POPULATION PARAMETERS OF WHITE SARDINELLA, *SARDINELLA ALBELLA* (VALENCIENNES, 1847) FROM NGA YOKE KAUNG COASTAL AREA

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Abstract

This study was conducted to estimate population parameters of white sardinella, *Sardinella albella* collected from Nga Yoke Kaung coastal area from June 2019 to May 2020. A total of 853 specimens of *S. albella* ranging the length 11.3 cm to 20.1 cm were used to analyze with FiSAT II. In present findings, length-weight relationship equation of this species was $W = 0.0712\ L^{2.2431}$ ($r = 0.91$) which showed a negative allometric growth pattern. The estimated mean condition factor indicated that they were in good condition. The asymptotic length (L_∞) and growth rate (K) were 21.53 cm (TL) and 0.98 year^{-1} respectively. The theoretical age at birth (t_0) and growth performance index (ϕ') were -0.18 yr^{-1} and 2.657 respectively. Natural mortality, fishing mortality, and total mortality for *S. albella* were estimated as 1.9, 1.99, and 3.89 respectively. The exploitation rate of *S. albella* from the present study was 0.51 which indicated that they were not overexploited.

Keywords growth parameters, length-weight relationship, mortality parameters, Nga-Yoke-Kaung coastal area, *Sardinella albella*, white sardinella.

Introduction

Sardinella albella (white sardinella) is a small, coastal, and pelagic species under Family Clupeidae which are widespread in tropical and subtropical oceans' warmer regions. When compared to other clupeids fish, by a combination of characteristics, including the second supramaxilla's symmetrical paddle shape, the last two anal fin rays being considerably larger, and the hind border of the gill opening having two distinct fleshy outgrowths (Whitehead, 1985). The French ichthyologist Achilles Valenciennes initially described and published this species in the literature in 1847 under the name *Kowala albella*. The local name of Sardinella was well-known as ‘Nga Kone Nyo’ in the Rakhine Coastal Region and ‘Baung Kyae’ in Myeik Archipelago (Nyo Nyo Tun, 2013).

Estimating fish landings requires knowledge of the length-weight relationship (LWR). It provides information about the population at that time and location. The cube of the fish's length often determines how much it weighs. The hypothesis that larger fish of a particular length are in better condition is supported by the length-weight relationship, which also gives a way to determine the condition factor, which shows the "Well-being of the fish" (Bagenal and Tesch, 1978).

The von Bertalanffy growth model, which is used to estimate, is appropriate for the observed growth of the majority of fish species. According to this idea, length is a function of the animal's age. To determine the rate of population decay, mortality rates were estimated. Evaluating mortality rates is essential for estimating fish population abundance. The more the fishing effort and demand for fishmeal, the production can be greater and it may lead to the overexploitation of stock.

Several studies on the population dynamics of *Sardinella* were carried out along the coast of India. However, there is relatively little information available in Myanmar regarding the *Sardinella* population parameters. Therefore, an attempt was made to investigate the length-

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weight relationship, growth, mortality, and exploitation rate of *S. albella* from the Nga-Yoke-Kaung coastal area.

Materials and Methods

Sample Collection

This study was carried out at two stations: Sin Ma (Lat 16º 43′N and Long 94º 22′ E) and Nga Yoke Kaung (Lat 16º 31′ N and Long 94º 17′ E) (Fig.1) from June 2019 to May 2020. Fresh fish samples were collected monthly by random sampling from drift gillnet and purse seine net in fish landing centers in Nga Yoke Kaung. A total of 853 *S. albella* ranging the length from 11.3 cm to 20.1 cm collected monthly were used for these estimations. The total length of fish was measured from the tip of the snout to the tip of the tail to the nearest mm and the length measurements were converted into length frequencies with constant class intervals of 1 cm. Fish were weighed nearest to 0.1 grams by using a digital weighing balance.

Length-weight Relationship Analysis

The length and weight relationship of fish was calculated by the equation of Pauly, 1983;

$$W= aL^b$$

Where, W= weight of fish in grams, L= total length of fish in cm, a= constant, and b=exponent. The values for 'a' and 'b' coefficients were calculated and linear regression equation was obtained by using natural logarithmic transformations. The correlation (r=R) which is a degree of association between the length and weight was obtained from the graph.

