Current Status of Dominant Pelagic Fish Species Caught by Purse Seine in the Eastern Sulu Sea and the Basilan Strait

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ABSTRACT

Data collection was conducted in four (4) pre-identified fish landing sites in Zamboanga City. Sampling was conducted every other two days of the month with the third day as a rest day. The strategies used included interviews with fishers and/or boat captains to determine fishing grounds, type of gear used, total catch, and the number of fishing days. Two data collectors per site determine the species, length (total length if small, and fork length on larger fish), and the weight measurements from the one kilo of samples extracted from the total catch. Results show that the CPUE for the whole commercial fisheries subsector averaged 10,890.5 kg/day while the purse seine, which is the most prevalent gear employed, had a higher average CPUE of 14,142 kg/day. Its monthly CPUE was highest in April at 19,800.28 kg/day and lowest in December at 9,624.83 kg/day. The total catch of the commercial subsector for 2013 was 22,855,452.85 kg with April registering the highest at 4,116,650.9 kg and lowest in December at 313,980 kg. Overall, *Sardinella lemuru* constituted 45.89% of the total commercial sector production for 2013, followed by *Amblygaster sirm* at 13.19%, *Selar crumenophthalmus* at 8.93%, *Rastrelliger kanagurta* at 8.81% and *Decapterus macrosoma* at 8.17%. The most exploited species was *Decapterus macrosoma* caught by Purse Seine with an E value of 0.71, followed by *Sardinella lemuru* with 0.59, *Amblygaster sirm* with 0.57, and *Rastrelliger kanagurta* with 0.51. The species *Selar crumenophthalmus* has the lowest E value at 0.38. The maximum length (Lmax) of *S. lemuru, A. sirm, R. kanagurta,* and *D. macrosoma* are much higher than the published values of length at first maturity of subject species. *Decapterus macrosoma, S. lemuru, A. sirm,* and *R. kanagurta* all have higher fishing mortality than natural mortality suggestive of overexploitation. *Amblygaster sirm* and *Rastrelliger kanagurta* caught by purse seine were both captured before maturity with L25 values of 15.0 cms and 19.0 cm respectively while *Sardinella lemuru* and *Decapterus macrosoma* were already matured when captured with values of 15.0 cm and 19.0 cm, respectively. Fishing pressure on the most dominant species, *S. lemuru,* is high and its maximum length has gone down by as much as 23% over the past decade.

1. INTRODUCTION

In the Philippines, the small pelagic fish as a group consists predominantly of round scads (*Decapterus spp.*), anchovies (*Stolephorous spp.*), sardines (*Sardinella spp.,*), and mackerels (*Rastrelliger spp.*). Included in this group are the herrings (Clupeidae), fusiliers (Caesionidae), bigeyed scads (Carangidae), flying fishes (Exocoetidae), and halfbeaks (Hemiramphidae). Small pelagic fishes are usually found in continental shelf waters (not exceeding 200m depth). They generally attain maximum weights not exceeding 500 g and have fast growth rates and short life spans (Zaragoza et. al. 2004).

In 2001, the country's small pelagic fisheries subsector production was about 1.1 million MT or roughly 35% of the total fisheries production. It is considered the main source of inexpensive animal protein for lower income groups in the Philippines. These groups constitute about 70% of the population and spend over 65% of their income on food. Thus, fisheries management is very important for the county's food security (Zaragoza et. al. 2004)

Capture fisheries in many parts of the Philippine archipelago is an important activity and this is also the case in the Zamboanga peninsula. Finfish species in this area are being caught using a variety of fishing gears such as purse seines, trawls, and other efficient fishing methods that can massively harvest these wild stocks (Stergiou et al. 1997).

In Zamboanga Peninsula (Region IX), 76.21% of all small commercial, 97% of all medium scale commercial, and 100% of all large commercial fishing vessels are based in Zamboanga City. In terms of gross tonnage, Zamboanga City constitutes 98.1% of all commercial fishing capacity (BFAR IX 2014). The most prevalent fishing gear used by the commercial fishing sub-sector is the purse seine which constitutes 31.2% (NSAP 2013).

In the early 1990s, a decline has been observed in the municipal fisheries but was offset by commercial fisheries. Around 47% of capture fisheries production (~787,000 tons) came from municipal fisheries and the rest (~885,000 tons) from commercial fisheries (Barut et al. 1997).

