1.27, F = 1.08), Tambelan fish mortality was nearly the same of *Nemipterus* group (Jalil et al. 2003).

Recruitment

Recruitment is the addition of new individual either due to the birth process and the process of growth and migration. In one population, recruitment is usually seen as a stage of the entry of individuals from youth to adult individuals who are ready to be captured. Indicators recruitment is usually the size of the population began to get caught by fishing gear used. Knowledge of the high fishing mortality these species endure may affect a fishery regulator's choice of management measures (Morgan and Burgess 2009).

From the length frequency analysis, then the level recruitment of each type of fish can be known. The results of the analysis of recruitment approaches was using Gausian distribution model as follows. Levels of recruitment from *Saurida grandisquamis* were happened two times within a year of entering fourth months to nine months. Percentage recruited in April reached 21.17% and in September reached 8.49%. But the percentages of the second month was not as high as in April as shown in Figure 1. Percentage recruit of *Lutjanus lutjanus* at the highest recruited in June reached 19.73%. In general, the level of recruit more evenly each month throughout the year with different percentages as in Figure 1.

Table 2. Total maturity (z), natural maturity (m) and fishing maturity (f) of demersal fishes

Species	M*	F	Z**	Note
Nemipterus sp.	1.05	0.57	1.62	Mortality of dominant catch in size > 135 mm
Saurida grandisquamis	0.35	1.31	1.66	Mortality of dominant catch in size > 200 mm
Upeneus asymmetricus	0.31	0.8	1.11	Mortality of dominant catch in size > 110 mm
Pentapodus setosus	0.35	0.29	0.64	Mortality of dominant catch in size > 196 mm
Selaroides leptolepis	0.64	0.33	0.97	Mortality of dominant catch in size > 106 mm
Lutjanus lutjanus	0.54	2.01	2.55	Mortality of dominant catch in size > 109 mm

Note: *: Empirical equation of Pauly; **: Empirical equation of Jones van Zelinge

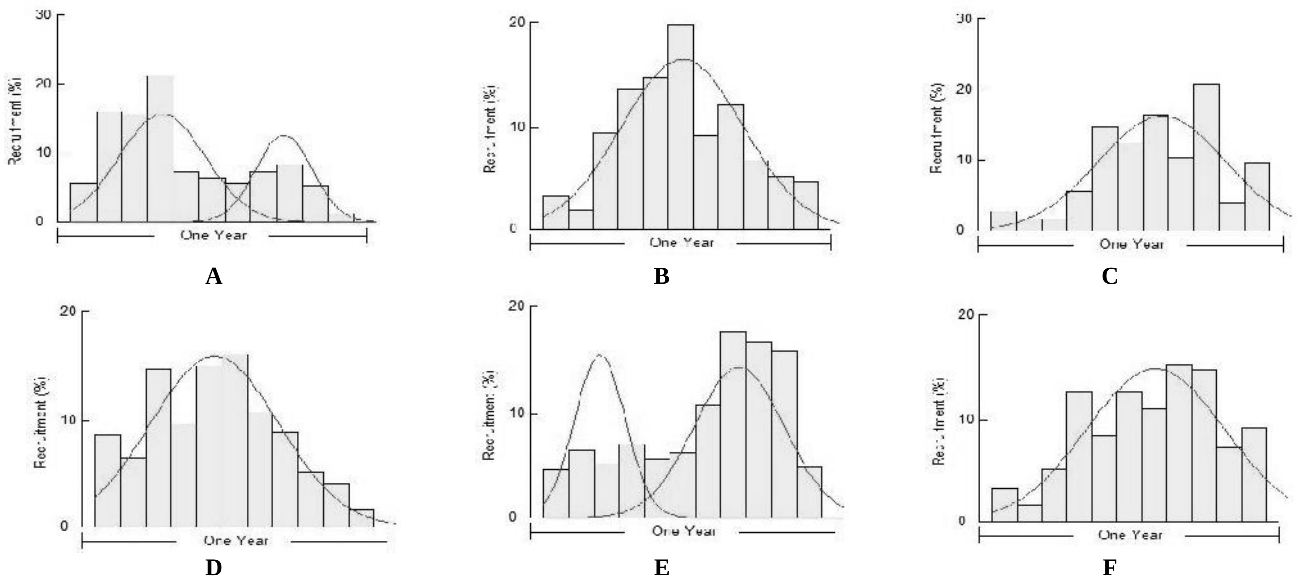

Figure 1. Recruitment percentage. A. *Saurida grandisquamis*, B. *Lutjanus lutjanus*, C. *Nemipterus* sp., D. *Pentapodus setosus*, E. *Selaroides leptolepis*, F. *Upeneus asymmetricus*

