

Population Dynamics and Fishery of Roughear Scad *Decapterus tabl* Berry 1968 (Perciformes: Carangidae) in Camotes Sea, Central Philippines

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Abstract

Population dynamics and fishery status of the roughear scad, *Decapterus tabl* Berry 1968 caught from Camotes Sea, Central Philippines were investigated. Asymptotic length (L_{∞}) was 32.55 cm while growth coefficient (K) was 0.97 year⁻¹. Total mortality (Z) was 5.57 year⁻¹ while natural mortality (M) and fishing mortality (F) were 1.71 year⁻¹ and 3.86 year⁻¹ respectively. Exploitation level (E) was 0.69. The length at which 50% of the fish were retained by the gear (L_{50}) was 17.48 cm. The recruitment pattern was continuous with one major peak in the months of February-March. The coefficient “ b ” of the length-weight relationship (LWR) was 2.986 (± 0.178) indicating isometric growth while results of the length-length relationships (LLRs) were highly correlated ($r^2 = 0.99$, $p < 0.01$).

The fishery of roughear scad revealed mean monthly catch per unit effort (CPUE) and income per unit effort (IPUE) ranging from 0.83-11.48 kg·man⁻¹·h⁻¹ and 73.10-1247.80 peso·man·h⁻¹ (1.72-29.39 USD) while total catch was estimated at 144,856 tonnes during the study period. High Z and F suggest that the roughear scad is facing high level of exploitation in the Camotes Sea. It is recommended that the reproductive biology should be studied to properly address the fishing pressure confronting this species.

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Introduction

The roughear scad, *Decapterus tabl* Berry 1968 is morphologically distinguishable from other red species of the genus *Decapterus* by its more rounded body, hooked upper jaw tip, partly serrated opercular membrane in adults and pectoral fin tips which do not reach vertically through the origin of the second dorsal fin (Berry 1968; Kimura et al. 2013). This species is reported to occur in 38 countries throughout the Pacific, Atlantic and Indian Oceans (Froese and Pauly 2015). In the Philippines, roughear scad is one of the target *Decapterus* fish resources and is subject to heavy exploitation by commercial fishing. *Decapterus* species, collectively known as roundscads is ranked first in the production of commercial fisheries in the country (DA-BFAR 2014).

Population assessment studies were conducted in some members of the genus *Decapterus* including *D. kurroides* Bleeker 1855 (Lavapie-Gonzales 1991), *D. macrosoma* Bleeker 1851 and *D. russelli* Cuvier 1833 (Ingles and Pauly 1984) in the northern and southern part of the Philippines using length frequency data. Most of the *Decapterus* related studies had gained momentum in the 70's, 80's and early 90's whereas published studies on life history patterns (e.g. biology & ecology) such as stock assessment for the roughear scad are not available elsewhere in the country.

Camotes Sea is one of the highly extracted marine habitats (DENR-PAWB 2009) and major source of fish in Central Visayas (Green et al. 2004). The roughear scad is one of the important small pelagic fishes supporting the commercial fishery in the area. This species has a high market demand locally due to its cheaper price relative to other pelagic fishes. Despite its significant contribution to the fishery and economic value, there are no adequate data pertaining to this species in the Camotes Sea or any part of the country. This study was undertaken to investigate the population dynamics and fishery of the roughear scad. Primarily, fish population assessments are conducted in order to generate accurate scientific data to provide advice on the optimum exploitation of the resource. The objectives of the present study were to establish the population parameters and fishery demographics of the roughear scad caught from Camotes Sea.

Materials and Methods

This study was conducted at Danao City fish port, Cebu (10^o31.024'N, 124^o01.745'E), a major fish landing area for commercial fishing from Camotes Sea (Fig. 1). Camotes Sea has an estimated area of 4,310 km² with majority of its portion within the Central Visayas jurisdiction (Green et al. 2004). A total of 6,160 length data of roughear scads caught by ring net and purse seine were collected monthly from August 2012 to July 2013. A minimum of 25 subsamples were gathered every month and brought to the laboratory for further processing. Total length (TL), fork length (FL) and standard length (SL) were determined to the nearest 0.1 cm while weight was measured to the nearest 0.01g. The individual sample was dissected for sex determination. Total length data were grouped at 2 cm intervals and subsequently analysed using the FISAT II software (Gayani et al. 2005).

