BIOS 569: Practicum in Field Biology

Impact of DOC in the Zooplankton Community Composition

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Abstract:

Dissolved organic carbon (DOC) plays an important role in the functioning of zooplankton communities. Several studies have sought to determine the food quality associated with the DOC concentrations. They have found that high concentration of DOC can affect the entire aquatic ecosystem. We want to know the effect of the DOC on the zooplankton communities present in the Hummingbird and Bay lakes (high and low DOC). With the purpose of analyze the effect of high and low concentrations of DOC in these two different communities we studied two kind of zooplankton, *Daphnia* and Copepods (filter and no filter feeder, respectively). Because high concentrations of DOC decrease the zooplankton community we expected to found significant differences in the zooplankton communities of both lakes. After analyze the data we found significant results that shown the zooplankton composition being affected by the high concentration of DOC, also it delay the growth of selective species like Copepods.

Introduction:

Dissolved organic carbon plays a very important role in aquatic ecosystems. Several hypotheses have sought to explain the impacts of increased DOC in the surface waters of the formerly glaciated landscape of eastern North America (Monteith 2007). There are two fundamentally different sources from which these aquatic systems receive organic material: 1. primary production that occurred within the system's boundaries (autochthonous sources) and; 2. primary production imported from the terrestrial watershed (allochthonous sources). (Cole 2010).

Zooplankton can be herbivorous, carnivorous or omnivorous and are considered one of the most diverse animal communities (Yebra 2001). The growth of zooplankton can be affected by biotic or abiotic factors. There are two kinds of zooplankton that we are going to analyze and compare in this study. The first one is *Daphnia,* which are filter feeders (not a selective species) and the second are c*opepods,* which are not filter feeders (selective species). Zooplankton prefers nutritious algae but also subsist on algae of lesser quality and on organic matter derived from terrestrial sources (Cole et al. 2010). Terrestrial organic matter has been studied for a long time because it plays an important role in aquatic food web dynamics (Brett et al 2009).

DOC influences the properties and productivities of lake ecosystems (Bade et al 2007). There are many hypotheses for why DOC has been increasing in the last few years. All of these hypotheses imply that DOC levels will continue to rise, with unpredictable consequences for the global carbon cycle (Monteith et al 2007).

Several studies have been conducted with the purpose of analyzing the effects of terrestrial particulate organic carbon (t-POC) on the food web of zooplankton (Pace 2004). Pace concluded that the t-POC has been incorporated by the zooplankton as part of their food web resources. Brett et al. (2009) tested the direct dietary impact of t-POC on *Daphnia magna* growth efficiency and reproduction. They found that the t-POC was a very poor quality resource for *Daphnia magna* and that it makes a minor contribution to zooplankton production (Brett et al. 2009).

The objective of this investigation is to analyze the impact of the DOC on the zooplankton community and see if this affects the growth of zooplankton populations.

We will explore these questions using two lakes with different DOC concentrations. Hummingbird Lake has higher concentration of DOC and Bay Lake has lower concentration of DOC. Higher DOC concentrations will affect the composition of the zooplankton community because they will not allow the proper growth of unselective species such as *Daphnia* sp. In addition because lakes with high DOC concentrations are not a good source of nutrients the growth of selective species like copepods will be delayed in them. Therefore our hypothesis is that Bay Lake will have more copepods and Daphnia sp. than Hummingbird Lake. We also hypothesize that zooplankton growth (measured as biomass) will be lower in Hummingbird Lake due to the poor food quality associated with higher DOC concentrations.

Methods:

Zooplankton samples were taken from Bay Lake and Hummingbird Lake. Bay and Hummingbird Lakes are characterized by different DOC concentrations, with Bay being lighter (approximately 6 mg/L DOC) and Hummingbird being darker (approximately 23 mg/L DOC). Zooplankton samples were taken using a zooplankton net, and performing one vertical tow from approximately 2-m above the sediment layer. The samples were taken in a soda bottle with a 35um filter that allows the water to pass in and out but does not allow the zooplankton to leave the bottle. A sample of zooplankton of Bay Lake was placed in Hummingbird Lake and vice versa. A mix bottle, (half of which was derived from the zooplankton community of Bay Lake and half of which was derived from the zooplankton community of Hummingbird Lake) was placed in each of the lakes. Also a control treatment with no zooplankton it was placed in each lake so that we could determine whether zooplankton outside the bottle could enter it.

