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The Extent of Inorganic Pollution in Wetland Areas and its Affect of Aquatic Life on Campus of College of DuPage

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(Biology 201 and Earth Science 198)

The Assignment: Conduct original research and write a paper about the research that follows a format in a particular scientific journal.

The purpose of the study was to examine the extent of inorganic pollution and its affect on the species diversity in the nine wetland areas on the campus of College of DuPage, IL. Selective chemical tests of water indicated excessive chloride level in seven of the wetlands, with only two natural marshes having low levels. The assemblages of macroinvertebrates found among the sites as summarized using correspondence analysis, were correlated to chloride level possibly indicating that chloride is affecting the macroinvertebrate communities. High level of chloride is believed the result of inputs of de-icing materials used on parking lots and sidewalks. Nitrate levels were generally lower (< 0.5 ppm), but were negatively correlated to Shannon diversity index of the macroinvertebrates. Sources of nitrate were the surface runoff and agricultural use (excessive amount of fertilizers) in the past.

Introduction

Human activities along wetlands often adversely affect these ecosystems by reducing habitat complexity (Whitter et al. 2002). Wetlands located in human-dominated landscapes receive sediments, nutrients, and other non-point source pollutants in excess of natural inputs, and studies have shown negative effects on wetland species and ecosystem functioning with such impacts (Poiani and Bedford 1995). Throughout much of North America, many wetlands have been modified from their original state due to pollution (Reid 1961).

Marked changes occur in the species abundance and composition of all types of aquatic communities, including benthic macroinvertebrates (Committee on Inland Aquatic Ecosystems 1996). Biomonitors offer scientists a way of evaluating the biological effects instead of trying to infer these effects through chemical analysis (Root 1990). Whitter et al. (2002) conclude that invertebrates more accurately reflect water quality and tend to have more direct habitat impacts on the invertebrate community than on that of the fish. The Biodiversity Recovery Plan reports that insect communities in the Chicagoland area, and the location of the present study, have been negatively effected by pollution (Chicago Region Biodiversity Council1999).

In the following study, biomonitoring of the wetlands located on the campus of College of DuPage, IL was conducted. The major sources of pollution of these wetlands were predicted to be salts from de-icing parking areas during winter, fertilizers inputs from lawn care, and atmospheric deposition. One of the predictions of the study was that higher concentration of pollutants would cause a decline in the species diversity and a change in the assemblage structure of the macroinvertebrate communities. Ponds and marshes located closer to the roads and buildings were predicted to have higher salt contamination from roads and parking lots. Finally, the artificially made reservoirs were predicted to be more polluted than natural formed marshes due to their function as store-water retention basins and lack of naturalized borders.

Study Area

The nine wetlands were located on the campus of College of DuPage, IL. The area was farmed up until 1965 when it was sold for building of the college. Hoddinott Marsh, Lambert Marsh, and the SRC Marsh were originally wetlands, although they have been modified by habitat recreation of the surrounding land to include tallgrass prairie. These marshes function as preserves with a purpose to maintain diversity of life forms. The West Retention Pond (RP), IC RP, and South RP date approximately 30 years, while the SRC RP and AC date approximately 20 years. All retention ponds were created for collection of snowmelt and storm water. The North Marsh was created by obstruction of ground water during campus construction. The marsh, which is 30 years in age, has since naturalized.

Methods

The study was performed in April, 2004 between 10 A.M. and noon. Selected chemical measurements were taken using LaMotte chemical kits (LaMotte Chemical Co., Chestertown, Maryland). Sampling of macroinvertebrates was done using dip nets (Mason 1996). Macroinvertebrate diversity was computed using the Shannon diversity index (Zar 1999). The ordination technique of correspondence analysis (CA) was used to summarize the community structure of macroinvertebrates along a two–dimensional plane. The first coordinate from CA and Shannon diversity biotic index were tested for relationship to chemical measurements using linear correlation as to infer causal relationships.

Results

The biotic measurements and concentrations of the tested chemicals are given in Table 1. According to water quality standards of IEPA (2000), concentration of chloride was exceeded for three areas: West pond, AC Pond and South Pond. Overall, chloride concentration was ranged from 72 to 1132 ppm, and were elevated in seven of the nine sites. Inventories of macroinvertebrate communities for nine wetland areas are given in Table 2.

The first axis of CA was correlated to chloride and also cyanide concentrations while Shannon diversity was negatively correlated to nitrate concentration (Table 3, Figure 1).