Condition Factor (k)

The condition factor (k) of fish was estimated by using the formula

$$k= 100*W/L^3 \text{ (Pauly, 1983)}$$

Where, k= condition factor, W= weight of fish in gram, and L= total length of fish in cm.

Estimation of Growth Parameters

The Electronic Length Frequency Analysis (ELEFAN) I program in the FiSAT software package was used to analyze the length data and estimate the von Bertalanffy growth parameters L_∞ and K. The length data were sorted into 1 cm size class intervals. Pauly's empirical equation (Pauly, 1979) was used to estimate the value of theoretical age at length zero (t_0):

$$\text{Log } (-t_0) = -0.392 - 0.275\text{Log } L_\infty - 1.038\text{LogK}$$

The resultant values of growth parameters (L_∞, K, t_0) were substituted in the von Bertalanffy growth equation;

$$L_t= L_\infty (1- e^{-K (t-t_0)})$$

Where L_t is the length at age t, L_∞ is the asymptotic length that is the mean length of fish would reach if they were to grow indefinitely, K is the growth coefficient or the rate at which L_∞ is approached and t_0 is the age of the fish at zero length.

The growth performance index (ø′) was calculated from the resultant values of asymptotic length (L_∞) and growth coefficient (K) using the equation:

$$ø'= 2\text{Log } L_\infty + \text{Log K (Pauly and Munro, 1984)}$$

The longevity of this species was estimated using the equation:

$$T_{max}= 3/K+t_0 \text{ (Pauly, 1983)}$$

Where T_{max} is the approximate maximum age fish would reach.

Estimation of Mortality Parameters

Using the length-converted catch curve provided by the FISAT II tool, the total mortality coefficient (Z) was calculated. The empirical equation of Pauly (1980) was used to calculate the natural mortality rate (M) using a mean surface temperature (T) of 27°C:

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

Where M is the natural mortality and K refers to the growth rate of the VBGF. Fishing mortality (F) was estimated by the following relationship

$$F = Z - M \text{ (Gulland, 1969)}$$

Where, F= fishing mortality, Z= total mortality, and M= natural mortality. The exploitation rate (E) was estimated from the equation: E= F/Z (Gulland, 1969).

