C. RESULTS

Results of the analyses are presented by species, although details for each analysis (graphs, tables and figures) are explained for the first species only. The order of presenting the results is as follows: general biology and geographical distribution of the target species; size distribution from the monitored catches, gonad development (maturation), growth and spawning potential ratio. The results summarizing monitored catch and effort are presented last.

C.1. *Siganus fuscescens* (samaral)

C.1.1. General Biology

Figure xx. The target species, *Siganus fuscescens*

Siganus fuscescens (Family Siganidae) can be found in shallow coastal waters to depths of 50 m, it is distributed in Indo-Malayan region from Andaman Islands eastward to New Caledonia, north to the Ryuku Islands, and south across the northren half of Australia; but extending to higher latitudes during summer, for instance in southern Honshu, Japan and southern New South Wales, Australia. Compared with the very similar *S. canaliculatus,* it seems to prefer clear water. *S. fuscescens* is common on coral reefs, around rock reefs and enters harbors. Fry arrive on coral reef flats in schools averaging about 200 individuals, but up to 5,000 individuals. After 3 months, school sizes drop to around 12 individuals. Adults feed on brown and green algae, juveniles on filamentous algae and seagrasses. This species is fished with a wide rage of gear types including small-meshed seine nets, set gill nets, fish corrals , and spear. Spawning is reported to occur in March-May and August-October in Bolinao, Pangasinan, with sizes at first maturity (L_{m50}) estimated to be 7.2 cm SL for males and 8.8 cm SL for females (Bellefleur, 1997, del Norte & Pauly 1990). In Pujada Bay, the spawning months include February-April and September-October (Jumawan-Nanual & Metillo, 2008). The species is of high importance to small-scale fishers, especially in areas with extensive seagrass beds. In Phillippine markets, they are sold as fresh,salted & dried or marinated. Maximum total length is reported to be about 40 cm, but commonly attain total lengths of 25 cm. (Froese & Pauly, 2016)

C.1.2. Size Distribution

A total of 1342 individuals were measured, and their size frequency distribution in catches from panamaral (English name), the only gear used to catch siganids in the monitored sites, is shown

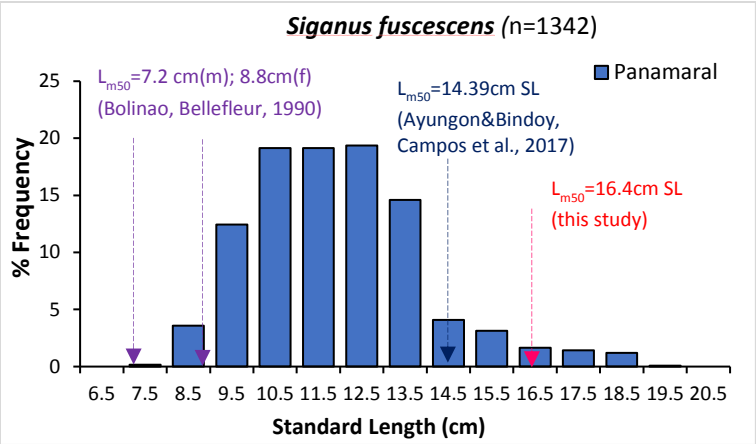


Figure xx. Size Distribution of *Siganus fuscescens* caught by panamaral during the sampling period in Looc and Lubang, Occidental Mindoro

in Fig. xx. The sizes of caught fish ranged from 7.5 to 19.5 cm SL. Estimates of lengths at first maturity (Lm50 based on SL) from other studies in the Philippines are also indicated in the figure.

C.1.3. Gonad development stages and Maturation Curve

The distribution of gonad development stages by size class in *S. fuscescens* is shown in Fig. xx. Of 264 specimens, only 9 were mature, while 11 were developing. The rest were immature. This low occurrence of mature individuals reflects the timing of the study outside of the main spawning season of the species (Feb-May). Hence, to facilitate the construction of a maturity ogive, specimens with developing gonads were considered as "maturing" and combined with those already in the mature stage. The smallest mature specimen measured is 10.9 cm SL and the largest is 14.1 cm SL. It is not clear if the local stock of *S. fuscescens* starts to mature at 10.9cm SL or smaller because very few mature specimens were observed during the study (21 Sep to 21 November), which did not cover the main spawning months of the species. Smaller mature individual *S. fuscescens* have been reported elsewhere in the country, including 7.2 cm SLm50 (male) and 8.8 cm SLm50 (female) in Bolinao, Pangasinan (Bellefleur, 1990). In the same area, de la Paz and Aragones (1988) reported *S. fuscescens* to mature at a size as small as 5.6 cm SL. The maturity ogive for the present study (Fig. xx) shows the size at first maturity (L_{m50}) in the study area is 16.4cm SL. This parameter, in turn, was used to estimate the spawning potential ratio of the target species as discussed in a later section.

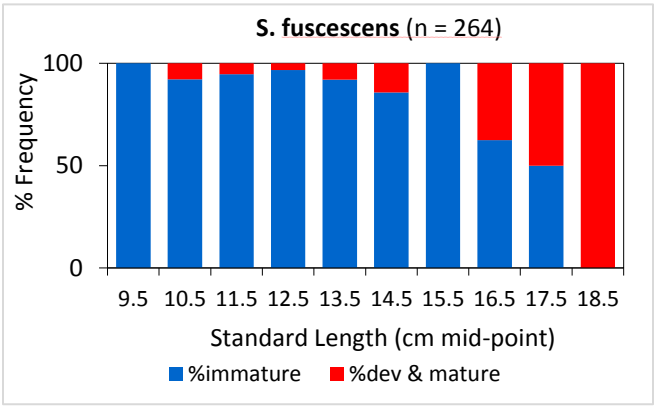


Figure xx. Gonadal Maturation of *Siganus fuscescens* caught by panamaral during the sampling period in Looc and Lubang, Occidental Mindoro

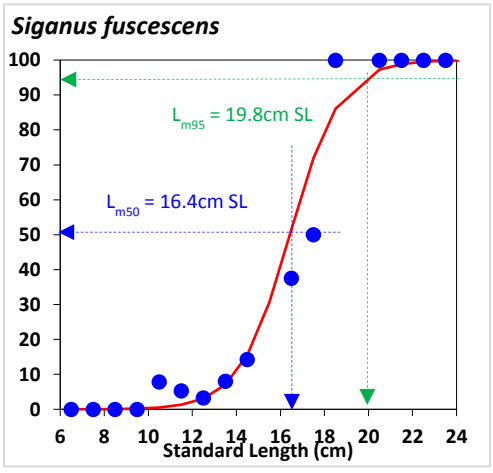


Figure xx. Maturity ogive of *S. fuscescens*.

C.1.4. Growth Curve

Figure xx shows the growth curve of *S. fuscescens* used in estimating the ages of mature specimens. Parameters of the VBGM are based on information from Ayungon, Negros Or. (Campos et al., 2017) ($L\infty$ = 25.0cm SL; K = 0.85 yr^{-1}). Based on the constructed growth curve, the corresponding age of the estimated Lm50 (16.4cm SL) of *S. fuscescens* in Looc and Lubang, Occidental Mindoro is about 15 months, while the smallest mature fish (10.9 cm SL) observed in this study had a correpsonding age of about 8 months. Comparing these results with those of previous studies, the smallest mature individual in Ayungon and Bindoy was also about 10.5 cm SL. pecimen.

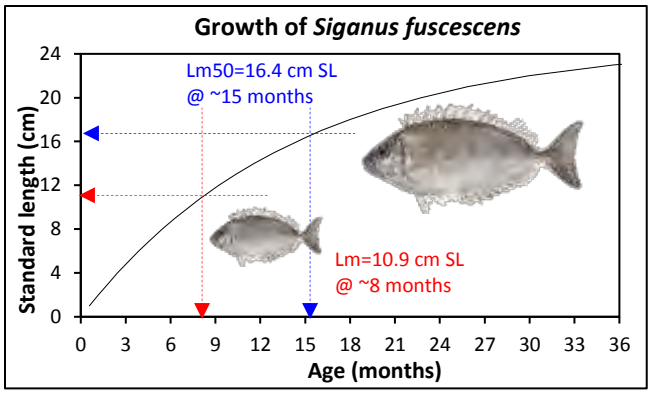


Figure xx. Growth of of *Siganus fuscescens* in Looc and Lubang, Occidental Mindoro

C.1.5. Length-Based Spawning Potential Ratio (LB-SPR)

The estimated SPR of *S. fuscescens* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 6.0% only. This is because the fishery is catching too many immature individuals (97%). In order to increase the spawning potential to the recommended value of 20% and 30%, the Lc or the length at first capture should be set between 13.07-14.04 cm SL. This indicates that catches smaller than this range of sizes should be banned.

Table xx. Estimated Spawning potential ratio of S. *fuscescens* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
10.31 cm (actual)	6%
13.07	23%
14.04	33%

C.1.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

- For panamaral (Drive-in triple net) targeting *S. fuscescens*, additional layers of nets cause too many small fish to get caught. Removing these layers but maintaining the legal mesh size (3 cm) should reduce the proportions of juveniles caught. This

may allow enough individuals to spawn before capture and increase the SPR of the stock to 20-30%.

- Fish buyers should also be informed with the above recommendations. Buyers should be instructed to buy *S. fuscescens* that are equal or greater than the presented size limit. Fishers will be discouraged to catch smaller individuals if they know that buyers will not buy smaller or less than the recommended size limit.

