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**SHORT COMMUNICATION**

# Abundance, Distribution, and Diversity of Tuna Larvae (Family Scombridae) in the Philippine waters

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ABSTRACT

The Philippines is a significant producer of tunas globally but has experienced a decline in tuna production in recent years. Thus, efforts to explore and assess new fishing grounds were conducted by the Bureau of Fisheries and Aquatic Resources (BFAR) through M/V DA-BFAR. Assessment of the spawning and nursery grounds of tunas in the country's EEZ was also undertaken to properly manage and conserve tuna stocks. The said assessment commenced in 2006 and is continuing up to the present. All the data from 2006-2018 were compiled, including the data from collaborative studies with the University of the Philippines-Marine Science Institute and Southeast Asian Fisheries Development Center to create an overall profile of Scombridae's abundance and distribution larvae in Philippine waters. The study results showed that family Scombridae is most abundant in the Philippine waters along Batanes-Polillo and areas off Eastern Luzon. Species diversity in Philippine waters was considerably high, with about six to eight dominant species. The most dominant species was *Thunnus albacares*, followed by *Thunnus obesus, Auxis* spp., *Katsuwonus pelamis*, unidentified Scombrid larvae, *Rastrelliger* spp., *Thunnus alalunga*, and *Thunnus tonggol*. The Scombridae species are diverse in the West Philippine Sea and Batanes-Polillo waters but not in Davao Oriental-Surigao waters.

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The Philippines is a significant producer of tunas globally, which ranks 4th in 2003 (Vera and Hippolito 2006) but recently slid down to 10th place, indicating considerable fisheries decline (FAO 2018). Since the early 2000s, efforts to properly manage tuna stocks have been initiated by the Bureau of Fisheries and Aquatic Resources (BFAR). Exploratory fishing activities in offshore areas and oceanographic surveys focusing on physicochemical and biological parameters, like phytoplankton and ichthyoplankton abundance, were conducted to cater to the needs of the fisheries sector. Among the measures undertaken to lessen overfishing was exploring new and alternative fishing grounds for the commercial fishers and the municipal fishers who want to venture out to offshore areas. At the same time, tuna spawning and nursery areas were assessed. These studies on-board M/V DA-BFAR started in 2006 and is continuing up to the present. This paper aims to determine the abundance of Scombridae larvae in Philippine waters based on historical data from M/V DA-BFAR cruises from 2006 to 2018.

The sampling area covers the entire Philippine waters which were classified into seven zones: Batanes-Polillo, Catanduanes-Eastern Samar, Internal Waters (Bohol Sea, Davao Gulf, Lagonoy Gulf, Leyte Gulf, Ragay Gulf, Sibuyan Sea, and Tayabas Bay), Mindanao-Celebes Sea, Sulu Sea, Davao Oriental-Surigao, and West Philippine Sea (Figure 1). Ichthyoplankton data from different cruises of M/V DA-BFAR from 2006 to 2018 were assessed for the incidence of Scombridae larvae. A total of 335 stations were examined. The weighted average density (total density) of tuna larvae was used to represent the

abundance at different sampling areas in Philippine waters. On the other hand, the mean weighted average density of tuna larvae was used to compare abundance by sampling zone. Moreover, individual count of the species of Scombridae was used to compute for species diversity. Simpson's and Shannon's Indices were chosen as measures of diversity because Simpson's Index is known for its unbiased characteristics, particularly in considering the evenness of samples, while Shannon's Index for its sensitivity to species richness.

It was found that the weighted average density of tuna larvae in the Philippine waters range from 1 larva/1000m$^3$ seawater to 651 larvae/1000m$^3$ seawater. The highest density was observed along Batanes/Polillo waters while the lowest density was recorded in Mindanao/Celebes Sea, Bohol Sea, and the Sulu Sea. In terms of overall abundance by area, the highest mean density was observed in the Batanes-Polillo waters. In contrast, the lowest mean density was found in the Sulu Sea (see Figures 2 and 3).