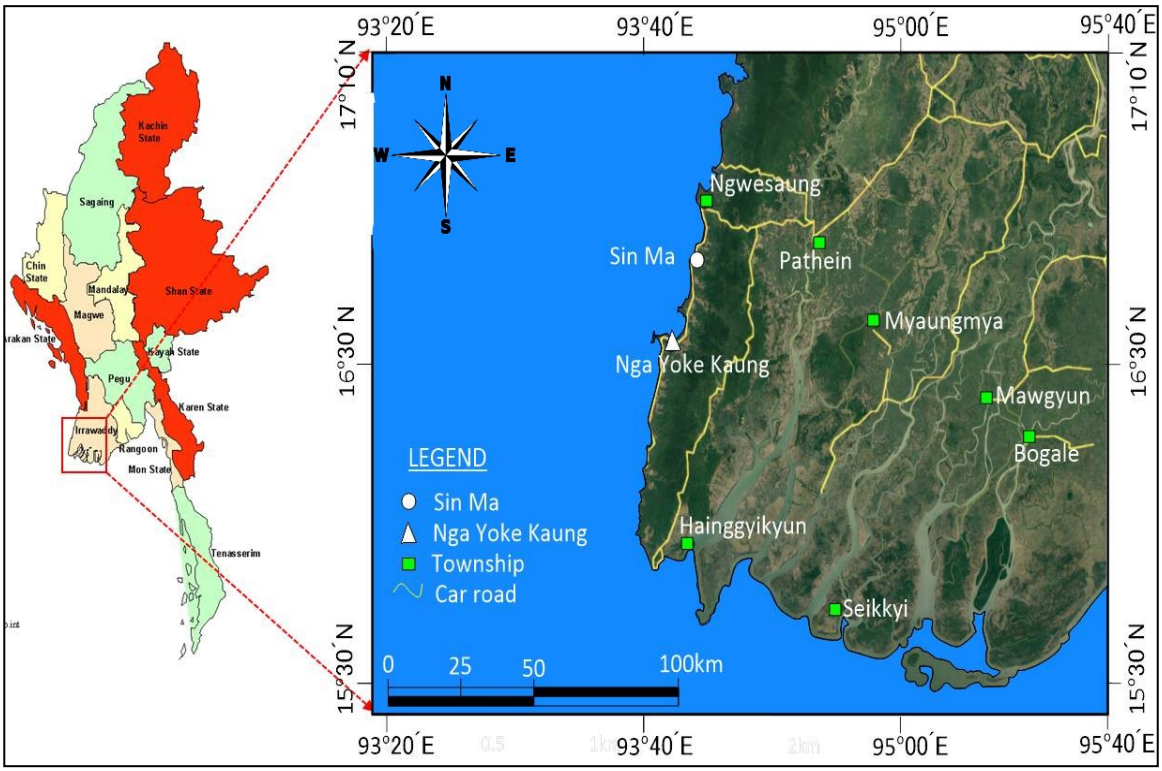

Figure 1 Map showing the locations of sample collecting area

Results

Length-weight Relationship Analysis

The linear regression of the length-weight relationship of *Sardinella albella* and their logarithmic transformations are mentioned in Figure 3.

The equation thus derived in respect of the length-weight relationship of *S. albella* was as follows:

$$W = 0.0712\ L^{2.2431},\ r = 0.91$$

The corresponding logarithmic regression equation can be represented as follows:

$$\text{Log } W = -2.6423 + 2.2431 \text{Log } L$$

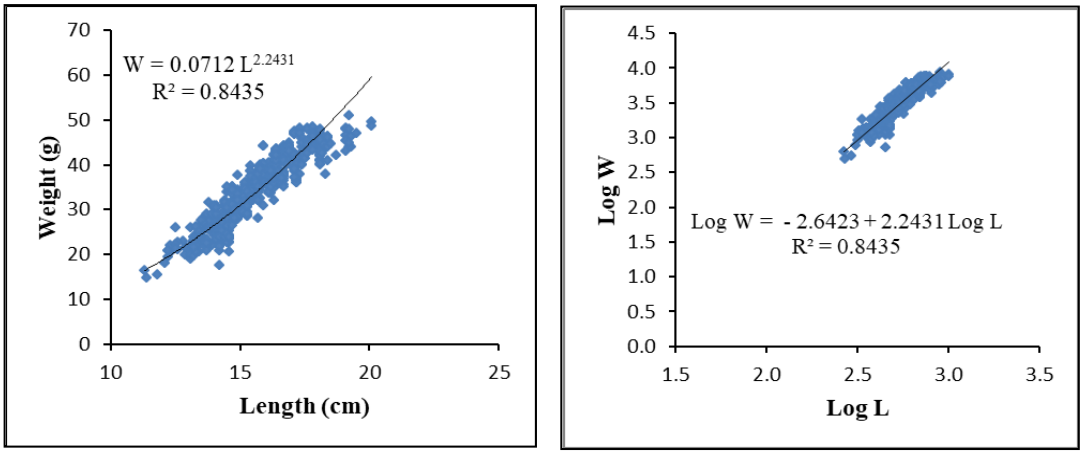

Figure 3 Length-weight relationship of *Sardinella albella* (June 2019 – May 2020) and their logarithmic transformations.

Condition Factor

The condition factor (k) which is the ratio between total length and weight was calculated for *S. albella* represented in Figure 4. The condition factor (k) for *S. albella* was 0.82-0.96 and the mean value was 0.89 ± 0.04. Nearly fifty- four percent of *S. albella* was higher than the mean value. The highest condition factor value was recorded in September while the lowest value was in May.

