A Survey of the Insect Population of Four Bog Lakes

Bios 569 - Practicum in Aquatic Biology

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Abstract:

Due to the unique characteristics of a bog lake, information and conclusions gathered from research on other water systems and their components can not be assumed to be applicable when attempting to understand a bog's structure. In order to obtain a better understanding of this acidic environment, and in particular the insect population it supports, four bog lakes on the University of Notre Dame's Environmental Research Center (UNDERC) were studied. Data was gathered on the macro-invertebrate larva in the water column using a Schindler Trap and an Ekman Grab. The adult population was surveyed by deploying emergence traps for a month long period. The migratory traits of Chaoboridae, the dominant component of the water column were studied for each bog and revealed an organized pattern relating to the amount of light trasmitted through the water in Ed's Bog, North Gate Bog and Reddington Lake, but not in Tender Bog. This may be a result of feeding habits or predation pressure from vertebrates. Analysis of the adults trapped revealed a similarity in the Chironomidae diversity but a disparity between total insect diversity with North Gate Bog and Tender Bog having a greater number than Ed's Bog or Reddington Lake. The highest total number of individual insects that emerged was discovered at Tender Bog and North Gate Bog despite their harsher acidic environment.

Insect Survey of Four Bogs

Introduction:

Science has long realized the influence aquatic insects exert on a viable ecosystem and has labored to understand that role in depth. Countless studies have examined major insect orders and the dynamic role they play in aquatic systems. One topic that until recently was overlooked by the scientific community is the impact of the Dipterans on aquatic systems. Previously thought to be too small to deserve attention, or perhaps overlooked due to the difficulties in studying due to their extreme diversity, they now command attention concerning their influence on environments varying from temperate streams (Berg and Hellenthal 1991) to a delta-swamp (Coler and Kondratieff 1989).

Efforts focusing on the order Diptera have begun to develop a profile on an insect which not only exist in diverse environments, but does so usually in dominant numbers. Reports have examined numerous external factors and the influence they exert on the insect population, specifically Chironomidae. Includes are acid level changes in streams (Griffths 1992) and their long term effect in lakes (Brodin and Grasberg 1993), effect of heavy metals (Khangarot and Ray 1989), and predation (Macchiusi and Baker 1992). The goal of these studies has been to discover and understand the insect controlling stimuli.

One environment that still is in need of an investigation into its insect profile, and what dictates it, is the bog lake. Due to their unique characteristics, they can not be described by using the specifications of other environments. It is necessary to first establish a chemical profile for each environment. Then, by monitoring the insect presence in the water column and the emergence patterns for the adults, a clear profile of the insect population will be known. These two sources of data can then be analyzed to see if the insects display similar traits to those in other habitats and if they are influenced by the same environmental factors.

Materials and Methods:

This study was conducted on four bogs located on the University of Notre Dame's Environmental Research Center (UNDERC) in Gogebic Co., Michigan. The four Bogs, Tender, Ed's, North Gate, and Reddington Lake, are within several miles of each other and despite fitting under the same classification they differ in several chemical traits.

The first component of the study was to sample the emerging adult insect population through the use of cone shaped emergence traps. They were designed to cover .3m^2 of the water surface and were constructed using two by two inch boards for the frame and enclosing them with tight nylon mosquito netting. A funnel was placed at the top of the cone to direct the insects into a glass mason jar which sat on top of the trap. All total, twenty four traps were constructed, six per bog. At each bog, three were set on the surrounding bog mat and three were placed on the water surface were they were supported by styrofoam cubes and anchored in place by weights lower to the bog bottom. The exact position of each trap was selected by use of a random number chart and a map sectioned into square meter cubes. Their approximate positions on each bog are illustrated in Figures 1-4. The traps were emptied roughly one every five days for four weeks. The insects were then preserved for later identification.

The second aspect of the study was to investigate the insects in the water column and their behavior. This was accomplished primarily by obtaining samples with a Schindler trap(Schindler 1969). Twice during the summer, separated by roughly a month, two samples were taken at each bog. They were obtained every two meters, starting at the surface, from random locations. The results were analyzed for insect presence and quantity. To complement this data, Ekman Dredge samples were retrieved from each bog, two from an area close to the shore and two from am area distant from the shore. They were then examined for any macro-invertebrate presence.

The final aspect of the study involved recording a profile of each of the bogs chemical profile. This was achieved by testing samples from the surface and deepest part of each bog for several characteristics, including dissolved oxygen, temperature, and chemical traits as instructed by Dr. Ronald Hellenthal. In order to facilitate these efforts, boardwalk systems were constructed at North Gate and Reddington and the existing system were repaired at Ed's and Tender Bogs.

Results:

The study gathered information concerning two main areas, the first being adult insect emergence from the four bogs. Table 1 list what type of insect and how many emerged at each location. The insects were identified using primarily the keys in Manual of Nearctic Diptera Vol 1-2. Many insects were unidentifiable due to their physical deterioration, inadequacies in the key with regards to females, and the limitations of the author. These were identified as far as possible and then placed in that division as unidentifiable. The process was continued for Dipterans to Family and Chironomidae down to tribe/sub family.