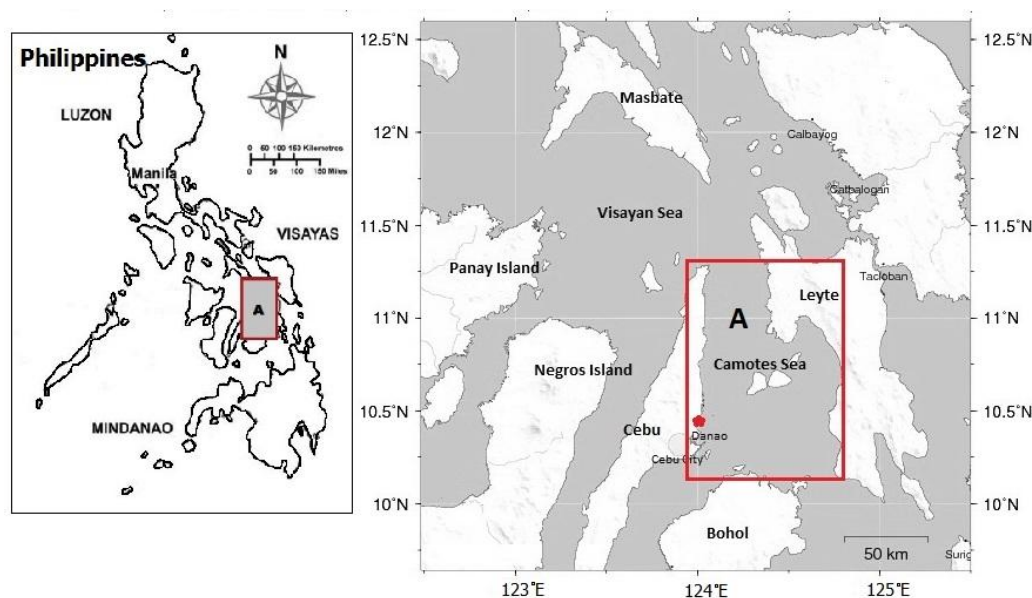


Fig. 1. Sampling site (star-shaped) where roughear scad caught from Camotes Sea were collected. Camotes Sea has an estimated area of 4,310 km² (Green et al. 2004).

Asymptotic length (L_{∞}) and growth coefficient (K) of the von Bertalanffy growth function (VBGF) were estimated by means of ELEFAN I (Pauly and David 1981). The estimates of L_{∞} and K value were used to estimate the growth performance index (Φ') (Pauly and Munro 1984) using the equation: $\Phi' = 2\log_{10}L_{\infty} + \log_{10}K$

The inverse von Bertalanffy growth equation (Sparre and Venema 1998) was used to find the lengths at various ages. The VBGF is defined by the equation: $L_t = L_{\infty} [1 - e^{-k(t-t_0)}]$ where L_t is the mean length at age t , L_{∞} the asymptotic length, K the growth coefficient, t the age and t_0 is the hypothetical age at which the length is zero (Pauly and David 1981).

The total mortality (Z) was estimated by a length converted catch curve method (Pauly 1984). Natural mortality rate (M) was estimated using the empirical relationship of Pauly (1980): $\log_{10}M = -0.0066 - 0.279 \log_{10}L_{\infty} + 0.6543 \log_{10}K + 0.4634 \log_{10}T$ where M is the natural mortality, L_{∞} the asymptotic length, K refers to the growth coefficient of the VBGF and T is the mean annual habitat temperature (taken at 28 °C) of the water in which the stocks live. After the estimation of Z and M , fishing mortality (F) was estimated: $F = Z - M$ where Z is the total mortality, F the fishing mortality and M is the natural mortality. The exploitation level (E) was estimated by the relationship of Gulland (1971): $E = F/Z$ or $F / (F+M)$.

Catch curve analysis was extended to estimate probabilities of capture using logistic transformation of L_{25} , L_{50} and L_{75} (lengths at which 25, 50 and 75% of *D. tabl* will be vulnerable to the gear). The recruitment pattern of the stock was determined by backward projection on the length axis of the set of available length–frequency data as described in FISAT. Levels of exploitation were also determined using the FISAT II software package.

The length-weight relationships were computed using the equation $W=aL^b$ (LeCren 1951) where W is the weight (g), L is the total length (cm), a is a coefficient related to body form and b is an exponent indicating isometric growth when equal to 3. The significance level of r^2 was estimated by linear regressions on the transformed equation, $\text{Log}(W) = \log a + b \log (L)$. Moreover, (1) TL vs FL; (2) FL vs SL; and (3) SL vs TL relationships were calculated by linear regressions. To test for likely significant differences in both slope and intercept, covariance analysis was performed. All statistical analyses were evaluated at $P<0.05$ significance level.

For the fishery status of roughear scad, fishers from 34 commercial boats were interviewed from December 2012 to November 2013 using a prepared survey form. Pertinent information that were gathered included number of fishing days per week, type of gear and specification, number of fishers per boat, number of hours per fishing, number of hauls per fishing operation, fishing ground and depth, total catch per fishing operation and selling price per kilogram.