The zooplankton community in each bottle was analyzed in the laboratory. The growth of each species was measured by taking pictures with the LAS EZ program and then using the Image J program to measure them. Average biomass was analyzed using a 2-way ANOVA test in SYSTAT (Version 13); with the two variables being grouped by species (*Daphnia* sp. and copepods) and by habitat (lakes). We also compared the number of copepods and *Daphnia* sp. in both lakes.

Results:

We miss a bottle on the field, for this reason we could not get some results about the second replicate and therefore no comparison between Bay Lake and Hummingbird Lake. We found more copepods than *Daphnia* in Hummingbird Lake. Both of the zooplanktons communities of Hummingbird Lake (copepods and *Daphnia sp.*) increased in number when they were transferred to Bay Lake. There was a significant increase in the zooplankton communities when they were transferred from Hummingbird Lake to Bay Lake. The *Daphnia* population in Hummingbird Lake had a higher mean biomass than the *Daphnia* population in Bay Lake. Copepods had a higher average biomass in Bay Lake than in Hummingbird Lake.

Discussion:

Our results suggest that DOC may have an effect on the composition of zooplankton communities, and may significantly reduce their growth. Based on the statistical analysis for the biomass in the zooplankton community we found significant results for the effect that DOC makes to the zooplankton community in the low DOC Lake. The statistical analysis for comparing the biomass of the zooplankton community in both lakes could not be performed since one of the bottles was lost in the field. For this reason there is no way to statistically compare the biomasses of the zooplankton communities between both lakes. However, we did find a clear tendency of the zooplankton community to have a greater average biomass in the low DOC lake (Bay Lake) than in the high DOC Lake (Hummingbird Lake).

We can compare our results with previous experiments that found significant differences between the zooplankton productivity in stained by DOC waters. Christensen found that lakes darkened by DOC had decreased phytoplankton production (Christensen 1980). Changes in light-attenuating DOC affected pelagic responses to nutrient inputs (Christensen 1996). Therefore our results are congruent with the negative relationship between high DOC and zooplankton communities.

When we put a sample of Hummingbird Lake's zooplankton in Bay Lake we found that this zooplankton sample did better in Bay Lake than in Hummingbird Lake. These data support the original prediction that zooplankton would exhibit greater biomass in the low DOC lake compared to the high DOC lake. It is important to mention that in this experiment we are not measuring other factors that can affect the population growth in natural conditions, like predation. There are studies that suggest that planktivorous fish prefer *Daphnia* because of their body sizes (Galbraith, 1967). Depending on the predation pressure made on the zooplankton community some populations will be affected and others will benefit by increasing the number of their population occasionally depending on the season of the year (Caceres, 1998).

We did not find any significant differences between Bay's copepods community and the Mix set in the same lake. This suggests that copepods were not affected when communities from other lake were coexisting with them. The ability of certain taxa to use taste to discriminate between high and low quality food particles has important implications for competition between zooplankton species and for interactions between planktonic grazers and their food resources (DeMott, 1986). Because copepods are not filter feeders (and therefore are more selective feeders), they have an advantage in the food sources available in the lake and it may be because *Daphnia* did not have a chance of obtaining good nutrients for better growth (Friedman, 1975). Therefore *Daphnia* was significantly affected (p value= 0.001) when it was competing with the copepod community from Hummingbird. In conclusion, the Hummingbird zooplankton (especially copepods) were more used to growth with high concentrations of DOC; so they were more apt to get the nutrients needed to grow, than *Daphnia's* communities in a low DOC lake.

When we compare the average number of copepod and *Daphnia* communities we found that the proportion of copepods in the sample was greater for *Daphnia* in Hummingbird. We also found that *Daphnia* were more abundant than copepods in Bay Lake. But there is no statistically significant data that prove a dramatic change in terms of the zooplankton communities that grow in both of the lakes. However, is important to clarify that both communities exhibited a significant increase in their populations when they were transferred from a high DOC to a low DOC lake (Hummingbird to Bay Lake respectively).

These results suggest that there is a tendency of the zooplankton to do better in low DOC lakes than in high DOC. For future we recommend that more than two replicates in more than two lakes be used. In addition it would be good to compare different zooplankton communities (not only *Daphnia* and copepods but other species of zooplankton) and how the DOC affects them. Also it would be good to analyze other factors that affect the zooplankton community such as predators and abiotic factors (temperature, pH, etc.).

