RESEARCH ARTICLE

Relative Abundance and Size Composition of Tuna Caught by Major Fishing Gears Landed in the General Santos Fish Port Complex, Philippines

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ABSTRACT

Tunas (family Scombridae) are the most abundant fish species caught by purse seine, ring net, and handline landed in the fish port markets of General Santos City. In this study, an assessment of tuna fisheries was conducted from January 2013 to December 2017. A total of six fish classifications, seven families, four genera, and seven species were observed from Market 1, Market 2, and Market 3 landing sites in the General Santos Fish Port Complex. On average, tuna catches contributed about 89% of the annual catch production and showed an increasing trend throughout the five years. The four genera of tunas were Katsuwonus (53.7%), Thunnus (25.9%), Auxis (8.4%), and Euthynnus (0.5%). The composition of tuna species comprised of oceanic tunas (*Katsuwonus pelamis, Thunnus albacares, Thunnus obesus*) and neritic tunas (*Auxis rochei, Auxis thazard, Euthynnus affinis*). *Katsuwonus pelamis* was the most dominant among the scombrid species with 53.66% relative abundance, followed by *Thunnus albacares* with 24.03%. Mainly, mature tuna sizes were observed using handline, which caught oceanic tunas ranging from 105 cm to 170 cm. Other gears, purse seine and ring net, caught immature sizes of most neritic tunas. Thus, tunas were caught throughout the year, and two peak seasons were observed from May to June and October to December during the five-year study period. The study's results on relative abundance, size composition, seasonality, and length-frequency distribution provide analysis and information that help implement fisheries management of tuna stocks in Region 12 and high seas pocket. Thus, this paper needs further investigations on catch per unit effort (CPUE), reproductive biology, and the value chain of the landed tuna catches to determine their significance to the economy of General Santos City.

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1. INTRODUCTION

General Santos City was designated as the "Tuna Capital of the Philippines" due to the production of the country's major sashimi-grade tuna as early as the 1970s. It also accounts for the second-largest daily total catch of fish in the country after Navotas City. Based on the National Stock Assessment Program (NSAP) (Emperua et al. 2017), 76% of tuna catches from domestic waters were landed in General Santos City fish port, and the remaining 24% were from the waters of Mati, Palawan, Surigao, Tawi-Tawi, and Zamboanga. The General Santos Fish Port Complex (GSFPC) has three markets: Market 1, Market 2, and Market 3, where catches of tunas are unloaded.

Tuna is vital to the ecology and economy of the Pacific. Large tunas are the main species targeted by commercial fishing. Tunas are widely known to be migratory as it travels long distances all over the world's oceans that occupy tropical, temperate, and even some cooler waters. Tuna fishing has a great history in the Pacific Islands region. It is where fishes are the primary food source and necessary for livelihood. The diverse tuna fishery of the Western and Central Pacific Ocean (WCPO) ranges from small-scale artisanal operations in the coastal waters of Pacific states to large-scale, industrial purse-seine, pole-and-line and longline operations in the exclusive economic zones (EEZs) of Pacific states and international waters (high seas) (Oceanic Fisheries Programme 2010). The targeted species by these fisheries were skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), and albacore tuna (*T. alalunga*) (Allain et al. 2016).

The Philippines is a major tuna producer in the Western and Central Pacific Ocean (Bureau of Fisheries and Aquatic Resources 2012a). The proportion of tuna to the overall landed catch in General Santos City fish port was 89% of the 1,012,488 MT recorded from 2008 to 2014, distinguished as tuna or a tuna-like species. The most dominant tuna species caught and landed in the city were composed of 45% skipjack, 25% yellowfin, and 23% frigate and bullet tuna. In 2014, about 47% were frozen tuna, of which more than 70% came from foreign vessels. Thus, 2014 was.

The West Pacific East Asia (WPEA) Project began in 2010. WPEA aims to strengthen the national capacities and international involvement of Indonesia, Philippines, and Vietnam in the Western and Central Pacific Fisheries Commission (WCPFC) activities. This is essential in improving the management, especially of the highly migratory species. NSAP provides the needed data in the WPEA project as it collects information on the catch, effort, and sizes of tuna species collected at landing centers in GSFPC, supplying essential information for tuna stock assessments. The Philippines is involved in the said project under the Conservation and Management Measures (CMMS).

Tunas belong to the family Scombridae, which grows rapidly and reaches mature sizes in a few years. Their growth rates change according to species, age, and location. Generally, larger tunas can grow to about 40–55 cm in the first year; then, the annual growth rate ranges between 20–30 cm per year, decreasing with age. On the other hand, tuna species that attain only small sizes grow to 20–35 cm in the first year, and their annual length increments rapidly decrease to less than 10 cm (FAO 2021).

Moreover, tuna-like species such as eastern little tuna (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), and bullet tuna (*Auxis rochei*) also contributed to the significant increase in the total volume of production of tuna catch in the region. As a result, General Santos City has been called the "Tuna Capital of the Philippines" due to its impressive total daily catch of tuna that exceeds any other fish ports in the country.