Catch Per Unit Effort (CPUE) was computed using the formula:

$$\text{CPUE} = \frac{\text{Total weight of catch (kg)}}{\text{No. of fishers (man)/ No. of hours spent in fishing (h)}}$$

Income Per Unit Effort (IPUE) was computed using the formula:

$$\text{IPUE} = \frac{\text{Total price of catch (peso)}}{\text{No. of fishers (man)/ No. of hours spent in fishing (h)}}$$

Catch estimate of roughear scad per month was standardised as kilograms per month and values were computed by direct relationship between mean monthly catch per unit effort (CPUE), actual fishing days and number of boat units. The total number of fishing days was computed by getting the mean number of fishing days operation per month excluding the days without fishing operation. The total number of boat units was based on the actual number of boat units operating each month. Catch was computed using the formula:

$$\text{Catch estimate} = \text{mean monthly CPUE} \times \text{actual fishing days} \times \text{number of boat units}$$

Results

Population parameters

The VBGF asymptotic length (L_∞) for the roughear scad was 32.55 cm and the growth coefficient (K) was 0.97 year⁻¹ (Fig. 2). The observed maximum length was 31 cm and the predicted maximum length was 31.29 cm while the confidence interval was 28.47-34.10 cm (95% probability of occurrence). The best estimated value for K was 0.97 year⁻¹ while the growth performance index (ϕ') was 3.012.

The value of the third parameter in the von Bertalanffy growth equation is assumed to be 0 at t_0 (Pauly and David 1981). Hence the computed VBGF model of body length as a function of age generated the sizes reached by roughear scad at 12.73, 20.28, 25.20, 28.08, 29.83 and 31.64 cm at 0.5, 1, 1.5, 2, 2.5 and 3 years (Fig. 3). The average growth for the first year was 1.57 (+/- 0.46) $\text{cm}\cdot\text{month}^{-1}$, 0.58 (+/- 0.17) $\text{cm}\cdot\text{month}^{-1}$ in the 2nd year and 0.22 (+/- 0.06) $\text{cm}\cdot\text{month}^{-1}$ in the 3rd year. The maximum length recorded during the period of the study was 31.4 cm and the corresponding age was 3.4 years.

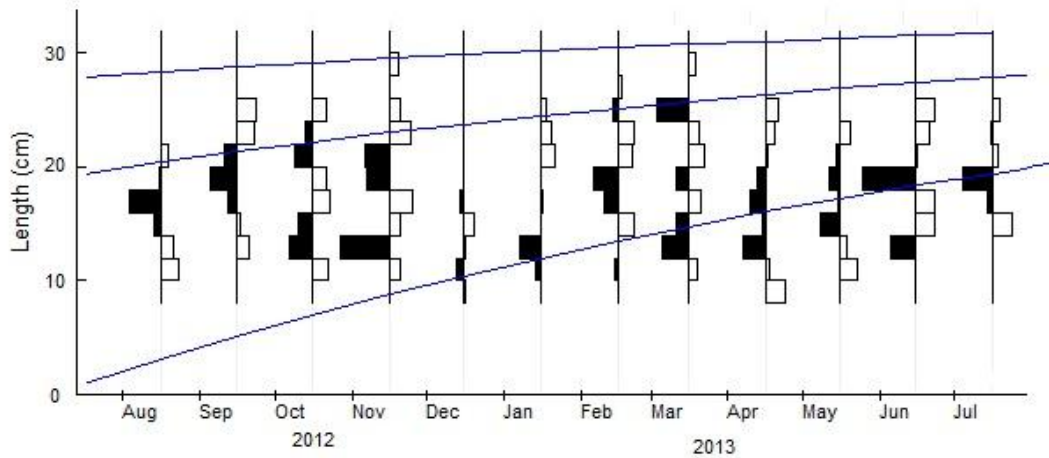


Fig. 2. Restructured length frequency data showing growth curves of roughear scad (n= 6,160).

The analysis of length converted catch curve generated a total mortality estimate of $Z = 5.57 \text{ year}^{-1}$. The natural mortality (M) was estimated (for $T=28^\circ\text{C}$) at 1.71 year^{-1} and the fishing mortality was 3.86 year^{-1} . The current exploitation level was computed at 0.69 respectively (Fig. 4).

