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Preliminary Comparison of Remote Sensing-Derived Chlorophyll a Concentration and Sea Surface Temperature with the Fisheries Resources and Ecological Data in Manila Bay

Jennifer A. Poniente and Mudjekeewis D. Santos*

Vetebrate Section
Capture Fisheries Research and Development Division
National Fisheries Research and Development Institute

*Corresponding Author: mudjiesantos@gmail.com

Abstract

Remote sensing is used to determine the chlorophyll *a* concentration and the sea surface temperature. Here, obtained remote-sensed chlorophyll *a* and sea surface temperature data from MODIS for Manila Bay from 2014 – 2015 was analyzed and initially correlated with the results from the fisheries resources and ecological assessment (this study).

Chlorophyll *a* concentration was generally concentrated on the eastern part of the bay all throughout 2014. Sea surface temperature was observed to be high during May, July, August, and October 2014. During the first quarter of 2015, a high concentration of chlorophyll *a* was generally concentrated on the eastern and southwestern part of the bay, while sea surface temperature was high and almost uniform except in the southern side of the bay. The second quarter of 2015 showed that the chlorophyll *a* is still concentrated in the eastern side of the bay, while the highest sea surface temperature was observed during May reaching more than 30 °C. Comparative analysis indicated that there is a correlation between remote sensing and actual chlorophyll *a* data vis-à-vis egg and larval aggregations. Further studies are warranted.

Keywords: Manila bay, chlorophyll a, sea surface temperature, remote sensing

INTRODUCTION

Manila Bay is one of the most important coastal and marine area in the Philippines as it provides an array of uses such as food resources, employment and income, and recreation to the people. It is located on the west of Luzon Island of Philippines and opens up to the West Philippine Sea. The 190 km coastline of the bay is under the provinces of Cavite, Metro Manila, Bulacan, Pampanga, and Bataan. Its average depth is 17 meter (PEMSEA, 2007) and the bay's watershed consists of 26 catchment zones (Jacinto *et al*., 2011).

Previous studies reported that Manila Bay until the 1970s was the country's second-biggest source of fish catch. In fact, it was once known as one of the premier fishing grounds in the country. More than 50% of gross national product comes from the Manila Bay (Carlo Castillo, 2000).

However, close to the largest population center, the bay and adjacent waters today constitute one of the most heavily exploited areas in the country (Silvestre et al., 1987).

Natural conditions (topography, presence of tributaries, wind forcing, circulation, etc.) coupled with different activities in and around the bay contribute to the significant variability, both at temporal and spatial scales, in the bay water quality conditions.

The moderate-resolution imaging spectroradiometer (MODIS) is a payload scientific instrument that was launched into Earth orbit by NASA in 1999 on board the Terra (EOS AM) Satellite, and in 2002 on board the Aqua (EOS PM) satellite. The instruments capture data in 36 spectral bands ranging in wavelength from 0.4 μm to 14.4 μm. The instruments image the entire Earth every 1 to 2 days. They are designed to provide measurements in large-scale global dynamics including changes in Earth's cloud cover, radiation budget and processes occurring in the oceans, on land, and in the lower atmosphere. With its low spatial resolution but high temporal resolution, MODIS data is used to track changes in the landscape over time. Examples of such applications are the monitoring of vegetation health by means of time-series analyses with vegetation indices, long-term land cover changes (e.g. to monitor deforestation rates), global snow cover trends, water inundation from pluvial, riverine, or sea level rise flooding in coastal areas, change of water levels of major lakes, and the detection and mapping of wildland fires.

Although remote sensing techniques possess considerable potential for monitoring on an operational basis due to the data acquisition mode and periodic onsite revisit capability, its application to assess the water quality conditions particularly for Manila Bay remains scarce and untapped.

The study aims to compare the seasonal patterns of spatial remote sensing data with the fisheries resources and ecological data gathered for the Manila Bay from 2014-2015.

MATERIALS AND METHODS

Monthly satellite chlorophyll *a* and sea surface temperature imagery were obtained from Giovanni Interactive Visualization Analysis (http://giovanni.gsfc.nasa.gov/) of NASA.