Hence, this study was conducted to aid in analyzing tuna fisheries for the National Tuna Management Plan to manage tunas and other highly migratory fish stocks and support the WPEA project needed by the WCPFC. Moreover, the specific objectives of this study were to (1) determine the relative abundance of oceanic and neritic tunas in GSFPC, (2) assess its size composition and seasonality, and (3) evaluate its relative percentage contribution by fish classification, family, genera, and species. This paper can also be used for the advanced implementation of the Bureau of Fisheries and Aquatic Resources (BFAR)-USAID Oceans' Ecosystem Approach to Fisheries Management (EAFM).

2. MATERIALS AND METHOD

2.1 Study site

The General Santos City Fish Port Complex (GSFPC) (Figure 1) has coordinates at approximately 6° 2' 8" north latitude and 125° 8' 32" east longitude. It covers an area of 32 hectares, which is strategically located at Barangay Tambler, General Santos City in South Cotabato. GSFPC, which lies along the shores of Sarangani Bay, is 17 km south of the city proper. Constructed and financed by the Japanese Overseas Economic Cooperation Fund under the Nationwide Fishing Ports Project Package II, the port complex is the second-largest fish port in the Philippines, next to the Navotas Fish Port Complex. Therefore, NSAP, through WPEA, identified GSFPC as one of the major landing centers for Region 12. Accordingly, it comprised three sampling sites: Market 1, 2, and 3 (Figure 2).

Landing centers Market 1, 2, and 3 were comprised of purse seine and ring net vessels in commercial tuna fleets (Figure 2). The purse seine boats range from 100 to 500 gross tons, with an average of about 250 gross tons. The handline fishing method is used to catch mostly adult tunas from 110 to 150 cm operating on a smaller scale in municipal tuna fisheries. In Market 1, the unloading time of a fishing vessel is from 5:00 AM to 10:00 AM, but in Market 2 and Market 3, the whole-day unloading depends on the buyer's availability.

2.2 Data collection

2.2.1 Sampling strategy

Data were collected through the "sampling method," where a small part of something or a small number of items from a group is selected for examination or analysis to estimate the quality as a

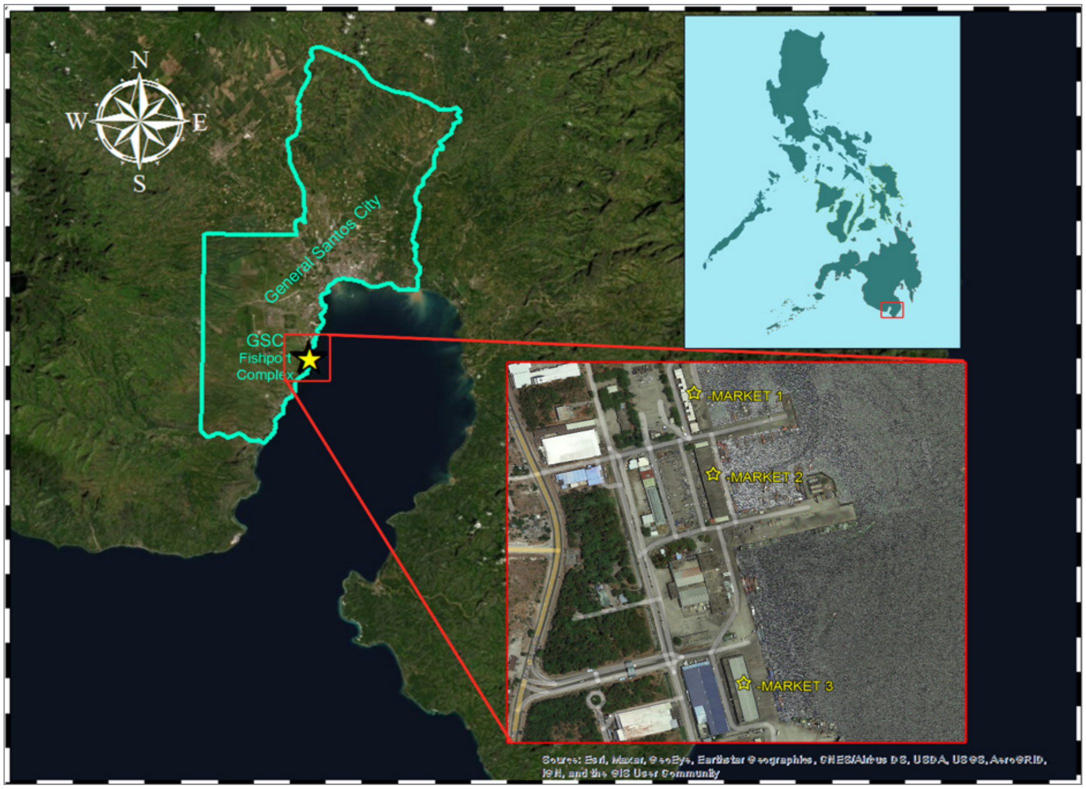

Figure 1. Map of General Santos Fish Port Complex

whole. Data collection was done through random selection.