In spite of its vast and rich fishing areas and its substantially large share in the country's national capture fisheries production, very few published studies are available regarding its status. Available reports dealing with stock assessment and its fishery status were done a few years ago such as those of Dalzell and Ganaden (1987) and Sajili et al. (2003, unpublished). Evidently, much is not known about the biology and status of the fishery stocks. The need to manage the exploitation of the fishery resources was already recognized as early as the 1960s and repeatedly echoed for several decades (Armada 2004). This study was undertaken to assess the status of the fishery stocks to serve as a basis for imposing catch ceiling limitations and the establishment of a closed season in the area (in accordance with Republic Act 8550, Chapter II, Sections 8 and 9). This will also aid in promoting the proper utilization, management, and conservation of fishery and other aquatic resources, including the crafting of relevant policies.

2. MATERIALS AND METHODS

Study Site

The study was conducted around the west coast of Zamboanga City. This includes the common landing sites in two (2) localities in the area of Brgy. Baliwasan (Petron and Tres Marias) and two (2) sites in Brgy. Cawit (Universal and A.M.R).

Data Collection

Data collection for the study was conducted in the landing sites of Zamboanga City for a period of one year (2013 only). There were two trained NSAP enumerators for each landing site. Interviews of key informants (fishers, dealers/buyers, or boat captain) were conducted including information on fishing grounds, types of gear used, total number of boats landed per day, number of fishing days, and total catch per fishing operation. These were recorded on the prepared catch forms. Sampling was done during peak hours of arrival per landing site. Data on CPUE, species composition, and length frequency of fish landed were computed/obtained using entries in the NSAP Form 2b. Apart from boats sampled, landed catch of fishing boats that were not sampled were also taken to obtain the total catch for a particular day.

For length-frequency data sampling, at least 1 kg of samples from each batch of catch was randomly selected and sorted out according to fish species (NSAP methodology by Lopez, undated). Samples were weighed first (in kg), then total length (in cm) taken using a ruler. Monthly data were summarized and tabulated by species composition and gear type.

Catch per unit effort (CPUE), a standard unit of effort in kilograms per day (kg/day) formulated by BFAR according to the type of fishing gear, was used to determine monthly CPUE. It is computed by taking the quotient of the catch (in kg) over the average fishing days. CPUE of the dominant fishing gear (purse seine) in the monitored sites was computed using actual and raised data. The CPUE of the top five fishing gears were plotted for comparison purposes only with that of the purse seine to justify the focus on the subject gear.

the total fish catch was determined through interviews and actual ocular verification of catch by the enumerators of the boats sampled. The catch of the boats that were not sampled was obtained through interviews and added to the figure of the boats that were sampled to arrive at the total catch for the day.

Dominant Species

The dominant species was determined by identifying the species with the biggest volume, followed by the next highest, and so on.

Population Parameters

Population parameters presented were obtained using the FAO-ICLARM Stock Assessment Tools (FISAT) software (Gayanilo et al. 1996). The software includes the Electronic Length Frequency Analysis (ELEFAN) routines to estimate the parameters of the von Bertalanffy Growth Function (VBGF). The asymptotic length (L_∞) and the growth constant (K) value were estimated via K-scan routine of ELEFAN 1, wherein the K-value is chosen to provide the "best fit" for the available length-frequency data of a particular species. The ratios of the coefficients of mortality and growth (Z/K) were estimated using the Powell-Wetherall plot (Powell 1979; Wetherall 1986). Natural mortality (M) was estimated using the M-empirical equation of Pauly (1984). Values obtained for mortality were used for the computation of exploitation rate (E). Probabilities of capture for the selected species were estimated from the left ascending arm of the catch curves. This involves extrapolating the right descending side of the catch curve such that fish that "ought" to have been caught are added to the curve, with the ratio of "expected" numbers to those that are actually caught being used to estimate the probabilities of capture.

Growth parameters were determined first by estimating L_∞ (asymptotic length) using the Powell-Wetherall method (Gayanilo and Pauly 1997) based on the equation of Beverton and Holt (1956):

$$Z = k \left((L_\infty - L) / (L - L') \right)$$

where Z is the total instantaneous mortality, k is the growth coefficient, L is the mean length, L_∞ is the asymptotic length, and L' is the initial length of the sample.

