ORIGINAL RESEARCH PAPER
VOLUME-6 | ISSUE-8 | AUGUST - 2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

Aspects of the fishery of *Selar crumenophthalmus* in Central Mexican Pacific coast

Fisheries

Elaine Espino-Barr INAPESCA, CRIP-Manzanillo. Playa Ventanas s/n, Manzanillo, Colima. C.P. 28200. - Corresponding Autor

Manuel Gallardo-Cabello Instituto de Ciencias del Mar y Limnología. Universidad Nacional Autónoma de México. Av. Ciudad Universitaria 3000, Col. Copilco, México, D.F. C.P. 04360.

Arturo Garcia-Boa INAPESCA, CRIP-Manzanillo. Playa Ventanas s/n, Manzanillo, Colima. C.P. 28200.

Marcos Puente-Gómez INAPESCA, CRIP-Manzanillo. Playa Ventanas s/n, Manzanillo, Colima. C.P. 28200.

ABSTRACT

Studies on the population dynamics of fish species exploited commercially allow to write down a series of management norms to avoid its overexploitation by means of catch quotas and exploitation indexes. Specimens for this study were obtained from November 2012 to October 2013, from the commercial captures in Manzanillo and Santiago bays in Manzanillo, Colima, México. The highest average captures occur during autumn and winter and diminish in spring and summer. The recruitment length was Lr = 18.20 cm, length of first capture was Lc = 20.00 cm. Total mortality for ages 2 to 4 years was Z = 1.630 and the survival rate was S = 0.196. Natural mortality rate was M = 0.700, and fishing mortality was F = 0.930, the exploitation rate was E = 0.570. Increasing fishing mortality from F = 0.930 to F = 2.000 will increment the yield per recruit from 45.9 g to 67.0 grams. The actual age of first capture is 2.3 years, and is the one that produces the best yields. Results on natural mortality rate (M) were compared to those of other authors in other geographic areas of the world, finding differences probably due to climate, genetic and latitudinal position, as well as to the fishing pressure. The increase of the fishing mortality and direct human consumption would improve the fishery yield and would provide higher protein consumption for the low income social class, due to the low cost of this species.

KEYWORDS:

Production, recruitment, first capture rate, total, natural and fishery mortality, exploitation rate, yield per recruit.

Introduction

The big eye scad *Selar crumenophthalmus* (Bloch, 1793) is a coastal pelagic fish distributed in the Indo-Pacific Ocean: from East Africa (Smith-Vaniz, 1984) to Rapa, North and South Japan and the Hawaiian Islands, South to New Caledonia; in the Eastern Pacific: from Mexico to Peru, including the Galápagos Islands (Chirichigno, 1974). Western Atlantic: Nova Scotia, Canada and Bermuda through the Gulf of Mexico and the Caribbean to São Paulo, Brazil (Figueiredo *et al*., 2002). Eastern Atlantic: Cape Verde to southern Angola (Smith-Vaniz *et al*., 1990). Breder and Rosen (1966) established that the big eye scad has an external reproduction, dioic, whose eggs and larvae are scattered in open waters by currents.

Worldwide captures of *Selar crumenophthalmus* from 1950 to 2013 were 66 330.91 t average, the minimum 1 300 t and the maximum was 213 300 tons. In our country captures of this species go up to 2 549 851 tons in five states from 2000 to 2016, reporting each one as continues: Guerrero 1 554 244 tons, Oaxaca 579 419 t, Colima 326 071 t, Jalisco 88 799 t and Michoacán 1 318 tons (CONAPESCA, 2017). It is important to mention that in other states the register is underestimated or do not appear. The price of this product can vary from one to two US dollars per kilogram.

Studies on the determination of total, natural and fishing mortality, as for the first capture length and exploitation indexes of *Selar crumenophthalmus* have been carried out by Datzell & Peñaflor (1989) in Philippines waters, Armada (2004) in Davao Gulf, Philippines, Adeeb *et al.* (2014) in Maldive waters and Panda *et al.* (2015) in Mumbai, India. Nevertheless, the studies on the analysis of the fishery of this species are scarce, taking into account its wide tropical distribution and its use for both direct human consumption and bait.

Because of this, the objectives of the present study were: determine total, natural and fishing mortality, length of recruitment and of first capture, exploitation index, yield per recruit and its simulation changing the first capture age. Likewise, the results obtained in this study were compared with those reported by other authors in different geographical locations.

Materials and methods

From November 2012 to October 2013, 230 organisms of the bigeye scad *Selar crumenophthalmus* were taken directly from the commercial captures in Manzanillo and Santiago Bays in Manzanillo, Colima, México (Fig. 1) to the laboratory of the Regional Fishery Research Center of the National Fishery Institute (CRIP-INAPESCA). Organisms were captured with fixed trap-net, gill net, "robador" (hand line with five hooks) and pound net, to obtain a stratified sample which includes all the age groups and size classes.