2.2.2 Required data to be collected

a. Catch and effort. The enumerators collected the data at the landing site through direct interviews with the fishers or the boat captain or operator. Data gathered included the fishing ground, name of the boat, total boat catch by gear type, and fishing effort (number of days fishing, number of crews, and number of auxiliary boats used). Nine highly trained enumerators were assigned to the fish port.

b. Total sub-sample weight and weight of each species group. This was done by borrowing sub-samples from the catch by gear. For Market 1, species monitored were mostly oceanic tunas, and 100% came from handline. Enumerators sampled 50% of the total boats landed per day, and as much as possible, enumerators measured the total catch of the boat they sampled. Purse seine and ring net unloaded their catch in Market 2 and 3. Enumerators sampled five bańeras in species length measurement for sub-samples. Neritic tunas were the most dominant species in Market 2 and Market 3; thus, they comprised oceanic, neritic, and small pelagics. The total landed catch for Market 2 and 3 was the sum of all the declared partial catch of the boat captain for each boat landed or unloaded. This applied to both ring net and purse seine gear. The raised catch for each species was based on the sampled weight per species divided by the total weight of sub-sampled species and multiplied by the weight of the total catch of the boat.

c. Length measurement by species by gear. All borrowed sub-sample was measured immediately. Data enumerators used a measuring board for neritic tunas and small pelagics, while a caliper was used for large pelagics and oceanic tunas. Tunas were measured by placing them on a measuring board on a flat surface horizontally. Its length was calculated from the tip of the upper jaw to the cartilaginous median part of the caudal fork. Oceanic and neritic tunas were in fork length due to their hard caudal fins, unlike other fishes in total length measurement since they have soft caudal fins, which can be folded easily (Lopez 2017). In Market 1, oceanic tunas were collected from the 50% of total boats landed per sampling day, and the length-weight per species was being measured. In Market 2 and 3, the five bañeras per boat landed on a sampling day were collected as sub-samples for

Market 1

Market 2

Market 3

Figure 2. Monitored landing centers in General Santos Fish Port Complex

length-weight measurement. All neritic tunas were measured per species. No required minimum number of tunas was to be measured in this sampling activity as long as it follows the NSAP protocols. It is much better to have more fish samples measured from the sampled boats to derive more reliable data.

d. Annual landed catch. Tuna catches were estimated using the total landed catch recorded during sampling days. The total catch was raised from the total number of sampling days conducted within the year to the total number of days for the year. Estimation is also done separately by fishing ground and fishing gears used.

$$\textit{Annual Landed Catch} = \frac{\textit{Total Monitored Landed Catch} \times \textit{365 Days}}{\textit{Total Number of Sampling Days}}$$

2.2.3 Frequency of sampling and schedules

Data enumerators followed the standard sampling schedule for NSAP by the National Fisheries Research and Development Institute (NFRDI) see Table 1. Sampling day is every after two days in each landing site regardless of Saturdays, Sundays, and Holidays equivalent to 10 and 11 surveys each month per fish landing site for 30 and 31 days in a month, respectively. However, in the fish port sampling schedule, day 3 is still duty day in terms of High Seas Pocket 1 fishing ground. Therefore, markets 1, 2, and 3 were treated as major landing centers.

2.3 Size Composition

The sizes of the samples from landed catch for both oceanic and neritic tunas were measured in fork length and recorded in centimeters. The size composition for each species was analyzed per gear using a length frequency histogram. In addition, the percentage of maturity of the samples was determined

Table 1. Standard Monthly Sampling Schedule

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Sampling Days - Landing Center 1
Sampling Days - Landing Center 2
R- Rest/Off Day

using the percentage of mature and immature catch based on the length at first maturity (L_m) taken from FishBase.

3. RESULTS AND DISCUSSION

3.1 Annual landed catch

From 2013 to 2017, GSFPC had an aggregated annual landed catch of 384,140 MT for purse seine, ring net, and handline in Market 1, 2, and 3 landing centers. The trend of yearly catch estimates of oceanic and neritic tuna by gear type is presented in Table 2. From 2013 to 2017, GSFPC recorded a total harvest of 199,003 MT. Purse seine contributed the highest percentage of the total catch with 199,003 MT, followed by ring net with 145,315 MT, and handline with 39,821 MT being the lowest.