C.2. *Selar crumenophthalmus (matambaka/matang baka)*

C.2.1. General Biology

Figure xx. The target species, *Selar crumenophthalmus*

Selar crumenophthalmus or the big eyed scad (Family Carangidae) usually found in small to large schools, mainly inshore or in shallow water; at times over shallow reefs and in turbid water, but ranging in depth to about 170 m. *s. crumenophthalmus* circumtropical from Indo-Pacific (East Africa to Rapa, north and southern Japan and the Hawaiian Islands, south to New Caledonia), Eastern Pacific (Mexico to Peru, including Galapagos Islands), Western Atlantic (Noca Scotia, Canada and Bermuda through the Gulf of Mexico and the Caribbean to Sao Paulo, Brazil) and Eastern Atlantic (Cape Verde to southern Angola). The species is mainly nocturnal, with groups or schools dispersing at night to feed inshore on small shrimps, benthic invertebrates and forams or offshore on zooplankton and fish larvae (Froese & Pauly, 2016). Maximum length is not well established but unverified report of 60cm SL; documented record of 27cmSL; commonly to about 24cmFL and 0.23 kg. The juveniles and adults are commonly caught by hook-and-line, with beach seines, trawls, purse seines, and traps with juveniles sometimes used as baits for tuna, while both adults and juveniles are marketed fresh and salted or dried in the market. *S. crumenophthalmus* sexually matures at 16.61-17.73 cm SL (L_{m50}) (FSP, 2002; Olano et al., 2009), with spawning extending a period of 6-7 months. In US Virgin Islands, spawn between March-September (Tobias, 1987), April through September or October in Hawaii (Clarke & Privitera, 1995), and April-November in Indian Ocean (Roos et al., 2007)

C.2.2. Size Distribution

Size distribution of the target species caught in Looc and Lubang, Occidental Mindoro during the smapling period (August 21-November 21, 2017) is shown in figure xx. A total of 569 fish individuals were measured within the 3-month monitoring period. Five (5) gears targeted *S. crumenophthalmus* namely Pamusit (Drive in Triple net), Panamaral (Drive in Triple Net), Barangay (Multiple Hook and Line), Lambat/Jamper (Gill Net) and Brgy Kawil (Modified Hook and Line). The smallest individual caught measured 9.5 cm SL (size class 9.5) caught by Pamusit. Approximately 30 % of the total catch is below Lm50 (14.75 cm SL). Estimates of Lm50 of Olano et al (2009), FSP (2002) and RARE 2016 in Ayungon and Bindoy were also indicated.

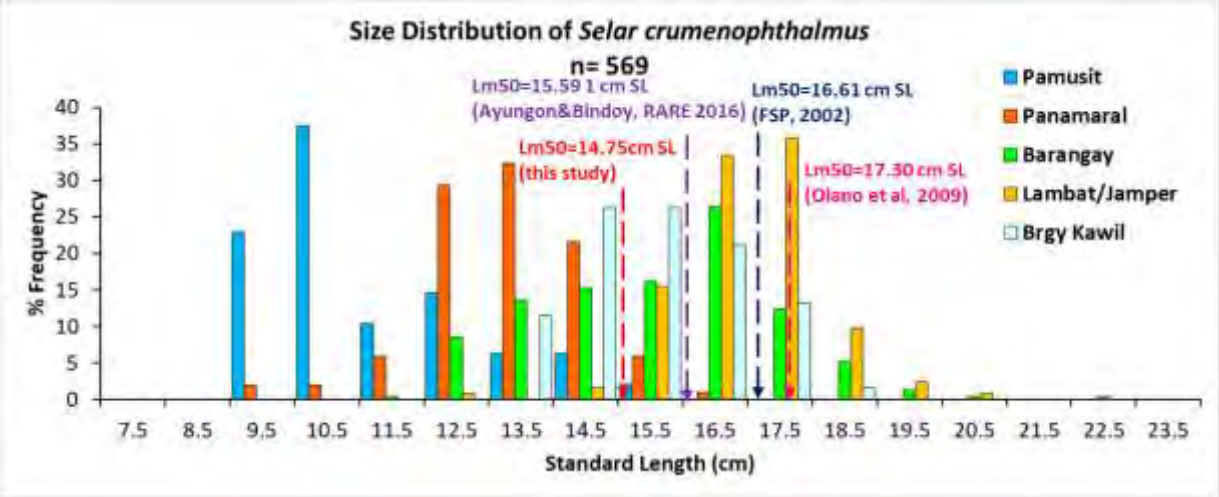


Figure xx. Size Distribution of *Selar fuscescens* caught by five (5) gears during the sampling period (August 21-November 21, 2017) in Looc and Lubang, Occidental Mindoro

C.2.3. Gonadal Maturation and Maturation Curve

A total of 218 *S. crumenophthalmus* were examined and staged and the smallest size examined measured is 12.4 cm SL (size class 12.5) and the largest is 20.3 cm SL (size class 20.5) but the smallest mature measured is 13.2 cm SL (Figure xx). Out of 218 individuals, 168 were staged as mature or 80% of the total specimens examined. 18 were immature and 32 were developing. Figure xx shows the maturation curve of ogive of S. crumenophthalmus in Looc and lubang, Occidental Mindoro. Based on the ogive, length at which 50% of the population matures (Lm50) is about 14.75 cm SL while Lm95 is 28.21 cm SL. Comparing results to a parralel study in Ayungon and Bindoy (Lm50=15.59 cm SL) last 2016, the Lm50 of the present study is lower. Accumulated data in FSP (2002) reported Lm50 for *S. crumenophthamus* is 16.61 cm SL and Olano et al. (2009) is 17.30 cm SL. Note that ogive and resulting L_{m50} and L_{m95} are dependent on the input length mature data, *i.e. there are months when larger individuals caught are larger in size which will result to larger* L_{m50} *and months when catches are smaller in size resulting to smaller* L_{m50}.

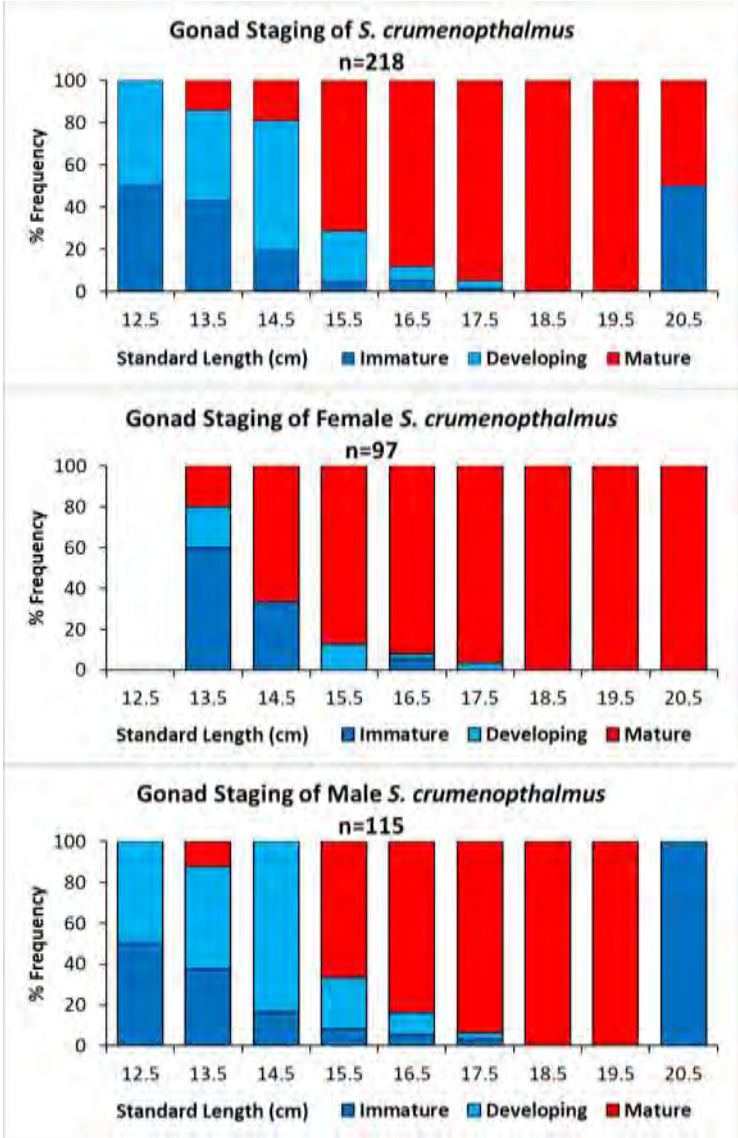


Figure xx. Gonadal Maturation of *Selar crumneophthalmus* caughtduring the sampling period in Looc and Lubang, Occidental Mindoro

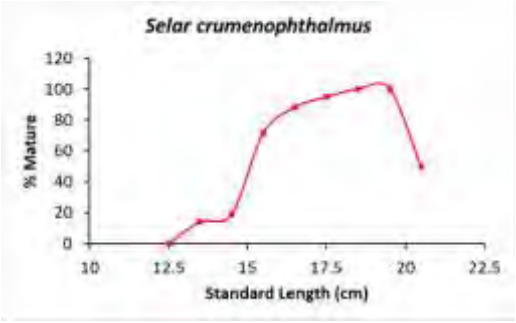


Figure xx. % Mature of *Selar crumneophthalmus*

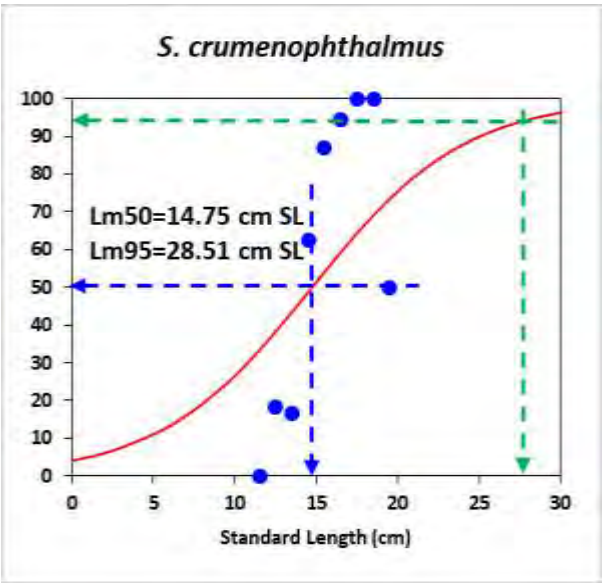


Figure xx. % Maturity Curve or Ogive *Selar crumenophthalmus* during the sampling period in Looc and Lubang, Occidental Mindoro

C.2.4. Growth Curve

Figure xx shows the growth curve of *Selar crumenophthalmus* which may be used in estimating the ages of mature specimens. Based on the constructed growth curve, the corresponding age of the estimated Lm50 (14.75 cm SL) of *S. crumenophthalmus* in Looc and Lubang, Occidental

Mindoro is about 6.5 months while the smallest mature observed in this study (10.32 cm SL) had a corresponding age of about 5 months.