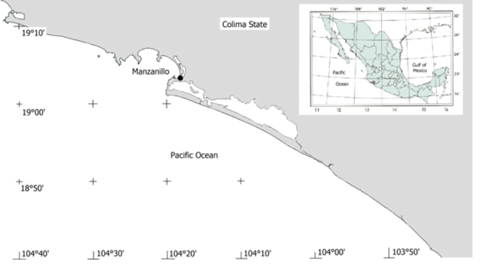

Fig. 1. Study area of Colima State, Mexico.

In the laboratory, data taken from each organism were: total length (TL, cm), total weight (TW, g), eviscerated weight (EW, g) and sex.

The results of growth parameters used in this paper were obtained by us and published (Espino-Barr *et al.,* 2016). Growth parameters were: L_∞ = 24.60 cm, k = 0.662 and t_o = -0.247. Mean size for each age were: age one = 13.73 cm, age two = 19.04 cm, age three = 21.73 cm, age four = 23.12 cm. The allometric index from the weight-length relationship was positive allometric *b* = 3.232 with total weight and b=3.227 with eviscerated weight. Longevity was obtained by Taylor method (Taylor, 1958, 1960): $A_{0.95}$ = 4.5 years.

The source of information was the Notice of Arrival or Landing Reports (Aviso de Arribo), which is the official statistical information provided by fishers with species name and capture quantities (kg per month), and collected in the Fisheries Bureau (Oficina de Pesca), from 2000 to 2016.

Values of individual total length (cm) were used to calculate length at first capture (L_{50} or Lc) and recruitment length (L_{25} or Lr), by means of the accumulated frequency. The logistic function is (Gaertner & Laloe, 1986, Sparre & Venema, 1995):

$$H_P = \frac{1}{1+e^{a+b*Lt}}$$

where: H_P = percentage of individuals, *a* and *b* are constants. Its logarithmic transformation is: ln 1 (1/Hp-1) = a-b· Lt

and the length at which 50% of the population is fished (L_{50}) is: $L_{0.50}$ = a/b.

Linearized catch curve method was used to estimate the total mortality coefficient (Z) by plotting age groups versus natural logarithm of the relative abundance of each group (Sparre & Venema, 1995), where *x* corresponds to age groups and *y* to natural logarithm of relative abundance for each age group.

Survival rate was obtained by the equation: $S = e^{-Z}$ (Ricker, 1948, Ehrhardt, 1981). Natural mortality (M) was estimated using the Taylor's method (Taylor, 1958, 1960):

$M = -Ln(1-0.95)/A_{0.95}$,

where: $A_{0.95}$ = longevity based on the von Bertalanffy growth parameters (von Bertalanffy, 1938).

Growth parameters were compared with the equation of growth performance index of phi prima $Ø' = \log k + 2 \cdot \log L_\infty$.

Exploitation rate was determined as E = F / Z (Sparre & Venema, 1995), and the yield per recruit (Beverton & Holt, 1957) with the equation:

$$y/r = F * e^{-Mr'} * W_\infty \left(\frac{1}{Z} - \frac{3e^{-Kr'}}{Z+K} + \frac{3e^{-2Kr'}}{Z+2K} - \frac{e^{-3Kr'}}{Z+3K}\right)$$

where: y = catch or yield, r = recruit, F = fishing mortality, M = natural mortality, $r' = t_R - t_0$ time between recruitment and the hypothetic t_0, W_∞ = corresponding weight to asymptotic length L_∞, Z = total mortality, and K = growth coefficient.

Results

Official data of annual catch for the years 2000 to 2016 in Colima show an inter-annual variation (Fig. 2), being more abundant in 2000, 2005, 2008, 2011 and 2013. Maximum catch of 62.9 tons was obtained during 2013. In other years the maximum catch ranked from 1.00 to 40.00 tons.

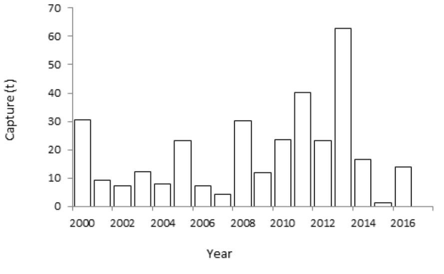

Fig. 2. Total catch of *Selar crumenphthalmus* in Colima State, Pacific coast of Mexico, from 2000 to 2016.

Monthly average captures in Colima were from 792.9 tons in October to 5 607.4 tons in January. The maximum value was of 16 322.0 tons in January and the lowest was 5.0 tons in June (Fig. 3).