Table 3 compares the estimated annual fish catch and relative percentage contribution of tuna species to the total fish harvest. The highest comparison was observed in 2014; tuna species shared 97,244 MT (92%), while in 2013, only 84% or 52,933 MT was shared by tuna. *Katsuwonus pelamis*, *Thunnus albacares*, *Auxis thazard*, *Auxis rochei*, *Thunnus obesus*, and *Euthynnus affinis* were the common tuna species monitored for purse seine (Figure 3a) and ring net (Figure 3b). Similar to Barut and Garvilles' (2015) study, the estimated tuna catch, especially oceanic tunas, increased in 2014. This was the year when NSAP expanded the major tuna landing sites, especially in the port of General Santos City. Thus, almost all tuna landing areas in the country were monitored using the government fund support through BFAR. Among the fishing gears, purse seine dominated the highest catch at 49–55%, followed by ring net and handline. For purse seine and ring net, *Katsuwonus pelamis* contributed the highest production from 2013 to 2017 with 63.22% and 55.44%, respectively, and *Euthynnus affinis* obtained the lowest production for ring net and purse seine. For handline, 82.32% of the total catch was contributed by *Thunnus albacares*, followed by *Thunnus obesus* (6.26%) and a small portion by *Thunnus alalunga* (0.21%). Handline had 11.20% bycatch. Twenty-one species of tuna have been recorded in the Philippine waters, but only five are caught in commercial quantity, namely yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*),

Table 2. Annual catch estimates of oceanic and neritic tunas by gear type from 2013 to 2017 in General Santos Fish Port Complex (in MT).

Gear	Species Name	Common Name	2013	2014	2015	2016	2017	Total
Purse Seine	*Katsuwonus pelamis*	Skipjack tuna	21,516	35,768	25,136	24,669	32,243	139,331
	Thunnus albacares	Yellowfin tuna	3,873	8,732	7,869	9,509	11,515	41,498
	Auxis thazard	Frigate tuna	876	3,435	1,600	1,426	686	8,023
	Auxis rochei	Bullet tuna	111	833	1,491	3,089	619	6,143
	Thunnus obesus	Bigeye tuna	265	765	610	541	1,127	3,308
	Euthynnus affinis	Kawakawa	66	233	78	130	195	701
Total			**26,706**	**49,766**	**36,784**	**39,363**	**46,385**	**199,003**
Ringnet	*Katsuwonus pelamis*	Skipjack tuna	13,208	27,006	15,770	16,012	21,570	93,565
	Thunnus albacares	Yellowfin tuna	3,206	5,115	3,348	6,962	7,237	25,868
	Auxis rochei	Bullet tuna	166	1,155	2,667	6,952	1,774	12,713
	Auxis thazard	Frigate tuna	961	3,144	2,347	1,781	1,405	9,639
	Thunnus obesus	Bigeye tuna	244	494	286	465	528	2,017
	Euthynnus affinis	Kawakawa	105	337	160	320	592	1,513
Total			**17,889**	**37,251**	**24,579**	**32,492**	**33,105**	**145,315**
Handline	*Thunnus albacares*	Yellowfin tuna	7,882	9,703	4,619	7,338	7,380	36,921
	Thunnus obesus	Bigeye tuna	457	511	354	544	941	2,807
	Thunnus alalunga	Albacore tuna	27	14	37	14	1	93
Total			**8,365**	**10,228**	**5,011**	**7,896**	**8,322**	**39,821**
Grand Total			**52,960**	**97,244**	**66,373**	**79,751**	**87,812**	**384,140**

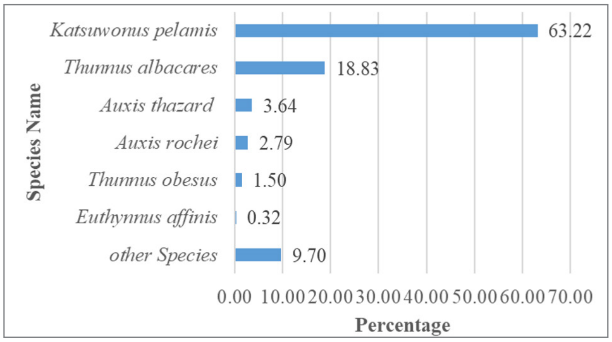

Figure 3a. Percentage contribution of tuna species caught by purse seine from 2013 to 2017

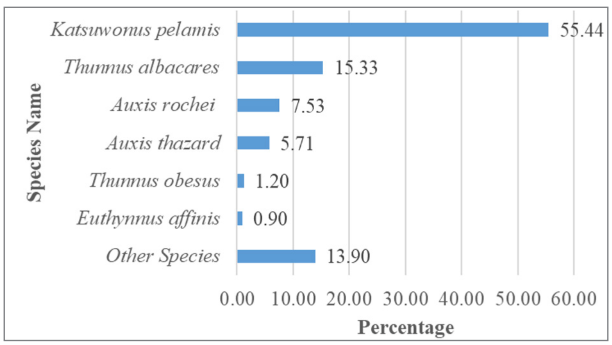

Figure 3b. Percentage contribution of tuna species caught by ring net from 2013 to 2017