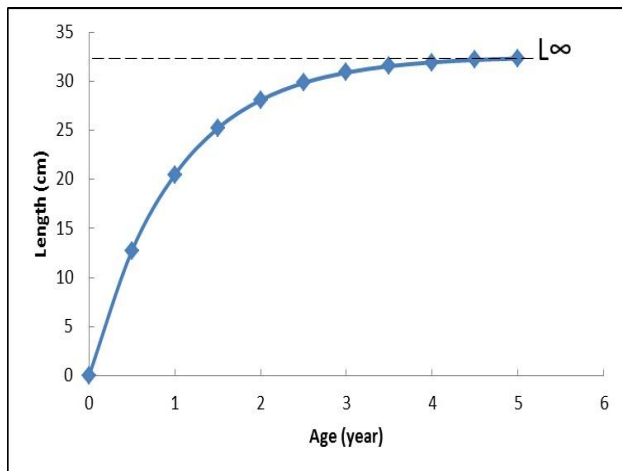


Fig. 3. Age and growth plot of roughear scad based on the computed parameters of the VBGF equation.

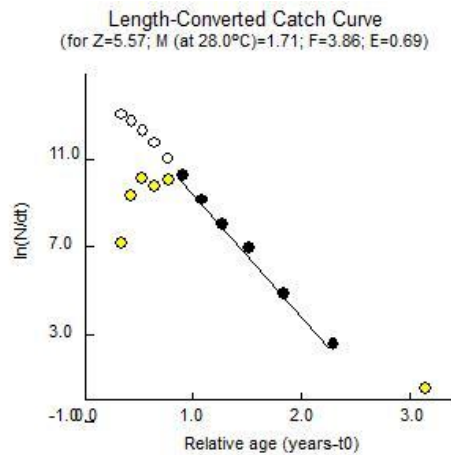


Fig. 4. Length converted catch curve of roughear scad.

The probability of capture for roughear scad was obtained from the analysis of length-converted catch curve using a logistic transformation to estimate L_{25} , L_{50} and L_{75} . The linearised form of the logistic curve corresponded to regression values of $a = -10.61$, $b = 0.61$ and $r = 0.96$, with $L_{25} = 15.67$, $L_{50} = 17.48$ and $L_{75} = 19.30$ cm (Fig. 5).

The recruitment pattern of roughear scad was continuous through the year with a major peak observed during the months of February- March (Fig. 6). The observed peak of recruitment pulse during the study period was 38.16%.

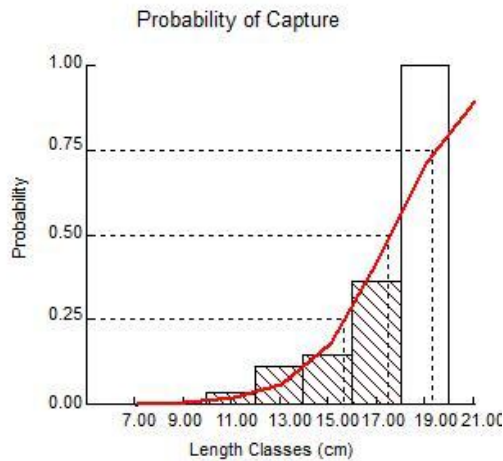


Fig. 5. Selection curve of roughear scad.

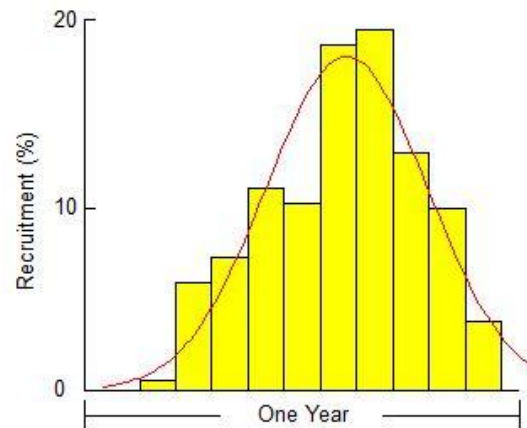


Fig. 6. Recruitment pattern of roughear scad.

Values acquired from the relative yield per recruit (Y'/R) analysis using selection ogive were used to determine the exploitation status. The exploitation status generated by the ratio of current exploitation rate ($E=0.69$) to the E_{max} (0.69) indicated that *D. tabl* fishery in Camotes Sea has reached optimum exploitation ($E/E_{max} = 1.0$) while E to E_{10} (0.60) suggested overexploitation standing ($E/E_{10} = 1.148$).

Length-weight and length-length relationships

Analysis of co-variance revealed non significant difference in growth in relation to length between the sexes hence the data for male and female were pooled together. The length of individual fish used to determine LWR ranged from 12.5- 31.4 cm and the weight from 15- 271.05 g (Fig. 7). The computed LWR equation in exponential form was $W = 0.0097L^{2.986}$, and in log form was $\log W = - 4.6325 + 2.9856 \log L$ ($r^2=0.98$, $p<0.05$). The growth coefficient (b) was computed at 2.986 (± 0.178) with b values ranging from 2.63- 3.33. The b value of LWR for roughear scad was not significantly different from 3 (T-test, $p>0.05$) indicating isometric growth.