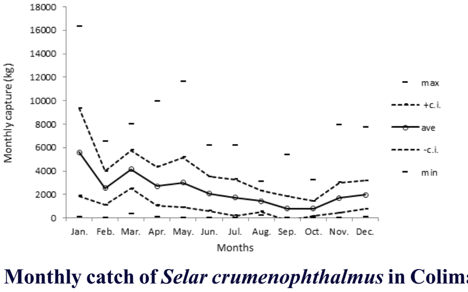

Fig. 3. Monthly catch of *Selar crumenphthalmus* in Colima State, Mexico; average values, maximum, minimum and confidence interval.

The recruitment length (L_{25}) was 18.2 cm that corresponds to an age of 1.8 years. The first capture length (L_{50}) was 20.0 cm corresponding to an age of 2.3 years (Fig. 4). Differences between sexes were found between sexes, being the recruitment length L_{25} = 19.5 cm (2.1 years) in females and 19.2 cm (2.0 years) in males. The first capture length L_{50} = 20.1 (2.3 years) in females and L_{50} = 20.1 cm (2.3 years) in males (Table 1).

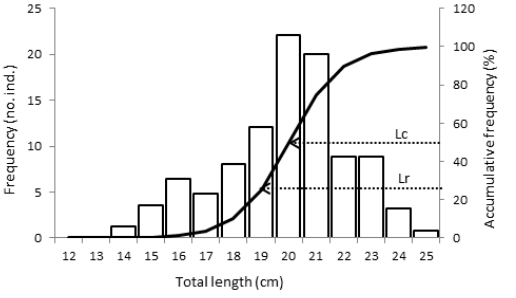

Fig. 4. Length frequency distribution, size of first capture (L_{50} or Lc) and recruitment (L_{25} or Lr) of *Selar crumenophthalmus* in Colima State, Mexico.

Table 1. First capture and recruit lengths, weight and age of *Selar crumenophthalmus* in Colima, México.

	Length *	Length (cm)	Weight (g)	Age (years)
all individuals	Lr	18.2	66.2	1.8
	Lc	20.0	89.7	2.3
females	Lr	19.5	82.0	2.1
	Lc	20.1	91.2	2.3
males	Lr	19.2	78.6	2.0
	Lc	20.1	91.2	2.3

*: Lt = recruitment length, Lc = first capture length

An ascendant slope from ages 1 to 4 years is shown in the catch curve. The right descendant side corresponds to ages with a complete recruitment to the fishing gears (Fig. 5). The regression equation calculated to obtain the slope was: y = 9.420 – 1.630 x, r^2 = 0.931, n = 5. Total mortality at ages between 2 and 4 years was Z = 1.630 and the survival rate was S = 0.196 (Table 2).

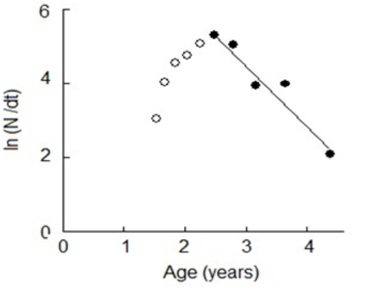

Fig. 5. Length-converted catch curve of *Selar crumenphthalmus* in Colima State, Mexico.

Table 2. Population parameters of *Selar crumenophthalmus* in Colima, México.

Parameter	Value
L_∞ (cm)	24.6
k ($year^{-1}$)	0.662
t_0	-0.247
Z ($year^{-1}$)	1.630
M ($year^{-1}$)	0.700
F ($year^{-1}$)	0.930
S	0.196
Longevity (years)	4.500
Survival %	19.59
Total mortality (%)	80.41
If Z =	100.00
dead by fishing	57.04
dead by natural causes	42.96
E = F/Z	0.570

Natural mortality rate was M = 0.700, therefore fishing mortality was F = 0.930. Value of the calculated exploitation rate was E = 0.570, which is close to E = 0.5 suggested by Gulland (1964) for a healthy fishery (Table 2).

Table 3 shows the parameter values used in the model of yield per recruit (y/r). The calculated values were y/r = 45.9 g with a value of current fishing mortality F = 0.930. The highest values that could be obtained without changing the fishing method would be increasing the fishing mortality to F = 2.00 (Figs. 6, 7) to obtain a y/r = 67.0 grams.

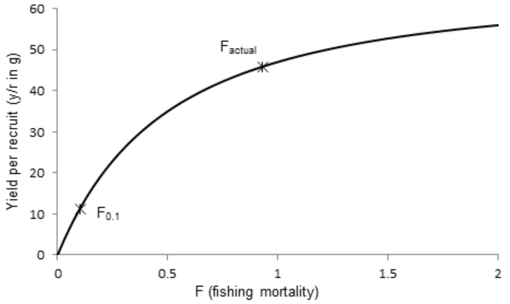

Fig. 6. Yield per recruit curve of *Selar crumenophthalmus* in Colima State, Mexico at present fishing mortality.