Figure 5 depicts the diversity of the Chironomidae population at each site using the grouping tribe. It illustrates that all of the bogs had a similar population and differed sometimes by as little as a single

Figure 1:

Reddington Lake

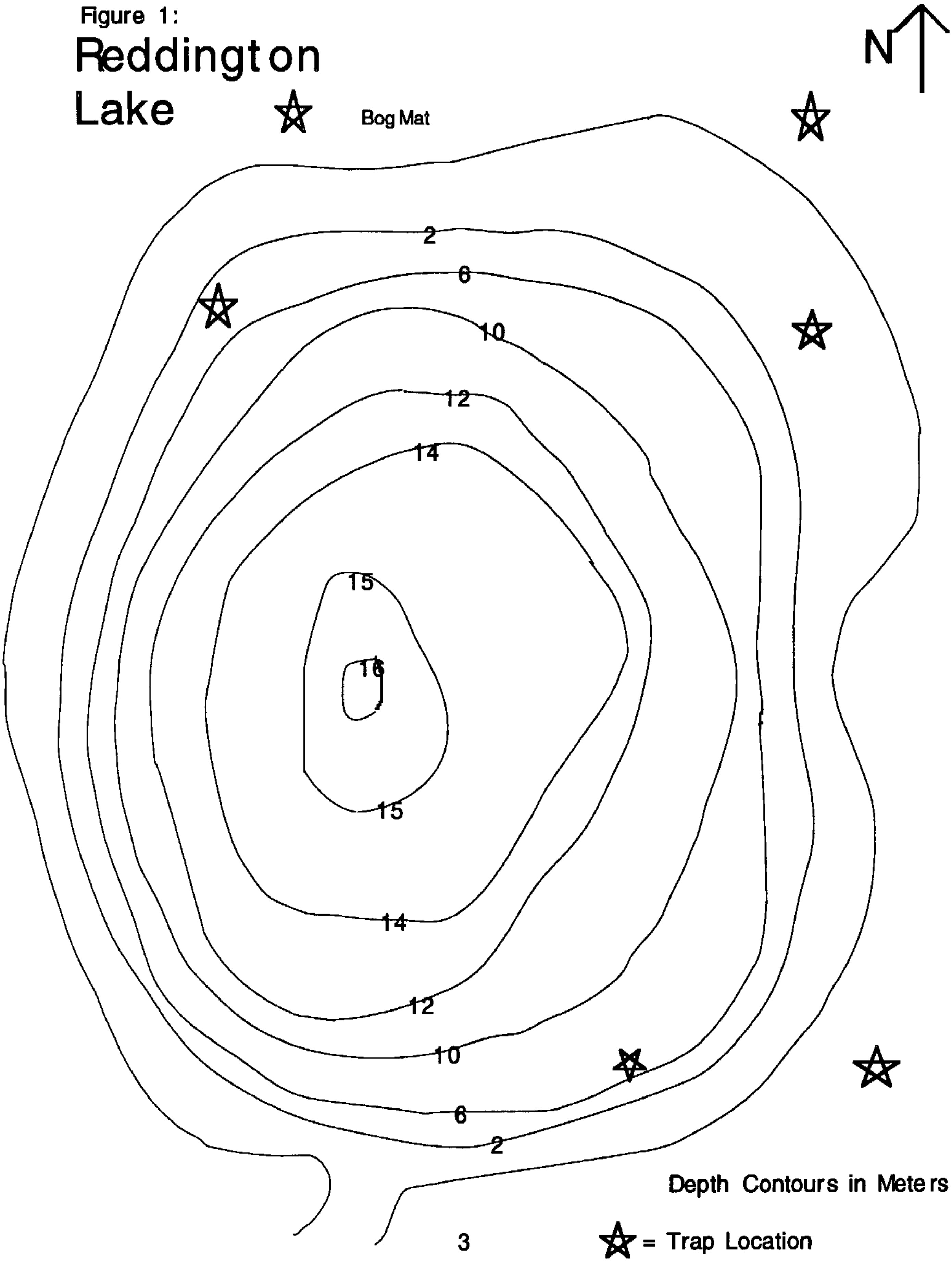
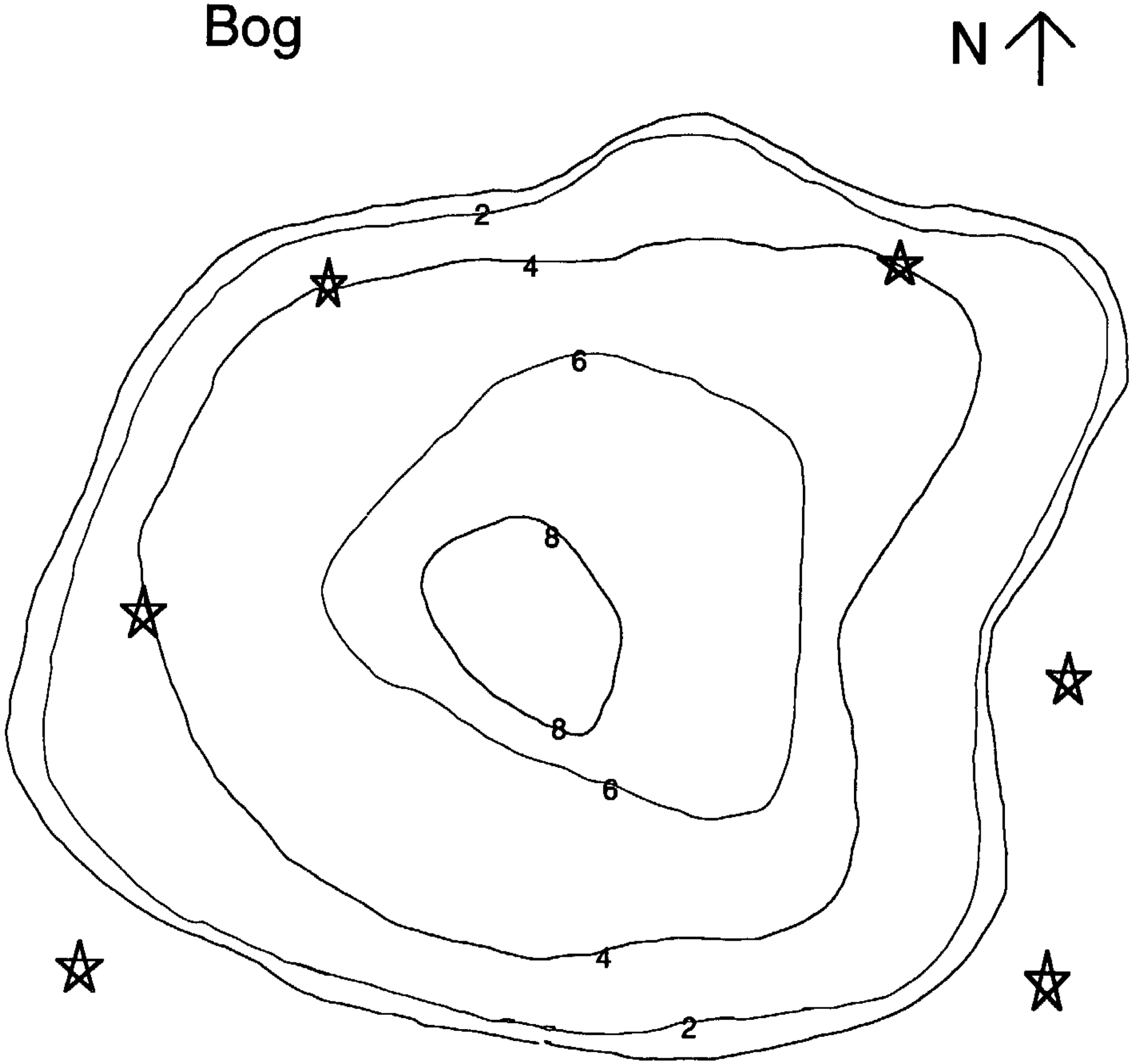