With the results obtained in this research experiment we can conclude that high DOC levels did have a negative effect on the zooplankton communities. Also we can state that selective species (like copepods) do better in high DOC lakes than non-selective species (like *Daphnia* sp.), but both of these species do better in low DOC level lakes.

TABLES:

Table 1

This table presents the p values for the copepod community in both Hummingbird and Bay Lakes (Hummingbird and Bay)

Location (Bottle)	**Taxa**	**P-value**
Hummingbird-Mix	Copepod	0.000
Bay-Mix	Copepod	0.208
Bay-Hummingbird Mix	Copepod	0.005
Hummingbird-Bay Mix	Copepod	0.124

Table 2

This table presents the p values for the *Daphnia* community in both Hummingbird and Bay Lakes

Location (Bottle)	**Taxa**	**P-value**
Hummingbird-Mix	Daphnia	0.043
Bay-Mix	Daphnia	0.001
Bay-Hummingbird Mix	Daphnia	0.000
Hummingbird-Bay Mix	Daphnia	0.000

FIGURES:

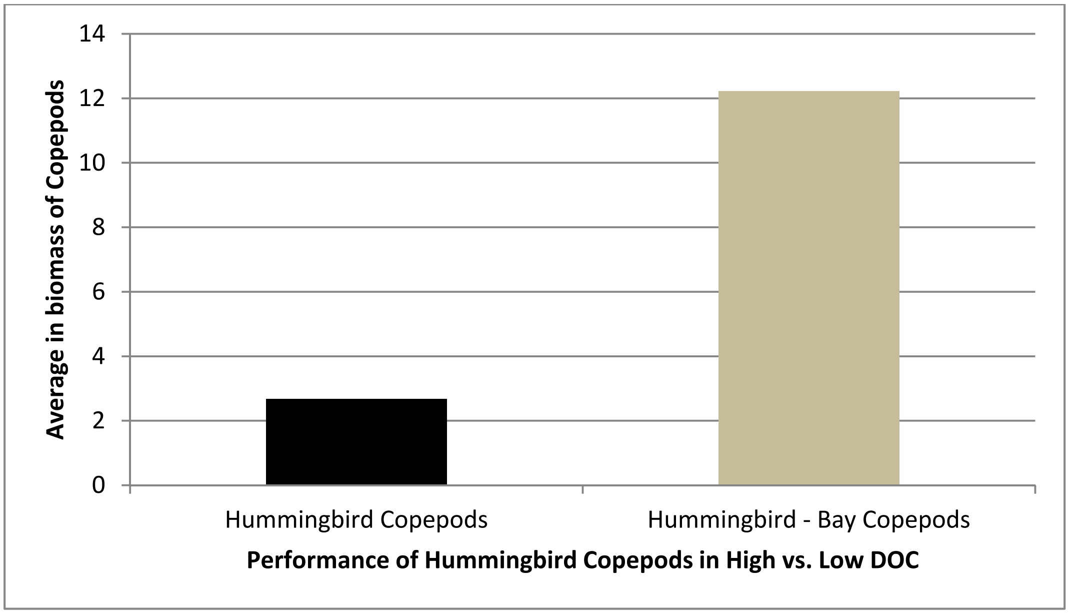


Figure 1:

Average biomass of copepods in Hummingbird Lake

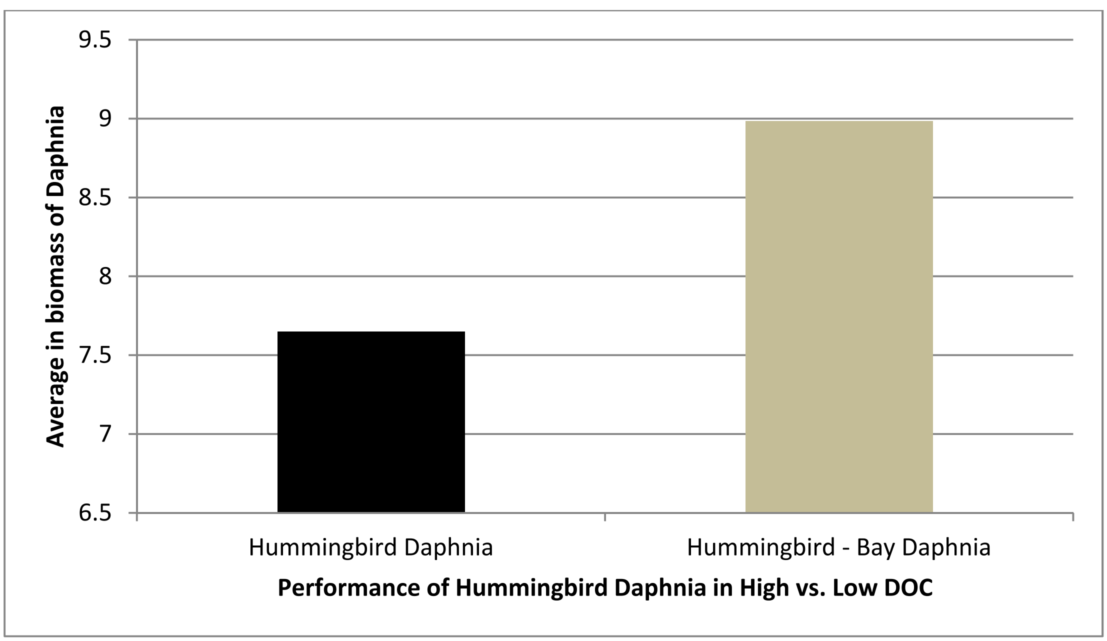


Figure 2:

Average biomass of *Daphnia* in Hummingbird Lake

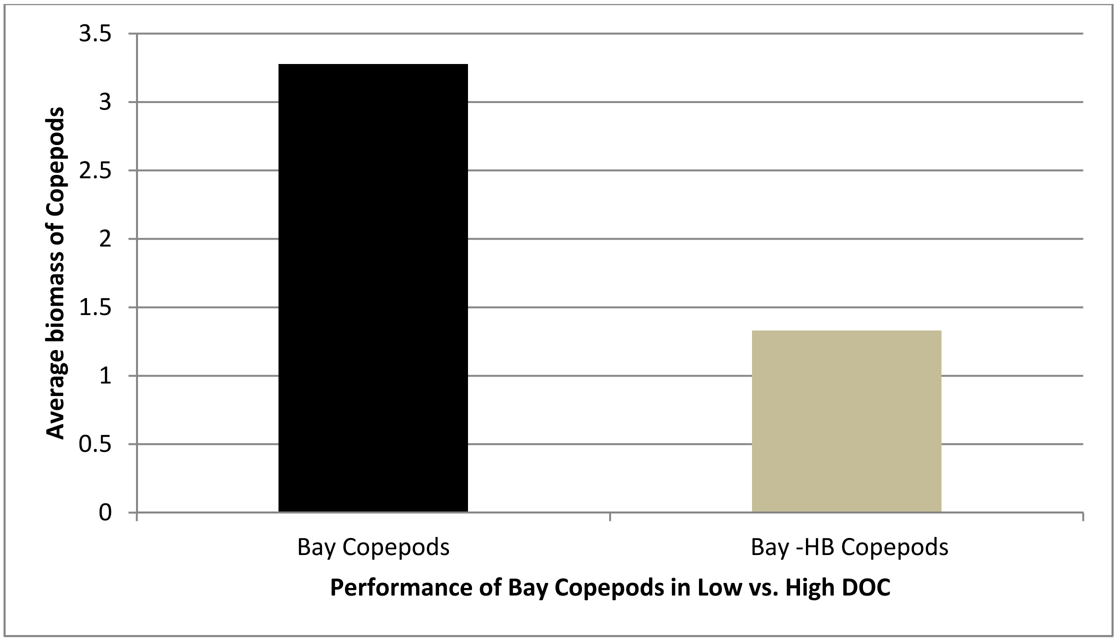


Figure 3:

Average biomass of copepods in Bay Lake

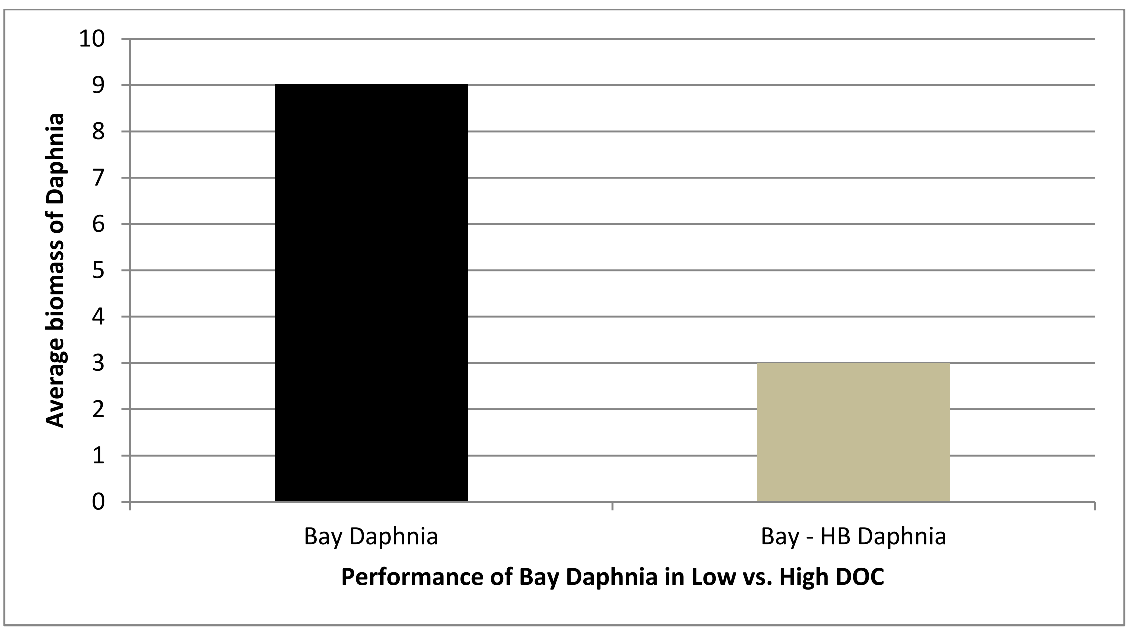


Figure 4:

Average biomass of *Daphnia sp.* in Bay Lake

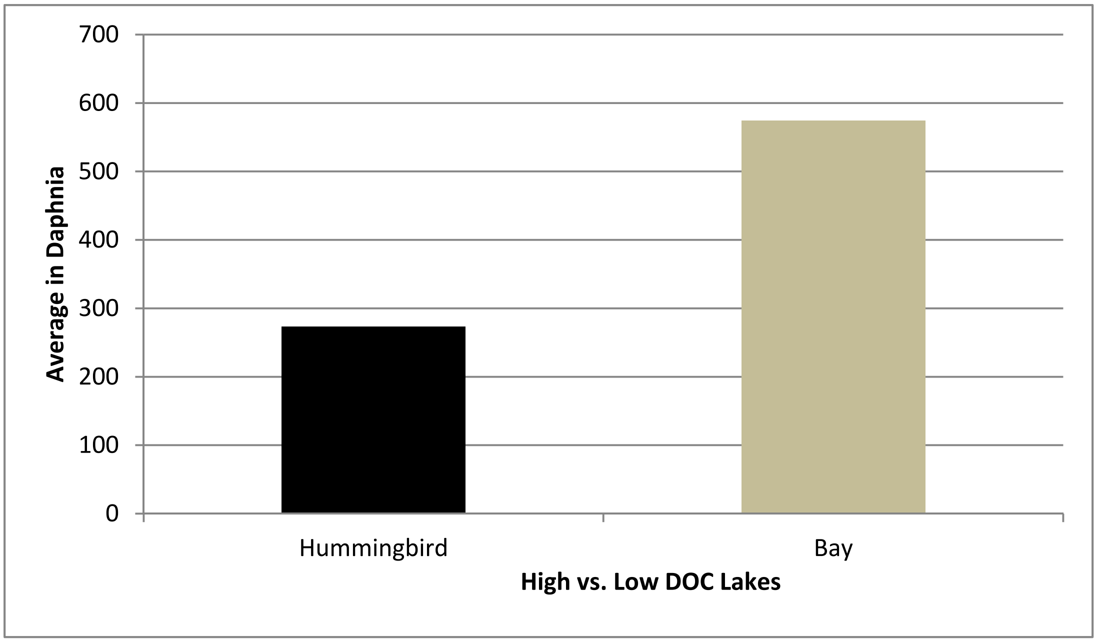


Figure 5:

Average abundance of *Daphnia* sp. in Hummingbird vs. Bay lakes (High vs. Low DOC respectively).