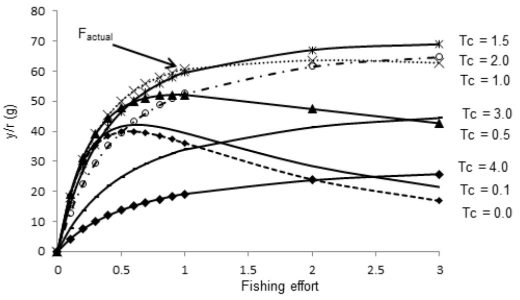

Fig. 7. Yield per recruit simulation with different ages of first capture of *Selar crumenophthalmus* in Colima State, Mexico.

Table 3. Parameters and values of yield per recruit model of *Selar crumenophthalmus* in Colima, México.

Parameter	Value
k (year^{-1})	0.662
M (year^{-1})	0.700
Tc (year)	2.3
Tr (year)	1.8
t_0	-0.247
Wmax (g)	173.3

Simulating different scenarios of the fishing activity, the method to obtain organisms of age 2.3 years provides the best yield. Any increase in age of capture results in a lower gain in weight (Fig. 7).

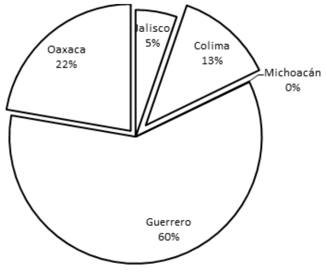

Fig. 8. Capture proportion of *Selar crumenophthalmus* in the States of the Mexican Central South Pacific.

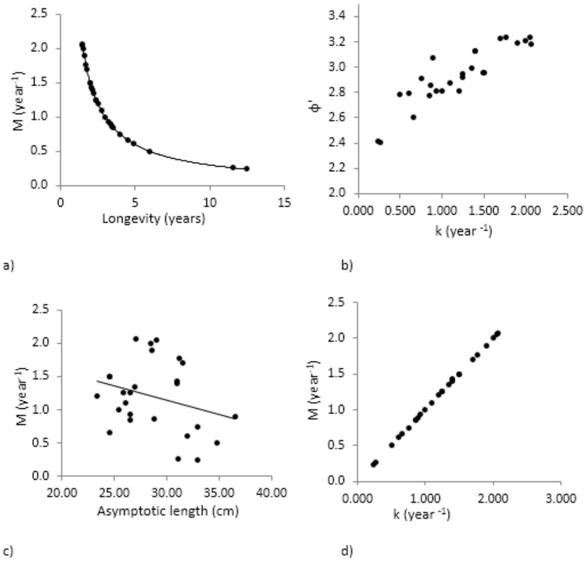

Fig. 9. Relationships between : a) growth performance (ϕ') and catabolic index (k), b) natural mortality and longevity, c) natural mortality and asymptotic length (L_∞), and d) natural mortality and catabolic index (k).

Table 4. Growth, Ø', longevity and natural mortality parameters *Selar crumenophthalmus* in Colima, México.

Locality	Length	L_∞ (cm)	k (1/y)	Ø'	Longevity (year)	M (year^{-1})	Author
Manila Bay, Philippines	TL (length frequency)	36.50	0.890	3.074	3.37	0.890	Ingles & Pauly (1984)
		31.00	1.400	3.129	2.14	1.400	
Java Sea, Indonesia	TL (length frequency)	26.90	1.350	2.990	2.22	1.350	Sadhotomo & Atmadja (1985)
Java Sea, Pekalongan, Indonesia	TL (length frequency)	25.90	1.250	2.924	2.40	1.250	Dwiponggo *et al*. (1986)
Camotes Sea, Central Visayas, Philippines	TL (otoliths daily marks)	31.20	1.770	3.236	1.69	1.770	Dalzell & Peñaflor (1989)
Tablas Strait-Tayabas Bay region, Philippines	TL (length frequency)	26.50	1.250	2.943	2.40	1.250	Philbrick (1988)
North Marianas, East Philippines	FL (annuli otoliths)	32.00	0.610	2.796	4.91	0.610	Ralston & Williams (1988)
Moro Gulf, Philippines	TL (otoliths daily marks)	27.00	2.070	3.179	1.45	2.070	Dalzell & Peñaflor (1989)
North Sulu Sea, Philippines	TL (otoliths daily marks)	29.00	2.050	3.237	1.46	2.050	Dalzell & Peñaflor (1989)
Guimaras Strait, Philippines	TL (otoliths daily marks)	31.50	1.700	3.227	1.76	1.700	Dalzell & Peñaflor (1989)
Guimaras Strait, Philippines	FL (length frequency)	25.40	1.000	2.810	3.00	1.000	Padilla 1991
Sofala Bank and Boa Paz, Mozambique	TL (length frequency)	32.90	0.750	2.909	3.99	0.750	Sousa (1992)
South west coast, Sri Lanka	FL (length frequency)	34.80	0.500	2.782	5.99	0.500	Dayaratne & Sivacumaran (1994)
Java Sea, off Pekalongan and Juwana, Indonesia	FL (length frequency)	26.10	1.100	2.875	2.72	1.100	Suwarso & Atmaja (1995)
Pujada Bay, Philippines	TL (length frequency)	23.30	1.200	2.814	2.50	1.200	Lavapie-Gonzales *et al*. (1997)
South Sulu Sea, Philippines	TL (length frequency)	24.60	1.490	2.955	2.01	1.490	Lavapie-Gonzales *et al*. (1997)
Leyte Gulf, Philippines	TL (length frequency)	24.60	1.500	2.958	2.00	1.500	Lavapie-Gonzales *et al*. (1997)
Camotes Sea, Philippines	TL (length frequency)	28.50	2.000	3.211	1.50	2.000	Lavapie-Gonzales *et al*. (1997)

