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Study on population parameters of kawakawa, *Euthynnus affinis (Cantor 1849)*, in Indian Ocean (a case study in Northwest Sumatra IFMA 572)

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ABSTRACT

Kawakawa (Euthynnus affinis) is the one of the important catch for fishermen in the Indian Ocean. To enhance the basic information on population dynamics, this study were carried out to investigate the estimation of growth rates, mortality coefficients and the exploitation rate of kawakawa based on length frequency data using FiSAT II software. Kawakawa were sampled from purse seine in Sibolga Fishing Port from July 2012 to February 2013. Numbers of 1,325 fish specimen were collected with ranged from 30 to 60 cm. The von Bertalanffy growth function estimates were $L\infty$ = 63.53 cm, K = 0.63 year^{-1} and t_0 = -0.21 years. The annual instantaneous rate of total mortality (Z) was 2.40 year^{-1}, the natural mortality (M) was 1.07 year-1 and the fishing mortality (F) was 1.33 year^{-1}. The exploitation rate (E = 0.55) was lower than the predicted value (Emax = 0.75) indicating that E. affinis was under exploited in the Indian Ocean.

Key words: population parameters, kawakawa, Indian Ocean

INTRODUCTION

Kawakawa (*Euthynnus affinis*) is an epipelagic species that live in warm waters with temperature range from 18°C to 29°C. This species distribute in oceanic islands and archipelagos in Indian Ocean and Western Pacific (Collette and Nauen, 1983). This highly migratory species prefer to stay close to the coast and forms large school and often mixed with other scombrid species (DPI-NSW, 2010). In Indonesia, the production of kawakawa from Indian Ocean is the largest among the other types of neritic tuna from 2001 to 2010. With neritic tuna production reached 1,325,232 tons of that time, the production of kawakawa is the highest with 27% followed by frigate and bullet tunas (25%), longtail tuna (24%), Narrow-barred Spanish mackerel (18%) and Indo-Pacific king mackerel (6%) (FAO, 2012).

Kawakawa in Indonesia is mainly caught as *bycatch* species from purse seine which targeting skipjack tuna and pelagic tuna such as: big eye tuna and yellowfin tuna (RITF, 2012). Due to the limited of any biological information on the *E. affinis*, this study was carried out to examine some biological characteristics of the species in Indian Ocean. Regarding this objective, this study investigated: (a) growth parameters; (b) recruitment pattern; (c) mortality; (d) length at first capture; and (e) relative yield-per-recruit. The results from this study can give important contribution in the management and responsible utilization of this important resource.

METHODS

Kawakawa data were collected by enumerator on commercial purse seine vessels in Sibolga, Western part of North Sumatra. This species is one of the important catch for purse seine fishermen in the area. The purse seine operation supported with fish aggregating device (FAD) with the main fishing ground in coastal neritic waters of west Sumatra as part of East Indian Ocean. Data collection was conducted during a period of July 2012 to February 2013.

Specimens were measured to the nearest 1.0 cm fork length (FL). However, for data analysis purposes, the length frequency data were pooled into groups with 2 cm length intervals.

Data were analyzed by using a common computer program ELEFAN I of FiSAT II software (Gayanilo et al., 2005). Growth was investigated from length frequency data using the von Bertalanffy growth function:

$$L_t = L_\infty (1 - \exp[-K (t - t_0)])$$

Where L_t is the length at age t, L_∞ is the theoretical maximum (or asymptotic) length that the species would reach if it lived indefinitely, K is a growth coefficient and t_0 is the theoretical age at zero length (Sparre and Venema, 1998). FiSAT II program only provided estimates of L_∞ and K; t_0 was estimated using Pauly's equation (Pauly, 1980):

$$\text{Log } (-t_0) = -0.3922 - 0.2752 \text{ Log } L_\infty - 1.038 \text{ Log } K$$

Estimated Length at first capture (*Lc*) and the proportions of capture were calculated by plotting the cumulative probability against mid-length. *Lc* was obtained as corresponding to the cumulative probability at 50 % using equation from Sparre and Venema (1998):

$$S_L = 1/[1 + exp(S1 - S2 * L)]$$

Where S_L is the logistic curve, *S1* and *S2* are constants in the formula for the length-based logistic curve and *L* is fish length.