Recruitment of *Nemipterus* sp. occurred evenly with a peak in September (20.81%). However, increased recruit began in May to a peak in September. At this time many young fishes started to grow into adulthood and begin to be captured. The percentage of *Nemipterus* sp. recruits as shown in Figure 1C. This pattern was similar to the type of fish *Pentapodus setosus* that the percentage of the highest recruited in June reached 16%. In March, the percentage of recruited began to show improvement and almost evenly each month as shown in Figure 1D.

Groups of *Selaroides leptolepis* possess high levels of recruitment two times a year. Dominant first recruited in February reached 6.32%, the highest peak in August was 17.72% (Figure 1E). Recruitment percentage of *Upeneus asymmetricus* was evenly in the month since April and the peak was in August 15.22%. The pattern of *Upeneus asymmetricus* was recruited during the entire year with a period of more uniform as shown in Figure 1F.

Table 3. Estimated size of catched fish in Tambelan

Species	Estimated size (mm)			Distribution of catched size
	L25	L50	L75	
Lutjanus lutjanus	152.32	218.19	284.06	54,76-180
Nemipterus sp.	378.16	536.88	695.61	65-210
Pentapodus setosus	607.76	822.09	1036.41	115-285
Saurida grandisquamis	265.65	342.35	419.05	110-315
Selaroides leptolepis	206.75	259.21	311.67	80-177,89
Upeneus asymmetricus	331.75	447.94	564.12	70-185

Table 4. VPA analyses of dominated caught fish

Species	Population				Ratio (%)	
	C (ind)	N (ind)	F (ind)	SSB (ton)	C/F	C/N
Saurida grandisquamis	48.0	391.7	41.6	0.4	86.767	12.2549
Nemipterus sp.	53.0	1802.9	10.7	0.3	20.253	2.9398
Upeneus asymmetricus	401.0	17720.0	5.1	3.7	1.261	2.2630
Pentapodus setosus	127.0	6005.5	2.8	12.2	2.190	2.1147
Selaroides leptolepis	78.8	4037.8	3.2	1.3	4.073	1.9509
Lutjanus lutjanus	147.1	5105.1	11.8	1.5	8.028	2.8824

Note: C = number of actual catches (ind); N = Estimated fish abundance (ind/area); F = Estimated catch (assuming that L∞, K, M according to the estimation); SSB = Steady State Biomass (tons); C/F = Ratio of actual number of catches against the estimated catch; C/N = Ratio of actual catches against the estimated total population

Captured opportunity

Catching opportunity is the percentage of fish capture using trawl gear. Fishes which showed a chance of being caught in a larger size were *Pentapodus setosus*, *Nemipterus* sp. and *Upeneus asymmetricus.* Opportunity of the size capture of the dominant fish is presented in Table 3. From the results revealed that fish which potentially have depleted due to fishing were *Lutjanus lutjanus*, *Selaroides leptolepis* and *Saurida grandisquamis*. The shorter of fish catch size indicated the lower fish size in the waters. It is an indicator of the decline of stocks in the waters. Opportunity of catching size also indicates the affectivity of fish capture. Reduction of abundance of the bigger fishes (Serra and Canales 2007) and with this, the decrease of the relative biomass reflected in the CPUE. Information from this study is an indirect indicator for the creation of capture efficiency (Canales et al. 2005). According to FAO (1999) red snapper as a group of bentho-pelagic can reach 80 cm in size, but the average catch was in the size of 50 cm.