Davao Gulf, Philippines	TL (length frequency)	28.60	1.900	3.191	1.58	1.900	Lavapie-Gonzales *et al*. (1997)
Camotes Sea, Central Visayas, Philippines	TL (length frequency)	28.80	0.860	2.853	3.48	0.860	Lavapie-Gonzales *et al*. (1997)
Davao Gulf, Philippines	TL (length frequency)	26.50	0.850	2.776	3.52	0.850	Armada (2004)
Gulf of Salamanca, Colombian Caribe	SL (length frequency)	31.10	0.260	2.400	11.52	0.260	García & Duarte (2006)
Bangaa faru, Male' atoll, Maldives, South India	FL (length frequency)	26.50	0.930	2.815	3.22	0.930	Adeeb *et al*. (2014)
Taiwan Strait and adjacent waters	TL (length frequency)	32.90	0.240	2.415	12.48	0.240	Hu *et al*. (2015)
West Bengal, India	TL (length frequency)	31.00	1.400	3.130	2.10	1.427	Panda *et al*. (2015)
Central Mexican Pacific, Mexico	TL (otoliths)	24.60	0.662	2.603	4.53	0.662	present study

Table 5. Parameters of *Selar crumenophthalmus* from different geographic locations*.

Author	Dalzell & Peñaflor (1989)	Armada (2004)	Adeeb et al. (2014)	Panda et al. (2015)	Present study
Study area	Philippines waters	Davao Gulf, Philippines	Maldive waters	Mumbai, NW coast, India	Colima, Mexico
b				3.370	3.232
L_∞ (cm)	27.0-31.6	26.5	26.54 FL	31	24.60
k (year^{-1})	1.7-2.05	0.85	0.93	1.4	0.662
t_o (year)	0.228			-0.06	-0.247
Longevity (years)	1.689-1.990	3.524	3.221	2.080	4.500
phi	3.16-3.25	2.776	2.82	3.13	2.603
Z (year^{-1})	5.97-10.01	4.10	4.01	4.62	1.630
M (year^{-1})	2.51-2.91	1.66	1.78	2.21	0.700
F (year^{-1})	3.21-7.44	2.44	2.223	2.41	0.930
E	0.530-0.740	0.60	0.560	0.520	0.570
Lr (cm)				12.80	18.20
Lc (cm)	13.2-23.7	14.80	16.70	24.00	20.00

Discussion

The highest average capture in Colima occur from October to March (except February), that is, during autumn and winter, and diminish during the months of April to September. The low capture during these months might be because the fixed trap-net is taken out to be cleaned and repaired (during the hurricane months).

First capture length of Lc = 20.0 cm (20.1 cm in females and males) correspond to an age of 2.3 years and coincides with the length of first reproduction L_{50} = 20.8 cm in males and 20.55 cm in females (Gallardo-Cabello *et al*., 2017). This means that the captured organisms might not have reproduced at least once, which would reduce the recruitment of the young and would expose the population to overexploitation. It is possible that this phenomenon takes place in the fishing on big eye scad with the fixed trap-net and the hand line with five small hooks, because in the more selective nets as the gill net, length of first capture could be higher to the average length of sexual maturity.

Total mortality of the big eye scad in Colima shows that 81% of the organisms die and 29% survives. For every 100 organisms that die, 59 die by fishing mortality and 43 of natural causes, which is predation, sickness senescence.