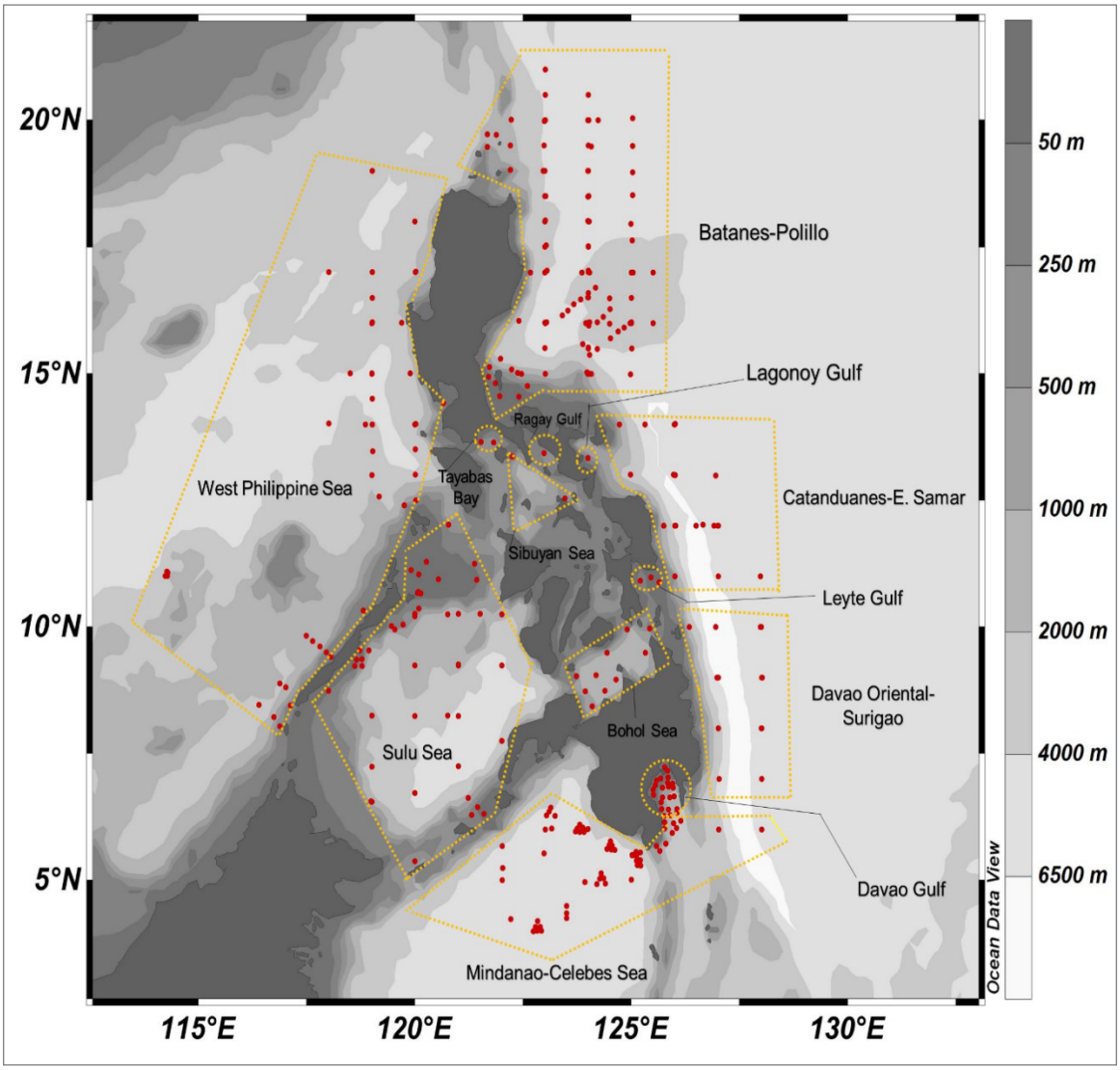


Figure 1. The sampling area.