A list of modified settings to generate the products based on global parameters were derived from NASA's ocean color sensors, including SeaWiFS, MODIS-Aqua, and MODIS-Terra. All therse were controlled in Ocean Color Radiometry Online Visualization and Analysis-

Global Monthly Products. The first setting was the spatial area of interest which provided the coordinates of Manila Bay, followed by "climatology" in the analysis options. The latter was verified to determine the available data from the list of sensors, which displayed the spatial resolution and the period of activity. Among these sensors, The MODIS-Aqua 4 km box, which is used to determine the chlorophyll *a* concentration and sea surface temperature was chosen. The final setting was the time. Visualization had multiple options, but the time-averaged, default Lat-Lon map was used to generate visualization.

The climatological chlorophyll *a* and sea surface temperature were processed using quantum GIS.

Temporal trends were drawn from monthly data of this Manila Bay project. TRMM precipitation data were obtained from NASA's precipitation measurement.

Fisheries and physicochemical data obtained from this study and rainfall data from PAG-ASA from 2012-2015 were plotted in a line graph to compare general trends.

RESULTS AND DISCUSSION

Remote Sensing

Remote sensing showed that the chlorophyll *a* concentration was generally concentrated on the eastern side of the bay near Manila and Cavite all throughout 2014 and the first half of 2015. During March 2014, chlorophyll *a* was concentrated on the western and eastern side of the bay, which supported the phytoplankton survey at that time. While in April, it was still concentrated on the eastern side. During May, chlorophyll *a* was patchy with the largest concentration found near the boundary of Manila and Cavite. This again coincided with the survey of the hydrobiological study component which had the highest concentration of phytoplankton found near the boundary. A high concentration was also observed near the boundary of Manila and Bulacan which supported the *in situ* data for chlorophyll *a* concentration. For July 2014, chlorophyll *a* was concentrated on the eastern and northern side of the bay and in August of the same year, it was concentrated towards the center and northeastern of the bay. During October, chlorophyll *a* was concentrated throughout the bay particularly on the western and southeastern. November chlorophyll *a* concentration was concentrated on the northeastern portion of the bay.

However, the chlorophyll *a* concentration was generally concentrated on the northern and southern part of the bay during January 2015 and on the eastern and southwestern during February, March, and April of the same year. During May, largest concentration of chlorophyll *a* was found near Metro Manila (see Figure 12.1).

Figure 12.2 showed that sea surface temperature showed that the highest temperature was observed during May, July, August and October. During March, the highest temperature was observed at the northwestern side of the bay which supported the in situ measurement of the hydrobiological study component. The same pattern was observed during April, however, the temperature was hotter. July 2014 sea surface temperature was uniform and high reaching 31°C throughout the bay. During August, the temperature was also high and almost uniform except in the southeastern and northwestern side along Cavite and between Pampanga and Bataan, respectively. Sea surface temperature showed higher temperature during October compared to November. During October, the temperature was almost uniform except on the southeastern side that had a lower temperature. During November, the temperature was higher on the northwestern side of the bay than the rest of the area.