In relation to the proportion of catches of *Selar crumenphthalmus* in the Mexican Central-South Pacific, figure 8 shows differences in each State; Guerrero has a higher register of the species (60%), followed by Oaxaca (22%), Colima (13%) and Jalisco (5%). The states of Michoacán and Chiapas do not register this product. We think it is important to note that this species is mainly used as bait for the fishing of big pelagic species in some states, as the sailfish *Istiophorus platypterus*, sword fish *Xiphias gladius*, marlins of the Istiophoridae family, and dorado mahi-mahi *Coryphaena hippurus*. But other states the use of this species is also appreciated for human consumption, as in Guerrero, Oaxaca, Colima and in a less proportion Jalisco. When this species is used as bait it does not appear in the fishing logs, which means that even with a great abundance it does not appear in the fishing statistics, as is the case of Michoacán and Chiapas States (Fig. 8). The state of Guerrero is characterized by consuming this fish in direct form prepared fried or roasted, because it has a great acceptance for its flavor and low price, reaching a high popular consumption by low income social classes. This phenomenon also occurs in Oaxaca and Colima although in lower amount.

Table 4 shows the values of the von Bertalanffy growth parameters L_∞ and k, phi index, longevity, natural mortality of *Selar crumenphthalmus* in different geographic localities. In all cases it is observed that as the longevity increases, the natural mortality decreases (Fig. 9a). This coincides with that set forth by Taylor (1958, 1960). In this case the natural mortality is related to the senescence of the organisms and does not consider other causes as predation of sickness, impossible to quantify in population dynamic analysis. Values of the k index fall in a range of phi' results, also consistent with data presented by the species (Fig. 9b). In this way, as the catabolic index k increases, the slope of the von Bertalanffy growth curve will be higher and the asymptotic length L_∞ will be reached faster, being the longevity lower and the natural mortality higher (Fig. 9c and d). These phenomena are observed in the studied organisms in different areas of Philippines (Dalzell & Peñaflor, 1989) in longevities from 1.4 to 1.8 years with natural mortality values from 2.07 to 1.70. A similar situation is presented by Ingles & Pauly (1984), Sadhotomo & Atmadja (1985), Philbrick (1988) and Panda *et al.* (2015).

On the other hand, high values of longevity translate into low natural mortalities, as occurs with organisms studied by Hu *et al.* (2015) in Taiwan, whose longevity is of 12.5 years and a natural mortality M = 0.24; or specimens studied by García & Duarte (2006), who report a longevity of 11.5 years and a natural mortality M = 0.26 in the Salamanca Gulf, Colombia. In our study *Selar crumenophthalmus* occupies and intermediate position in terms of longevity of 4.5 years, that translates into a natural mortality of M = 0.662. Nearby data were obtained by Ralston & Williams (1988) in the Philippines, with a longevity of 4.9 years and a natural mortality of M = 0.61, Sousa (1992) with a longevity of 4.0 years and a M = 0.75 in Mozambique, or Dayaratne & Sivacumaran (1994) who found a longevity of 6 years and M = 0.500 in Sri Lanka.

According with this, *Selar crumenophthalmus* can be considered as a short life species by some authors of longer life cycle by other analysts.

Table 5 shows the von Bertalanffy's growth parameters, longevity, total, natural and fishing mortality values, recruitment length and first capture length, also the allometric index of the weight-length relationship and the phi' values of *Selar crumenophthalmus.*

Total mortality values obtained for this species in the Gulf of Davao, Philippines by Armada (2004) was Z = 4.10, as that reported in Maldives waters by Adeeb *et al.* (2014) of Z = 4.01 and that obtained by Panda *et al*. (2015) in Mumbai, India of Z = 4.62, although similar between them, are higher than the one obtained in this study: Z = 1.63. Similarly, Dalzell & Peñaflor (1989) reported for eight localities in Philippines, values of total mortality even higher, between 5.97 and 10.01.

Likewise, it has been observed that the fishing mortality, although similar between them, are much higher than in our study, F = 0.93.

Armada (2004) reported F= 2.44, Adeeb *et al.* (2014) published F = 2.223 and Panda *et al.* (2015) F = 2.41. Also Dalzell & Peñaflor (1989) published values of F oscillating between 3.21 and 7.44, being the highest values found for this species. All these values show that this species is much more fished in the mentioned localities in Asia, for direct human consumption than happens in Manzanillo, Colima, México, where this species is used mainly as bait and is not recorded in the fishing statistics.

The first capture length were found to be lower in the Gulf of Davao, Philippines of Lc = 14.80 cm (Armada, 2004), and in the Maldives of Lc = 16.70 cm (Adeeb *et al.,* 2014), than that found in our study: Lc = 20.00. However, Panda *et al*. (2015) obtained a higher value of Lc = 24.00 cm. Dalzell & Peñaflor (1989) obtained for eight localities in Philippines values of Lc between 13.20 cm and 23.70 cm. Difference in these first capture lengths is related to the size of the mesh of nets used to fish these pelagic fish.

