Relationships Between Riparian Vegitation and Water Quality in Four North-Temperate Lakes

Bios 569 – Practicum in Aquatic Biology

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Abstract

The affect of riparian vegetation as it correlates to water quality is an area of study that has, until recently, long been left unexplored. Macrophytes can be used as indicators of water quality and so it is important to understand the connection. In this study four lakes were examined on the UNDERC (University of Notre Dame Environmental Research Center) property. Water quality tests were conducted as well as vegetation sampling. Correlations were then drawn between these results. It was observed that Secchi depth and pH played the largest role in species presence at the different sites.

Introduction

Riparian vegetation as it relates to water quality has been the focus of many recent environmental studies. This is of no accident. The value of riparian vegetation is now understood to be great. Much can be understood about the quality of the adjacent water by looking at the species of macrophytes. This is because species are selective of their habitat (Prescott 1967). Riparian vegetation is essential for maintaining high water quality along all shorelines, lakes included. Not only does riparian vegetation maintain water quality but it also provides habitat for wildlife and fish, thermal cover, bank stabilization, flood control and food chain support. Riparian Vegetation traps sediments and pollutants thus keeping water quality high (Riemer ,1969). Because of this implication, it is important to monitor the riparian vegetation.

Lake riparian zones, known as littoral zones to limnologists, are not as well defined as fluvial riparian zones. In fact the word literally means "belonging to a river bank" (Verry 207). The fundamental function of this area, however, is to mediate fluxes between terrestrial and aquatic systems, therefore a lake contains this zone. As these areas are studied in greater detail connections between terrestrial and aquatic areas become more apparent.

This study focuses on the riparian vegetation of four north-temperate lakes on the properties of the University of Notre Dame Environmental Research Center. In past years studies have been concerned with the aquatic macrophyte population, but here the focus is on the terrestrial populations of lakes that vary in chemical composition. It is believed that, as with the aquatic vegetation, there is a correlation between bank side vegetation and water quality.

Materials

* Maps of UNDERC lakes
* Small piece of string
* Scientific Calculator (TI-85)
* Measuring tape
* Small Flags to mark sites
* Plant Press
    * Corrugated Cardboard

*Newspaper
*Blotter Sheets (12" X 18")
*Wooden slats
* Belts (to hold press together)
* Gardening Spade
* Pocket Knife
* Ziploc Storage Bags (Gallon size)
* Fisher Brand tape
* Dissolved Oxygen Meter
* Conductivity Meter
* Portable pH Meter
* Secchi disc
* Small Notebook for data
* Field bag for holding specimens
* Reference books for identification

Methods:

Three lakes and one bog were chosen on the basis of previous research found in the Guide to UNDERC, and spot observations. These aquatic habitats varied in known water quality and observed vegetation. The four habitats chosen were Hummingbird, Bog Pot, Ward and Tender Bog. Maps of each of these lakes and bogs were then printed and a string was used to mark of different size increments around the perimeter. The increments were then numbered. A calculator was then used to randomly pick five sites from each of these lakes. The sites were to be 10' X 5'. Using the measuring tape to determine correct placement the sites were then marked off using small flags at each corner point.

Plants were then collected three different times during the summer; May 26-28 and June 24-27 and July 12-14, so as to attempt to collect flowers as well as shoots. Plants were collected from the water's edge and the tree line. The location of the tree line was determined on an individual basis by a significant abundance of trees in one area. On Bog Pot and Hummingbird plants were only collected at the water's edge because the tree line was at the water's edge for the most part. At Tender Bog and Ward the two different sites were collected from. To collect the plants a garden spade was used when it was necessary to retrieve the roots whereas a pocketknife was used where only the branch or stem was needed. The plants were then placed in a Ziploc storage bag and the bag was marked using Fisher Brand Tape so as to know which site the plant came from. The plants were then brought to the lab and either pressed right away or they were placed in a refrigerator until it was a better time to press them.

To press the plants they were spread out between two sheets of newspaper, placed between two blotter sheets and then between corrugated cardboard so as to allow air to circulate. The belts were then put around the press and pulled tight. It was necessary to retighten the belts once the plants started to dry so as to press them as flat as possible. Once dry and pressed, the plants were identified using the materials provided in the lab. Barbara Hellenthal was also consulted both on the UNDERC site and at Notre Dame about identification. Specimens that could not be identified in the lab were brought back to the Notre Dame herbarium to be compared to known specimens.

Water quality tests were conducted the same periods that plants were collected. To perform the tests it was necessary to row out to the deepest part of the lake, which was estimated from previous data. The Secchi disc was lowered into the water and the length was measured when it could no longer be seen and when it could be seen again upon raising. The average of these two reading was then calculated and recorded. Lowering the probe into the water and allowing the meter to come to a reading for one minute measured conductivity. Dissolved oxygen and temperature were measured in much the same way but measurements were taken every meter instead of just once. Placing the pH meter into the water and allowing it too to come to a reading for one minute measured the pH. The three latter instruments were calibrated in the lab using the appropriate solutions before they were taken into the field.

Once all the plants were identified and the water quality tests completed the results were then graphed and placed in tables so as to draw conclusions. These graphs were constructed using Microsoft Excel.

Results

Dissolved Oxygen and Temperature

The results for Dissolved Oxygen were inconclusive. Measurements were far beyond expected values and so must be disregarded. Errors could have arisen from improper calibration with the meter.