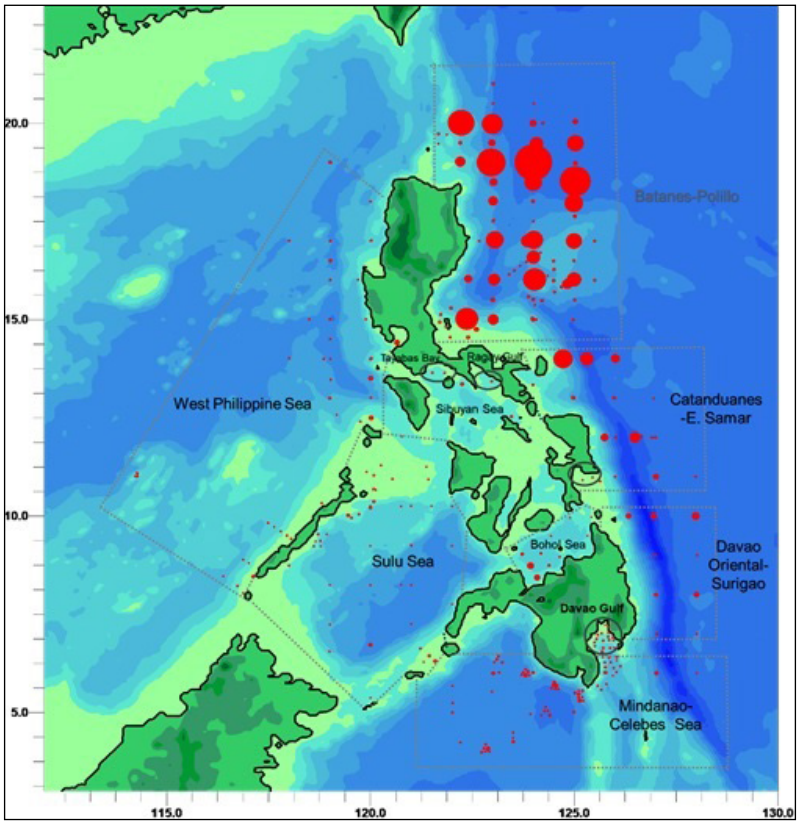


Figure 2. The abundance and distribution of tuna larvae in the Philippine waters. The red circles on the map indicate the density of the larvae. Surfer scale: 0.01 inches = 10 tuna larvae/1000m$^3$seawater; 0.25 inches = 1000 tuna larvae/1000m$^3$seawater.

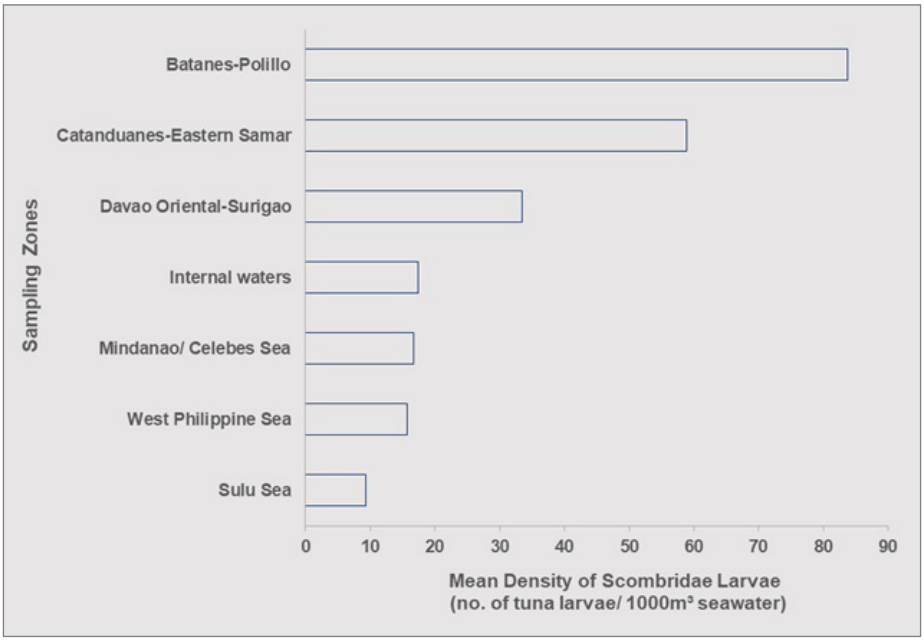


Figure 3. The mean densities of tuna larvae at different sampling areas in the Philippine waters.