Finally, the exploitation rate values show a high similitude in the suited cases, being E = 0.60 that of Armada (2004) and E = 0.57 in the present study; E. 0.56 (Adeeb *et al.,* 2014), and E = 0.52 by Panda *et al*. (2015). The optimum values are those closest to E = 0.50, according to Gulland (1964). Values higher than this exploitation rate can indicate overexploitation of the resource, as could be in some localities in Philippines, where the value reaches E = 0.74 in a few localities.

Conclusions

- The highest average captures of Selar crumenophthalmus in Colima, México, occurs from October to March (except February), that is, during autumn and winter, and diminishes in April and September, spring and summer.
- The recruitment length was Lr = 18.20 cm. Length of first capture was Lc = 20.00 cm. Differences between sexes were Lr = 19.50 cm for females and Lr= 19.20 for males, Lc = 20.10 for both sexes.
- Total mortality for ages 2 to 4 years was Z = 1.630 and the survival rate was S = 0.196.
- Natural mortality rate was M = 0.700. Fishing mortality was F = 0.930.
- The exploitation rate was E = 0.570.
- Increasing fishing mortality from F = 0.930 to F = 2.000 will increment the yield per recruit from 45.9 g to 67.0 grams.
- The actual age of fist capture is 2.3 years, and is the one that produce the best yields.

Recommendations

Instead of using this species mainly as bait in the capture of bill fishes and dolphin fish, fishing could be increased to well be used as direct consumption food for humans, that is, that the benefits include coastal populations as in many Asian countries like Philippines, India and others. This increase in the fishing mortality would improve the fishery yield and would provide higher protein consumption for the low income social class resources, due to their low cost.

Also, it is important to continue with the study of the population dynamics of this species and analyze the selectivity effects of the fishing gears, in relation to the recruitment patterns and other aspects that will improve the management of this fishery.

We also recommend and emphasize in the importance of preventing any damage to the mangroves, reducing spawning and nursery areas for many species; also pollution, both thermal and solid and chemical wastes should be avoided in lakes and coastal lagoons which diminish the quality of life of the species that inhabit them.