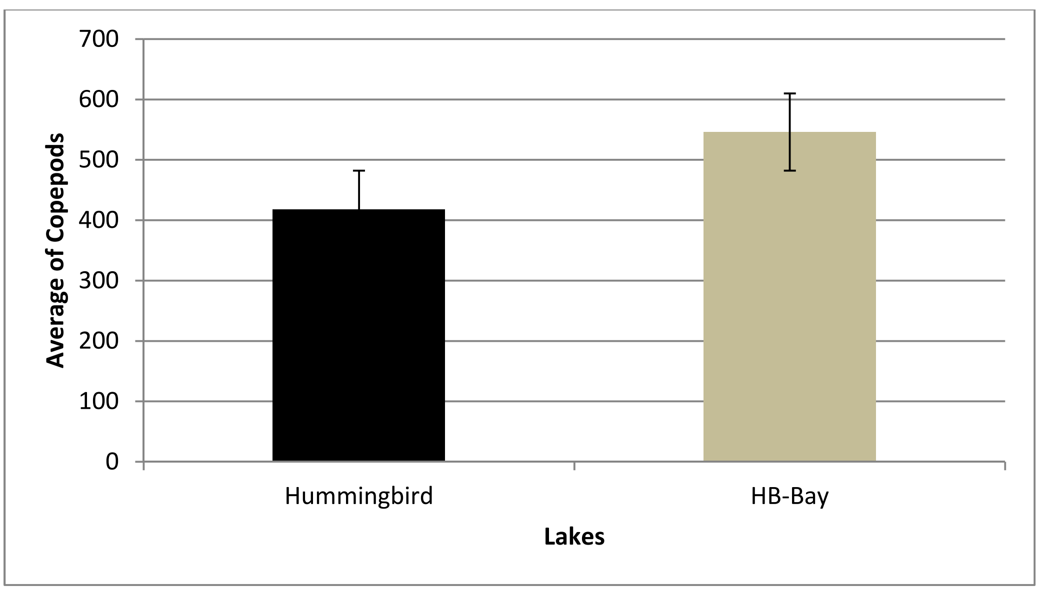


Figure 6:

Average abundance of *copepods* in Hummingbird vs. Bay lakes (High vs. Low DOC respectively).