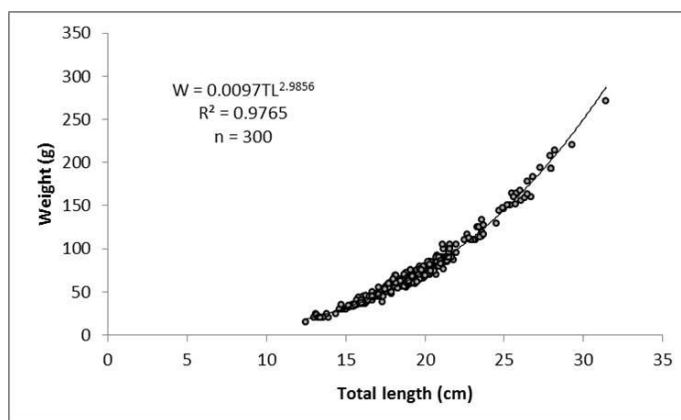


Fig. 7. Length- weight relationship of roughear scad.

The relationships between *TL*, *FL* and *SL* of roughear scad along with the estimated parameters of the length-length relationship and the coefficient of determination r^2 are presented in Table 1. All LLRs were highly significant ($p < 0.01$), with all of the coefficient of determination values at 0.99.

Table 1. Descriptive statistics and length-length relationships between total length (TL), fork length (FL) and standard length (SL) of *Decapterus tabl* caught from Camotes Sea during August 2012 to July 2013.

Equation	n	L,mean ± SD ($L_{min} - L_{max}$)	a	b	r^2
$TL = a + b \times FL$	317	18.36 ± 3.47 (8.3 – 31.4)	0.089	1.003	0.99
$FL = a + b \times SL$	317	16.63 ± 3.11 (7.5 – 28.5)	0.150	0.976	0.99
$SL = a + b \times TL$	317	15.27 ± 2.90 (6.7 – 26.5)	- 0.216	1.011	0.99

(n: number of individuals, a: intercept, b: slope, r^2 : coefficient of determination).

Fishery pattern

Mean CPUE was highest in the month of February 2013 and lowest in June 2013 with values 11.48 and 0.83 $\text{kg man}^{-1}\text{h}^{-1}$. Mean IPUE was also highest in February 2013 and lowest in June 2013 with monetary values of 1247.80 (29.39 USD) and 73.10 (1.72 USD) $\text{peso man}^{-1}\text{h}^{-1}$ (Fig. 8). Mean monthly catch estimate was highest in February 2013 at 36,413 tonnes and lowest in June 2013 at 2,968 tonnes (Fig. 9). Mean CPUE, mean IPUE and mean monthly catch estimate were highly correlated ($p < 0.01$). Total catch of roughear scad from December 2012 to November 2013 was estimated at 144,856 tonnes.

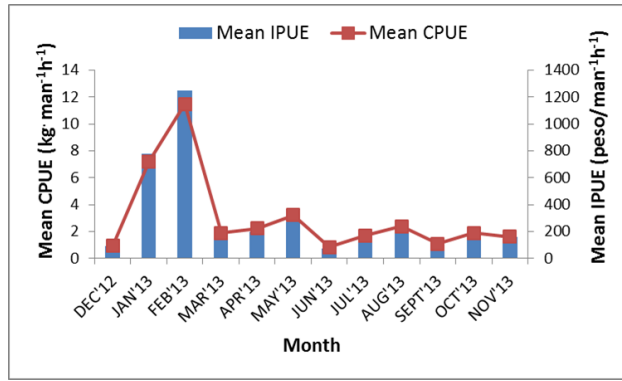


Fig. 8. Mean CPUE and Mean IPUE of roughear scad.

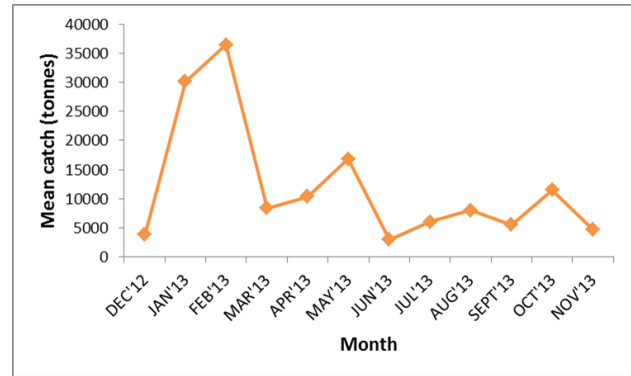


Fig 9. Mean monthly catch of roughear scad caught from December 2012 – November 2013.