References

1. Adeeb S., Fadzly N., Md Sah A.S.R. (2014) Population dynamics of bigeye scad, Selar crumenophthalmus in Bangaa Faru, Maldives. Journal of Marine Biology and Oceanography 3: 3.
2. Armada N.B. (2004) Fish resource assessment and management recommendations for Davao Gulf. p. 332-335. In: DA-BFAR (Department of Agriculture-Bureau of Fisheries and Aquatic Resources). In turbulent seas: the status of Philippine marine fisheries. CRMP document No: 02-CRM/2004. Cebu City, Philippines. 378 p.
3. Beverton R.J.H., Holt S.J. (1957) On the Dynamics of exploited fish population. Fish. Invest. Minist. Agric. Fish. Food 2(19): 1-533.
4. Breder C.M., Rosen D.E. (1966) Modes of reproduction in fishes. T.F.H. Publications, Neptune City, New Jersey. 941 p.
5. Chirichigno N.F. (1974) Clave para identificar los peces marinos del Peru. Inf. Inst. Mar Perú (44): 1-387.
6. CONAPESCA. (2017) Sistema de Información de Pesca y Acuacultura (SIPESCA). Comisión Nacional de Pesca y Acuacultura. México. https://sipesca.conapesca.gob.mx
7. Dalzell P., Peñaflor G. (1989) The fisheries biology of the big-eye scad Selar crumenopthalmus (Bloch) in the Philippines. Asian Fish. Sci. 3: 115-131.
8. Dayaratne P., Sivakumaran K.P. (1994) Bio-socio-economics of fishing for small pelagics along the south west coast of Sri Lanka. Bay of Bengal Programme, Colombo, Sri Lanka. BOBP/WP/96.
9. Dwiponggo A., Hariati T., Banon S., Palomares M.L.D., Pauly D. (1986) Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. ICLARM Tech. Rep. 17, 91 p.
10. Ehrhardt N. (1981) Curso sobre métodos en dinámica de poblaciones. 1a.Parte. Estimación de parámetros poblacionales. México, D.F. pp. 150.
11. Espino-Barr E., Gallardo-Cabello M., Puente-Gómez M., Garcia-Boa A. (2016) Growth of the Bigeye Scad Selar crumenophthalmus (Teleostei: Carangidae) in Manzanillo Bay, Mexican Central Pacific. J Mar Biol Oceanogr 5:3. doi: 10.4172/2324-8661.1000160
12. Figueiredo J.L. de, dos Santos A.P., Yamaguti N., Bernardes R.A., Del Bianco Rossi-Wongtschowski C.L. (2002) Peixes da zona econômica exclusiva da Região Sudeste-Sul do Brasil: Levantamento com Rede de Meia-Água. São-Paulo: Editora da Universidade de São Paulo; Imprensa Oficial do Estado, 242 p.
13. Gaertner D., Laloe F. (1986) Etude biometrique de la talle a'premier maturité sexualle de Geryonmaritae, Maning et Holthuis, 1981 de Senegal. Oceanologica Acta 9: 479-487.
14. Gallardo-Cabello M., Espino-Barr E., Puente-Gómez M., Garcia-Boa A. (2017) Reproduction off big eye scad Selar Crumenophthalmus (Teleostei: Carangidae) in the Mexican Pacific coast. Asian Journal of Science and Technology. 8(03):4536-4542.
15. García C.B., Duarte L.O. (2006) Length-based estimates of growth parameters and mortality rates of fish populations of the Caribbean Sea. J. Appl. Ichthyol. 22: 193-200.
16. Gulland J.A. (1964) Manual of methods of fish population analysis. FAO Fisheries Technical Paper, 40: 1-60.
17. Hu W., Ye G., Lu Z., Du J., Chen M., Chou L.M., Yang S. (2015) Study on fish life history traits and variation in the Taiwan Strait and its adjacent waters. Acta Oceanol. Sin. 34(2): 45-54.
18. Ingles J., Pauly D. (1984) An atlas of the growth, mortality and recruitment of Philippines fishes. ICLARM Tech. Rep. 13. 127 p.
19. Lavapie-Gonzales F., Ganaden S.R., Gayanilo Jr F.C. (1997) Some population parameters of commercially important fishes in the Philippines. Bureau of Fisheries and Aquatic Resources, Philippines. 114 p.
20. Padilla J.E. (1991) Managing tropical multispecies fisheries with multiple objectives. Ph.D. thesis, Simon Fraser University. 235 p.
21. Panda D., Jaiswar A.K., das Sarkar S., Chakraborty S.K. (2015) Growth, mortality and exploitation of bigeye scad, Selar crumenophthalmus off Mumbai, north-west coast of India. Journal of the Marine Biological Association of the United Kingdom, 1-6. doi:10.1017/S0025315415001459
22. Philbrick C. (1988) Length frequency analysis of pelagic fish species. Fishbyte 6(3): 5-6.
23. Ralston S., Williams H.A. (1988) Depth distributions, growth, and mortality of deep slope fishes from the Mariana Archipelago. NOAA Tech. Memo. NMFS. NOAA-TM-NMFS-SWFC-113, 47 p.
24. Ricker W.E. (1948) Methods of estimating vital statistics of fish population. Science Series 15, Ind. Un. Publ., USA, pp. 101.
25. Roos D., Roux O., Conand F. (2007) Notes on the biology of the bigeye scad, Selar crumenophthalmus (Carangidae) around Reunion Island, southwest Indian Ocean. Scientia Marina 71(1): 137-144.
26. Sadhotomo B., Atmadja S.B. (1985) On the growth of some pelagic fishes in the Java Sea. J. Pen. Perikanan Laut (33): 53-60.
27. Smith-Vaniz W.F. (1984) Carangidae. In: W. Fischer and G. Bianchi (eds.) FAO species identification sheets for fishery purposes. Western Indian Ocean fishing area 51. Vol. 1. [pag. var.]. FAO, Rome.
28. Smith-Vaniz W.F., Quéro J.-C., Desoutter M. (1990) Carangidae. p. 729-755. In: J.C. Quero, J.C. Hureau, C. Karrer, A. Post, L. Saldanha (eds.). Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 2.
29. Sadhotomo B., Atmadja S.B. (1985) On the growth of some pelagic fishes in the Java Sea. J. Pen. Perikanan Laut (33):53-60. (in Bahasa Indonesia).
30. Sousa M.I. (1992) Seasonal growth of five commercially important fishes at Sofala Bank, Mozambique. Rev. Invest. Pesq. (Maputo) 21: 79-97.
31. Sparre P., Venema S.C. (1995) Introducción a la evaluación de recursos pesqueros tropicales. Parte 1 - Manual. FAO Doc. Tec. de Pesca 306/1, Roma.
32. Suwarso B.S., Atmaja S.B. (1995) Growth parameters of the main small pelagic species. p. 85-96. In: Potier M. Nurhakim S. (eds.) Biology, dynamics, exploitation of the small pelagic fishes in the Java sea.
33. Taylor C.C. (1958) Cod growth and temperature. Journal du Conseil 23(3): 366-370.
34. Taylor C.C. (1960) Temperature, growth and mortality – the Pacific cockle. Journal du Conseil 26(1): 177-124.
35. von Bertalanffy L. (1938) A quantitative theory of organic growth (inquiries on growth laws). Human Biology 10(2): 181-213.
36. Zar J.H. (1996) Biostatistical analysis. 3rd edn. Prentice Hall. USA. 662 p.