Discussion

resence of nitrates suggests some anthropogenic inputs on the given area. Fertilizers applied in lawn care are potential source of nitrate pollution (Hudak 2000). Although low in concentration, nitrate-nitrogen was still negatively correlated to Shannon diversity. Possibly, this could be evidence of a shift in community structure to this change in nitrate-nitrogen. A hazard of nitrates on the aquatic life is the process of eutrophication that leads to dominance of the certain species of the phytoplankton and extinction of some macroinvertebrate species.

Although, correlation between cyanide and the first axis was found, this result was not considered important due to too low concentration and one suspect higher reading. Moreover, even high concentration of cyanide at pH 8 is innocuous (Turkman 1996). In this study, six out of nine water reservoirs had pH 8.

oncentration of chloride in ponds located closer to the roads, sidewalks, and buildings was higher than for other wetland areas as predicted due to contamination of those with potassium and sodium chlorides that were used on pavement during winter time. High chloride levels were not artifacts of only the artificial wetlands as Hoddinott Marsh was found to have concentrations exceeding 500 ppm. This indicates mobility of chloride despite the naturalized terrestrial borders to the marsh. The correlation to the first axis of CA suggests chloride is impacting the assemblages of macroinvertebrates inhabiting the wetlands.

Although low in concentration, nitrate-nitrogen was still negatively correlated to Shannon diversity. Possibly, this could be evidence of a shift in community structure in response to nitrate-nitrogen. Even low levels of nitrate may alter the community of phytoplankton in which many other organisms ultimately depend, thereby affecting food webs to which macroinvertebrates belong.

Further study of the relationships between living organisms and their surrounding environment is necessary to establish causal links. Based on high levels of chloride measured form the wetlands, efforts to reduce chloride inputs are waranted to avoid faunal collapse within the wetland communities.

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Figure 1. Negative correlation between nitrates concentration and Shannon species diversity index.