Discussion

Population parameters

Despite of the utilisation of the roughear scad as one of the prime commodities in the fishery sector for years, it is confronted with a considerable dearth of information. However, its growth parameters, mortality rates and exploitation rates can be compared with other well studied congeners in the Philippines and in some parts of Asia (Table 2). The roughear scad is the largest *Decapterus* species in the Indo-west Pacific with a maximum size of 48 cm FL (Smith-Vaniz 1986); however the maximum size recorded in this study was only 31.4 cm TL. The smaller size obtained from this study could be the effect of fishing pressure resulting to growth overfishing or differences in environmental factors, particularly water temperature and food availability (Pauly 1998; Froese 2006). On the other hand, Ronquillo (1974) has indicated that scads may change from a pelagic to a demersal mode of life as they increase in size, hence larger fishes may not be caught by the gear. However, comparison using the available data on growth performance index (ϕ'), the value obtained for the roughear scad ($\phi'=3.012$) suggested that it grows faster than the rest of its congeners locally and in other countries as well.

The length at age data extrapolated from VBGF equation (Fig. 3) revealed that roughear scad reached a size of 20.48 cm in 1 year which is about 62.9% of its asymptotic length. This result suggests that it grew very quickly in 1 year. The mean size at first capture, L_c/L_{50} i.e. the length at which 50% of the fish is retained by the gear produced a value of 17.48 cm (Fig. 5) indicating that the species is exploited at the first year of its life. The annual mortality parameters, Z , M and F for roughear scad were estimated at 5.57, 1.71 and 3.86 year⁻¹. It is observed that fishing mortality (3.86 year⁻¹) was higher than natural mortality (1.71 year⁻¹) suggesting the unbalanced standing of the stock. Gulland (1971) has pointed out that a stock is optimally exploited if fishing mortality is equal to natural mortality; $F_{opt}=M$ or $E=0.5$ hence E higher than 0.5 suggests overexploitation.

Table 2. Population parameters of *Decapterus* species from the Philippines and from different countries.

Location	Species	L_{∞} (cm) (TL)	K (yr ⁻¹)	ϕ'	Z (yr ⁻¹)	M (yr ⁻¹)	E (yr ⁻¹)	Source
Palawan	<i>D.macrosona</i>	30.0	0.74	2.82	5.79	1.47	0.75	Ingles and Pauly 1984
Manila Bay	<i>D.russelli</i>	30.0	0.54	2.69	2.06	1.19	0.42	Ingles and Pauly 1984
Davao Gulf	<i>D.kurroides</i>	25.0	0.80	2.39	4.31	1.62	0.62	Lavapie-Gonzales 1991
Leyte Gulf	<i>D.macrosona</i>	27.30	1.40	---	4.67	2.28	---	Lavapie-Gonzales et al. 1997
Camotes Sea	<i>D.macrosona</i>	28.0	1.60	---	5.13	2.47	0.51	Lavapie-Gonzales et al. 1997
Sulu Sea	<i>D.macrosona</i>	27.80	1.20	---	7.25	2.05	0.72	Lavapie-Gonzales et al. 1997
Moro Gulf	<i>D.macrosona</i>	21.40	2.30	---	4.25	3.38	0.20	Lavapie-Gonzales et al. 1997
Camotes Sea	<i>D.russelli</i>	35.10	1.40	---	6.71	2.13	0.68	Lavapie-Gonzales et al. 1997
Pujada Bay	<i>D.macrorellus</i>	24.30	1.80	---	3.66	2.78	0.24	Lavapie-Gonzales et al. 1997
Tayabas Bay	<i>D.maruadsi</i>	27.30	1.10	---	5.39	1.95	0.64	Lavapie-Gonzales et al. 1997
Sulu Sea	<i>D.maruadsi</i>	25.00	1.20	---	3.51	2.11	0.40	Lavapie-Gonzales et al. 1997
Camotes Sea	<i>D.maruadsi</i>	31.17	1.30	---	6.86	2.10	0.69	Lavapie-Gonzales et al. 1997
Tawi-Tawi	<i>D.macrosona</i>	24.9	0.77	2.68	3.49	1.59	0.54	Aripin and Showers 2000
Camotes Sea	<i>D.tabl</i>	32.55	0.97	3.01	5.57	1.71	0.69	Present study
Other countries								
Indonesia	<i>D.macrosona</i>	25.50	0.90	2.80	-----	-----	-----	Atmadja 1988
Indonesia	<i>D. russelli</i>	30.2	0.90	---	4.8	1.80	0.60	Widodo 1988
India	<i>D. russelli</i>	23.20	1.08	---	6.65	1.90	0.71	Murty 1991
Malaysia	<i>D.russelli</i>	23.5- 32.2	0.56- 1.10	2.65	1.29	1.01- 2.07	0.09- 0.61	Mansor and Abdullah 1995
India	<i>D.russelli</i>	24.0	1.42	---	7.75	2.63	0.66	Jaiswar et al. 2001
India	<i>D.macrosona</i>	23.8	0.75	---	1.78	1.42	0.2	Rohit and Shanbhogue 2005
India	<i>D. russelli</i>	23.2	0.7	---	2.7	1.35	0.5	Rohit and Shanbhogue 2005
India	<i>D. russelli</i>	27.10	1.22	---	3.79	2.08	0.49	Manojkumar 2007
India	<i>D. russelli</i>	27.7	1.24	---	6.66	2.1	0.68	Poojary et al. 2011
India	<i>D.russelli</i>	25.60	0.95	---	4.61	1.81	0.61	Panda et al. 2012