Length-converted catch curves were developed from the length frequencies to estimate the total mortality (Z) (Gayanilo et al., 2005). Natural mortality (M) was determined using Pauly's equation (Pauly, 1983):

$$\text{Log M} = -0.0066 - 0.279 \text{ Log } L_\infty + 0.6543 \text{ Log } K + 0.4634\ T$$

where T is the mean annual habitat temperature.

The exploitation ratio (E) was calculated from simple equation of:

$$E = F / Z$$

where F is fishing mortality ($F = Z - M$).

RESULTS AND DISCUSSION

The field survey covered a period of 8 consecutive months from July 2012 to February 2013. A total of 1,325 measured specimens of kawakawa were examined with fork lengths (FL) ranging from 30 to 60 cm (Fig. 1). The analysis that includes growth parameters, mortality rates, probability of capture, recruitment pattern, relative yield-per-recruit and relative biomass-per-recruit will provides a comprehensive initial understanding of the population dynamics for *E. affinis* in the Indian Ocean.

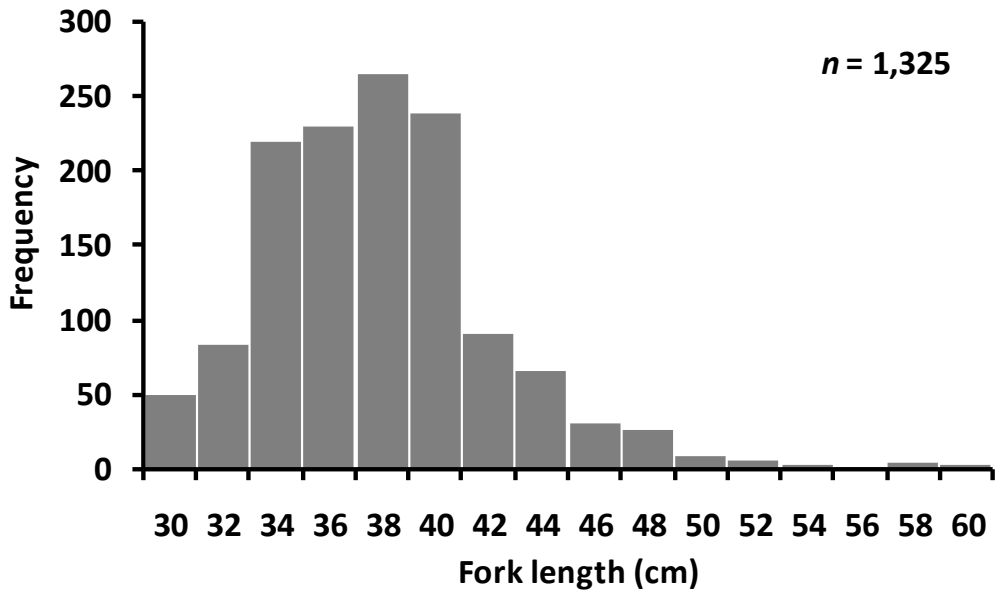

Figure 1. Length frequency for kawakawa (*Euthynnus affinis*) pooled into groups with 2 cm length intervals.

The result of the seasonalized von Bertalanffy growth curves shows that there are six cohorts from July 2012 to February 2013. The majority of the captured fish was within the size from 30 to 60 cm. The estimated von Bertalanffy growth parameters for this species are $L\infty$ = 63.53 cm, K = 0.63 yr^{-1} and t_0 = -0.21 yr^{-1}. The growth curves were plotted from raw data and considered for other analyses.