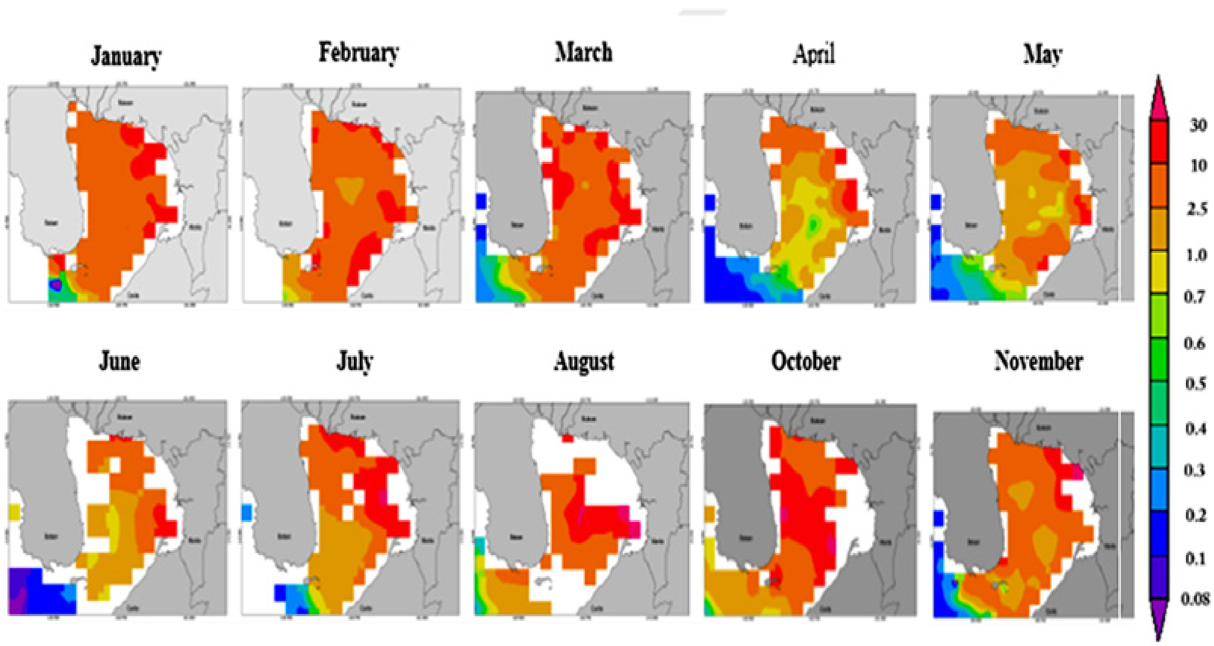


Figure 12.1. Chlorophyll concentration (mg m^{-3}) in Manila Bay in 2014

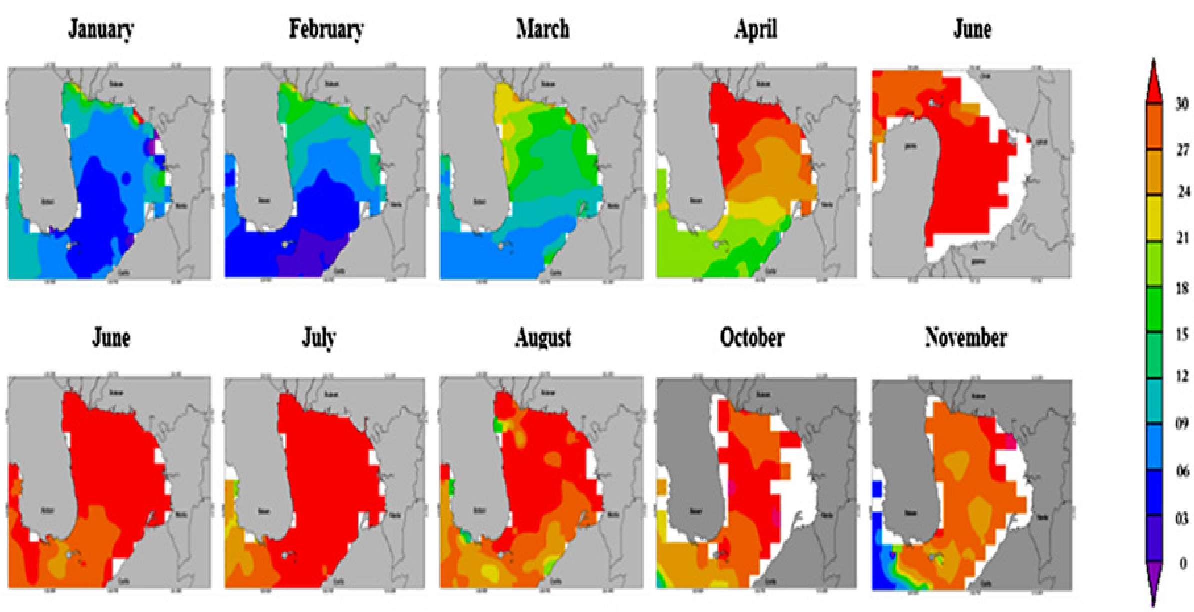


Figure 12.2. Sea surface temperature (ºC) in Manila Bay in 2014

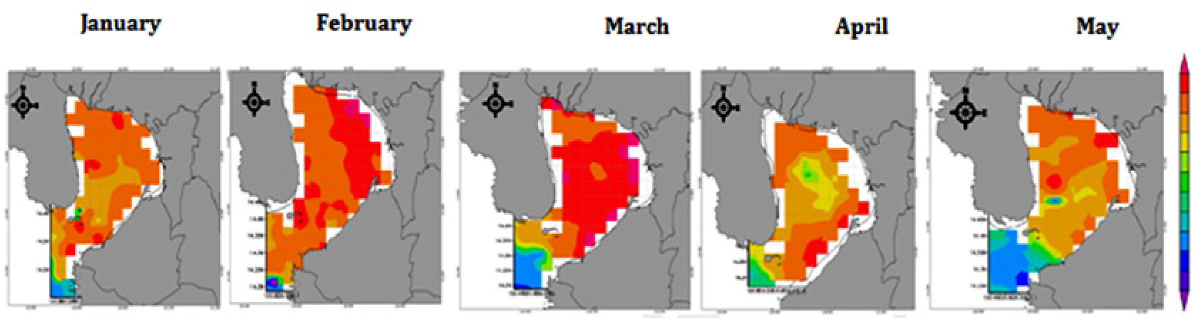


Figure 12.3. Chlorophyll concentration (mg m^{-3}) in Manila Bay in 2015

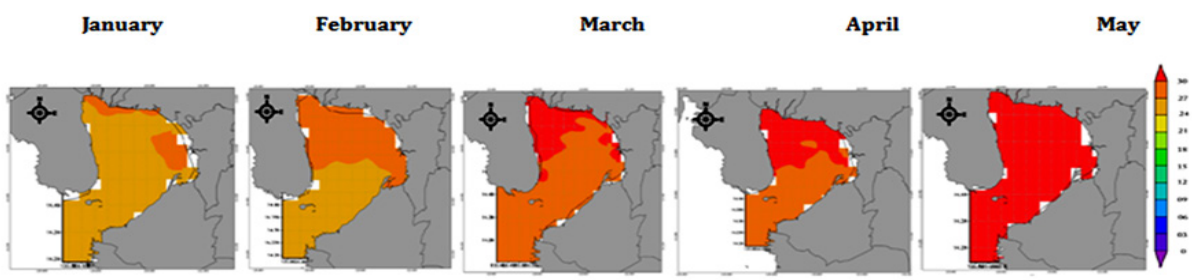


Figure 12.4. Sea surface temperature (ºC) in Manila Bay in 2015

January 2015 sea surface temperature was high reaching 27°C, lower than February sea surface temperature with 28°C. The temperature was really high during May 2015 reaching more than 30 °C.

Figure 12.5 focused on the identification of temporal trends in selected measures of the environmental quality of Manila Bay. The values were averaged to yield the average parameter for a specific month.

Our data support the findings of the actual chlorophyll *a* data of the hydrobiological survey in Manila Bay. Vergara et al. (2015) investigated that across the surface, chlorophyll *a* was commonly concentrated in either the northern, northeastern, or eastern parts of the bay. Generally, the concentration was on the eastern side of the bay which had the highest concentration of phytoplankton based on the study of Gatdula et al. (this Volume). This also coincided with the study of Tobias et al. (2015) (this Volume) that fish larvae were consistently found in the eastern part of the bay throughout the duration of his study. Those were the areas where high concentrations of zooplankton and nutrients were observed (Hydrobiological study of Manila Bay).

We drew the temporal trends of the Manila Bay every March (2012-2015), and it appears that high concentrations of fish eggs and fish larvae were amassing in the southeast side of the bay correlated with actual and remote sensing-detected chlorophyll *a* content.