Figure 2:

North Gate Bog



Contour Depths in Meters

☆ = Trap Location

Figure 4:

Tender Bog

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Environmental Research Center
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Source: UNDERC class of 1991

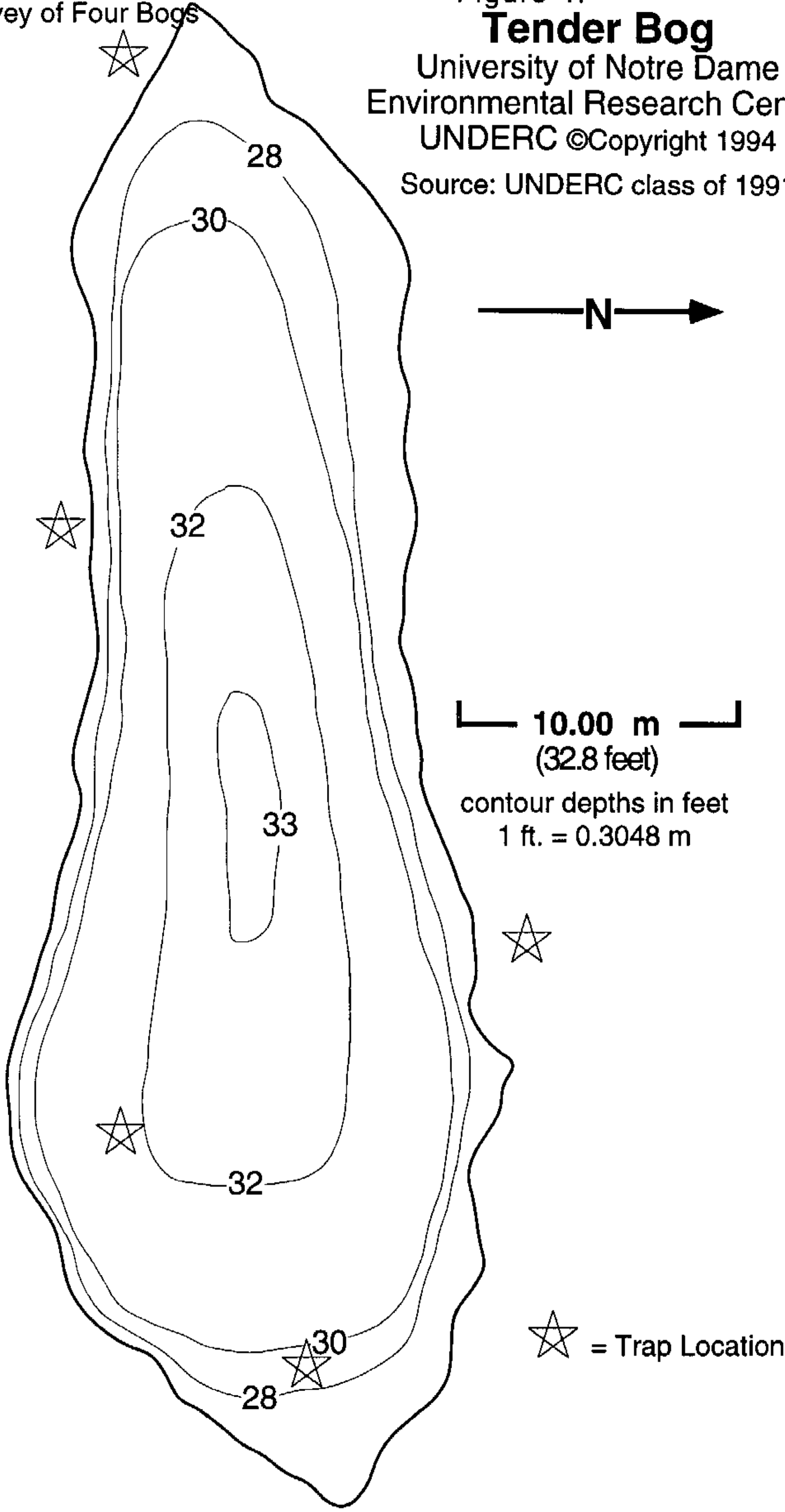


Figure 3:

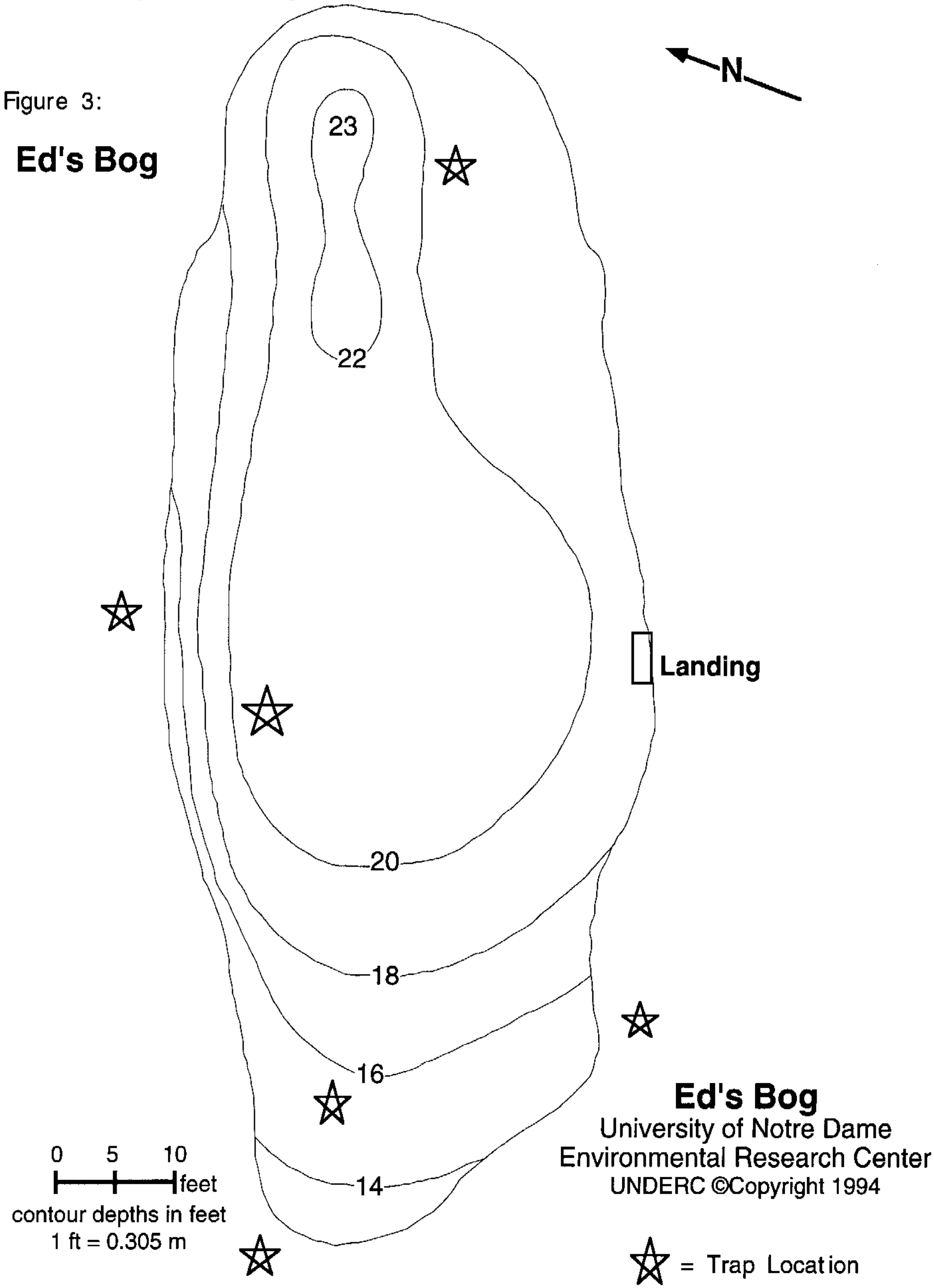

Ed's Bog
N
23
22
20
18
16
14
Landing
0 5 10
feet
contour depths in feet
1 ft = 0.305 m
Ed's Bog
University of Notre Dame
Environmental Research Center
UNDERC ©Copyright 1994
= Trap Location

Table 1: Number of Insect Emmergence at each Site

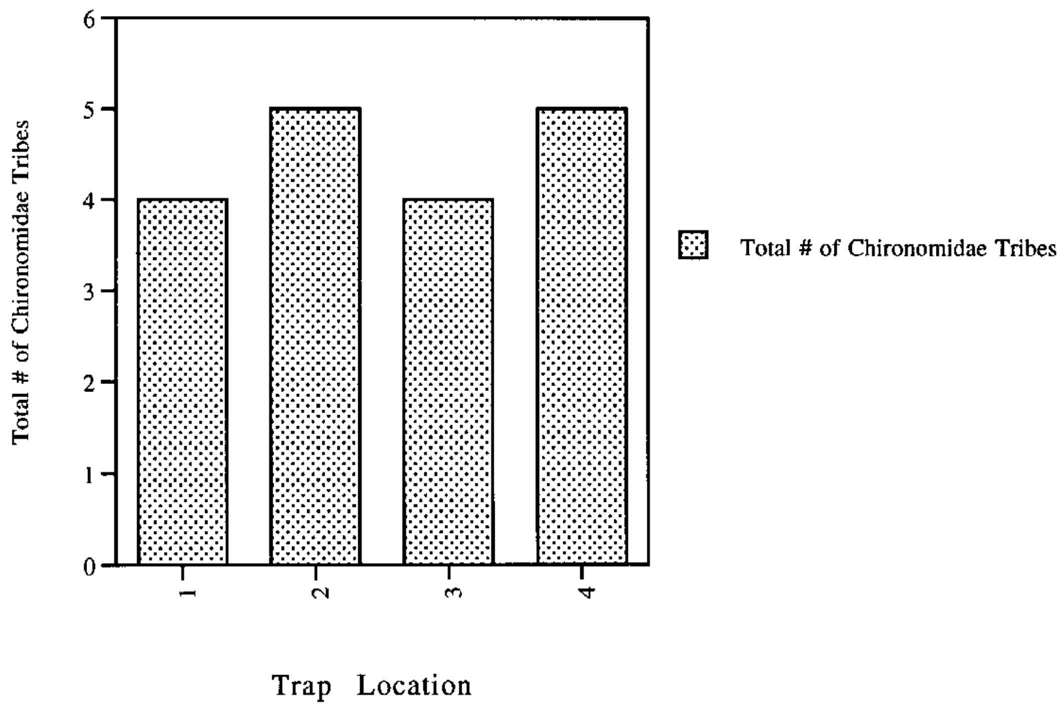
	Tender Bog	Ed's Bog	North Gate Bog	Reddington Lake
1. Chironomidae				
A. Orthocladiinae	4	10	7	1
B. Chironominae				
a. Chironomini	41	17	8	9
b. Tanytarsini	1	--	--	1
c. Unidentifiable	47	16	16	10
C. Tanypodinae				
a. Macropelopiini	--	1	--	1
b. Pentaneurini	11	1	6	1
c. Unidentifiable	2	3	1	3
D. Diamesinae	--	2	8	--
2. Chaoboboridae				
A. Chaoborinae	3	2	5	11