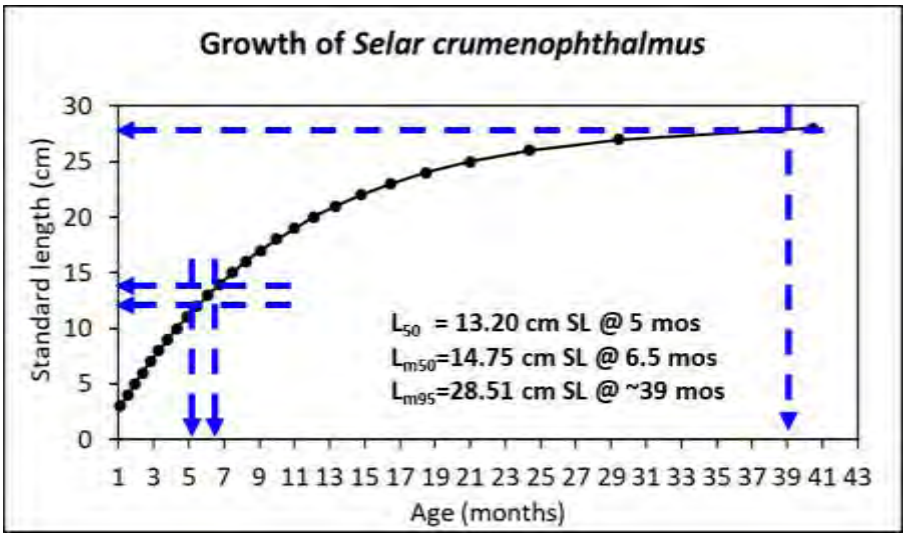


Figure xx. Growth of of *Selar crumenophthalmus* in Looc and Lubang, Occidental Mindoro during the sampling period from August 21-Novemer 21, 2017)

C.2.5. Length-Based Spawning Potential Ratio (LB-SPR)

The estimated SPR of *S. crumenophthalmmus* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 16.0% only. This is a much higher value because the fishery is catching more mature individuals (80%). In order to increase the spawning potential to the recommended value of 20% and 30%, the Lc or the length at first capture should be set between 17.98-19.97 cm SL. This indicates that catches lower than this should be banned.

Table xx. Estimated Spawning potential ratio of S. *crumenophthalmus* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
17.34 (actual)	16%
17.98	21%
18.97	26%
19.97	33%

C.2.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

- Drive-in triple nets (Pamunit & Panamaral) catch smaller fish than the other gear types that catch this species. Since both mixed mesh gill nets only catch S. crumenopthalmus incidental to their targets (squid & siganids), their use can be restricted to areas where

by-catches can be minimized. In so doing, less small S. crumenopthalmus will be caught in the fishery, increasing the length at first capture. Based on the results of the study, size limit should be set between 17.98-19.97 cm. This will allow enough individuals to spawn before capture and increase the SPR of the stock to 20-30%

C.3. *Tylosorus crocodilus (katsawang)*

C.3.1. General Biology

Figure xx. The target species, *Tylosorus crocodilus*

A pelagic species inhabiting more coastal waters than *Tylosurus acus,* but also found in offshore waters. Carnivorous, feeding mainly on small fishes. Caught by casting or trolling surface or near-surface lures; also, with purse seines and drift nets. Marketed mostly fresh. Maximum standard length (without caudal fin) at least 124 cm, commonly to 90 cm; maximum body length (without head and caudal fin) 82.5 cm; unverified reports give up to 150 cm total length. A worldwide species in tropical and warm temperate waters (replaced by *T. crocodilus fodiator* in the eastern Pacific). Throughout the area, from southern Japan through the Philippines and Indonesia to northern Australia.

C.3.2. Size Distribution

A total of 221 individuals were measured caught by three gears; Pamusit, Pangatsawang and Palutang. 52 were from pamusit, 162 from pangatsawang and 7 from palutang. The smallest recorded is caught by pamusit measured 37.5 cm SL and the largest is caught by pangatsawang that measured 77.7 cm SL. Approximately 80% of the total catch is below the calculated Lm50 which is65.59 cm SL. Among the three gears used for targeting *T. crocodilus*, Pamusit caught larger individuals compared to the other two. Study by Sabrah et al. (2017) in Suez Canal reported Lm50 of 51.7 cm TL. This value is lower compared to the value computed by the study.

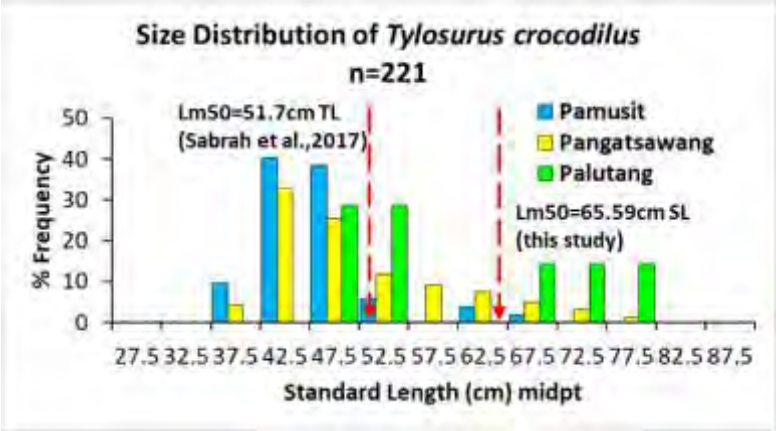


Figure xx. Size Distribution of *Tylosorus crocodilus* caught by three (3) gears; Pamusit, Pangatsawang and Palutang

C.3.3. Gonadal Maturation and Maturation Curve

Twenty-six (26) specimens of *T. crocodilus* were examined and staged. Three stages were identified; immature, developing and mature with sizes ranging from 42.5-77.5 cm SL. The smallest mature specimen belongs to size class 57.5 cm SL and all individuals present is size class 77.5 cm SL were all staged as mature (100%). The calculated Lm50 is 65.89 cm SL and Lm95 is 82.71 cm SL.

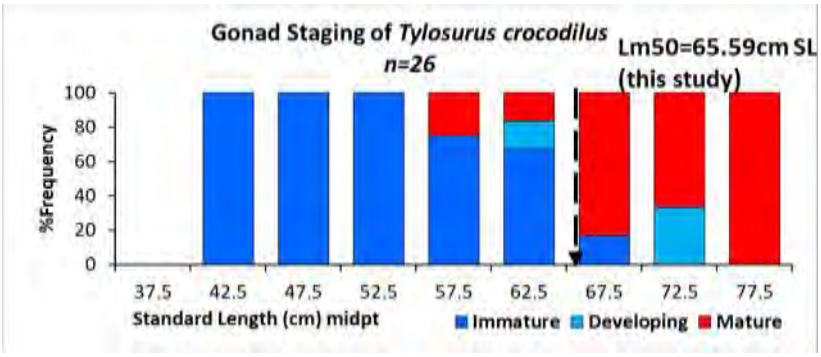


Figure xx. Gonad Staging of *Tylosorus crocodilus*

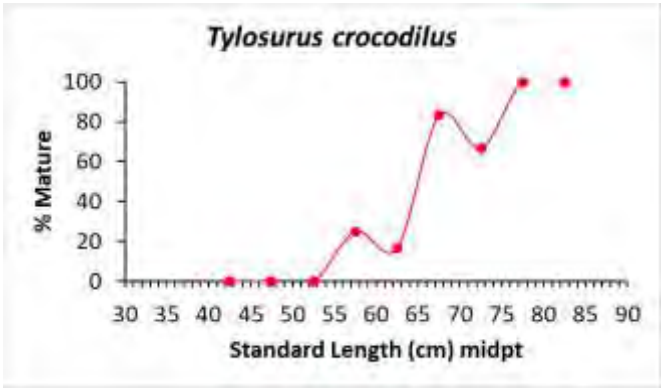


Figure xx. % Mature of *T. crocodilus*

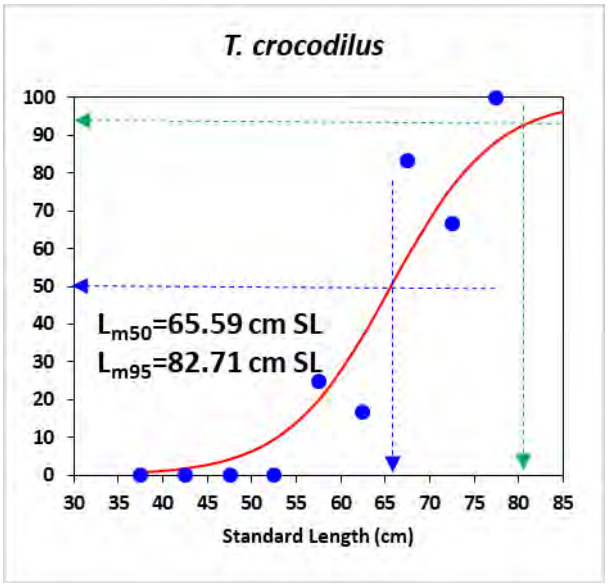


Figure xx. Maturity Curve or Ogive of *T. crocodilus*

C.3.4. Growth Curve

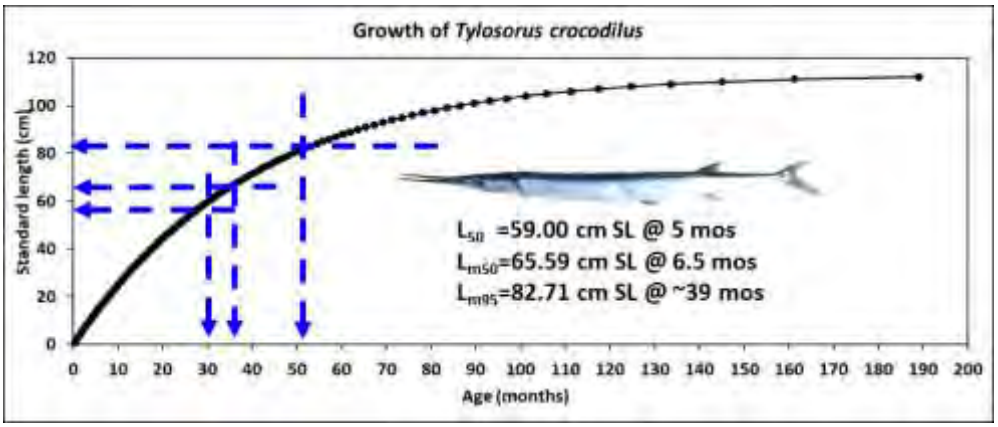


Figure xx. Growth Curve of *T. crocodilus* in Looc and Lubang, occidental Mindoro

Figure xx shows the growth curve of *T. crocodilus* which may used in estimating the ages of mature specimens. Based on the constructed growth curve, the corresponding age of the estimated Lm50 (65.50 cm SL) of *T. crocodilus* in Looc and Lubang, Occidental Mindoro is about 35 months while the smallest mature (59.00 cm SL) observed in this study had a corresponding age of ~30 months. Comparing the results of a study by Sabrah et al. (2017), the corresponding age of their computed Lm50 (51.7 cm) is about 25 months only. Note that the estimated of the present study covered only 3 months of monitoring and on the examined specimens.

C.3.5. Length-Based Spawning Potential Ratio (LB-SPR)

The estimated SPR of *T. crocodilus* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 2.0% only. This is because the fishery is catching immature individuals (~95%). In order to increase the spawning potential to the recommended value of 20% and 30%, the Lc or the length at first capture should be set between 56.99.-62.61 cm SL. This indicates that catches lower than this should be banned.