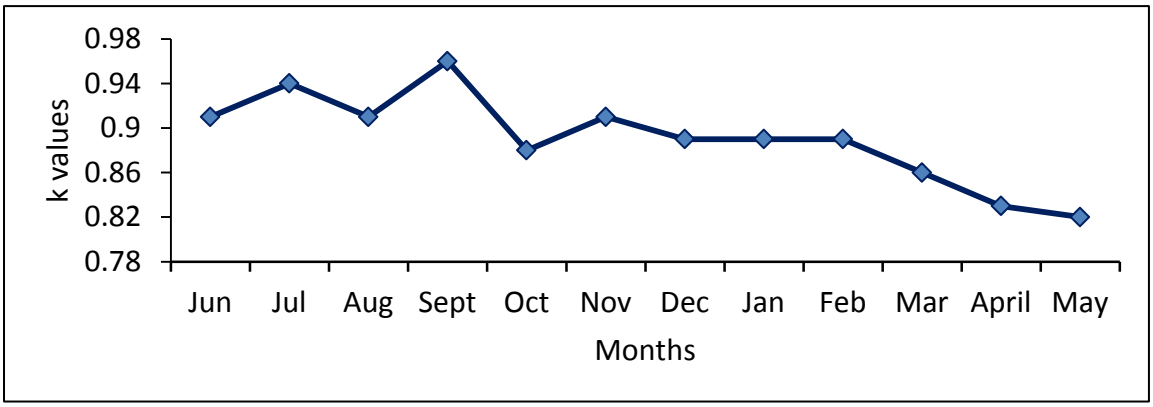

Figure 4 Monthly condition factors for *S. albella* (June 2019 – May 2020).

Growth Parameters

From the analysis of length-frequency data by the ELEFAN I, the estimates of growth parameters obtained were; asymptotic length (L_∞) =21.53 cm and growth coefficient (K) = 0.98 per year (Figs. 5. A and 5. B). The growth performance index ø´ was 2.657 and the estimated t_0 value was -0.18. Thus, the von Bertalanffy growth equation of *S. albella* can be expressed as $L_t = 21.53\ (1\text{-}e^{-0.98\ (t+0.18)})$. Accordingly, the total length attained by *S. albella* is 10.47 cm, 14.76 cm, 17.38 cm, 18.99 cm, 19.97 cm, and 20.58 cm at the end of 0.5, 1, 1.5, 2,2.5, and 3 years in its life respectively. Longevity (T_{max}) of *S. albella* calculated from Pauly's equation is 2.8 years.

Mortality Parameters

The natural mortality (M) of *S. albella* obtained from Pauly's empirical formula at 27˚C annual average sea surface temperature was 1.9 $year^{-1}$. The estimation of Z calculated by the length-converted catch curve method was 3.89 $year^{-1}$(Fig. 5. C). The computed fishing mortality (F) was 1.99 $year^{-1}$. Smaller sizes (yellow dots) had to be excluded, and large size fish had only a

few samples therefore had to be excluded from mortality calculation, so only the black dots were included to determine the total mortality. The exploitation rate (E) of this species was 0.51.

