Effects of eutrophication on fish populations in the vicinity of Rumuji Lake in the Niger Delta region of Nigeria

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ABSTRACT
There were high concentrations of phosphorus and nitrogen in the lake which supported algae bloom and resulted in water level decline. Massive blooms of algae were observed, a lot of which were the potentially toxic blue-green variety. Eutrophication specially favoured water lettuce and water ferns. Eutrophication was observed to have arisen from sediment and nutrient deposition into the lake which emanated from soil erosion and other agents of pollution such as excess phosphorus and nitrogen. There was increased growth of aquatic weeds especially in areas receiving high nutrient loads. Floating vegetative mat produced by algae resulted in significant oxygen depletion from the water and lower levels of nutrients in sheltered areas which are breeding and nursery grounds for fish such as catfish. The rapid proliferation of algae and other aquatic weeds in the lake due to eutrophication in areas receiving high nutrient load led to adverse effect on fish production as fish breeding areas were destroyed. Also, the polluted water harboured disease vectors which attacked fish. The weed and vegetative mat negatively affected productivity by disrupting important food chains. The weed shaded phytoplankton from sunlight and reduced air circulation in the water. Eutrophication caused diversity loss in the fish populations as well as changes in phytoplankton composition with the blue greens becoming dominant giving rise to algal blooms.

KEYWORDS: Eutrophication; Vegetative cover; Phosphorus; Nitrogen; Pollution; Fertilizers; Lake

1.0 INTRODUCTION

Phosphates and nitrates are very essential nutrients for plants which have to be available in enough quantities. However, if they get into ponds, rivers, lakes, and other bodies of water and become too concentrated in our water environments they can cause serious pollution problems. Phosphates usually enter ponds, lakes and rivers from drainage from farmland in the form of fertilisers, runoff from manure, etc. or as sewage effluent which contains dishwasher detergents. Eutrophication is characterized by excessive plant and algal growth due to the increased availability of one or more limiting growth factors needed for photosynthesis (Schindler 2006), such as sunlight, carbon dioxide, and nutrient fertilizers. Eutrophication occurs naturally over centuries as lakes age and are filled in with sediments (Carpenter 1981). Eutrophication harms ecosystems, plants, animals, and increases toxic algae incidences. Increased number of toxic algal blooms which are a hazard to people, domestic animals and wildlife can lead to loss of some plants, animals and their habitat. Eutrophication leads to reduced levels of oxygen in the affected bodies of water. Human activities have accelerated the rate and extent of eutrophication through both point-source discharges and non-point loadings of limiting nutrients, such as nitrogen and phosphorus, into aquatic ecosystems (i.e., cultural eutrophication), with dramatic consequences for drinking water sources, fisheries, and recreational water bodies (Carpenter et al. 1998). Water level fluctuations play a significant role in the lake nutrient dynamics, and consequently may have a strong influence on the biological communities and productivity. Some algal blooms pose an additional threat because they produce noxious toxins (e.g., microcystin and anatoxin) (Chorus and Bartram 1999). Eutrophication is also associated with major changes in aquatic community structure. During cyanobacterial blooms, small-bodied zooplankton tend to dominate plankton communities, and past observational studies have attributed this pattern to anti-herbivore traits of cyanobacteria (e.g., toxicity, morphology, and poor food quality) (Porter 1977).

2.0 MATERIALS AND METHOD

Water samples for physicochemical and plankton analyses were collected from five sampling sites. Nitrate, nitrite, ammonium, phosphate, total phosphorus, carbonate, bicarbonate and chlorophyll-a concentrations were determined following the analytical procedure of APHA (APHA, 1992). For the quantification of the zooplankton, subsamples were collected within the macrophyte beds using a tube and were pooled into a vessel in order to form an integrated sample of approximately 10 L (Kuczynska-Kippen, 2003).