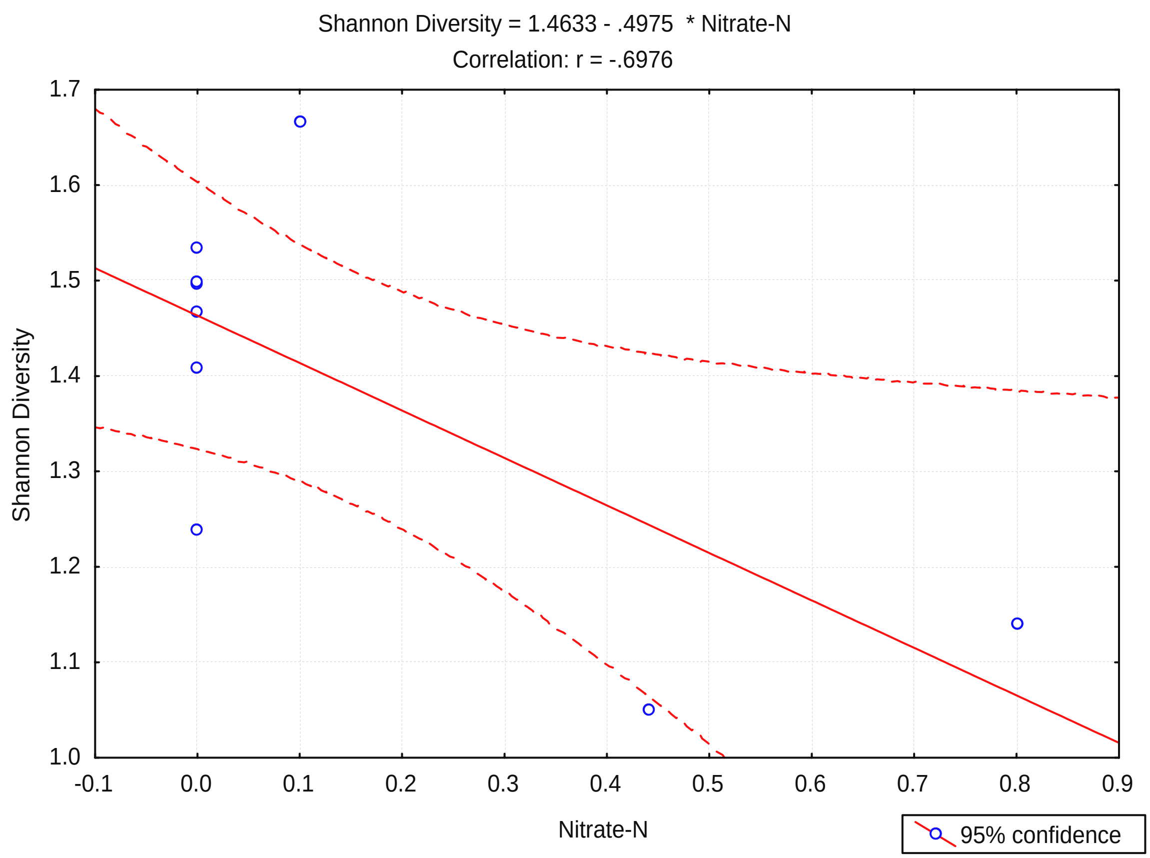

Table 1. Concentration of chemicals statistical data from nine different areas in parts per million. RP=retention pond; NH_3-N=ammonia/ammonium-nitrogen; NO_3-N= nitrate-nitrogen; Cl^-=chloride; CN^- =cyanide; DO=dissolved oxygen; CO_2=dissolved carbon dioixide; Dim 1=first coordinates from the first dimension of correspondence analysis; PO_4=phosphate; Sh. Div= Shannon diversity.

Sample site	Hoddinott Marsch	West Pond	Lambert Marsh	SRC Marsh	SRC RP	IC RP	AC RP	North Marsh	South Pond
NH_3-N	1	0	0.5	0	0	0.5	0.5	1	0.5
NO_3-N	0.2	0	0.1	0	0	0.44	0	0	0
Ortho-PO4	0.2	0	0.1	0.2	0.2	0.2	0	0	0
Cl^-	354	560	260	100	300	200	1132	72	508
pH	8	8	8	7	7	8	7.9	8	8
Alkalinity	0	0	190	0	0	0	0	0	0
Hardness	260	295	320	240	320	300	460	500	340
CN-	0	0.2	0	0	0	0.1	0.25	0	0
DO	5	14	23	3.6	6	4	10.6	7	12.8
CO2	0	0	14	0	0	10	5	0	0
Sulfide	0.2	2	0.1	0.2	0	0.2	0.1	0.1	0
Dim 1	-0.7487	-0.7717	-0.6932	-0.4856	-0.134	-0.634	-1.3544	-0.6933	-0.7276
Sh. Div.	1.14	1.497	1.667	1.535	1.408	1.051	1.467	1.499	1.239

Table 2. Total number of macroinvertebrates collected from nine wetland areas on the campus of the College of DuPage, Illinois.

Group of Macroinvertebrates	Hoddinott Marsh	West Pond	Lambert Marsh	SRC Marsh	SRC Pond	IC Pond	North Marsh	South Pond	AC Pond
Physa	15	1	1	26	4	0	0	2	7
Lymnaea	0	0	0	0	4	0	0	3	7
Unionidae	0	0	0	1	6	1	5	0	1
Oligochaeta	0	0	0	0	1	0	1	0	0
Hirudinea	0	1	0	1	0	0	0	0	0
Crayfish	0	1	3	0	0	4	0	0	0
Hyallela azteca	12	14	0	8	0	13	0	25	15
Pisauridae	0	0	1	3	0	0	1	0	0
Red Acari	0	0	0	5	0	1	0	0	0
Poduridae	0	0	0	0	0	0	100	0	0
Caenia	0	3	0	0	0	0	0	3	0
Tramea	1	1	1	0	0	0	0	0	1
Argia tibialis	9	4	0	0	0	0	0	4	23
Trichocorixa	2	0	0	0	0	0	1	0	0
Notonecta	8	0	0	1	0	0	0	0	0
Gerris	0	0	0	0	0	0	1	1	0

Table 2 (continued)

Group of Macroinvertebrates	Hoddinott Marsh	West Pond	Lambert Marsh	SRC Marsh	SRC Pond	IC Pond	North Marsh	South Pond	AC Pond
Deronectes	14	0	1	0	0	0	0	0	0
Peltodytes	0	0	0	0	0	0	0	1	0
Aedes	0	0	0	2	0	0	13	0	0
Cricotopus	0	0	0	2	0	0	8	1	1
Blood Midge	1	0	1	0	0	0	0	3	0
Prionocera	1	0	0	0	0	0	0	0	0
Stratiomys	0	1	0	0	1	0	0	0	0

Table 3. Correlation coefficients testing relationships of physical factors to ordinate assemblage structure of macroinvertebrates and Shannon diversity. * denotes significance ($p<0.05$).

Variable	Coordinate Dimension 1	Shannon Diversity
Ammonia-N	-0.10	-0.41
Nitrate-N	-0.29	*-0.78
Ortho-Phosphate	-0.21	-0.41
Chloride	*0.78	0.13
pH	-0.11	-0.41
Alkalinity	0	0
Hardness	0.47	0.33
Cyanide	*0.87	0.01
Dissolved Oxygen	0.14	0.27
Carbon Dioxide	0.31	-0.51
Sulfide	-0.25	0.28