	Tender Bog	Ed's Bog	North Gate Bog	Reddington Lake
3. Assorted Diptera				
A. Syrphidae	1	--	--	1
B. Scatophgidae	1	--	--	--
C. Dolichopodidae	2	--	4	--
D. Muscidae	1	--	--	--
E. Canaceidae	--	--	1	--
F. Athericeridae	--	2	--	1
G. Pshychodidae	--	1	1	--
H. Culicidae	--	--	1	--
I. Ceratopogonidae	--	--	2	--
J. Sciomyzidae	--	--	1	--
K. Empididae	--	--	1	--
4. Odonata				
A. Corduliidae	1	--	--	--

Insect Survey of Four Bogs

	Tender Bog	Ed's Bog	North Gate Bog	Reddington Lake
5. Lepidoptera				
A. Puralidae	1	--	1	--
6. Tricoptera				
A. Limnephilidae	11	4	6	3
Unidentifiable	74	43	54	16

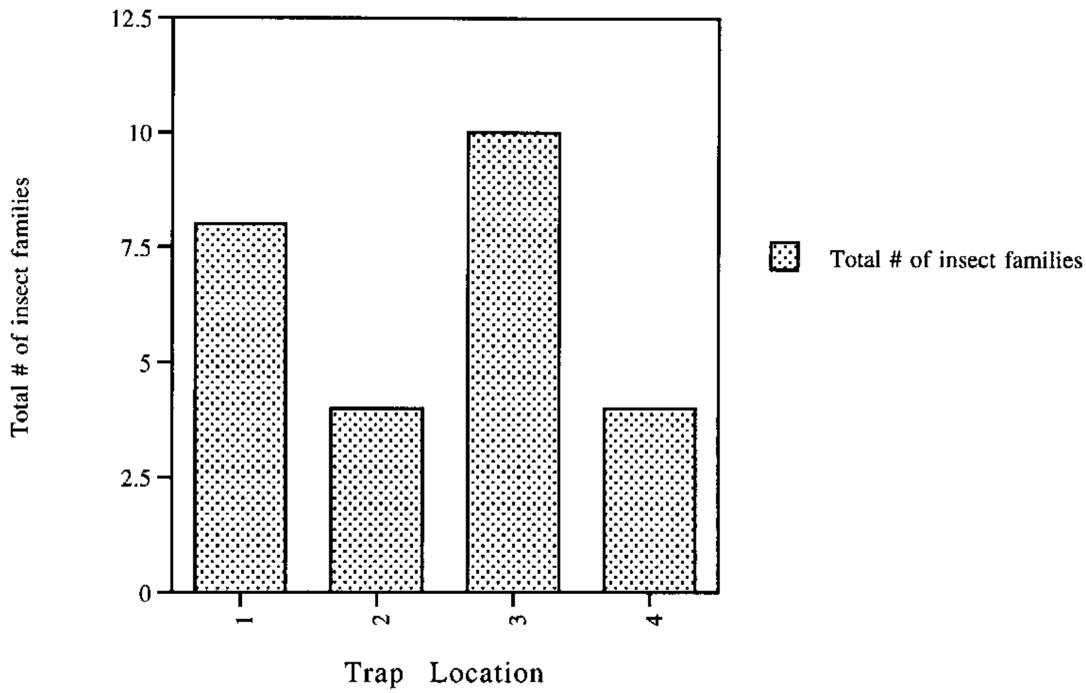
Figure 5: Chironomidae tribe diversity at each Bog



1=Tender Bog 3=North Gate Bog

2=Ed's Bog 4=Reddington Bog

Figure 6: Insect Family Diversity at each Bog



1=Tender Bog 3=North Gate Bog

2=Ed's Bog 4=Reddington Bog

insect. Ed's and Reddington have one additional tribe for a total of five, while North Gate Bog and Tender Bog had four. Figure 6 charts the total diversity for each site using the insect's family as the division. North Gate Bog contained fourteen different families, followed by Tender Bog with twelve. Ed's Bog and Reddington Lake each had eight different insect families.