L_{∞} - Asymptotic Total Length; K - Growth Constant; ϕ' - Growth Performance Index; Z - Total Mortality; M - Natural Mortality; F - Fishing Mortality; E - Exploitation Rate

Based on Gulland's definition, the value of E (0.69) in this study appeared that roughear scad is overfished in the study area. On the other hand, E_{\max} value at 0.69 indicated that roughear scad has reached full exploitation at Camotes Sea and therefore catches were close to its maximum sustainable limits. Furthermore, based on E_{10} which is the precautionary approach and is recommended by FAO code of conduct for responsible fisheries (FAO 1995), this present study obtained a value of 1.148 which suggests that it is already slightly overexploited. Given the high values of fishing mortality (F), exploitation rate (E) and ratio, it can be deduced that *D.tabl* stock in the study area is facing excessive fishing pressure. Similarly, the E values of scads that were studied at Camotes Sea revealed that *D.macrosona* (0.51 yr⁻¹), *D. russelli* (0.68 yr⁻¹) and *D. maruadsi* (0.69 yr⁻¹) were also overfished including the majority of the scads in other locations (Table 2). The annual recruitment of roughear scad consisted of one seasonal pulse (Fig. 6) of which highest peak was observed in February and March with values 18.60 and 19.56 % respectively. This result suggests that only one cohort is produced per year. The unimodal recruitment pattern of *D. tabl* did not conform with the common bimodal recruitment seasons in the Philippines (Pauly and Navaluna 1984).

Moreover, single mode of recruitment was also observed in *D. macrosoma* and *D. russelli* from Palawan and Manila Bay waters (Ingles and Pauly 1984). In this study, roughear scad has protracted recruitment wherein major peak was observed at the end of the northeast monsoon. According to Pauly and Navaluna (1984), the onset of spawning and recruitment for most fish species in the Philippines are more likely an influence of monsoon seasonality. There is no published report on the spawning of *D. tabl* in the Camotes Sea; however the major recruitment peak observed in this study should conform to the spawning season of this species in the area. Conversely, a data from Fishbase accounted that this species from Suruga Bay, Japan (Iwasaki and Aoki 2001) showed a spawning activity from June to October; however no recruitment was reported.

Length-weight and length-length relationships

The growth coefficient b for most fishes lies within the expected range of 2.5- 3.5 (Froese 2006). Values of b closer to 3 indicate isometric growth while values that are significantly different from 3 suggest allometric growth (Pauly 1984). The estimated b (2.986) of the roughear scad was not significantly different from 3 (T-test, $p>0.05$) suggesting isometric growth. This result implies that the length and body weight of the fish increase in equal proportions (Pauly 1984) and small fish in the sample exhibit the same form and condition as large specimens (Froese 2006). The b values of male and female roughear scad caught from Camotes Sea were lower than those of the same species from Suruga Bay, Japan and Southwestern EEZ, Brazil (see Table 3). This study suggests that roughear scad from Camotes Sea has a slower growth resulting to its smaller size. According to Pauly (1998), metabolic rates increase with temperature and that growth is limited by respiratory metabolism thus tropical fishes generally tend to be smaller than their cold water counterparts. On the other hand, LLRs of the species are highly correlated ($p<0.01$) indicating that the increase of one length variable would also increase the growth of the other length variables (Table 1).

Table 3. Values of the coefficients “ a ” and “ b ” for roughear scad obtained from Fishbase.