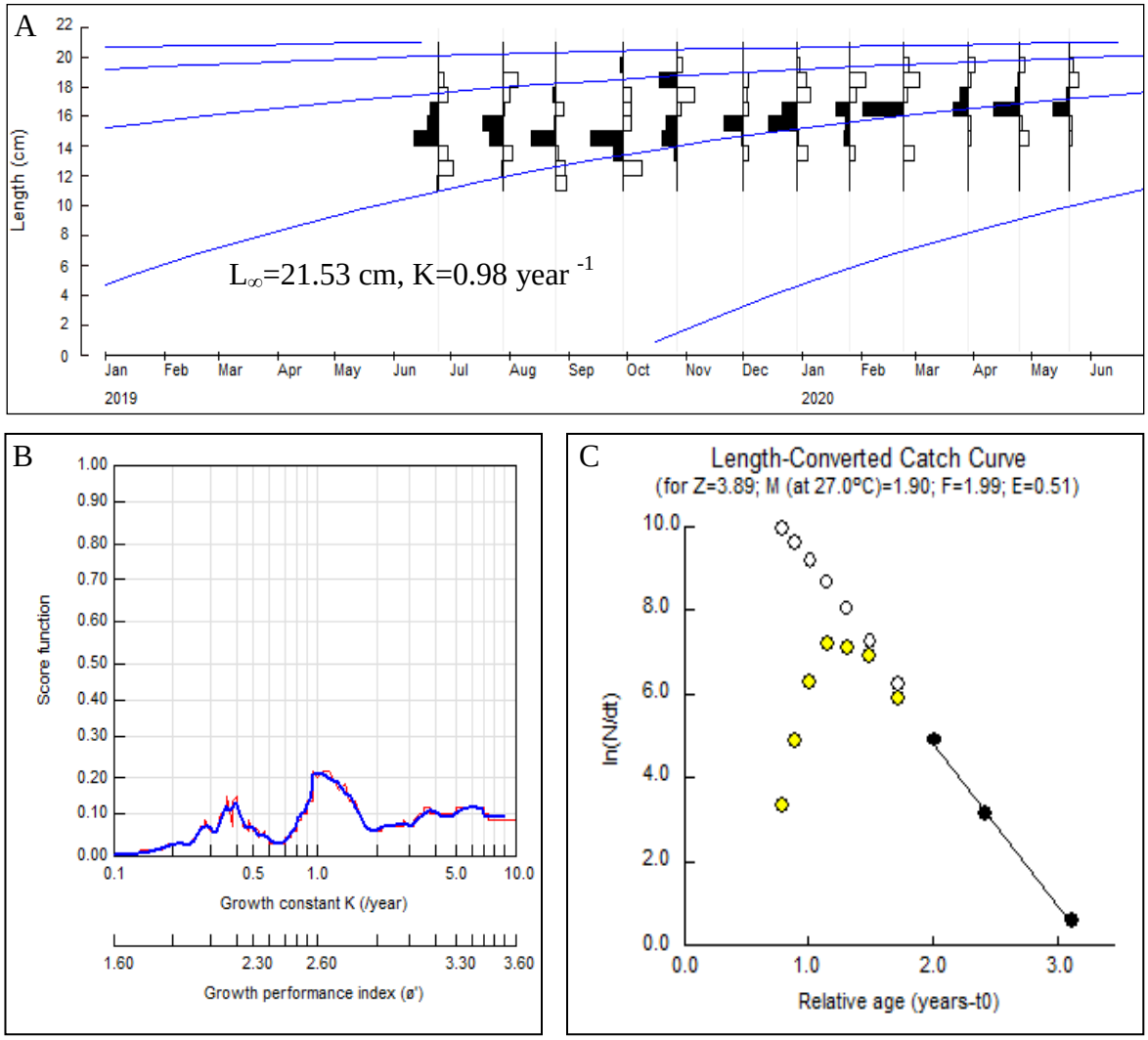

Figure 5 A-C Estimated population parameters of *S. albella*: A). von Bertalanffy growth curves of *S. albella* superimposed on the restructured length-frequency histograms; B) Estimation of K; C) Length-converted catch.

Discussion

The formula "W= aL^b" was used to approximate the length-weight relationship. Fish growth can be determined by the result "b" value. Fish can grow allometrically or isometrically. The growth of fish is isometric when the "b" number is 3, meaning that there is no change in the fish's body form as it develops. Fish grow allometrically if the "b" value is greater or less than 3. If b>3, the fish becomes relatively stouter or deeper-bodied as it grows in length; if b<3, the growth pattern is negative, this mean that the fish becomes slenderer as it grows in weight (Khin May Chit Maung, 2016). In the present study, the 'b' value obtained from the regression line of the graph for *Sardinella albella* was 2.2431, indicating a negative allometric in growth. Thus present result matches the result of Le Cren, 1951. He suggested that the value of exponent ‘b’ is to be equal to ‘three’ or usually lies between ‘two’ and ‘four’.

A correlation coefficient (r) measures the strength of the relationship between the two variables, length and weight. The value of the coefficient of correlation (r) lies between -1 and

+1 (Banerjee 2004). The present result of the r value was 0.91, indicating that the length-weight relationship was positively associated as shown by an r-value above 0.5 (Omogoriola, 2011). As a result, there was a high correlation between the length and weight of *S. albella*.

A quantitative indicator of the fish's health state is the condition factor. Fish are deemed to be in good condition if their condition factor value is more than 0.56. (Bennet, 1970). The fact that these species' condition factors were higher than their average values in the study indicated that they were in good condition. Similar to this, Nyo Nyo Tun (2013) reported that the condition factors of *Sardinella* species from Myeik water were close to 1.1 and came to the conclusion that these species' populations were in good health.