There were 12 genera of Scombridae larvae in the samples that were identified into 16 possible species. The most dominant species was *Thunnus albacares*, followed by *Thunnus obesus*, *Auxis* spp., *Katsuwonus pelamis*, unidentified Scombrid larvae, and *Rastrelliger* spp. (Figure 4). Other significant tuna species like the albacore tuna (*Thunnus alalunga*) and longtail tuna (*Thunnus tonggol*) comprised 2.68% and 1.98%, respectively, of the total composition; while, the rest of the species were only noted on a minimal amount. Species diversity tests bring out considerably high diversity with an estimate of six to eight dominant species comparative to the relative abundance of the mentioned species above (see Table 1). The highest species diversity was observed in the West Philippine Sea and lowest in Davao Oriental-Surigao waters (see Figure 4 and Table 2).

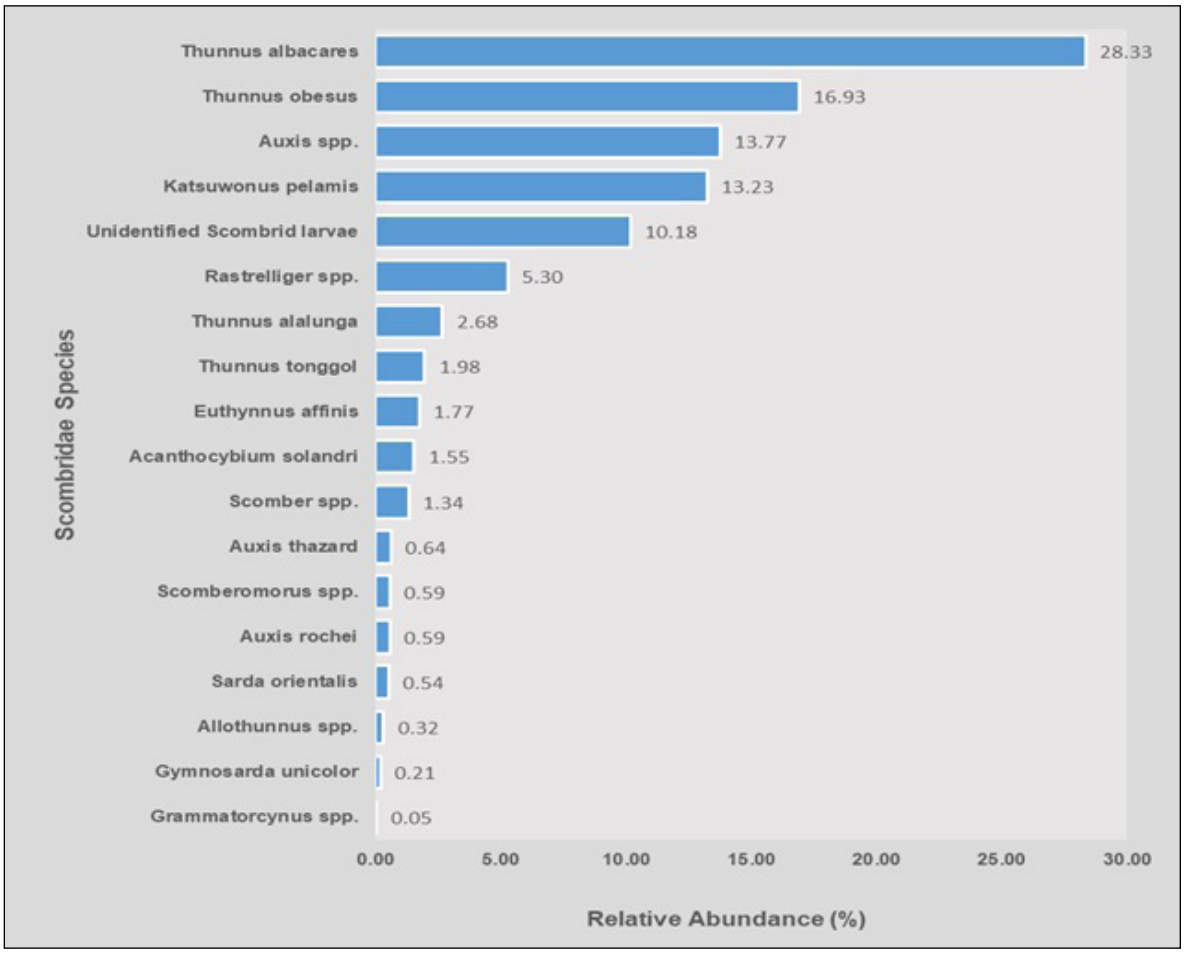


Figure 4. The relative abundance (%) of the identified species of Scombridae larvae in the Philippine waters based on individual count.

Table 1. The diversity of Scombridae in the Philippine waters.

| Simpson's Index | Computed Value | Shannon's Index | Computed Value |
|---|---|---|---|
| **1-D** | 0.8399 | **H'** | 2.1119 |
| **1/D** | 6.2462 | **eH'** | 8.2636 |
| **Evenness** | 0.3470 | **Evenness** | 0.7307 |

Table 2. The diversity of Scombridae at different sampling areas in the Philippine waters. The values with asterisks indicate the zones observed with high species diversity and species evenness.

| Sampling Area | Simpson's Index of Diversity (1-D) | Simpson's Evenness | Shannon's Index (H') | Shannon's Evenness |
|---|---|---|---|---|
| West Philippine Sea | 0.8498* | 0.5121 | 2.0733* | 0.8083 |
| Batanes Polillo | 0.8391 | 0.3884 | 2.0432 | 0.7369 |
| Catanduanes-Eastern Samar | 0.8125 | 0.7621* | 1.7238 | 0.8859* |
| Internal waters | 0.8113 | 0.4416 | 1.9038 | 0.7662 |