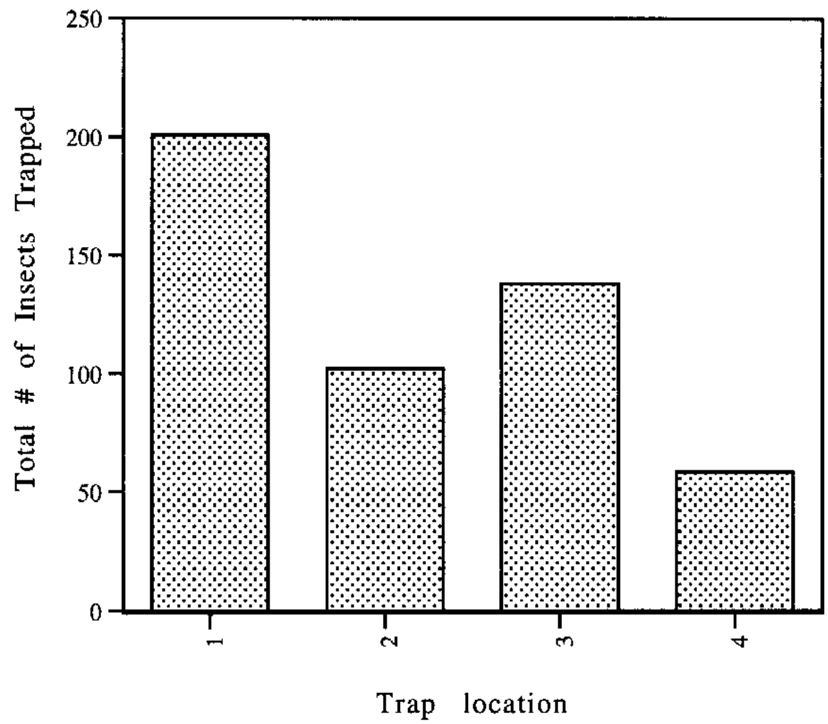
A relationship is present between diversity of Chironomidae and number of other insects. Figure 7 illustrates the total number of insects collected over the four week period at each site. Tender Bog had the highest yield with 201 followed by north Gate Bog at 138. Ed's yielded amounted to 102 insects with Reddington yielding the lowest total, 58 adult insects emerged. One of the variables in the procedure was the placement of the traps, with half randomly anchored to float on the water surface and the other half staked to the surrounding bog mat.

Figure 8 contrasts the total insects, for all four bogs, that emerged from the bog mat against the amount that arose out of the open water. The data is variable with the land traps at North Gate, 79-59, and Tender Bog, 109-92, catching more insects while the opposite is true at Ed's Bog, 57-45. Reddington Lake was the only environment were a clear statistical preference was demonstrated with 51 caught from the water and only 7 on land.

The other group of results revolved around the habits of the Chaoboridae, the dominant insect larva in the waters. Tables 2-5 list the amount of Chaoboridae observed using a Schindler tap at varying depths. Both replications are listed for each of the four time periods of both study day. No results are present for North Gate Bog on June 17 because no chaoborus were observed at any time. Figures 9-12 compare the percentage of Chaoborus observed at two depths for each time interval though a specific day. A clear pattern of upward migrating during the dark time periods and a downward movement during the light periods is evident in Ed's Bog. This trait is revealed in North Gate Bog and Reddington, but is less reliable due to the small amount of data. No discernable pattern was seen in the Tender Bogs samples. The results of the Ekman grabs proved to be minimal as little living was found in the samples. The only significant information was the discovery of two Chironomidae larva in North Gate Bog's sediment and three Chaoboridae in Ed's Bog's sediment.

The final results of the study were tests, including acidity, dissolved oxygen and temperature profiles, chemical assays of each of the four habitats and are included in their entirety in an other students' report (Thuente unpublished, 1994) and will be specifically mentioned in the discussion section.

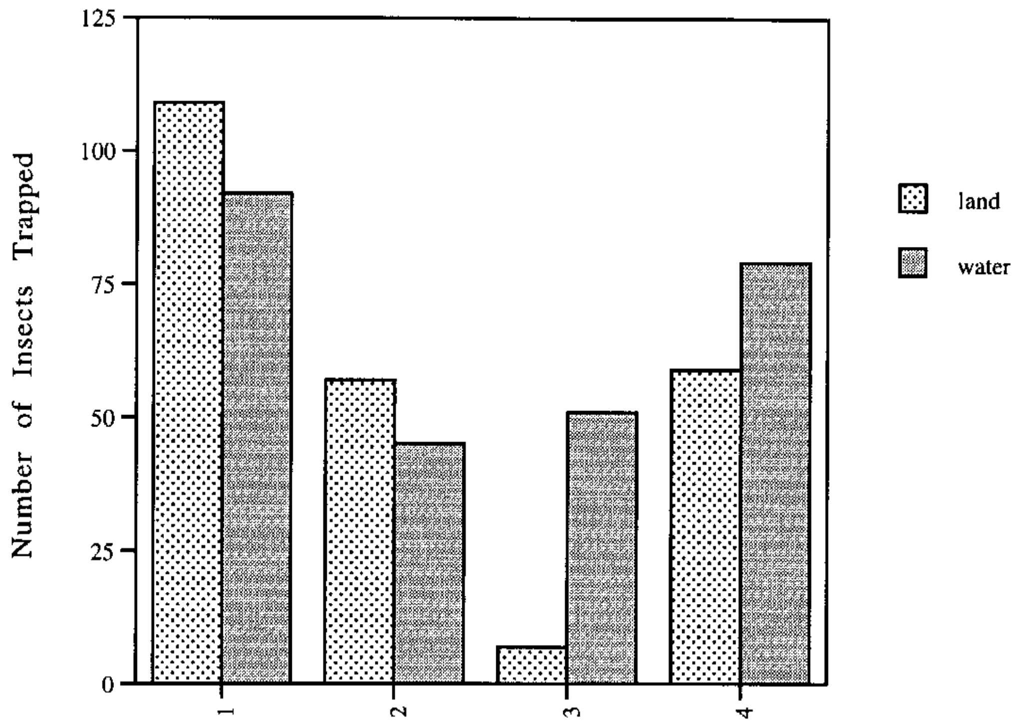
Figure 7: Comparison of Total insects Tapped at each Bog.