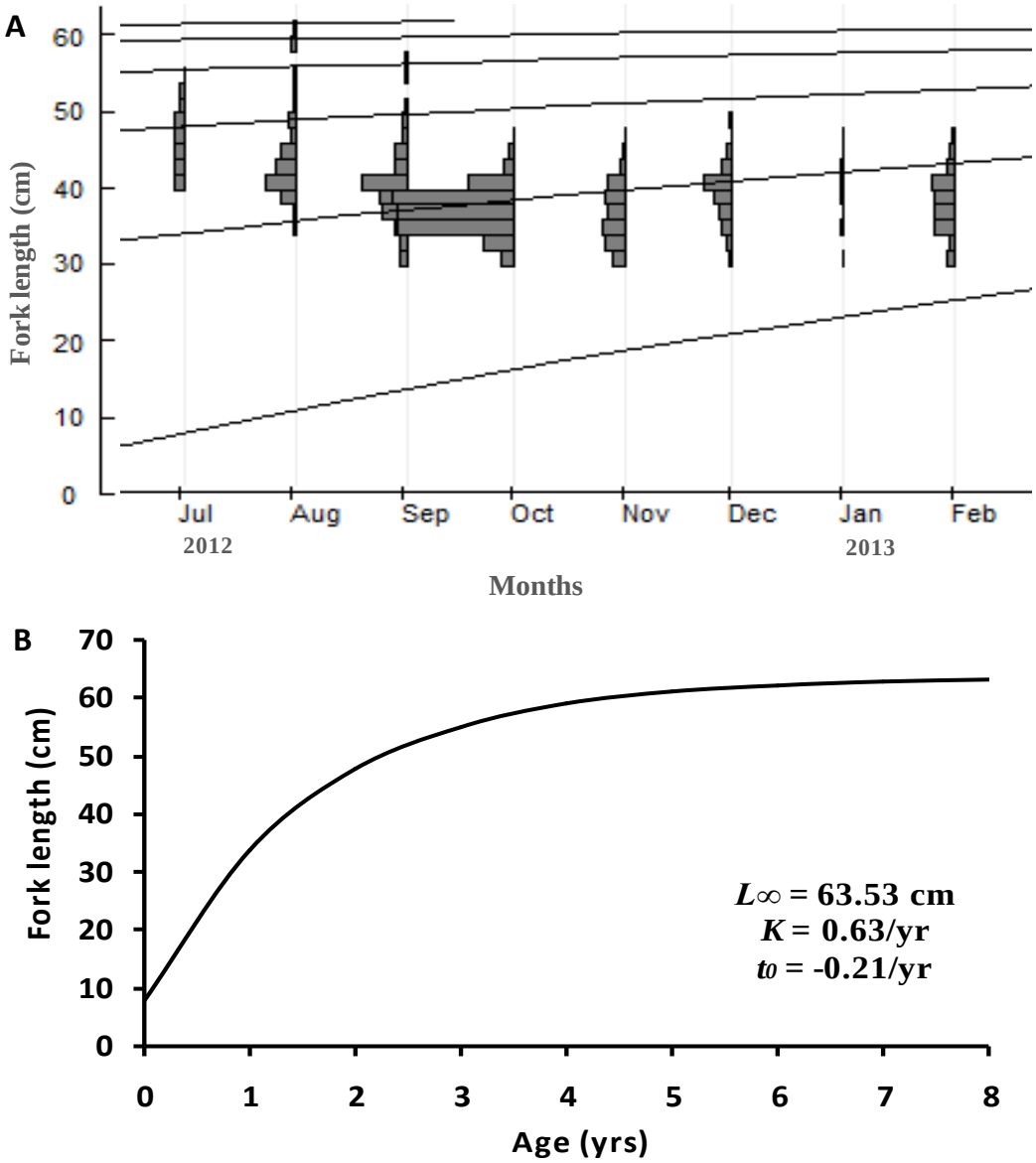

Figure 2. Seasonalized von Bertalanffy growth curves ($L\infty$ = 63.53 cm, K = 0.63 yr^{-1} and t_0 = -0.21 yr^{-1}) based on the length frequencies histograms (A) and growth of *E. affinis* in Indian Ocean (B).

In this study, length infinity (L_∞) is generally lower than other location except in West Coast of Sri Lanka. On the other hand, the growth rate (K) is generally higher than other location except in Maharashtra waters of India and Persian Gulf of Oman. Table 1 shows the comparison between growth parameters (L_∞ and K) in Indian Ocean among different studies.

Table 1. Estimates of growth parameters from various studies for kawakawa in Indian Ocean.

Location	*L∞ (cm)*	*(K/year)*	Reference
West Coast of Sri Lanka	61.5	0.52	Dayaratne and De-Silva; 1991
Maharashtra waters India	81.7	0.79	Khan; 2004
Persian Gulf of Oman	87.66	0.51	Motlagh et al.; 2009
Indian waters	81.92	0.56	Abdussamad et al.; 2012
Persian Gulf of Oman	95.06	0.67	Kaymaram and Darvishi; 2012
West Coast of Sumatera Indonesia	63.53	0.63	Present study

The recruitment patterns for *E. affinis* showed one annual pulse of recruitment. The major recruitment occurred on July with 19.38% from total recruitment (Fig. 3.a). The annual instantaneous rate of total mortality obtained from the length converted catch curve was 2.40 yr^{-1} and the natural mortality at 28^{o}C and fishing mortality estimated were 1.07 yr^{-1} and 1.33 yr^{-1} respectively (Fig. 3.b). Length at first capture (*Lc*) was estimated at 37.12 cm (Fig. 3.c). Using the selection ogive method, the yield per recruit gave an E_{max} = 0.75. The current exploitation rate was calculated E = 0.55 (Fig. 3.d).