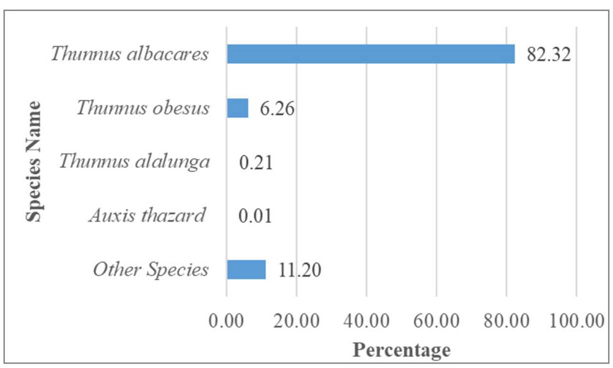

Figure 3c. Percentage contribution of tuna species caught by handline from 2013 to 2017

eastern little tuna or kawa-kawa (*Euthynnus affinis*), bigeye tuna (*Thunnus obesus*), and frigate tuna (*Auxis thazard*) (Bureau of Fisheries and Aquatic Resources 2012b).

Figure 4 shows the relative percentage contribution by fish classification. Oceanic tuna, neritic tuna, small pelagic, large pelagic, and pelagic were the fish classifications monitored in GSFPC. Oceanic tunas (*Thunnus albacares*, *Thunnus obesus*, and *Thunnus alalunga*) contributed the bulk of the catch with 73.11%, followed by the neritic tunas (*Auxis thazard*, *Auxis rochei*, *Euthynnus taffinis*) with 14.21%. The remaining 10.13%, 1.61%, 0.80%, and 0.13% were contributed by small pelagics, large pelagics, pelagics, and demersal fishes, respectively. There are seven families recorded in Market 1, Market 2, and Market 3 during the study period. Figure 5 shows that 87.32% of the total production recorded in GSFPC was family Scombridae, tuna, and tuna-likes among seven families monitored. The remaining 12.68% was shared by Carangidae, Istiophoridae, Coryphaenidae, Balistidae, Acipenseridae, and Xiphiidae. Relative abundance of tuna by genera (Figure 6) up to the species level (Figure 7) was also monitored by NSAP and presented in this study. Katsuwonus, Thunnus, Euthynnus, and Auxis were the common genera in Market 1, 2, and 3. For the species level as to the whole production recorded in the fish port from 2013 to 2017, *Katsuwonus pelamis* obtained more than 50% of the catch, 24.03% for *Thunnus albacares*, more than 4% each for *Auxis rochei* and *Auxis thazard*, and 2% below for *Thunnus obesus*, *Euthynnus affinis*, and *Thunnus alalunga*. Other species or by-catch shared 11.49% of the total harvest.

Table 3. Comparison of estimated annual fish catch estimates (MT) and tuna species relative percentage contribution to the total fish harvest in General Santos Fish Port Complex from 2013 to 2017.

Year	Est. Annual Catch(MT)	Tunas Catch (MT)	%
2013	62,888	52,933	84
2014	106,012	97,244	92
2015	76,192	66,373	87
2016	90,733	79,755	88
2017	98,175	87,812	89
Total	434,001	384,118	89

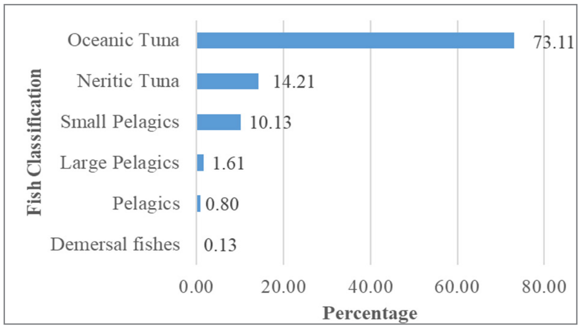

Figure 4. Relative percentage contribution by fish classification from 2013 to 2017

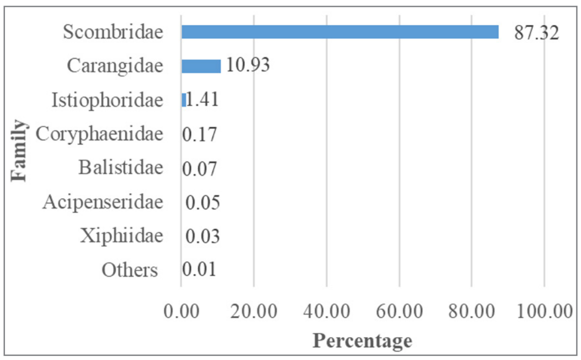

Figure 5. Relative percentage contribution by fish families from 2013 to 2017

3.2 Seasonality

Tuna seasonality has been found to increase in the second quarter and at the end of each year (Figure 8). The noticeable dip in catch production from July until October could be attributed to the closed fishing season in High Seas Pocket 1 during these months.