3.0 RESULTS and DISCUSSION

Eutrophication can be defined simply as the increase in the rate of production and accumulation of organic carbon in excess of what an ecosystem is normally adapted to processing (Nixon, 1995; Rabalais, 2004). In this study, the eutrophication was caused by the run-off of animal manures and fertilisers containing nitrates and phosphates from farms into the lake. Erosion was another contributing factor to the destruction of the lake. In this study, it was observed that there were high concentrations of phosphorus and nitrogen in the lake which supported algae bloom and resulted in water level decline. Massive blooms of algae were observed, a lot of which were the potentially toxic blue-green variety. This finding is in consonance with the results obtained by Smith (1998) which revealed that the supply rate of nitrogen and phosphorus also strongly influenced the growth of algae and vascular plants in freshwater and marine ecosystems. Nitrates and phosphates overstimulated the growth of algae, causing unpleasant odors. Eutrophication depleted the amount of dissolved oxygen in water that is crucial to other aquatic life. Eutrophication specially favoured water lettuce and water ferns. The eutrophication was observed to have arisen from sediment and nutrient deposition into the lake which emanated from soil erosion and other agents of pollution such as excess phosphorus and nitrogen. According to Chessman et al. (1992), the direct effect of nutrient enrichment in streams is excessive accumulation of filamentous benthic algae during the peak summer growing season, altering flow environment; physical benthic habitat used by stream invertebrates and vertebrate organisms. Minimum, there is a remarkable consistency in the response of algal biomass to nutrient enrichment. Strong positive relationships between algal biomass and nutrient loading have been observed in most lakes and reservoirs that have been studied (Jones and Bachmann, 1976). There was increased growth of aquatic weeds especially in areas receiving high nutrient loads. The results of this study agree with the work by Foy and Withers, (1995) which reports that in many areas, P inputs from fertilizers and manures greatly exceed P outputs in farm produce, and P is thus accumulating yearly in the soil (Foy and Withers, 1995). Further, floating vegetative mat produced by algae resulted in significant oxygen depletion from the water and lower levels of nutrients in sheltered areas which are breeding and nursery grounds for fish such as catfish. A critical load is the amount of nitrogen deposition that an ecosystem can tolerate without damage (Jefferies and Maron, 1997). According to Selberg et al., (2001) hypoxia also alters spatial patterns of human use by influencing the spatial distribution of fisheries resources. The rapid proliferation of algae and other aquatic weeds in the lake due to eutrophication in areas receiving high nutrient load led to adverse effect on fish production as fish breeding areas were destroyed. Also, the polluted water harboured disease vectors which attacked fish. Cyanobacterial species produced algal toxins that can be lethal to aquatic life and to humans and livestock. The weed and vegetative mat negatively affected productivity by disrupting important food chains. Hypoxia (i.e. condition of low oxygen) due to vegetative mat caused by algal bloom led to anoxic water environment which adversely affected fish. This result is consistent with that reported by Rabalais and Turner, (2001) as they said that if hypoxia is coupled with stratification of the water column, which limits mixing of more oxygen rich waters from the surface to the bottom, oxygen depletion can occur. The weed shaded phytoplankton from sunlight and reduced air circulation in the water. Eutrophication caused diversity loss in the fish populations as well as changes in phytoplankton composition with the blue greens becoming dominant giving rise to algal blooms. Jorgensen, (1980) reported that when oxygen is severely depleted, or anoxic, H_2S builds up in the bottom waters as anaerobic bacteria metabolism reduces sulfate to H_2S. Some researchers have reported that the lake is increasingly being polluted and the water quality has been deteriorating due to a wide range of water pollutants, especially nutrients (Hecky, 1993). To an extent, increased nutrients will increase biological production, whereas hypoxia reduces biomass and habitat quality and quantity (Caddy, 1993; Nixon and Buckley, 2002).

4.0 CONCLUSION

Poor agricultural practices and erosion are the main contributors to run-off of fertilisers into lakes, streams and other bodies of water. Therefore, the control of erosion remains a viable strategy for curbing eutrophication. High rates of photosynthesis associated with eutrophication can deplete dissolved inorganic carbon and raise pH to extreme levels during the day. Specific health risks appear when fresh water, extracted from eutrophic areas, is used for the production of drinking water. Therefore, the provision of enough pipe-borne water is crucial in the developing world.

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