In general the lakes showed a good deal of mixing with gradual temperature change. Tender Bog showed some significant stratification due to its depth. (See attached graphs)

pH

A large number of families seemed to prefer the more neutral environment of Ward Lake. The family Rosaceae and Equistaceae were found almost exclusively in this habitat as well as the Oxalidaceae, Typhaceae, Lycopodiaceae, Lamiaceae, Clusiaceae and Apiaceae families although only one sample of each of these was found anywhere. The family Ericaceae tended to favor more acidic habitats like Tender Bog and Hummingbird with some species of Carex found only in this habitat. *Ledum groenlandicum* Oeder (Ericaceae) was also only found where the pH was below 5.0. Tamaracks, or *Larix laricina* DuRoi (Pinaceae) were also only found in the acidic habitats of Tender Bog and hummingbird. Bedstraw or *Galium trifidum* L. (Rubiaceae) was found in more neutral habitats like Ward and Bog Pot. The families Violaceae and Dryopteridaceae also tended to favor more neutral habitats being found only in habitats with a pH of 6.0 or higher. The families Poaceae and Potomogetonaceae were also only found where the pH was above 6.0. See table 1 for pH trends and chart 1 for the list of macrophytes present.

Conductivity

No species of the families Oxalidaceae, Poaceae, Typhaceae, Equistaceae or Myricaceae were found in habitats with conductivity lower than 100.0 uS/cm. Many more species were found in the habitat of Ward Lake that held a conductivity more than four times that of the next closest reading held at Tender Bog (24.7 uS/cm). Many species were found at both Hummingbird and Tender Bog, which held similar conductivities of 18.4 and 24.7. These species include the family Araceae, *Kalamia prolifolia* Wangeth , *Vaccinium oxycoccus* L. and *Ledum groenlandicum* Oeder of the Ericaceae family. Conductivity seems to be a determining factor for the family Araliaceae, it being found only at Bog Pot, which held the lowest conductivity of 14.2. *Viola renifolia* Gray (Violaceae) was also only found at this habitat. See table 2 for conductivity readings and Chart 2 for macrophytes present.

Secchi Depth

The amount of dissolved carbon seems to be a significant factor in the presence of the Equistaceae, Lycopodiaceae, Myricaceae and Poaceae families, these families only being found where the transparency was 2.0 meters or greater. Bog Pot and Tender Bog held similar transparency readings and the species *Trientalia borealis* Raf. (Primulaceae) and *Coptis trifolia* L.(Ranunculaceae) were only found at these two sites. Hummingbird held a very low Secchi depth reading of .75. See table 3 for Secchi disc reading and Chart 3 for the list of macrophytes present.

Discussion

As seen in the results section of this paper, trends can be observed in these four lakes. These trends based on water quality show that there is a correlation between riparian vegetation and that water quality. More lakes and bogs, however, should be studied to obtain more conclusive evidence.

Secchi reading probably provide the most important information because secchi readings are a measurement of the amount of dissolved carbon in the water. DOC is the primary cause of water color. Riparian vegetation is the main input of DOC to a body of water. Smaller lakes typically have a greater DOC content because of the greater ratio between surface area and riparian zone area (Rasmussen et al. 1989) Tender Bog and Hummingbird are examples of this. The vegetation then that grows there can be tied, in part, to this fact.

Hummingbird and Tender Bog are also the most acidic, and it is the pH which probably affects the vegetation the most. The specific pH seemed to create the largest division in the collected specimens and probably is the best indicator of what macrophytes will be present. Bogs are nutrient poor, or oligotrophic, so species have to adapt to this feature thus many species are not able to thrive in this area (Crum, 1992).

Conductivity is the measure of the resistance of a solution to electric flow. Conductance is caused by dissolved ions. There is a positive correlation between pH and conductivity and so that is why many families were found in these sites. Depth, drainage area, volume and fetch all affect the conductivity of a body of water. (UNDERC presentation). Larger lakes with more surface and drainage area tend to be more conductive; this is why Ward has such high readings.

Dissolved oxygen and temperature can also be tied to the riparian vegetation. Tall trees and shrubs can block the wind that controls the mixing of the waters. This creates clines in the water. Vegetation also provide shade for the lakes, this comes into play with the smaller lakes where the tree line is more or less adjacent to the waters edge (Verry 2000).

There are many other important aspects to look at when studying water quality and riparian zones. The drainage area is one of the most important features. The flow of water through a watershed can ultimately determine the nutrients delivered to a lake. Small seepage lakes with no inlet like Hummingbird are typically more affected by riparian wetlands through the watershed (Veery et all. 2000). Watershed area also affects the conductivity. Lake size should also be considered. Larger lakes like Ward typically have high biodiversity (Barbour and Brown 1974). Depth can also be important because some lakes are deep enough to intercept aquifers with strong groundwater flow. Other chemical tests should also be conducted in the future such as tests for alkalinity, nitrogen, phosphorus and color. These tests have been completed in past studies that have studied aquatic vegetation but were not conducted during this study.

In conclusion, the riparian areas surrounding lakes have proven in this study to be an important influence on water quality. As human impacts affect the natural world at increasing rates it is vital to understand these relationships in order to protect our environment. Understanding is the key to conservation.

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