Table xx. Estimated Spawning potential ratio of *T. crocodilus* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
41.16 cm (actual)	2%
56.99	19%
57.79	29%
62.61	30%

C.3.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

For the three gears targeting *T. crocodilus* (Pamusit, Pangatsawang, Palutang), only surface gill nets (palutang) catch larger fish, while all 3 catch substantial portions of juveniles. It is unclear if

surface gill nets are fished in areas where the other 2 gear types do not operate. If this is so, catches of juveniles may be reduced by regulating catches of the latter.

C.4. *Cheilopogon katoptron (himalit)*

C.4.1. General Biology

Maximum standard length of *C. katoptron* (Indonesian flyingfish) is about 18 cm. Pelagic in nearshore surface waters, never spread to open sea. Minor importance in fisheries in Viet Nam and Philippines is observed. Distributed in the western Pacific Ocean (Viet Nam, Thailand, Indonesia, Philippines, and northern Australia).

Figure xx. The Target species *Cheilopogon katoptron*.

C.4.2. Size Distribution

A total of 412 *C. katoptron* were measured (from length measurements made by the enumerators and from biological samples brought to the lab). The smallest recorded individual measured 15 cm SL (size class 14.5) and the largest is 29.5 cm SL (size class 29.5). The calculated Lm50 of the study is 17.01 cm SL which is lower than the smallest individual measured. This shows that 53% of the total individual sampled were all mature.

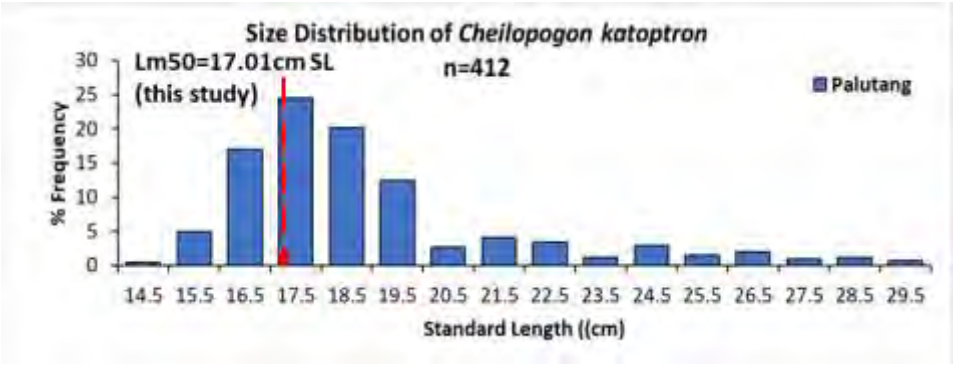
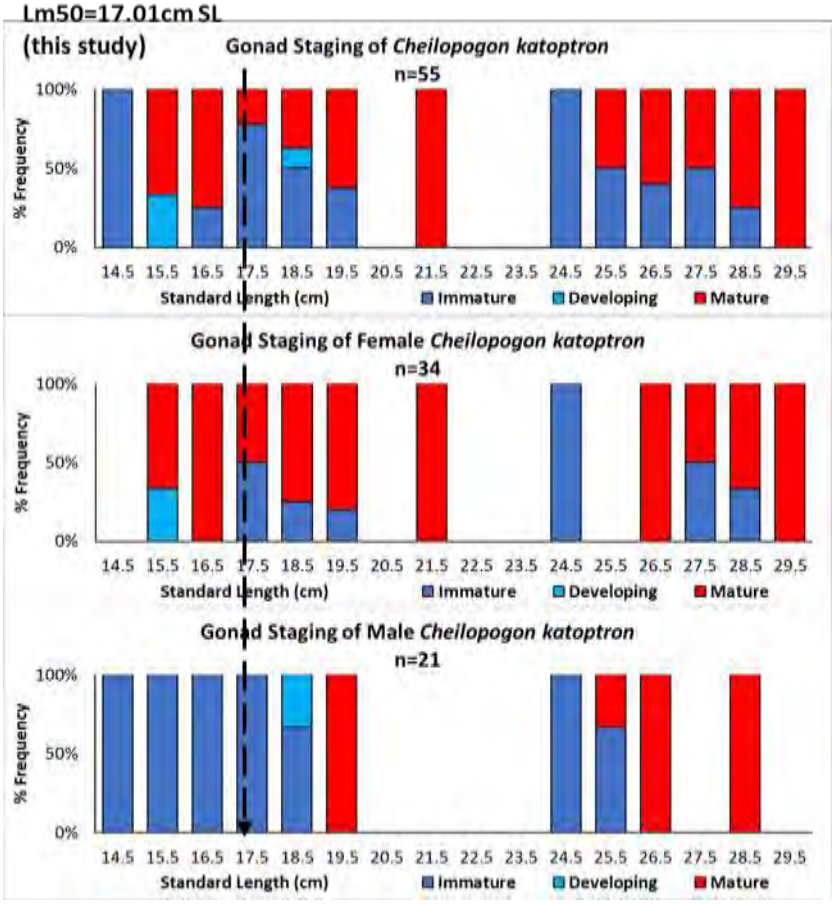


Figure xx. Size Distribution of *C. Katoptron* caught by Palutang (Surface gill net)

C.4.3. Gonadal Maturation and Maturation Curve



Only 55 biological samples of *C. katoprton* were examined and staged. 34 out of 55 were females and the rest are males. Three stages were identified, immature, developing and mature. The smallest female mature measured 15.5 cm SL (size class 14.5) and the smallest mature in male measured is 15 cm SL (size class 14.5) while the largest female and male measured 29.5 cm SL and 28.5 cm SL (size class 28.5 and 27.5). Based on the maturity curve of mature individuals of *C. katoptron*, L_{m50} is 17.01 cm SL and Lm95 is 21.95 cm SL.

Figure xx. Gonadal Maturation of *C. katoptron*

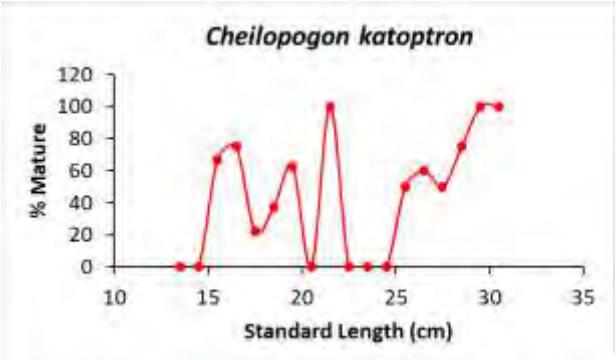


Figure xx. % Mature *C. katoptron*

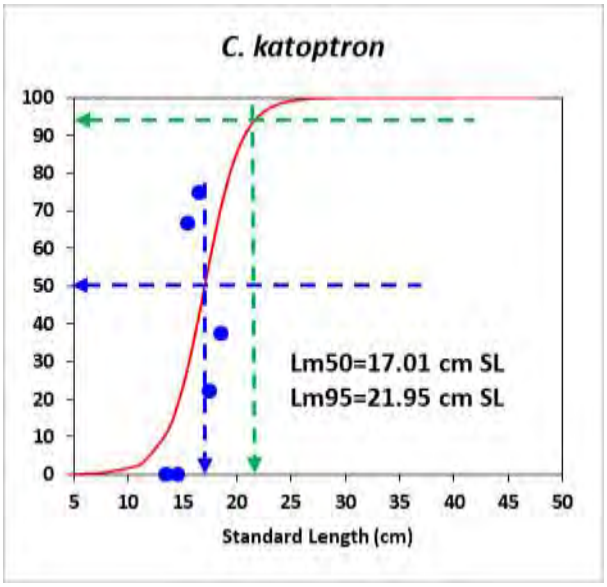


Figure xx. Maturity Curve or ogive of *C. katoptron*

C.4.4. Growth Curve

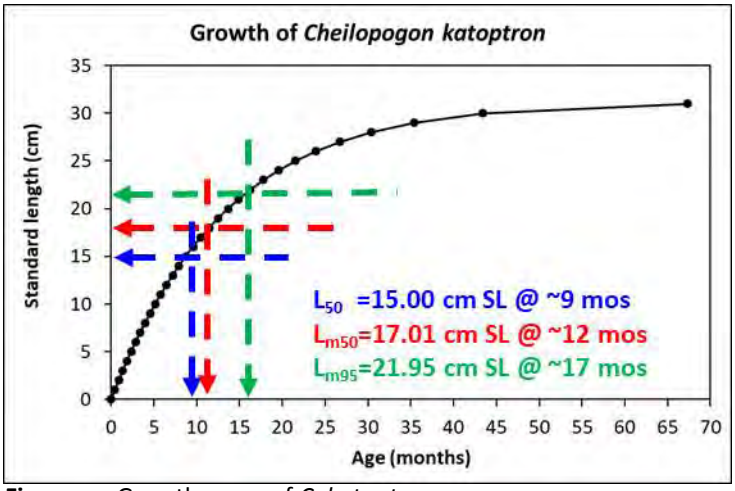


Figure xx. Growth curve of *C. katoptron*

Figure xx the growth curve of *Cheilopogon katoptron*. Since no available on *C. katoptron* was conducted, growth coeffiecient "k" and "Linf" used on constructing the growth curve were derived from Lavapie-Gonzales et al. (1997-1999). Based on the constructed growth curve of *C. katoptron,* the corresponding age of the smallest mature (15.00 cm SL) is approximately 9 months. Lm50 (17.01 cm SL) and Lm95 (21.95 cm SL) have a corresponding age of approximately 12 months and 17 months respectively.

C.4.5. Length-Based Spawning Potential Ratio (LB-SPR)

Table xx. Estimated Spawning potential ratio of *C. katoptron* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
16.12 (actual)	30%

The estimated SPR of *C. katoptron* caught in the fishery in Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 30%. This value is high relative to the other target species. Flying fish are considered as small pelagic fish but are locally caught in open water. Because sea conditions in the study area are rough for a good portion of the year, fishing is not year round, allowing a natural refuge for local pelagic resources. This may not necessarily be true for shallow water demersal fish which are more accessible for a longer part of the year.

C.4.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

- Actual SPR value off the catches (30%) is equal to the recommended value (20-30%). To further sustain the fishery, the median size of the catches should be set at 17.0 cm SL or higher. Surface gillnet catches should be regularly monitored with strict regulation of mesh size.
- Fish buyers should also be informed with the above recommendations. Buyers should be instructed to buy *C. katoptron* that are equal or greater than the presented size limit.

Fishers will be discouraged to catch smaller individuals if they know that buyers will not buy smaller or less than the recommended size limit.