| Mindanao/Celebes Sea | 0.7507 | 0.2674 | 1.7264 | 0.6375 |
| Sulu Sea | 0.7404 | 0.0965 | 1.7284 | 0.6549 |
| Davao-Surigao | 0.6592 | 0.3668 | 1.4644 | 0.7042 |

In terms of dominant species by sampling area, the dominant species monitored in Batanes-Polillo was *Thunnus obesus*; unidentified scombrids in Catanduanes-Eastern Samar; *Thunnus albacares* in Davao Oriental-Surigao; *Auxis* spp. in Internal Waters; *Thunnus obesus* and *Thunnus albacares* in Mindanao-Celebes Sea; *Thunnus albacares* in the Sulu Sea; and *Katsuwonus pelamis* and *Thunnus albacares* in the West Philippine Sea (See Table 3).

Table 3. The different species of Scombridae observed at various sampling areas in the Philippine waters. The highlighted values pertain to the individual count of the dominant species per sampling zone.

| **Scombridae Species** | **Batanes Polillo** | **Catanduanes-Eastern Samar** | **Davao Orient -Surigao** | **Internal waters** | **Mindanao-Celebes Sea** | **Sulu Sea** | **West Philippine Sea** |
|---|---|---|---|---|---|---|---|
| *Acanthocybium solandri* | 16 | 3 | | 2 | 2 | 1 | 5 |
| *Allothunnus* spp. | 4 | | | | 1 | 1 | |
| *Auxis rochei* | | | | | 1 | 10 | |
| *Auxis* spp. | 17 | | 8 | 104 | 22 | 88 | 18 |
| *Auxis thazard* | | | | 3 | 5 | 4 | |
| *Euthynnus affinis* | 2 | | 1 | 11 | 9 | 9 | 1 |
| *Grammatorcynus* spp. | 1 | | | | | | |
| *Gymnosarda unicolor* | 1 | | | | 2 | | 1 |
| *Katsuwonus pelamis* | 112 | 5 | 4 | 19 | 36 | 40 | 31 |
| *Rastrelliger* spp. | 16 | 9 | 16 | 36 | 6 | 10 | 6 |
| *Sarda orientalis* | 2 | | | 2 | 5 | | 1 |
| *Scomber* spp. | 1 | | 6 | 13 | 5 | | |
| *Scomberomorus* spp. | 6 | 1 | | 1 | | 1 | 2 |
| *Thunnus alalunga* | 36 | | | | 3 | 4 | 7 |
| *Thunnus albacares* | 85 | 11 | 57 | 83 | 102 | 162 | 29 |
| *Thunnus obesus* | 136 | 6 | 6 | 23 | 105 | 31 | 9 |
| *Thunnus tonggol* | 26 | | | | | 9 | 2 |
| Unidentified Scombrid larvae | 101 | 16 | 5 | 42 | 1 | 6 | 19 |