3.3 Size Composition

This study indicates that 80.8% of the *Thunnus albacares* catch from handline fishing were of mature size, and 19.2% were immature based on FishBase's established length at first maturity (L_m) of 103 cm in the Philippines. In contrast, all the catch from purse seine and ring net fishing are juvenile (Figure 9). However, some authors showed different sizes at first maturity for yellowfin tuna showing deviance among them; Indian Ocean Tuna Commission (2009) and Zhu et al. (2008) estimated L_m at around 100 cm in the Indian Ocean, while McPherson (1991) estimated it at 108 cm in the Western Pacific Ocean. Schaefer (1998) calculated this parameter at 92 cm in the Eastern Pacific Ocean, and Itano (2000) obtained a size at first maturity of 104 cm for the equatorial West Pacific. Thus, all these studies on length at first maturity showed that *Thunnus albacares* caught by handline were all in matured sizes.

Thunnus obesus, observed to be only caught by handline, with L_m of 100 cm (FishBase) in the Eastern Pacific and the Indian Ocean, showed a lower mature catch of 73%, thus having 27% of the catch immature (Figure 10). This was related to Kikawa's (1953) study, wherein Pacific bigeye tuna's minimum size at first maturity was reported as 91–100 cm. For bigeye tuna inhabiting the Atlantic, Indian, and Pacific Ocean, Calkins (1980) reported bigeye tuna reached sexual maturity at 100-130 cm when they were about three years old.

Purse seine and ring net fishing which only catches small fishes showed evident catching of immature fishes, especially tunas. Most of the

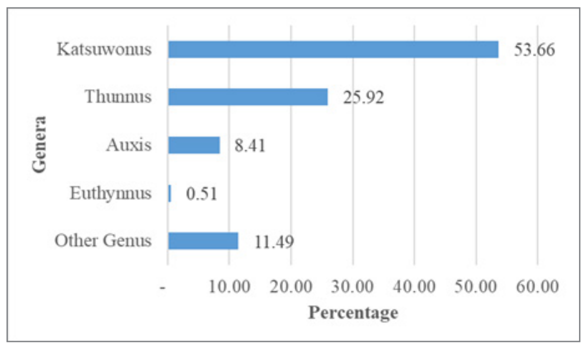

Figure 6. Relative abundance of tuna by genera from 2013 to 2017

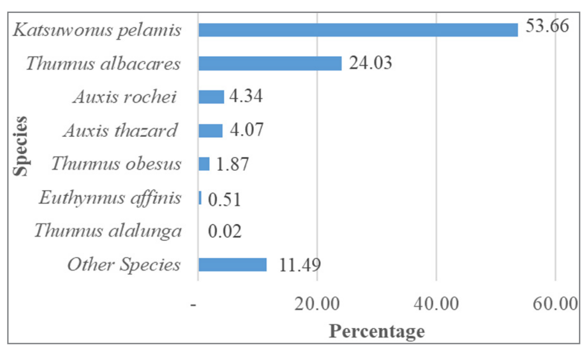

Figure 7. Relative abundance of tuna by species from 2013 to 2017

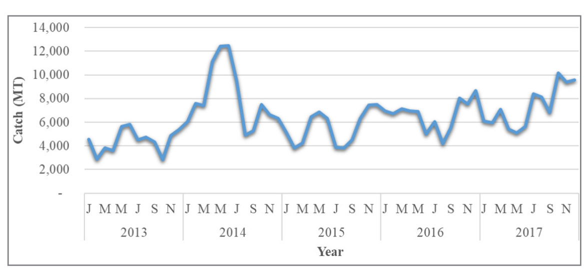

Figure 8. Seasonality of tuna fishes from 2013 to 2017

catches were immature for the neritic tunas like *Auxis thazard* and *Auxis rochei* with L_m at 30 cm and 24.1 cm for Eastern Atlantic (FishBase). In this study, ring net fishing showed only 8.2% for *Auxis thazard* and 24.3% for *Auxis rochei* were mature (Figures 11 and 12). Purse seine fishing showed a better catch having 16.4% and 30.8% mature catch, respectively. Froese and Pauly (2000), length at first maturity (L_m) of the species in the Philippines has values of 21.7-38.6 cm for *Auxis rochei* and 21.5-38.6 cm for *Auxis thazard*, wherein the values in this study caught matured tunas. Macias et al. (2005) have also suggested that *Auxis rochei* attain maturity when the fish has a fork length of 35 cm. Thus, this study showed that these neritic tunas were caught in immature sizes before they reached their length at first maturity.