C.5. *Cheilopogon spilopterus (himalit)*

C.5.1. General Biology

Figure xx. The Target species *Cheilopogon spilopterus*

A pelagic fish in nearshore and neritic surface waters. It is considered to be a minor importance in fisheries (Thailand). *C. spilopterus* feeds on zooplankton and small fishes. Distributed in the eastern Indian and western Pacific oceans from Andaman Sea to Samoa. Length at first maturity is 28.5 cm SL. Other name is Many spotted flyingfish due to the occurrence of many spots located in its pectoral fins. Maximum standard length of *C. spilopterus* is about 25 cm.

C.5.2. Size Distribution

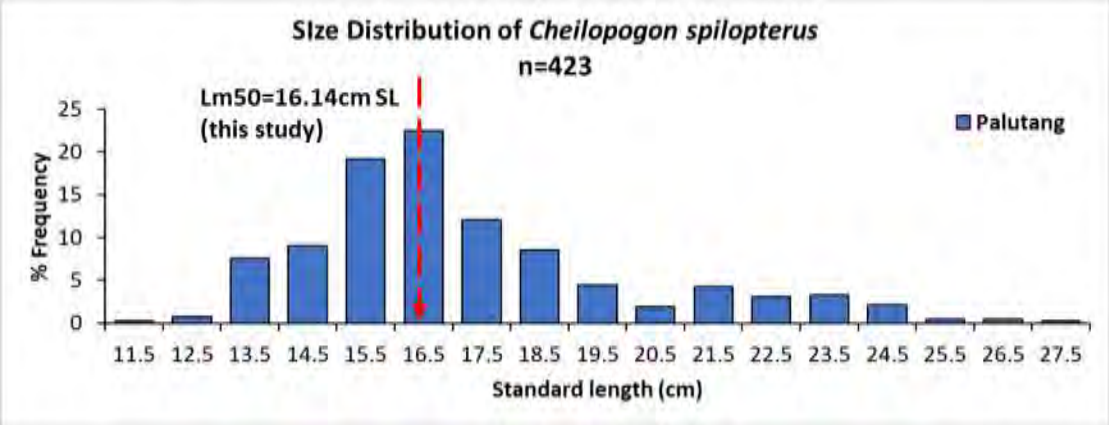


Figure xx. Size distribution of *C. spilopterus* caught by Palutang (Surface gill net).

A total of 423 C. *spilopterus* were measured and these samples were combination of weekly measurements of enumerators and bought biological samples. The smallest individual measured 11.8 cm SL and the largest is 27.3 cm SL. The calculated Lm50 of the study is 19.73 cm SL and ~75% of the measured individuals were caught before it reaches the calculated Lm50.

C.5.3. Gonadal Maturation and Maturation Curve

Only 53 biological samples of *C. spilopterus* were examined and staged. Of 53 samples, 35 were females and 18 were males. 20 females were mature and 15 were immature. Only 1 sample in

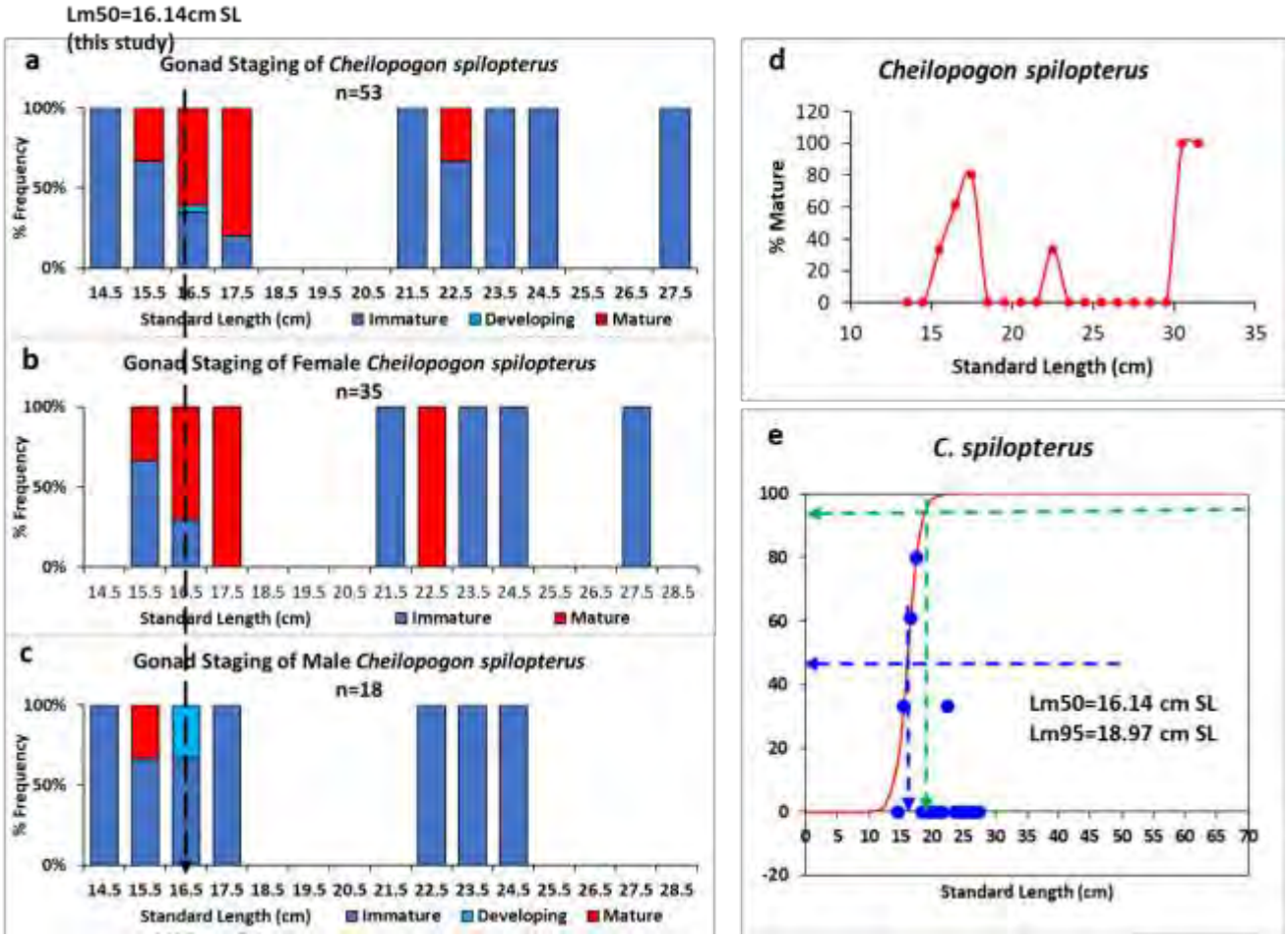


Figure xx. Gonad Maturation (**a**-combined**; b-** female**; c-** male**; d-** % Mature**; e-** Maturity Curve or ogive of *C. Spilopterus*

males were staged mature, 1 developing and 16 were immature. Based on the maturity curve of the mature samples, the calculated Lm50 is 16.14 cm SL and Lm95 is 18.97 cm SL. The smallest mature individual measured 15.6 cm SL.

C.5.4. Growth Curve

The growth curve of *Cheilopogon spilopterus* is in figure xx. Since there is no available data on *C. katoptron,* growth coeffiecient "k" and "Linf" used on constructing the growth curve were derived from Lavapie-Gonzales et al. (1997-1999) Based on the constructed growth curve of *C.*

katoptron, the corresponding age of the smallest mature (15.60 cm SL) is approximately 9 months while the estimated Lm50 (16.14 cm SL) has a corresponding age of 12 months. The corresponding age of Lm95 (18.97 cm SL) is approximately 13 months.

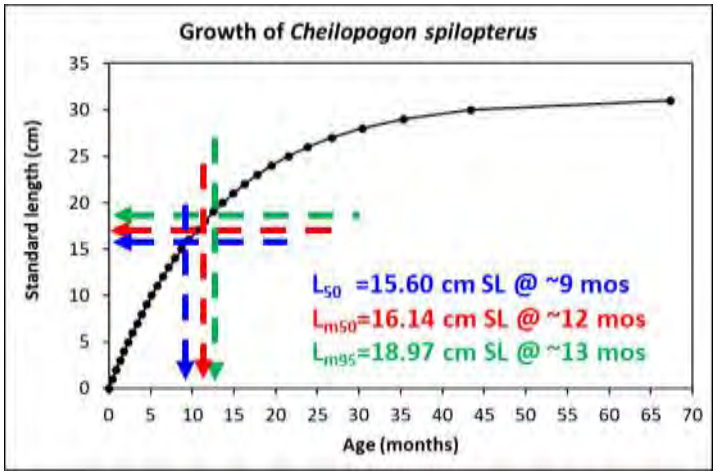


Figure xx. Growth curve of *C. spilopterus*

C.5.5. Length-Based Spawning Potential Ratio (LB-SPR)

The estimated SPR of *C. spilopterus* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 22%. This value is in the lower range of acceptable values (20-30%). This species is caught primarily by surface gill nets, similar to the previous species, but it is not clear whether the two are caught in different areas. The differences in their size distributions in the catch may be due to differences in biology rather than different habitats. If this is the case, they share the same habitat and are caught together, hence targeting the minimum size set for C. katoptron (17.0cm SL) would be beneficial to both stocks and to the fishery in the long run.

Table xx. Estimated Spawning potential ratio of *C. spilopterus* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
14.35 (actual)	22%
15.34	28%
15.51	31%

C.5.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

- The median size of the catches should be set at 17.0 cm SL or higher. Surface gillnet catches should be regularly monitored with strict regulation of mesh size.
- Fish buyers should also be informed with the above recommendations. Buyers should be instructed to buy *C. spilopterus* that are equal or greater than the presented size limit. Fishers will be discouraged to catch smaller individuals if they know that buyers will not buy smaller or less than the recommended size limit.

C.6. *Acanthurus olivaceus (Itingan/Itingan orange)*

C.6.1. General Biology

Figure 7. The target species *Acanthurus olivaceus.*

A coral-reef species that ranges in light olive grey to dark brown color with a horizontal bright orange band, but also found over sand near reefs. Frequently seen in small aggregations and feeds on benthic algae. is caught by traps, nets, or spears and usually marketed fresh. Usually found in Central and western Pacific; in the west from southern Japan to central New South Wales; in the east to Hawaii and Tuamotu Archipelago. Records of *A. olivaceus* from the Indian Ocean have been misidentifications of *A. tennetti*, except for Christmas Island where the species occurs naturally. Maximum total length is about 35 cm. but common size is 26 cm. (source: FAO)

C.6.2. Size Distribution

The size distribution of *A. olivaceus* during the sampling period is shown in figure xx. Length measurements shown are from the biological samples only and no weekly measurements from the enumerator. The estimate of length at first maturity L_{m50}, explained below, are based either on actual estimates from the present study and/or from the literature. The length at first maturity is superimposed on the size distributions to show the relative portions of the stock (adult vs non-adult) caught by the fishery. A total of only 20 individuals were processed and examined. The smallest individual caught measured 14 cm SL. (size class 13.5) while the largest is 21.6cm SL (size class 21.5). Of the catches, approximately 60% of the total processed individual were caught below Lm50 (18.84 cm SL). This indicates that *A. olivaceus* were mostly caught as immature.