The observed highest mean density of Scombridae larvae in the Eastern Pacific Seaboard (Batanes-Polillo waters, Catanduanes-Eastern Samar, and Davao Oriental-Surigao waters) and the lowest mean density in the Sulu Sea could be due to the hydrological profile of the sampling areas. The Philippine Pacific Seaboard is a known migration route of tunas in the Pacific as they go along with movements of favorable currents like the North Equatorial Current (Nepomuceno et al. 2016) while the Sulu Sea is an enclosed sea where monsoons influence its primary productivity. Jones (2002) stated that although the Sulu Sea is more productive than the nearby South China Sea (West Philippine Sea), its central area can be considered a desert. He also added that the fisheries catch from the area appeared to be limited or close to being limited by primary production. In this sense, tuna broodstock on the area might be limited due to its hydrological profile. The Pacific Seaboard off Luzon, on the other hand, is mainly influenced by current flows, which affects the chlorophyll-a concentrations and distributions on the area particularly off eastern Luzon (Cabrera et al. 2015). The said concentrations of chlorophyll-a (an indicator of phytoplankton abundance), as affected by the bifurcation of NEC, could be a significant factor in the abundance and distribution of tuna larvae as well. The Pacific Ocean is oligotrophic, and most species, specifically the migratory ones like tunas, rely on favorable oceanographic conditions to continue their biological processes and survival. Also, NEC, as a strong current, transport planktonic organisms like the larvae of fishes easily. Its strength was also found by Cabrera et al. (2015) to cause horizontal advection off eastern Luzon.

There were 21 tuna and tuna-like species in the Philippines, but only six of the Scombridae species were caught in commercial quantities. They were the *Thunnus albacares*, *Katsuwonus pelamis*, *Thunnus obesus*, *Euthynnus affinis*, *Auxis thazard*, and *Auxis rochei*. Yellowfin tuna and skipjack tunas are often caught in offshore areas while the rest of the mentioned species were found in inshore waters (PCMARD 1993; Barut undated). The highest production of yellowfin tuna and skipjack tuna in the country in terms of volume were recorded in South Cotabato, while the eastern little tuna and frigate tuna were in Sulu and the big-eye tuna in Davao City. Other important areas include Palawan, Quezon, Zamboanga del Sur, Eastern Samar, Cagayan, and Zambales (Philippine Statistics Authority 2017). In this study, there were six to eight dominant species of Scombridae larvae observed with larger species dominating open waters and smaller species in inshore waters. The species diversity of Scombridae larvae could be attributed to the feature of the sampling areas, biology of the species, and sampling season. The previous study on the abundance and diversity of Scombridae larvae in the Philippine Eastern Pacific Seaboard revealed that species diversity was affected by the sampling area and sampling month (Nepomuceno et al. 2016). Moreover, a study conducted by Lehodey et al. (2002) on climate-related variability of tuna populations showed that recruitments of *Thunnus albacares* and *Katsuwonus pelamis* were high during El Niño while the *Thunnus alalunga* during La Niña. Impacts of global warming on big-eye tuna populations were also investigated by Lehodey et al. (2010), and it revealed improvement in the spawning of big-eye tuna when the surface temperature becomes optimal for their spawning. Still, it tends to decline when the surface temperature becomes too warm for them. They also found that the older stages' natural mortality increases due to low habitat values such as too warm surface temperatures, decreasing oxygen concentrations in the subsurface, and less food. As for other species of tunas, spawning differs from region to region under favorable hydrological conditions (FAO 1983).