The estimated values of L_∞ were further processed in ELEFAN I (ELectronicLEngth Frequency ANalysis)

Table 1. Number and distribution of commercial fishing boats (Source: BFAR-IX, 2014)

Area	Small scale	Medium scale	Large scale	Undetermined	Total
Zamboanga City	157	449	95	7	708
Zambo.Del Norte	9	4	0	-	13
Zambo.Del Sur	24	2	0	-	26
Zambo. Sibugay	15	4	0	-	19
Isabela City	1	4	0	-	5
Total	206	463	95	7	771

Figure 1. Zamboanga City map showing landing sites.

for the verification of the value for Loo and k. Analysis in the estimation of growth parameters and mortality uses the von Bertalanffy (1934) growth equation:

$$Lt = L_\infty (1 - e^{-k(t-to)})$$

Where Lt is the length of fish at age t, e is the Naperian logarithm, and to be the hypothetical age the fish would attain at length zero.

Mortalities and exploitation rate were then calculated using the equation:

$$Z = M + F$$

where Z is the instantaneous total mortality, M is the instantaneous natural mortality due to predation, aging, and other environmental causes, and F is the instantaneous fishing mortality caused by fishing.

Furthermore, M was estimated using the empirical formula of Pauly (1984):

$$Log M = 0.654 Log k - 0.28 Log L_\infty + 0.463 LogT$$

Where L_∞ and k are the VBGF growth parameters. and T is the annual mean habitat temperature (°C) of the water in which the stock in question lives.

Expanding the equation for mortality would lead to the computation of exploitation rate using:

$$E = F/Z$$

Where E is the exploitation rate. The use of equations from growth parameters and mortalities, prediction of recruitment patterns, and virtual population analysis could be estimated using the routines found in FISAT programs.

3. RESULTS AND DISCUSSION

The commercial fisheries subsector in the Zamboanga Peninsula is unique in that 76% of small-scale, 97% of medium-scale, and 100% of large-scale commercial fishing vessels are based in Zamboanga City alone, and only 24% of small-scale and 3% of medium-scale are based in the other localities of the three provinces of Zamboanga Del Sur, Zamboanga Del Norte, and Zamboanga Sibugay. In terms of the number of units, Zamboanga City is home to 31% of all commercial fishing boats, but in terms of boat tonnage, the city hosts the lion's share with 98.1% of total gross tonnage.

Monitored Fishing Boats

Figure 2 shows that the majority of the fishing boats that operated in the area used the gear purse seine, with total boat units of 248 or 75.4% of the overall monitored commercial fishing boats in the Zamboanga Peninsula. It was followed by bag net and ring net with identical 29 units each (NSAP 2014).
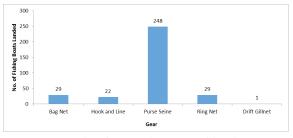

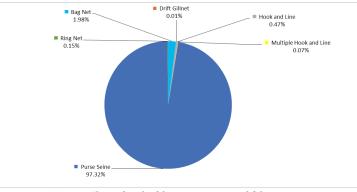Figure 2. Number of monitored commercial fishing boats in Zamboanga Peninsula
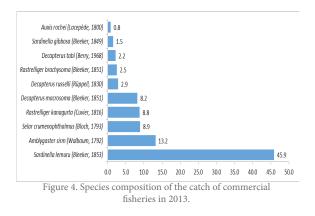
Figure 3. Share of catch of dominant commercial fishing gears

Figure 3 contributes to the uniqueness of the commercial fisheries situation in the Zamboanga Peninsula as it is almost exclusively the domain of purse seine in terms of catch.

Catch records show that purse seine has the highest catch volume with 22,243.86 MT or 97.32% of total annual catch, followed by bag net with 452.15 MT or 1.98%, while the lowest volume was registered by the gear multiple hook and line with 15.98 MT or only 0.07% of the total landed catch in the area.

Dominant Species

The species *Sardinella lemuru* dominated fish production in 2013 (Figure 4). Sardines (*S. lemuru, A. sirm,* and *S. gibbossa*) made up 60.6% of total commercial fisheries production in. The top ten (10) species constituted 94.8% of the total catch which was mostly pelagic fish species. The next most dominant was *Amblygaster sirm*, also a sardine species, at 13.2%, followed by *Selar crumenophthalmus* at 8.9%, *Rastrelliger kanagurta* at 8.8%, *Decapterus macrosoma* at 8.2%, *Decapterus russelli* at 2.9%, *Rastrelliger brachysoma* at 2.5%, *Decapterus tabl* at 2.2%, *Sardinella gibbosa* at 1.5% and the last at the tenth place is the species *Auxis rochei* at 0.8% comprised catch.