Tunas caught by these fishing gears are of similar sizes, making it worse for the slightly larger tunas, *Euthynnus affinis* with L_m of 39.8 cm, and *Katsuwonus pelamis* with L_m of 40 cm (FishBase) in the Philippines. Both ring net and purse seine fishing showed a dominant juvenile catch of 100% and

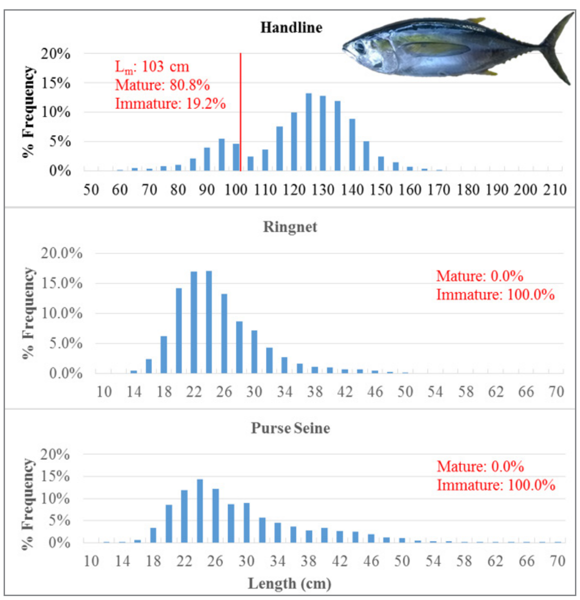

Figure 9. Size composition of *Thunnus albacares* landed in the General Santos Fish Port Complex from 2013 to 2017

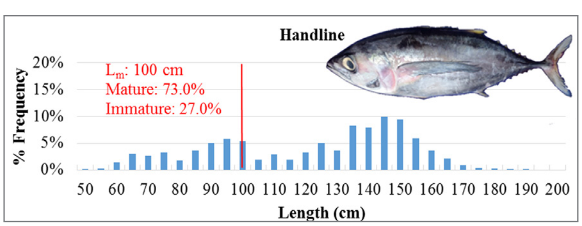

Figure 10. Size composition of *Thunnus obesus* landed in the General Santos Fish Port Complex from 2013 to 2017

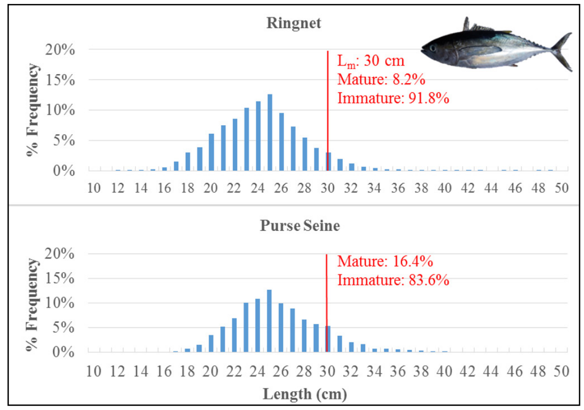

Figure 11. Size composition of *Auxis thazard* landed in the General Santos Fish Port Complex from 2013 to 2017

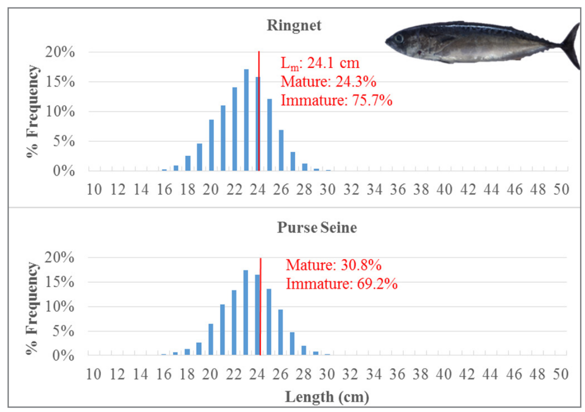

Figure 12. Size composition of *Auxis rochei* landed in the General Santos Fish Port Complex from 2013 to 2017

99.9%, respectively, for *Euthynnus affinis* (Figure 13). The size at first maturity of male *Euthynnus affinis* gonads is 45.53 cm FL, resulting from the undergone reproductive biology study of male *Euthynnus affinis* in Bali (Arnenda et al. 2021).

Katsuwonus pelamis, in this study, has slightly better catches at only 96.3% and 87% juvenile catch, respectively, for each fishing gear (Figure 14). According to Nugraha and Rahmat (2008), the first maturation of *Katsuwonus pelamis* occurred at 40.0–40.6 cm, which concluded that *Katsuwonus pelamis* should be caught above 40.6 cm. Still, this species was captured in immature sizes.

4. CONCLUSION

This study showed that most oceanic tunas such as *Katsuwonus pelamis*, *Thunnus albacares*, and *Thunnus obesus* were caught by purse seine and ring net. These comprised a bulk harvest of the fishers followed by neritic tuna species (bullet, frigate, and eastern little tuna) and other pelagic species with