It is possible that the phytoplankton and zooplankton communities appearing in the bay were influenced by the interactions between temperature, nutrients availability and the water quality.

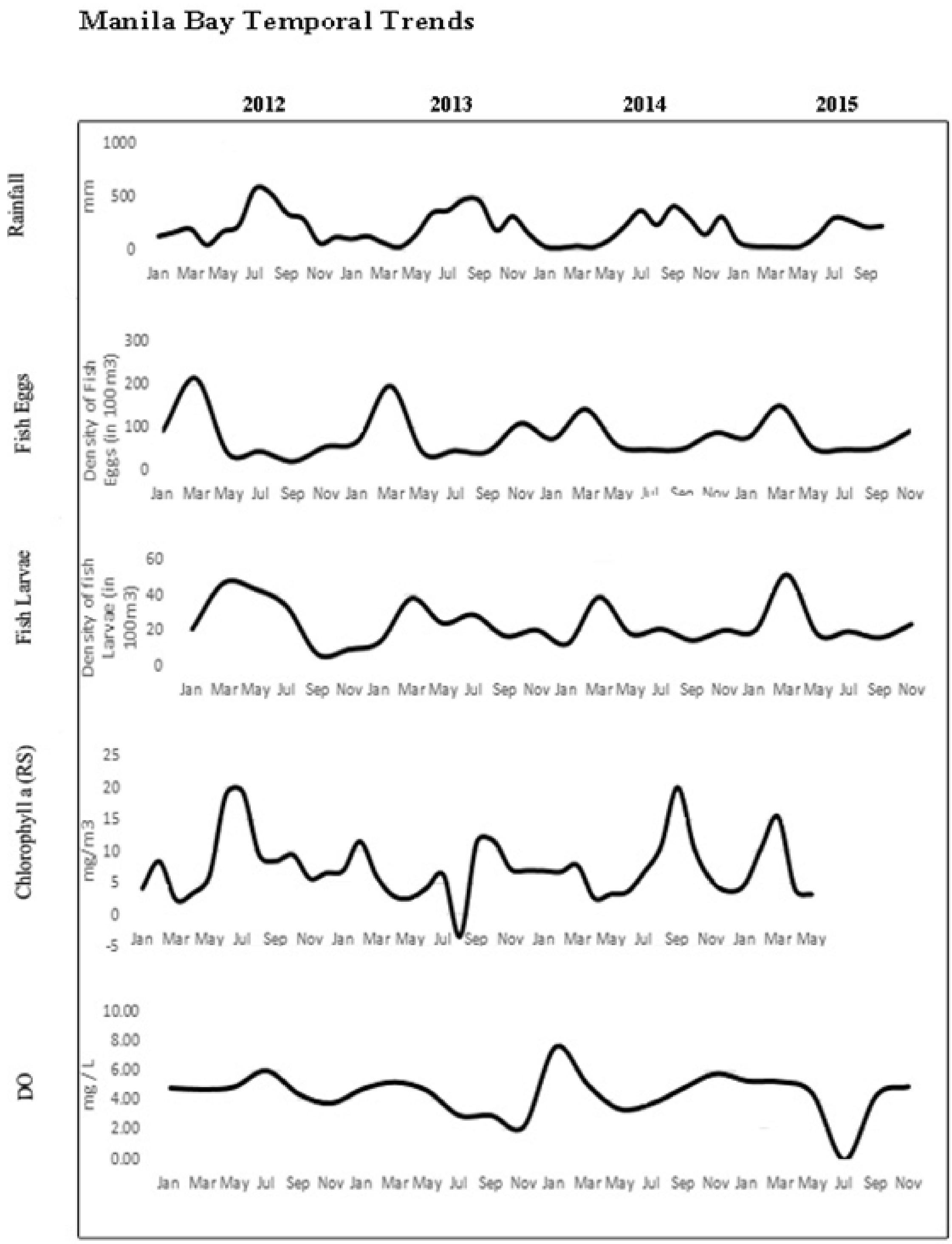
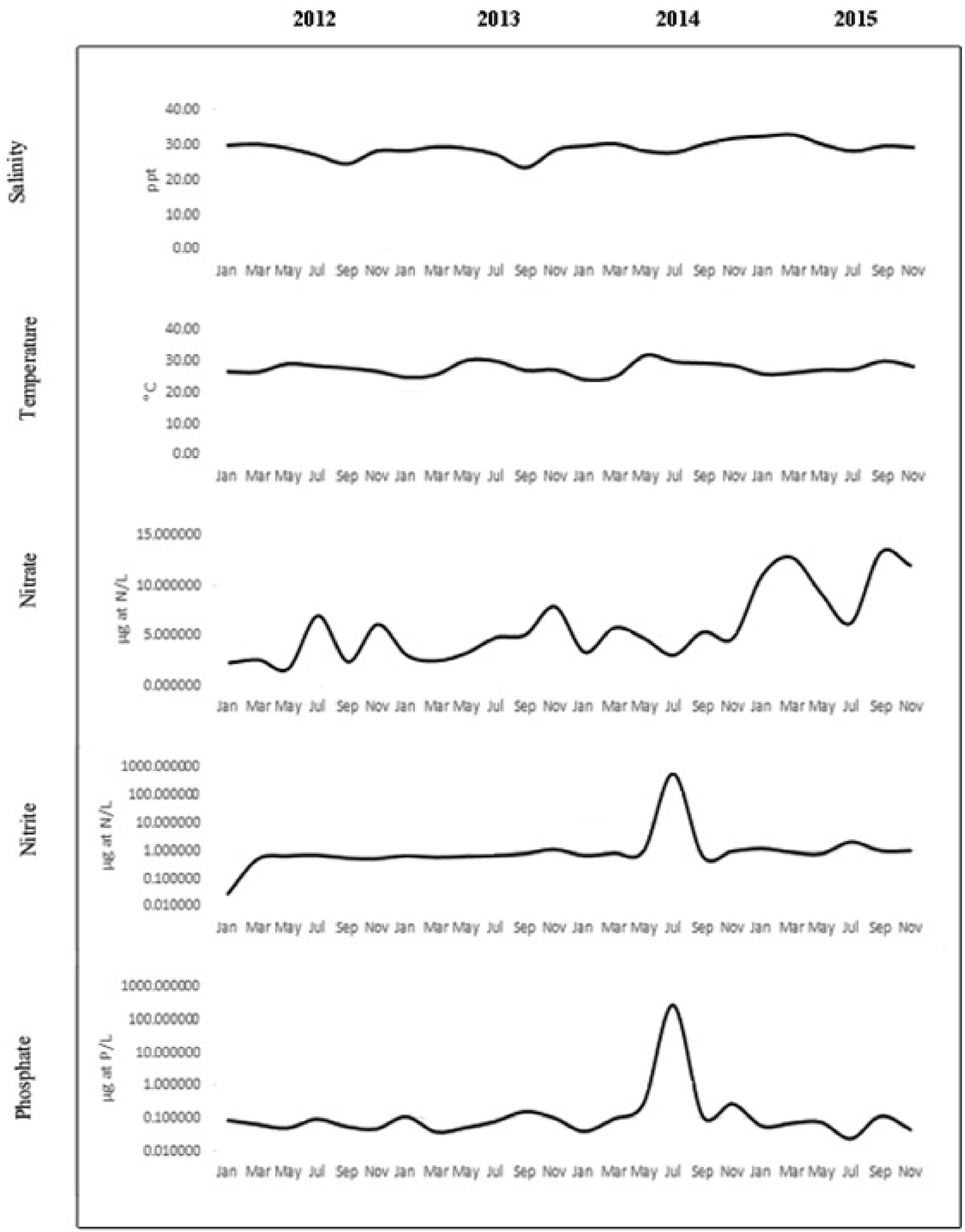