Figure 4. Species composition of the catch of commercial fisheries in 2013.

Landed Catch

The total landed catch for this study period (2013) yielded 22,937.40 MT. Catch figures show that commercial fishing recorded the biggest volume with 22,855.50 MT while municipal fishing registered only 81.93 MT. Figure 5 shows that April had the highest landed catch with 4,116.7 MT. This was followed by the months of May and June, while lowest was in December with 314 MT. There was a sudden drop in the volume of catch in September because that was the time when the month-long Zamboanga siege occurred which prevented many fishing boats from going out to fish.

Figure 5. Monthly distribution of landed catch (MT) of the commercial fisheries sector

Since the majority of the catch of the commercial fisheries subsector is made up of sardines, there is some apprehension that the increased effort in April might have an adverse effect on the minor peak of sardine spawning which occurs between April and May (UNDP-GEF SCS SFM Project, unpublished).

Catch per Unit Effort

Figure 6 shows that April of 2013 had the highest production, followed by the month of May. The months of November to February have the lowest landed catch which coincided with the implementation of the closed season for sardines under the Joint DA-DILG Administrative Order No.1. Catch per unit effort is also highest during the month of April, while the month of December has the lowest catch volume It is notable that the high CPUE in April was somewhat sustained through October. The annual average CPUE of the commercial fisheries sector was 10, 890.5 kg/day.

In general, the catch was proportionate with the effort except for the months of September and October when the month-long Zamboanga Siege prevented most of the commercial fishing boats from fishing.

Table 2. Growth parameter estimates of the dominant pelagic fish species for 2013

Species	Gear	Growth			
		L max	L∞	k	ø
Sardinella lemuru	Purse Seine	19.76	20.25	0.64	2.419
Amblygaster sirm	Purse Seine	23.68	24.1	0.4	2.366
Rastrelliger kanagurta	Purse Seine	32.73	32.9	0.22	2.377
Selar crumenophthalmus	Purse Seine	26.48	27.1	0.34	2.397
Decapterus macrosoma	Purse Seine	22.09	22.1	0.37	2.257

Figure 6. Monthly fish harvest and CPUE trend of commercial fisheries
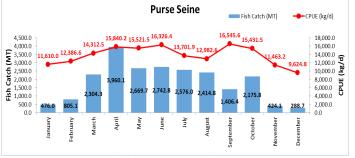

Figure 7. Monthly harvest and CPUE of the Gear Purse Seine.

The monthly CPUE trend of the dominant gear, purse seine, likewise mirrors those of the commercial fisheries subsector but with a much higher annual average of 14,142 kg/day where the peak was in April with a CPUE of 19,800 kg/day (Figure 7). This average CPUE is much higher than the CPUE for purse seine in Western and Central Visayas in 2002 with a value of 8,933.24 kg/day as reported by Guanco et.al (2002).

Biological Parameters Estimates

Growth, mortality, and probability of capture parameters values were obtained using FAO-ICLARM Stock Assessment Tools (FISAT) software (Gayanilo et al. 1996).

Growth

Table 2 reveals that the five dominant species caught by purse seine have maximum length (L_{max}) values that are very near (less than 1 unit) the asymptotic length (L_∞) values, suggesting that the commercial fisheries subsector in the Zamboanga Peninsula is obtaining relatively the maximum possible yield from the subject fishery (Froese and Pauly 2000).

The maximum length (L_{max}) of *S. lemuru, A. sirm, R. kanagurta,* and *D. macrosoma* are much higher than the published values of length at first maturity of subject species. This implies that said species had the opportunity to reproduce and contribute to recruitment. There is no published value for length at first maturity for *S. crumenophthalmus*, so no comparison can be made, but if the exploitation rate for the species (Figure 7) is any indication, its maximum length could be higher than its length at first maturity.