Based on the results, it can be concluded that family Scombridae is most abundant in the Philippine waters along Batanes-Polillo waters and areas along Eastern Pacific Seaboard. Its species diversity in the Philippine waters was considerably high, with six to eight dominant species. The most dominant species was *Thunnus albacares* followed by *Thunnus obesus, Auxis* spp., *Katsuwonus pelamis*, unidentified Scombrid larvae, *Rastrelliger* spp., *Thunnus alalunga*, and *Thunnus tonggo*; based on their relative abundance. The Scombridae species are diverse in the West Philippine Sea and Batanes-Polillo waters and not in Davao Oriental-Surigao waters. However, there is a need to validate data of the identified spawning grounds to serve as a basis for determining specific measures to protect and to properly manage tuna resources. Management measures should focus on the conservation and protection of tuna larvae spawning grounds to reduce their mortality rate and secure the recruitment of the stocks.

## REFERENCES

Barut N. undated. National Report on the Fish Stocks and Habitats of Regional, Global, and Transboundary Significance in the South China Sea. Philippines.

Cabrera OC, Villanoy CL, Alabia ID, Gordon AL. 2015. Shifts in chlorophyll a off eastern Luzon, Philippines, associated with the North Equatorial Current bifurcation latitude. Oceanography [Internet]. [cited 2019 Sept 02]; 28(4): 46–53. Available from: https://doi.org/10.5670/oceanog.2015.80.

FAO. 2018. The State of World Fisheries and Aquaculture 2018. Meeting the sustainable goals. Rome. [Internet]. [cited 2019 Sept 02]. Available from: http://www.fao.org/3/i9540en/i9540en.pdf

FAO. 1983. Species Catalogue. Vol. 2. Scombrids of the world. An annotated and illustrated catalogues of Tunas, Mackerels, Bonitos and related species known to date. FAO Fisheries Synopsis No.125, Volume 2. [Internet]. [cited 2019 Sept 02]. Available from: http://www.fao.org/3/ac478e/ac478e00.htm

Jones ISF. 2002. Primary production in the Sulu Sea. Journal of Earth System Science. 111: 209–213. Available from: https://doi.org/10.1007/BF02701967

Lehodey P, Chai F, Hampton J. 2002. Modelling climate-related variability of tuna populations from a coupled ocean-biogeochemical-populations dynamics model. Fisheries Oceanography. 12(4-5): 483-494. Available from: https://doi.org/10.1046/j.1365-2419.2003.00244.x

Lehodey P, Senina I, Sibert J, Boop I, Calmettes B, Hampton J, Murtugudde R. 2010. Preliminary forecasts of Pacific bigeye tuna population trends under the A2 IPCC scenario. Progress in Oceanography [Internet]. [cited 2019 Sept 02]; 86(1-2): 302-315. Available from: https://doi.org/10.1016/j.pocean.2010.04.021

Nepomuceno L, Bacordo RS, Viron JG, Arinque RA, Fortaliza Rt, Ramiscal Rv. 2016. Establishing Spatio-temporal Profile of Scombrid Larvae: the Philippine Eastern Pacific Seaboard in Focus. Fish for the People. 14(1): 21-29. Available from: http://hdl.handle.net/20.500.12066/982

[PCMARD] Philippine Council for Aquatic and Marine Research and Development. 1993. Status of the Philippine Tuna Fisheries. PCAMRD-DOST Primer No.18.

Philippine Statistics Authority. 2017. Volume 25. 2014 to 2016.

Schlitzer R. 2012. Ocean Data View [Internet]. [cited 2019 Aug 27]. Available from: http://odv.awi.de

Smith PE, Richardson SL. 1977. Standard Techniques for Pelagic Fish Egg and Larva Surveys. FAO Fisheries Technical Paper No. 175. Food and Agriculture Organizations of the United Nations. Rome.

Vera CA, Hippolito Z. 2006. The Philippines Tuna Industry: A Profile. [Internet]. [cited 2019 Sept 02]; p. 16. Available from: http://aquaticcommons.org/250/1/The_Philippines_tuna_industry,_a_profile.pdf