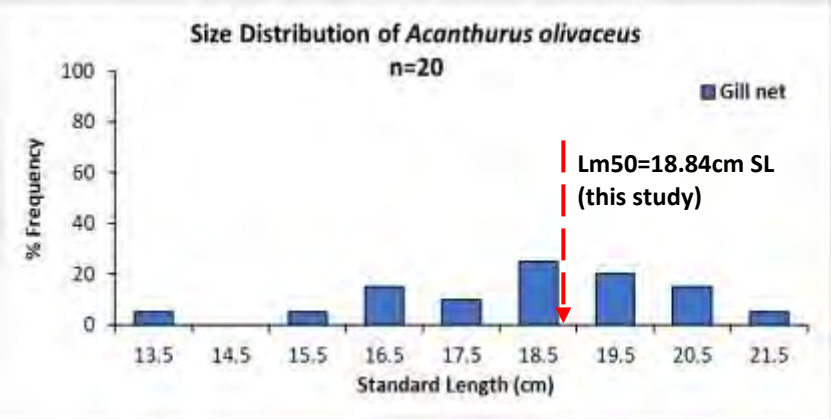
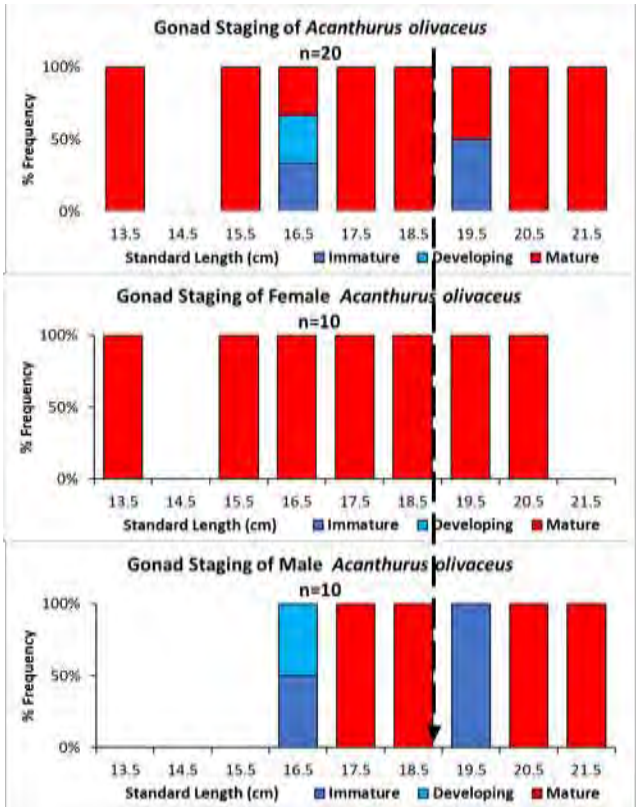


Figure xx. Size distribution of *Acanthurus olivaceus* caught in Lubang, Occidental Mindoro from August 21-November 21, 2017.

C.6.3. Gonadal Maturation and Maturation Curve



Lm50=18.84cm SL (this study)

Figure xx. Gonadal maturation of *Acanthurus olivaceus s* in Lubang, Occidental Mindoro: **"**n" above bars refers to the number of specimens examined per size class.

The distribution of gonad development stages by size class in *A. olivaceus* is shown in Fig. xx. These data were used to construct a maturity curve from which the size at first maturity (L_{m50}) was estimated. This parameter, in turn, will be used in estimating the spawning potential ratio of the target species as discussed in a later section. The data used to construct the maturation bar chart and curve include only those from biological samples brought back to the lab. A total of 20 individuals were examined for gonadal staging. 10 are females and 10 are males. Of these, 16 individuals were mature ranging from 13.5-21.5 cm SL size class. All females were staged as mature and male individuals have 1 developing and 2 immature stages, the rest were mature. Figure xx shows the maturation curve of *A. olivaceus* in Lubang, Occidental Mindoro with the derived Lm50 and Lm95 which are

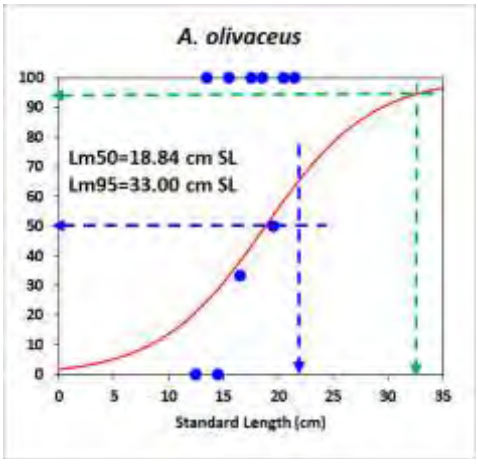


Figure xx. Maturity Curve or of *A. olivaceus*

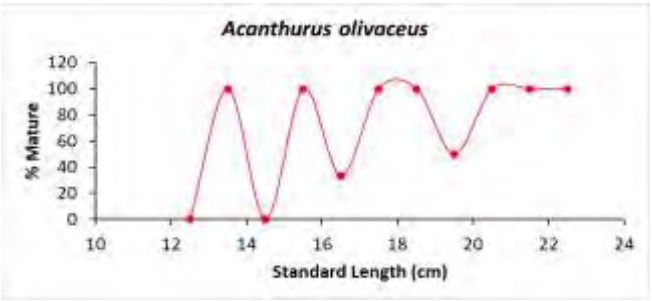


Figure xx. % Mature of *A. olivaceus*

needed in estimating the spawning potential ratio (SPR) of the stock. Based on the maturity curve, the length at which 50% of fish are mature (Lm50) is about 18.84 cm SL. It should be noted that the maturity curve and the derived Lm50 and Lm95 are dependent on the input length and maturity data of the samples from the sampling date. There may be instances that there are months with more mature fish and wide size ranges and months with less catches and narrower ranges. The corresponding estimates Lm50 and Lm95 will differ in different scenarios. Calculated Lm50 and Lm95 for *A. olivaceus* are 18.84 cm SL and 33.00 cm SL. The smallest mature measured 14.0 cm SL.

C.6.4. Growth Curve

Figure xx shows the growth curve of *A. olivaceus* which may use in estimating the ages of mature specimens. For the standard length (s axis), maximum length (35 cm) was used than the L infinity (21 cm) to accommodate the bigger computed Lm95 (33.0 cm SL). Based on the constructed growth curve, the corresponding age of the estimated Lm50 (18.84 cm SL) of *A.olivaceus* in Looc and Lubang, Occidental Mindoro is approximately 9 months while the smallest mature (14.0 cm SL) observed in this study had a corresponding age of ~6 months. Note that these estimates are based only on the examined specimen.

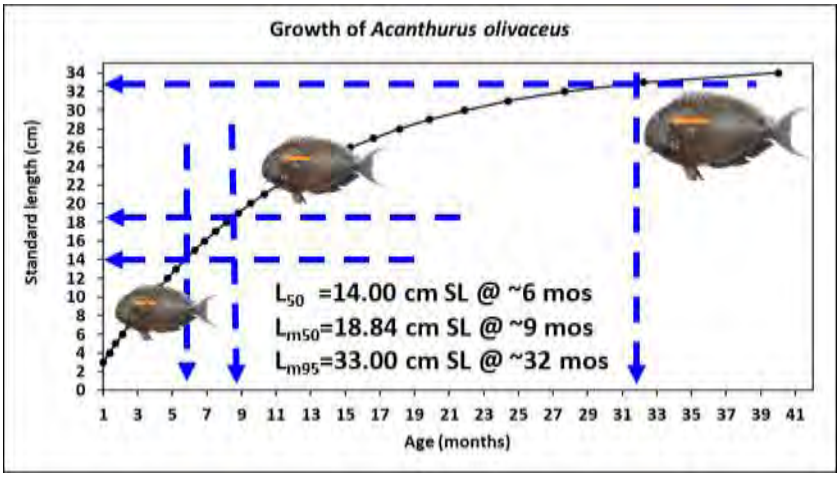


Figure xx. Growth Curve of *A. olivaceus*

C.6.5. Length-Based Spawning Potential Ratio (LB-SPR)

Table xx. Estimated Spawning potential ratio of *A. olivaceus* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
20.19 (actual)	10%
25.83	20%
27.52	30%

The estimated SPR of *A. olivaceus* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 10.0% only. In order to increase the spawning potential to the recommended value of 20% and 30%, the Lc or the length at first capture should be set between 25.83-27.52-2 cm SL. Since bottom-set gill nets are used to catch a wide range of species, imposing mesh size

regulations beneficial to A. olivaceus alone, or to any single species group for that matter, may not be practical. Other gear types, such as hook and line or spearfishing, allow more control on the sizes of landed catches and are more preferable for use in reef areas. A more wide-ranging measure is to establish marine protected areas in strategic locations around the island with strict implementation.

C.6.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

- The mesh size gears targeting *A. olivaceus* (gill nets) should be increased to allow smaller/younger fish to pass though the net. Sixty percent (60%) of catches are smaller than the estimated value of Lm50 (18.84 cm SL). Based on the results of the study, size limit should be set between 25.83-27.52 cm SL. This will allow enough individuals to spawn before capture and increase the SPR of the stock to 20-30%
- Fish buyers should also be informed with the above recommendations. Buyers should be instructed to buy *A. olivaceus* that are equal or greater than the presented size limit. Fishers will be discouraged to catch smaller individuals if they know that buyers will not buy smaller or less than the recommended size limit.

C.7. *Acanthurus xanthopterus (Itingan Labahita)*

C.7.1. General Biology

Figure 7. The target species *Acanthurus olivaceus.*

A. xanthopterus are more common in lagoons and bays than exposed outer reef areas; usually found at depths greater than 10 to 15 m; reported to 90 m. More inclined than other species of Acanthurus to stray from the shelter of coral reefs or rocky outcrops. May occur as solitary individuals or in small aggregations. Feeds on benthic algae, including the fine film of diatoms and detritus on sand; occasionally caught by hook and line with animal material as bait (unusual in this respect for a surgeonfish). Found in wide-ranging in the Indo-Pacific region (absent from the Red Sea to the Persian Gulf) from East Africa to French Polynesia and Hawaii, as well as the

tropical eastern Pacific; in the western Pacific from southern Japan to the southern Great Barrier Reef.