Figure 12.5. Manila Bay Temporal Trends for 2012 - 2015
Source: Fisheries Resources and Ecological Assessment of Manila Bay Project



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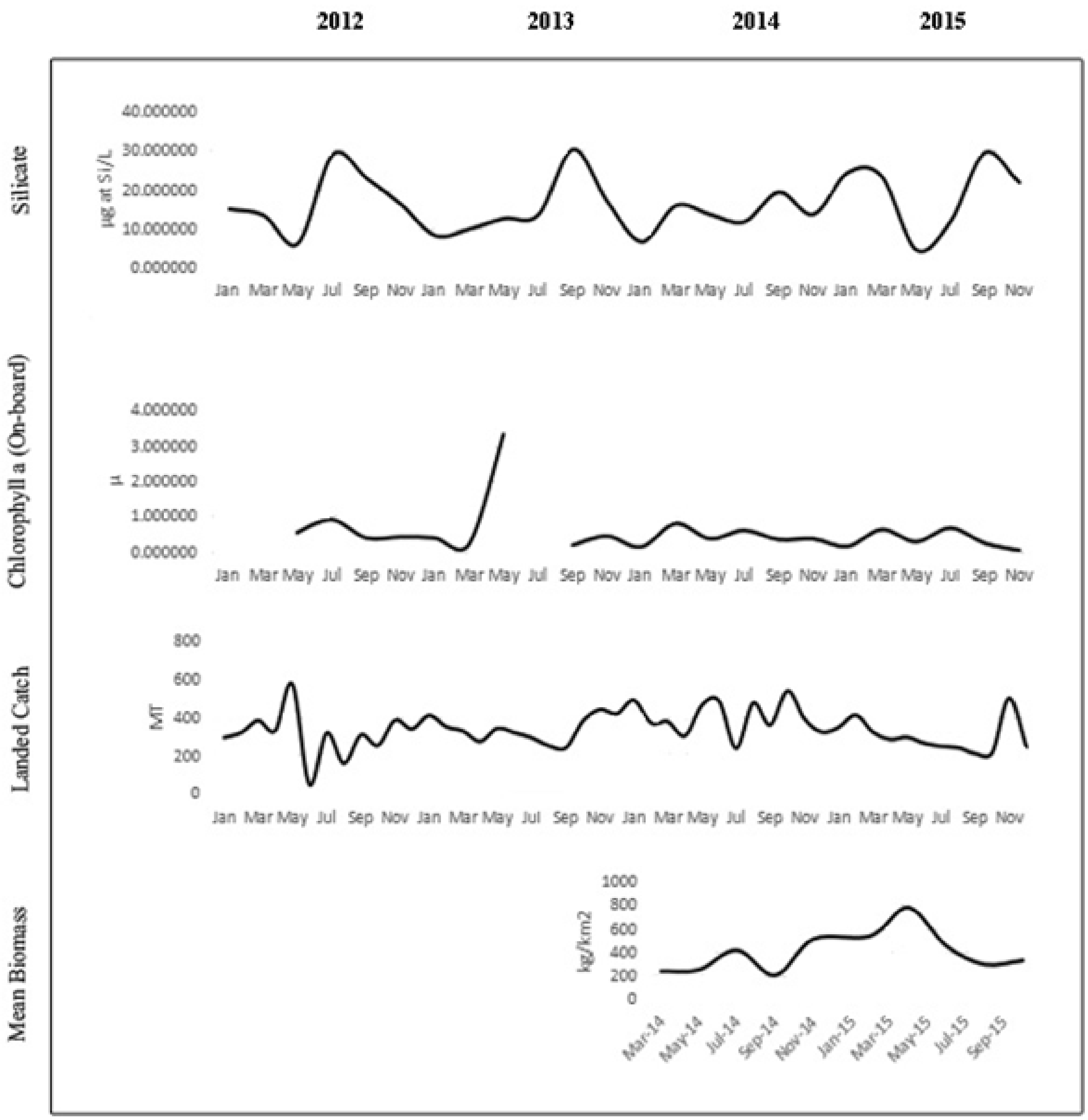

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