For the fishery to be managed sustainably, estimation of population parameters is also crucial. The estimated asymptotic length (L_∞) of *Sardinella albella* in the present study was 21.53 cm. This value was higher than the values estimated at 13.3 cm by Sekaran (1955), 17cm by Nair (1960), 13 cm by Bennet (1961), and 16.8 cm by Makwaia and Nhwani (1992). Aripin and Showers (2000) described the L_∞ value for this species as 20.2 cm from the Philippines. Nyo Nyo Tun (2013) stated that the growth parameters, L_∞ = 17.85 cm and K = 0.54 year $^{-1}$ observed for *S. albella* from Myeik coastal waters. Abdussamad *et al*. (2010) estimated the L_∞ value of this species from the Gulf of Mannar coast was 20.8 cm (Table.1).

The growth curvature (K) observed was 0.98 year^{-1}. As shown in Table. 1, the K value from the present study was lower than the findings from Bennet (1961), Makwaia and Nhwani (1992), Aripin and Showers (2000), and Abdussamad *et al.* (2010).The growth performance index (ϕ') from the present study was higher than the value reported by Nyo Nyo Tun (2013) and less than the result described by Aripin and Showers (2000).

Qasim (1973) stated that a high K value indicated a strong metabolic rate, and such fish matured at an early age that was greater than L_∞. The current finding indicates that *Sardinella* species have short lifespans due to the high K value and longevity estimation (T_{max}). The length increases per unit of time, which is known as the growth rate. In the present study, there was a significant increase in length during the initial year of life, following which the rate of growth progressively decreased with increasing age. Fish grow longer as they age, but their growth rates gradually slow (Sparre and Venema, 1992).

Table 1 Comparison of population parameters estimates for *S.albella* from different localities.

$L\infty$ TL, cm	K yr^{-1}	ϕ'	F yr^{-1}	M yr^{-1}	Z yr^{-1}	E	localities	References
13.3	1.44	2.41					Mandapam area, India	Sekharan, 1955
17	1.1	2.5					Palk Bay, Gulf of Manaar	Nair, 1960
13	1.65	2.45					Gulf of Manaar, India	Bennet, 1961
16.8	1.15	2.51	1.9	1.8	3.7	0.51	Dares Salaam, Tanzania	Makwaia and Nhwani, 1992
20.2	1.6	2.82	3.48	2.62	6.1	0.57	Tawi-Tawi, Philippines	Aripin and Showers , 2000
20.8	1.1		3.06	2.19	5.25	0.58	Gulf of Mannar	Abdussamad *et al.*, 2010
17.85	0.54	2.236	1.49	1.36	2.85	0.52	Myeik, Myanmar	Nyo Nyo Tun , 2013
21.53	0.98	2.657	1.99	1.9	3.89	0.51	Nga Yoke Kaung, Myanmar	Present study

Estimated mortality rates were used to determine the rate of population death. The mortality rates from the present study were lower when compared to the rates (Z = 6.1, M = 2.62, F = 3.48) reported by Aripin and Showers (2000) from the Philippines, (Z = 3.7, M = 1.8, F = 1.89) by Makwaia and Nhwani (1992) from Tanzania, (Z = 2.85, M = 1.36, F = 1.49) by Nyo Nyo Tun (2013) from Myeik waters as mentioned in Table 1. Natural mortality refers to death brought on by predators such as cannibalism, disease, stressful circumstances during spawning, malnutrition, and age. The death rates of the same species might vary based on the predators and competitors, which are also impacted by fishing activity. The death rate from fishing in the current research was considerably greater than the mortality rate from natural causes.

The rate of exploitation is the rate at which fish resources are used up by fishing activities. The optimal exploitation rate (E_{opt}) for any exploited stock is 0.5 (Gulland, 1971).The rate of exploitation obtained in this study was 0.51 which indicated that the resource of *S. albella* in Nga Yoke Kaung coastal water was not overexploited.

Conclusion

Using length weight frequency data, population parameters such as growth parameters, mortality parameters, and exploitation rate of *Sardinella albella* were estimated and discussed. According to the present study, it could be concluded that *S. albella* from Nga Yoke Kaung coastal area was in good condition. The present estimate of the exploitation rate indicated that the population of this species in the study area is not overexploited. The present study will provide information about fishable stocks and also will contribute additional information to the existing knowledge. This information is required for consideration of the management of measures of the species in the future. This will be the primary contribution to the biological study of these species, as well as information for fishery managers to better manage them.

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