C.7.2. Size Distribution

The size distribution of *A. xanthopterus* during the sampling period is shown in figure xx. Length measurements shown are from the biological samples only and no weekly measurements from the enumerator. A total of only 44 individuals were processed and examined. The smallest individual caught measured 9 cm SL. (size class 8.5) while the largest is 39.8 cm SL (size class 39.5). Of the catches, ~95% of the total processed individual were caught below Lm50 (14.02 cm SL). This indicates that *A. olivaceus* were mostly caught as immature.

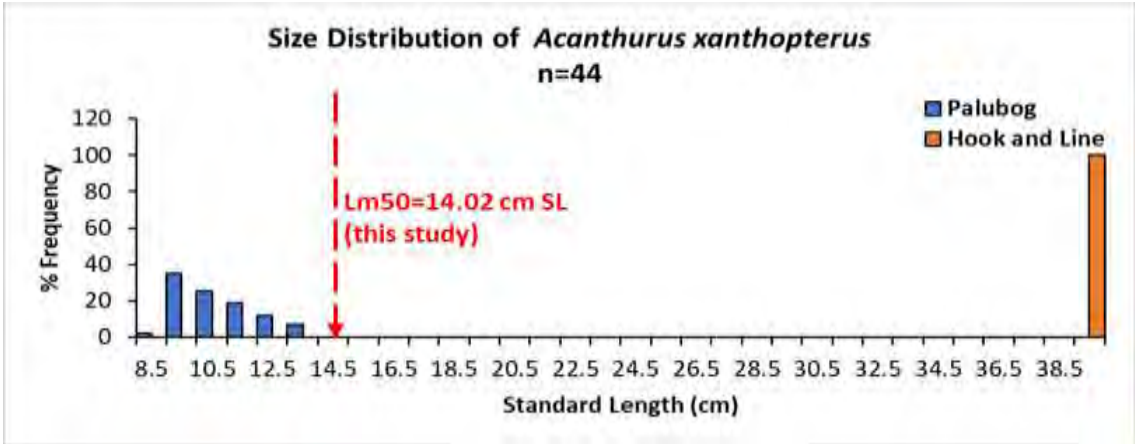


Figure xx. Size distribution of *Acanthurus xanthopterus* caught in Lubang, Occidental Mindoro from August 21-November 21, 2017.

C.7.3. Gonadal Maturation and Maturation Curve

The distribution of gonad development stages by size class in *A. xanthopterus* is shown in Fig. xx. All 44 individuals were examined for gonadal staging but only 29 were plotted, the other 14 individuals were all undefined. 7 females and 22 males were identified. The smallest individual for female and male are 10.4 cm SL and 9.0 cm SL (size class= 9.5) while the largest are 13.4 cm SL and 14 cm SL (size class= 12.5, 13.5 cm SL). 5 individuals were mature, and all are females, all males are staged as immature. Figure xx shows the maturation curve of *A. xanthopterus* in Lubang, Occidental Mindoro with the derived Lm50 and Lm95. Based on the maturity curve, the length at which 50% of fish are mature (Lm50) is about 14.02 cm SL and the calculated Lm95 for is 21.01 cm SL.

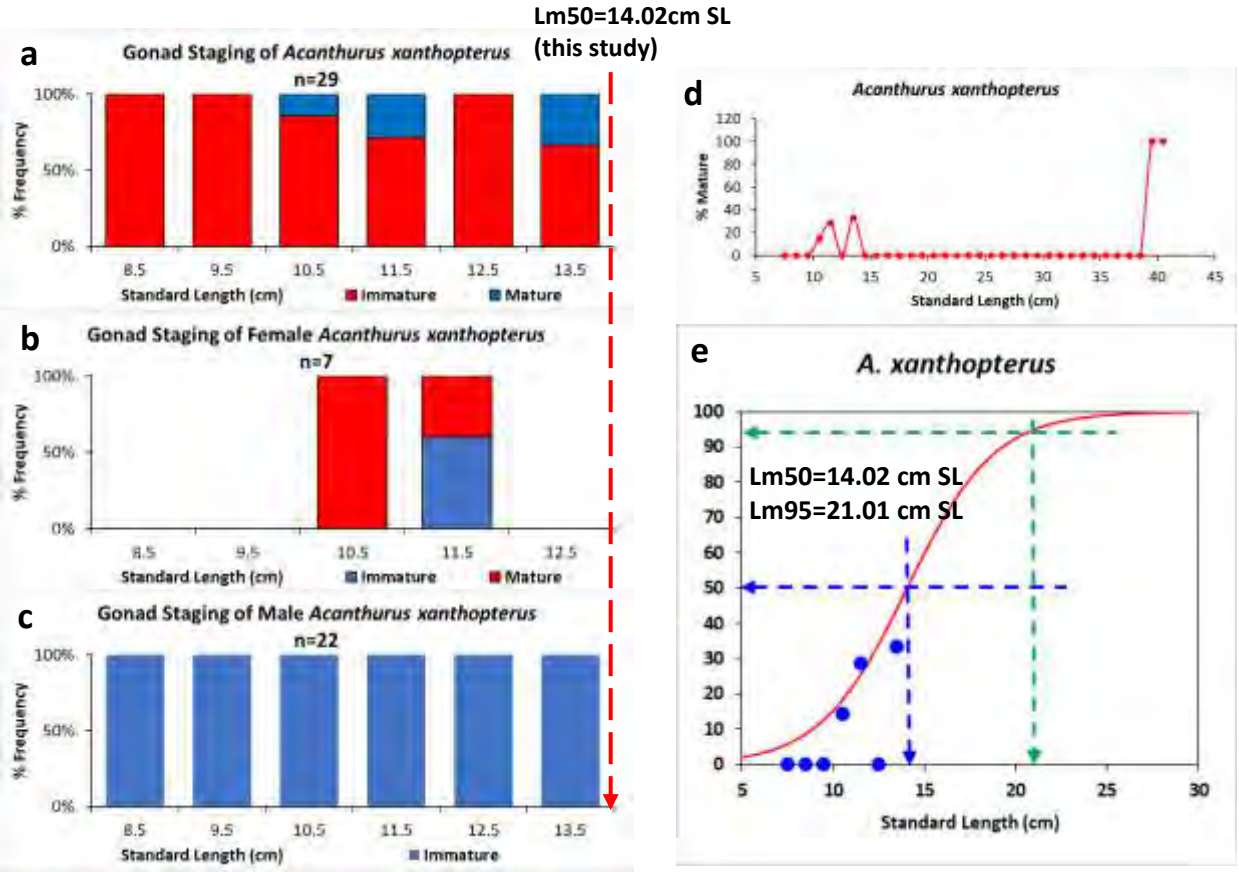


Figure xx. Gonadal maturation of *Acanthurus xanthopterus* in Lubang, Occidental Mindoro: **a**-combined; **b**-female; **c**-male; **d**-% mature; **e**- Maturity Curve

C.7.4. Growth Curve

Figure xx the growth curve of *Acanthurus xanthopterus* using growth coefficient taken from fishbase (L inf= 42.6 cm and k=0.287). Based on the constructed growth curve of *A. xantthopterus,* the corresponding age of the smallest mature (10.40 cm SL) individual

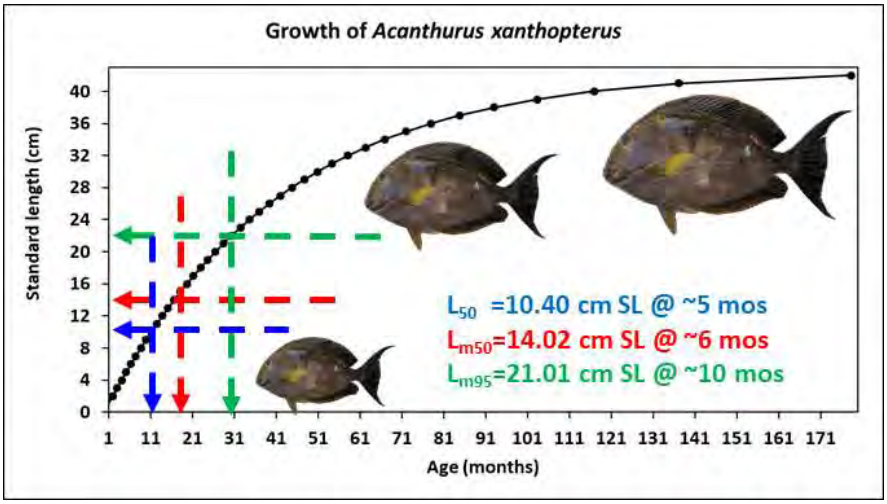


Figure xx. Growth Curve of *Acanthurus xanthopterus*

recorded in the study, estimated Lm50 (14.02 cm SL) and Lm95 (21.01 cm SL) is approximately 5, 6 and 10 months.

C.7.5. Length-Based Spawning Potential Ratio (LB-SPR)

Table xx. Estimated Spawning potential ratio of *A. xanthopterus* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
8.59 (actual)	1%
19.21	22%
21.53	31%

The estimated SPR of *A. xanthopterus* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At present, SPR of the stock based on the 3-month monitoring data is 1.0% only. This is because the ~95 of the catch is below the estimated Lm50(18.84 cm SL). In order to increase the spawning potential to the recommended value of 20% and 30%, the Lc or the length at first capture should be set between 19.21-21.53 cm SL. The difference in catches between gill nets and hook and line is clearly shown in Fig. xx above. Size regulations of landed catches are more achievable for hook and line

C.7.6. Harvest Control Recommendations.

Based on the results of the 3-month monitoring the following are recommended:

- The mesh size gears targeting *A. xanthopterus* (bottom-set gill nets/palubog) should be increased to allow smaller/younger fish to pass though the net. 60% of the catch brought to the lab is lower than the computed value of Lm50(14.02 cm SL). Based on the results of the study, size limit should be set between 19.21-21.53 cm SL. This will allow enough individuals to spawn before capture and increase the SPR of the stock to 20-30%
- For hook and line targeting *A. xanthoptherus,* sizes below the recommended value (9.21-21.53 cm SL) should be banned and only bigger or equal than the recommended value should be caught.
- Establish MPAs
- Fish buyers should also be informed with the above recommendations. Buyers should be instructed to buy *A. olivaceus* that are equal or greater than the presented size limit. Fishers will be discouraged to catch smaller individuals if they know that buyers will not buy smaller or less than the recommended size limit.