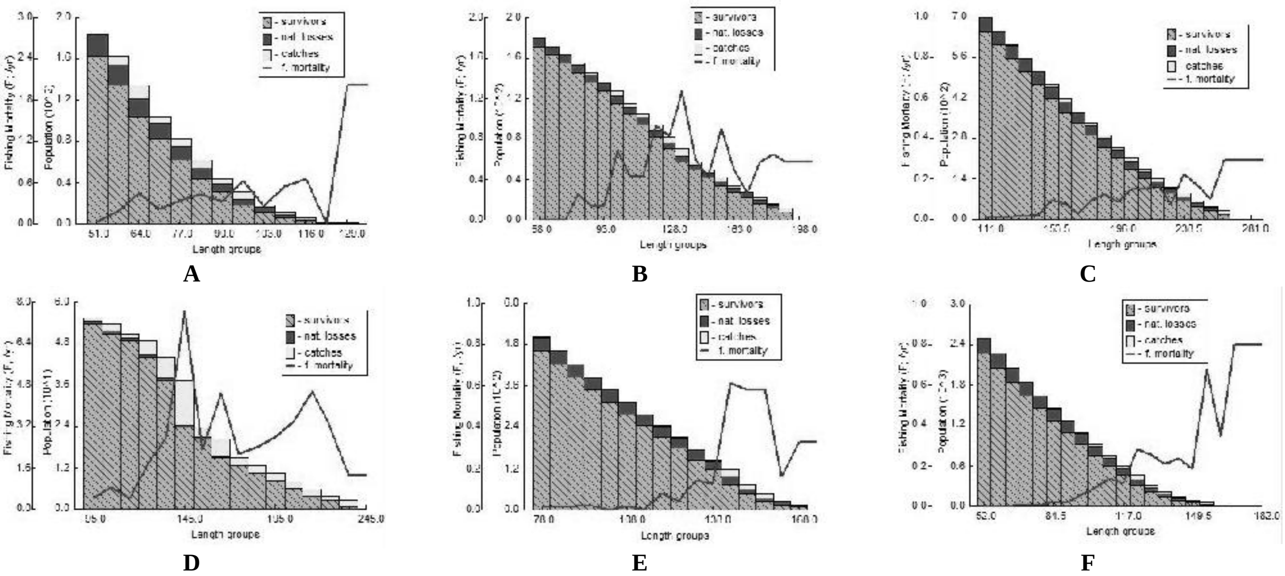

Figure 2. The pattern of distribution of survival rates, natural mortality, catch and catch rates of: A. *Nemipterus* sp., B. *Lutjanus lutjanus*, C. *Pentapodus setosus*, D. *Saurida grandisquamis*, E. *Selaroides leptolepis,* and F. *Upeneus asymmetricus.*

Virtual population analysis

Virtual population analysis principally is the estimation of population in an area of waters that includes information about the amount of population growth (survival) and death (mortality). The results of the evaluation of estimated population catch rate and catch rate of each size of dominant fish are presented in Figure 2 and Table 4.

From the results revealed that the fish with high survival rate due to the condition of aquatic ecosystems in Tambelan regarding to fish catches was *Pentapodus setosus*. *Saurida grandisquamis*, *Lutjanus lutjanus* and *Nemipterus* sp. tended to be susceptible to fishing pressure. All three types of these fishes can quickly run into stock in the waters. Demersal groups of fish such as *Cynoglossus* sp. was difficult to escape from the capture process (Veiga et al. 2009). The low estimated total abundance and standing stock of biomass in the waters was also possible to cause the rapid decline of fish stocks populations in the waters. According to Ridho et al (2004) biomass density of demersal fish in the Natuna Sea was from 2.35 ton/km^2 decreased to 1.3 ton/km^2.

CONCLUSION AND RECOMENDATION

The natural mortality rate of *Pentapodus setosus* due to fishing activities was relatively lower compared to other fishes. Fish with solely high recruit percentage indicates that the fish possess spawning periods annually, while the number with more evenly distributed peaks are more resistant to fish catches. Opportunity catch of larger fishes than actual size of the fishing waters indicated that the standing stock was decreasing. Types of fish which were susceptible to fishing pressure are *Saurida grandisquamis*, *Lutjanus lutjanus* and *Nemipterus* sp.

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