Stable Isotopes Reveal Anthropogenic Impacts on the Littoral Food Webs of Laguna de Bay, Philippines

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Freshwater ecosystems are currently threatened because of unsustainable urbanization. Human activities in catchment alter lake and marine ecosystems through rivers. Especially in developing countries, lake ecosystems in urban areas are heavily affected by industry, sewage, household wastes, and deforestation. Driven by rapid population growth in the Philippines, Laguna de Bay (LDB) is highly suitable test ecosystem to further understand how anthropogenic disturbances impact biological communities and trophic relations in lakes. We aim to assess such impacts using land use data and human population density (HPD) of each catchment surrounding the LDB. Moreover, we use carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope analysis to examine how human activities in the catchment affect water quality, and in turn, littoral food webs at 30 sites of the LDB. In all these sites, we measured total nitrogen and total phosphorus as indicators for nutrient loadings from the catchment and total dissolved solids, dissolved oxygen, conductivity, pH, salinity, temperature as physico-chemical environments. We collected biological samples zoobenthos, phytoplankton, meio- and macrozooplankton, and *Oreochromis niloticus*. We also collected epilithic organic matter (EOM) and particulate organic matter (POM) as basal resources of littoral food webs. We measured $\delta^{13}C$ and $\delta^{15}N$ for these samples. With an 82% cumulative variance from PC1 and PC2, principal component analysis successfully clustered sites according to its bays (Central, West, East, and South). The results showed that the sites in the Central and West Bays are more disturbed than the ones in the East and South Bays which is reflected in the water quality parameters and community structures of mollusks and zooplankton around LDB. Ultimately, significant variation (Kruskal Wallis H test, $P < 0.01$) among the trophic levels of benthic and pelagic primary consumers (mollusks and zooplankton, respectively) and *O. niloticus* between sites was observed which may indicate heterogeneity of water quality due to varying degrees of anthropogenic disturbances. Our isotope data on food webs provide clarity and evidence on the link between human activities and food web properties in the lake ecosystem.

Keywords: trophic position, stable isotope analysis, food web, human population density, eutrophic lake