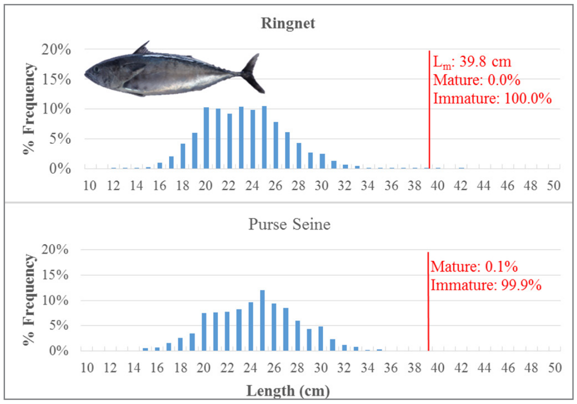

Figure 13. Size composition of *Euthynnus affinis* landed in the General Santos Fish Port Complex from 2013 to 2017

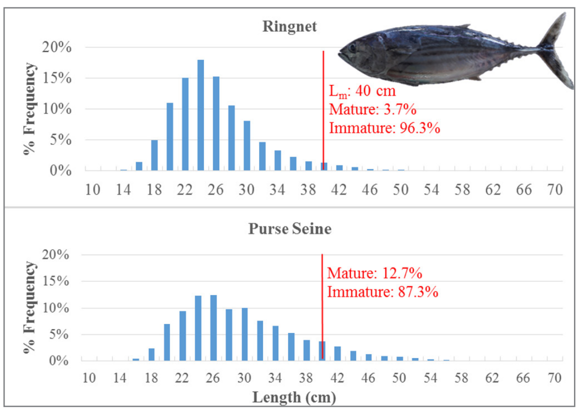

Figure 14. Size composition of *Katsuwonus pelamis* landed in the General Santos Fish Port Complex from 2013 to 2017

demersal fishes caught in minor yield, which were landed in the fish port of General Santos City. The tuna catch showed an increasing trend from 2013 to 2017, and the highest production was observed in 2014 with 97,244 MT.

Scombridae was the family that attained a high percentage, followed by Carangidae, Istiophoridae, and Coryphaenidae. Most of these tuna species were caught year-round in 2013–2017 data. Its peak seasons were observed in May, June, and December, while lean seasons were in February and August.

The size composition of these six tuna species was analyzed through its length-frequency determination for 2013–2017. Tuna sizes vary depending on the fishing gears used, and it was observed that the handline gear caught the most mature yellowfin and bigeye tunas. Both species caught by handline had sizes with two distinct modes: 50–95 cm and 100–195 cm. Few sizes were observed above 200 cm in the sampled lengths. However, the handline captured mostly adult tunas with sizes ranging between 135–150 cm for *Thunnus obesus* and 120–140 cm for *Thunnus albacares*. Purse seine and ring net caught 70–100% immature sizes of neritic tunas and some yellowfin and skipjack species. According to the Food and Agriculture Organization (FAO 2021), most tunas reach their age of maturity between 2–5 years. *Katsuwonus pelamis* with the sizes 42–50 cm for females and 45-52 cm for males had reached their age of maturity in two years. *Thunnus albacares* matured in 2.5–3 years with sizes ranging between 100–110 cm, while *Thunnus obesus* attained its maturity at sizes between 100–110 cm, which spans 3 to 3.5 years. Neritic tunas reached their maturity at sizes 35 cm, 30 cm, and 45–50 cm for *Auxis rochei*, *Auzis thazard*, and *Euthynnus affinis*, respectively.

Based on the results, regulation of fishing gears used was the management measure need to be implemented by BFAR for the National Tuna Management Plan. Almost all oceanic and neritic tuna species were caught in juvenile sizes using purse seine and ring net. Therefore, the purse seine and ring net catcher vessels must be required to modify the maximum stretched depths of their nets by ten fathoms from 125 fathoms depth stretched (FDS) to ensure a further reduction in catching bigeye tuna under DA-FAO 236. This will ensure that bigeye tuna caught by ring net and purse seine nets will only comprise approximately 0.5% of the total catch. Regulations on fishing gears are implemented in concurrence with the specific policies and regulations on fish aggregating devices (Bureau of Fisheries and Aquatic Resources 2012b).

This paper links to tuna management and conservation program due to the data alignment and to ensure effective data collection and analysis to support management decisions for the rational use and conservation of tuna fisheries. It will also be linked to fisheries management areas (FMAs) by managing tuna fisheries at the FMA level, allowing for a more ecosystem-based approach to fisheries management, which considers both ecological well-being and human well-being through good governance to ensure sustainable fisheries. Hence, this paper recommended in future studies the following: reproductive biology of oceanic and neritic tunas to confirm L_m values, analyses on catch per unit effort (CPUE), and value chain analysis of the landed catch to determine its significance to the economy in the General Santos city.

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AUTHOR CONTRIBUTIONS

Pechon R: Writing - Original Draft, Writing - Review and Editing, Visualization, Investigation. **Donia EA:** Conceptualization, Methodology, Validation. **Pautong AT:** Formal Analysis, Data Curation. **Kimber A:** Software. **Cecilio MA:** Supervision.

CONFLICTS OF INTEREST

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work reported in this paper.

ETHICS STATEMENT

The researchers followed all institutional and national guidelines for the care and use of laboratory animals.

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