Location	Sex	Length (cm)	Length type	a	b	r^2	Source
Suruga Bay, Japan	Female	18 – 43	FL	0.00995	3.117	0.966	Iwasaki and Aoki 2001
Suruga Bay, Japan	Male	18 – 43	FL	0.00979	3.185	0.968	Iwasaki and Aoki 2001
Southwestern EEZ of Brazil	Mixed	_____	_____	0.00780	3.140	_____	Madureira and Rossi-Wongtschowski 2005
Camotes Sea, Philippines	Female	13.2-28.2	TL	0.0095	3.00	0.976	Present study
Camotes Sea, Philippines	Male	12.5-31.4	TL	0.0098	2.978	0.979	Present study
Camotes Sea, Philippines	Mixed	12.5-31.4	TL	0.0097	2.986	0.976	Present study

(a : intercept, b : slope, r^2 : coefficient of determination, FL: fork length, TL: total length).

Nature of fishery

In the Camotes Sea, commercial catch was mostly composed of small pelagics of the carangid family that included *D. tabl*, *D. macrosoma*, *D. kurroides* and *Selar crumenophthalmus* Bloch 1793. Scads were caught daily except on occasions of bad weather and storm. During full moon, commercial fishing was aided by artificial light and sonar device. The current fishing gear used in the commercial fishery for scads was mainly operated by ringnet. During the study, 82% (28 boat units) were ring netters while 18% (6 boat units) were purse seiners. According to Green et al. (2004), trawl, bagnet and purse seine were the major fishing gears during the early 60's but these have been replaced by ringnet during the 70's. Ring netters and purse seiners set their operation during night time and they utilised "payaos" or fish aggregating devices, which were basically made up of floating bamboo and palm frond rafts with attached light that were anchored at the fishing ground. All fishing boats were highly motorised with gross tonnage from 10.35- 17.0. The length and depth of nets ranged from 220-400 m and 80-132 m respectively. Mesh size of nets ranged from 1.9-10.16 cm. Bigger boats had sonar device with associated boats that included a light boat and two carrier vessels while smaller boats had one light boat and a smaller carrier vessel. The number of fishers in the boat ranged from 20- 30 individuals. The depth at which they fished ranged from 40-180 m and the number of hauls varied from 1-4. Fishing operations lasted for 13-20 h including the time of departure from the landing area until they returned.

Based on the data extrapolated from the suvey (Dec. 2012-Nov. 2013), the mean CPUE and mean IPUE (Fig. 8) were highest in the month of February ($11.48 \text{ kg} \cdot \text{man}^{-1} \cdot \text{h}^{-1} / 1247.80 \text{ peso} \cdot \text{man}^{-1} \cdot \text{h}^{-1}$ or 29.39 USD) and lowest in the month of June ($0.83 \text{ kg} \cdot \text{man}^{-1} \cdot \text{h}^{-1} / 73.10 \text{ peso} \cdot \text{man}^{-1} \cdot \text{h}^{-1}$ or 1.72 USD). These results indicate that the higher the catch, the more revenue is generated from the resource even if prices are relatively low during peak season due to competition. The mean monthly catch started to increase in January with a pronounced peak in February followed by a minor peak in May (Fig. 9). On the contrary Trinidad et al. (1993) have reported that the highest production of its congeners in the Philippines happened between March and June ensuing the end of northeast monsoon and the beginning of southwest monsoon.

The finding of the present study is slightly advance since highest peak was detected at the end of the northwest moonsoon while the second less pronounced peak occurred in May. Dalzell and Penaflor (1989) opined that seasonal production rates of the bigeye scad *S. crumenophthalmus*, a close relative of *D. tabl* caught by ringnet at Camotes Sea could be due to a combination of actual changes in the biomass and behaviour of the fish. The same might be applied to roughear scad in the area. It was observed that *D. tabl* catch in the months of January and February showed bigger sizes than those that were caught in May. Disparity in the sizes may affect the production between these months. Furthermore, the slight deviation of the production peak of roughear scad from other members of the genus *Decapterus* as reported by Trinidad et al. (1993) may suggest some form of migratory behaviour of this species.

Conclusion

There is no available literature dealing with the population dynamics and fishery of *D. tabl* in the Philippines hence no comparison can be made within the same species across the country. However, comparison can be made with others members of the genus *Decapterus*. The information given here provides a detailed investigation on the population dynamics and fishery of *D. tabl*. Furthermore, this study has shown high Z and F for *D. tabl* stocks in the Camotes Sea while E is beyond the optimum suggesting that this species is facing high level of exploitation. Moreover, it is recommended that the reproductive biology of the species should be studied so that effective scientific advice can be suggested to manage the fishery.

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