C.8. *Ctenochaetus striatus (Itingan/Itngan Stripes)*

C.8.1. General Biology

Figure xx. The target species *Ctenochaetus striatus*

One of the most abundant and ubiquitous of surgeonfishes, occurring in various reef habitats from protected lagoons to ocean reefs. Feeds on detritus with a combination of suction and scraping with its numerous comb-like teeth. No definite fishing localities. Taken mainly in nets and traps and usually marketed fresh. Distributed widespread in the Indo-Pacific region, but absent from the Gulf of Oman, Persian Gulf, and Hawaii; ranges in the western Pacific from southern Japan to the southern Great Barrier Reef. Maximum total length 25 cm, commonly to 18 cm. (source:: FAO)

C.8.2. Size Distribution

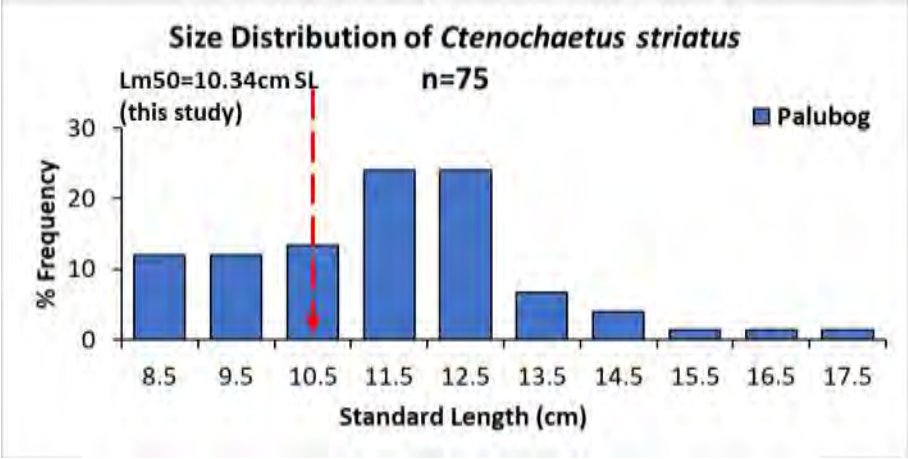


Figure xx. Size Distribution of *Ctenochaetus striatus* caught by Palubog (Bottom-set Gill Net)

75 measurements were done in *C. striatus* and these measurements were all taken from biological samples collected. The smallest measurement caught by Palubog is 8.2 cm SL (size class 8.5) and the largest is 17.2 (size class 17.5). The calculated Lm50 is 10.34 cm SL which indicates that during the sampling dates, the catches caught by Palubog is ~25% smaller than the calculated Lm50.

C.8.3. Gonadal Maturation and Maturation Curve

Out of 75 samples bought, only 67 were brought to the lab, examined and staged. The other 8 were recorded by the field assistant but gonads were either indeterminate or could be found. Out of 67 individuals, 33 were females and 34 were males. The smallest mature caught by *palubog* was 8.2 cm SL for females and 8.3 cm SL for males. The largest mature individual measured 14.2 cm SL for females and 17.2 cm SL for males. Three stages were identified in the

biological samples; immature, developing and mature. Based on the maturity curve (figure xx) of *C. striatus*, the calculated Lm50 is 10.34 and Lm95 is 17.36 cm SL. The calculated Lm50 is 10.34 cm SL which indicates that during the sampling dates only 25% of the catches from palubog is

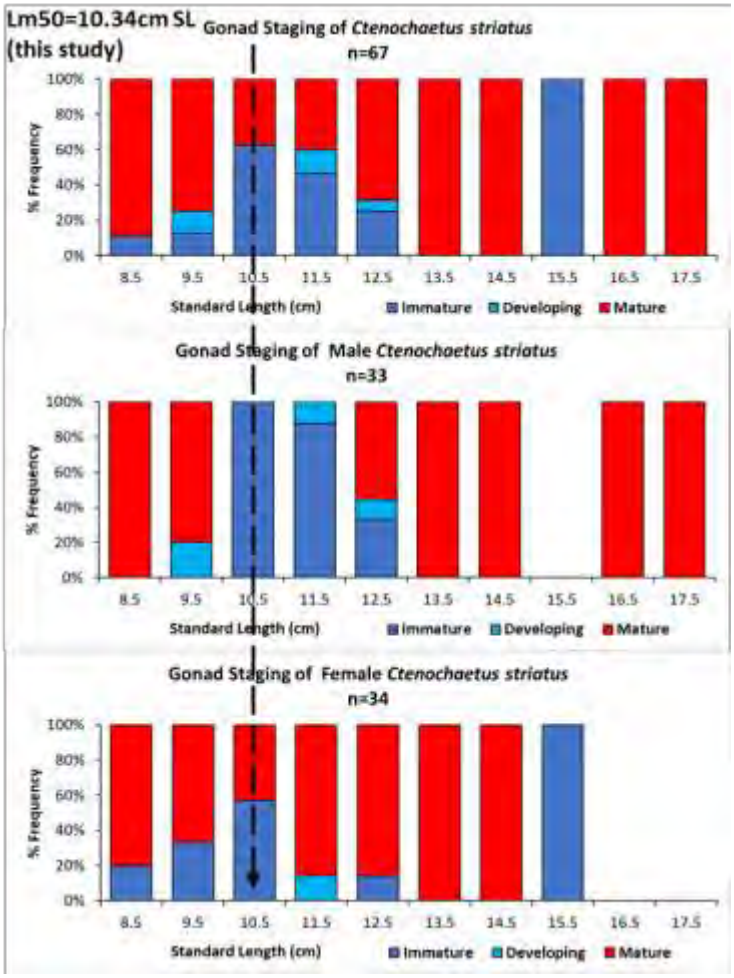


Figure xx. Gonadal Staging of *C. striatus*

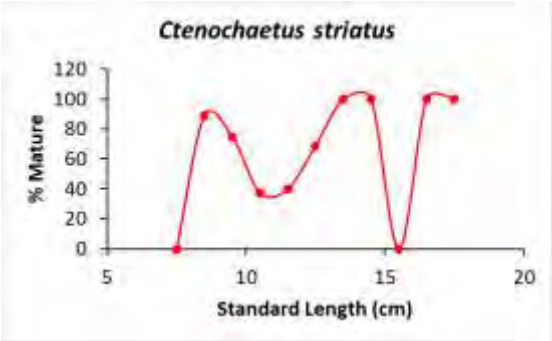


Figure xx. % Mature of *C. striatus*

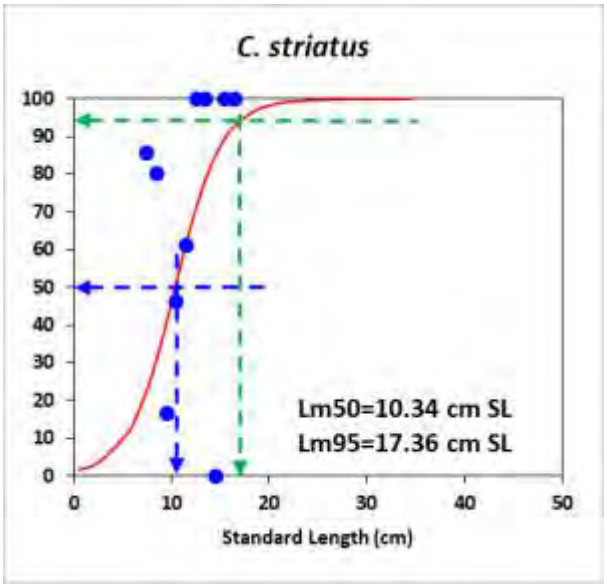


Figure xx. Maturity Curve or ogive of *C. striatus*

smaller than the calculated Lm50.

C.8.4. Growth Curve

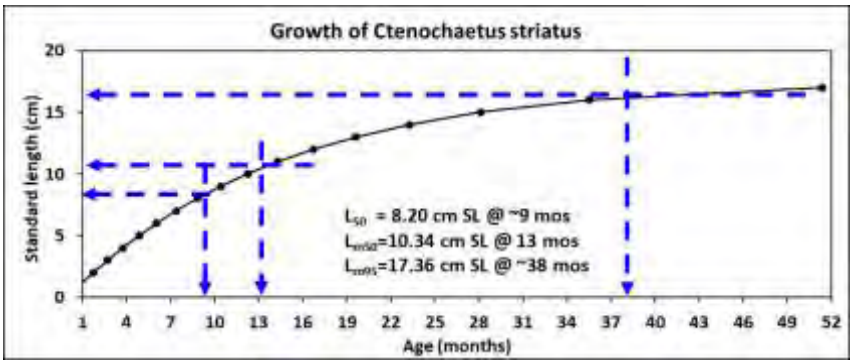


Figure xx. Growth curve of *C. striatus* in Looc and lUbang, Occidental Mindoro during the sampling period

Based on the constructed growth curve (figure xx), the corresponding age of the estimated Lm50 (10.34 cm SL) of *C. striatus* in Looc and Lubang, Occidental Mindoro is about 13 months while the smallest mature (8.2 cm SL) specimen had a corresponding age of ~9 months while it will take approximately 38 months in order to reach Lm95 (17.36 cm SL).

C.8.5. Length-Based Spawning Potential Ratio (LB-SPR)

Table xx. Estimated Spawning potential ratio of *C. striatus* in Looc and Lubang, Occidental Mindoro.

L_c (cm)	Spawning Potential Ratio
10.34 (actual)	64%

The estimated SPR of *C. striatus* caught in the fishery in Looc and Lubang, Occidental Mindoro is shown in Table xx. At presesnt, SPR of the stock based on the 3-month monitoring data is 64.0%. This is a much higher value because the fishery is catching more mature individuals (75%). The recommended value of spawning ratio is 20% and 30% in which the computed LB-SPR for *C. striatus* exceeds. This may indicate that the striated surgeonfish of Looc and Lubang is at sustainable level. But note that SPR presented here is just for 3-month monitoring period only and during the sampling period, Palubog (Bottom set gill net) is rarely used due to fishers opted to use other gears that catches abundant fishes that time.

C.8.6. Harvest Control Recommendations

Based on the results of the 3-month monitoring the following are recommended:

- Actual SPR value of the catches (64%) is well above the recommended value (20-30%). To further sustain the fishery, modal size of the catches may be set at 10.34 cm SL.
- Fish buyers should also be informed with the above recommendations. Buyers should be instructed to buy *C. striatus* that are equal or greater than the presented size limit. Fishers will be discouraged to catch smaller individuals if they know that buyers will not buy smaller or less than the recommended size limit.