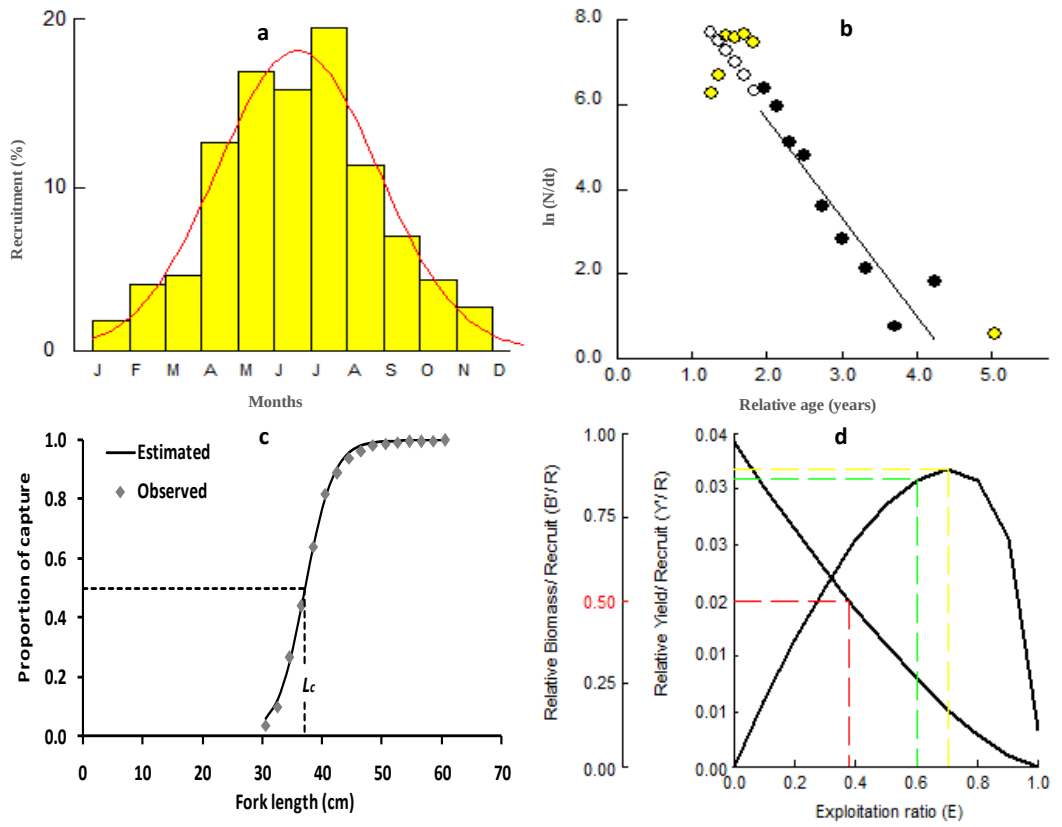

Figure 3. (a) Recruitment pattern; (b) Length-converted catch curve Z = 2.40 yr^{-1}; M (at 28.0°C) = 1.07 yr^{-1}; F = 1.33 yr^{-1}; (c) Length at first capture, shown by the dash line, is L_c = 37.12 cm; and (d) Relative yield-per-recruit (Y′/R) and relative biomass-per-recruit (B′/R) as calculated using the selection ogive method (E_{max} = 0.75; $E_{0.1}$ = 0.60; $E_{0.5}$ = 0.38).

The current observed exploitation rate (E) of *E. affinis* is 0.55. This value is lower than exploitation rate at maximum yield (E_{max}) at 0.75. This result indicates that kawakawa is under exploited in Indian Ocean and be able to improve fishing vessel. However, because of this species come under as bycatch species, its utilization should consider the impact for other species, especially main target species such as skipjack tuna.

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