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Master of Science in Environmental Science

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Sea Surface Temperature and Chlorophyll-a Preferences of Yellowfin tuna (Thunnus albacares) in the Philippine waters

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ABSTRACT

Improving the current understanding of the relationship between fish distribution and its environment is an important step towards ecosystem-based and sustainable fisheries management. This work focused on the environmental preferences of Yellowfin tuna (YFT) or Thunnus albacares which is a valuable and economically important fish resource in the Philippines. The main aims of this study are to (1) analyze the publicly available YFT catch and catch-per-unit-effort (CPUE) records in $5^o \times 5^o$ spatial grids from 1997 to 2017, and (2) utilise this information to determine the YFT chlorophyll-a (C_a) concentration and sea surface temperature (SST) preferences within the Philippine waters. This was done using remote sensing, geographical information systems, and non-linear statistical modelling. Long-term time series of YFT longline and purse seine monthly total catch weights in the study area showed increasing trends within the past decades, then stability within the recent years and the catch weights were strongly correlated with the fishing effort—especially for longline. The trend analysis per grid showed areas with data scarcity, differences in seasonality or fishing seasons, and areas where there is a shift in gear use. Differences were also found between the trends and seasonality of the catch and effort from both fishing gears, and this reinforced the use of aggregated normalised CPUE ($CPUE_N$) instead of gear-dependent observations to model the YFT preference. Weak and statistically insignificant correlations observed between the $CPUE_N$ and environmental predictors also warranted the use of non-linear models. Despite the limitations in the spatial resolution of $CPUE_N$, the final generalised additive model (GAM) performed comparably well with the results from existing studies (R^2 = 0.52 and RMSE = 0.19). The significant predictors, from highest to lowest importance, were spatial factor, C_a, C_a lag_3, SST, and month. High $CPUE_N$ was also associated within the south and west portions of the study area during June to August. The high dependence of $CPUE_N$ with spatial factor was attributed to the availability of observations and its bias to some areas instead of migration patterns. Furthermore, the YFT C_a and SST preferences in the study area were

identified as 0.1–0.2 mg m-3 and 29.5–30.5ºC, respectively, and were consistent with the results from other studies in the tropics. YFT in the study area preferred warmer but not necessarily highly productive waters. The C_a peak in middle concentrations and the presence of C_a lag predictor both suggested that YFT aggregation may not be directly caused by high primary productivity, and delays in the relationship between nutrient availability and YFT as a high tropic level predator is possible. The model output was deemed insufficient to reveal environmental processes that are associated with YFT distribution. The model output maps, however, showed similarities in general patterns of regional and quarterly YFT catch, especially within the Celebes and Sulu Seas and the Moro Gulf. While the environmental preferences of YFT in the Philippine waters were identified in this study, the need to improve the fisheries data logging in the country was also emphasized. High resolution fisheries data input to the model is expected to further reveal variations at a finer scale and be used to analyze the underlying environmental processes that affect YFT distribution.