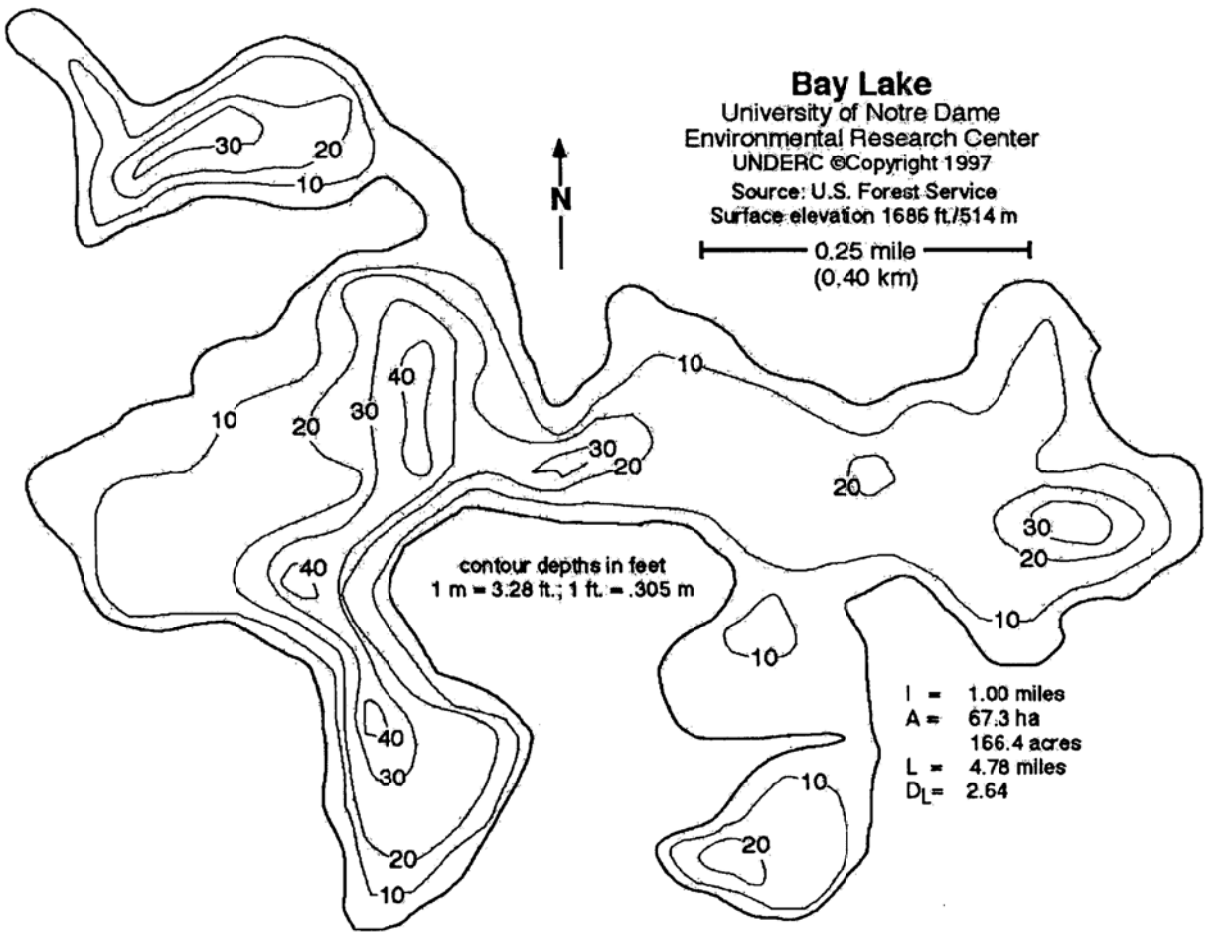
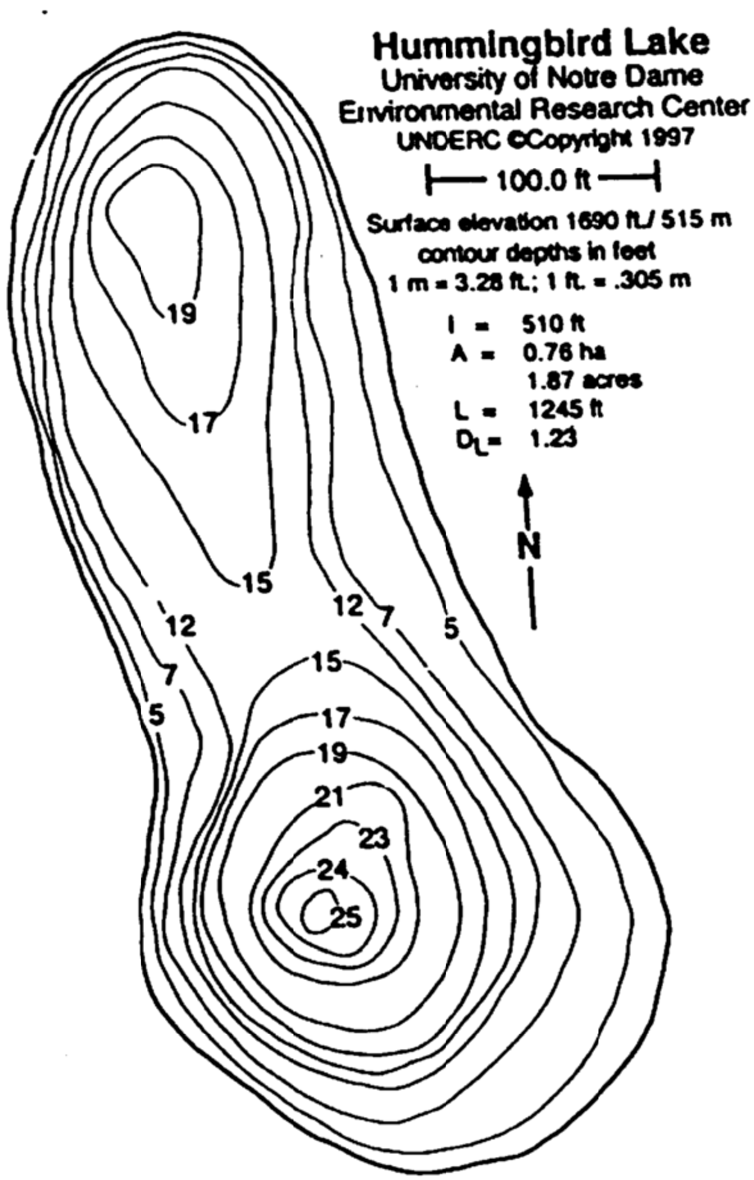


Figure 7: Bathrymetric Map of Bay Lake (Low DOC)

Figure 8:



Bathrymetric Map of Hummingbird Lake (high DOC)

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