The maximum length and asymptotic length of the most dominant species, *S. lemuru*, caught by purse seine in Zamboanga in 2013 are significantly lower by 23% and 22% respectively than those of the same species caught in Western and Central Visayan Sea in 2002 (Guanco 2009). In the light of the findings that *S. lemuru* in the Philippines belongs to the same stock (Santos et. al), it appears that the Bali sardines caught by purse seine in Zamboanga have become smaller, an indication of overexploitation.

Mortality

The mortality of a cohort is composed of mortality due to fishing (F), and mortality caused by

Table 3. Mortality estimates of the dominant pelagic fish species for the year 2013

Species	Gear	Mortality			
		F	M (at 28oC)	E	Z
Sardinella lemuru	Purse Seine	2.18	1.49	0.59	3.67
Amblygaster sirm	Purse Seine	1.37	1.04	0.57	2.41
Rastrelliger kanagurta	Purse Seine	0.66	0.65	0.51	1.31
Selar crumenophthalmus	Purse Seine	0.55	0.91	0.38	1.46
Decapterus macrosoma	Purse Seine	2.52	1.02	0.71	3.53

Table 4. Probability of capture estimates of the dominant pelagic fish species for 2013

Species	Gear	Probability of Capture	
		L25	L50
Sardinella lemuru	Purse Seine	15.05	15.67
Amblygaster sirm	Purse Seine	14.68	15.33
Rastrelliger kanagurta	Purse Seine	13.01	13.45
Selar crumenophthalmus	Purse Seine	17.91	19.18
Decapterus macrosoma	Purse seine	19.04	19.97

predation, disease, and deaths due to aging, which is known as natural mortality (M). With these factors, exploitation rate (E) can be computed using the ratio of fishing mortality (F) over total mortality (Z), and the resulting value will indicate the fishing condition of a certain area.

Pauly and Ingles (1984) stated that the optimum fishing mortality in an exploited stock should be approximately equal to natural mortality, or optimum exploitation rate is approximately equal to 0.50. A predominance of estimates of values of E >0.5 in a number of stocks should be suggestive of overexploitation.

In the table of the five dominant species (Table 3), *D. macrosoma*, *S. lemuru*, *A. sirm*, and *R. kanagurta* all have higher fishing mortality than natural mortality suggestive of overexploitation.

The higher rate of fishing mortality than natural mortality indicated in Table 3 further confirms the notion of overexploitation of the sardine stocks.

The exploitation rates for the dominant species are all above the threshold except for *Selar crumenophthalmus* which is unusually low (Figure 8). *Selar crumenophthalmus* is the only species that show apparently no sign of overfishing since natural mortality is higher than the fishing mortality. This is understandable because purse seine catches only the big-eyed scad occupying the upper layer of the water column while the bigger ones apparently residing in the deeper portions as shown by the assessment study of Honda Bay (Ramos et al, undated) are beyond the reach of the purse seine nets. This situation can lead to improved recruitment by giving the species the opportunity to reproduce.

Probability of Capture

In Table 4, *Amblygaster sirm* and *Rastrelliger kanagurta* caught by purse seine were both captured before maturity and could have dire consequences for the fish populations. The figures for *Sardinella lemuru*
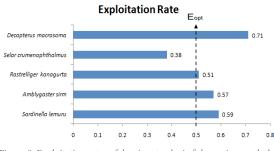

Figure 8. Exploitation rates of dominant pelagic fish species caught by purse seine

and *Decapterus macrosoma* indicate that these were already matured when captured and may have had the opportunity to spawn and contribute to recruitment.

4 . S U M M A R Y

The **Z**amboanga Peninsula is the major source of the country's sardine production where the major gear used is the purse seine which contributed almost to the entire commercial fisheries production (97%). In terms of capacity, more than 98% of the total gross tonnage of commercial fishing is based in Zamboanga City. Sardines dominate the fish catch, making up 60% of the total fish catch.

The catch per unit effort of the whole commercial fisheries subsector for 2013 averaged 10, 890.5 kg/day while that of the dominant gear, purse seine, was higher at 14,142 kg/day. Generally, the catch per unit efforts of both the commercial fishing subsector and that of purse seine alone are directly proportionate to the volume of catch landed.

The maximum length and the asymptotic length of *S. lemuru*, the most dominant species caught by the purse seine in 2013 was smaller than that of the same species caught in the Visayas which indicates that the sardines are getting smaller. This situation warrants

further studies on their biology and economics to further enhance the management measures for the species already in place.

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