1=Tender Bog 3=North Gate Bog

2=Ed's Bog 4=Reddington Lake

Figure 8: Insect Emergence from different Trap Enviroments



Trap Location

1=Tender Bog 3=North Gate Bog

2=Ed's Bog 4=Reddington Bog

Table 2; Chaoborus Patterns in Tender Bog

Tender Bog	June 17,1994								July 7, 1994							
Time	1st		2nd		3rd		4th		1st		2nd		3rd		4th	
Surface	18	8	19	33	137	18	33	23	9	1	2	2	7	2	14	15
2 meters	10	2	17	32	21	16	11	20	9	3	4	2	5	2	4	6
4 Meters	7	2	9	29	6	45	13	12	2	3	8	3	4	4	1	8
6 Meters	4	3	15	4	4	16	11	10	8	2	3	7	1	7	7	5
8 Meters	3	0	8	2	13	7	11	4	4	4	5	1	5	6	0	5
10 Meters	0	1	6	1	5	13	5	11	2	1	3	1	2	1	0	0

Observation Periods 1st-6:20 AM, 2nd-12:20 PM 3rd-6:20 PM, 4th-12:20 AM

Table 3:Chaoborus Patterns in Ed's Bog

Ed's Bog	June 17, 1994								July 7,1994							
Time	1st		2nd		3rd		4th		1st		2nd		3rd		4th	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Surface	0	0	1	2	4	3	43	52	5	5	1	5	4	7	28	12
2 Meters	20	26	18	31	28	14	24	32	21	7	10	15	11	7	11	4
4 Meters	10	11	11	21	28	28	22	18	5	5	12	8	4	3	20	9
6 Meters	11	3	16	13	7	17	13	22	6	2	10	5	4	7	1	2

Observation Periods 1st-5:45 AM, 2nd-11:45 AM 3rd-6:45 PM, 4th-12:45 AM

Table 4: Chaoborus patterns in North Gate Bog

North Gate Bog	June 17, 1994	July 7, 1994							
	No chaoborus found at any depth during this sampling period	1st		2nd		3rd		4th	
Surface		0	0	0	0	0	0	2	1
2 Meters		0	0	0	0	0	0	0	0
4 Meters		0	0	0	0	0	0	0	0
6 Meters		0	0	1	0	0	0	0	0
8 Meters		0	0	0	0	0	0	0	0

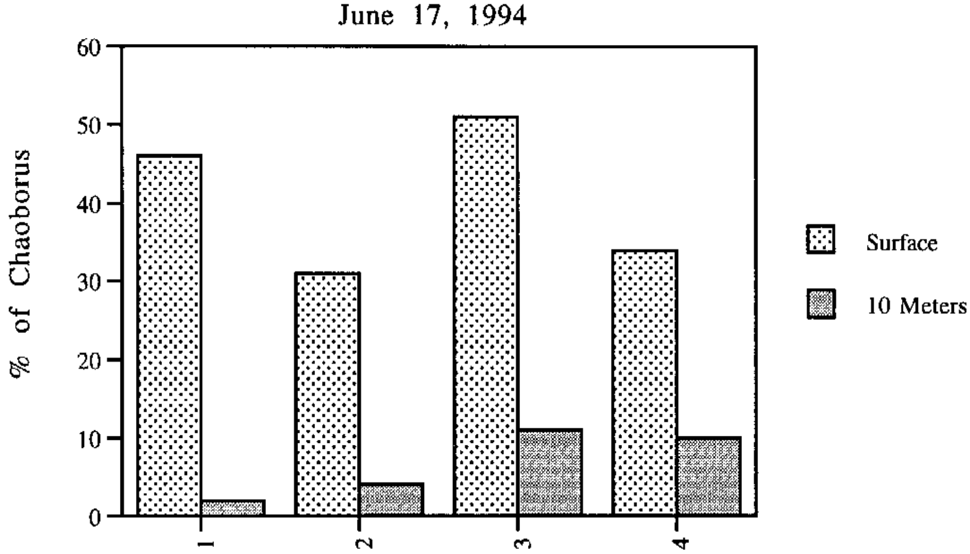
Observation Periods 1st-5:15 AM, 2nd-11:15 AM 3rd-5:15 PM, 4th-11:15 PM

Table 5: Chaoborus patterns in Reddington Lake

Reddington Lake	June 17, 1994								July 7, 1994							
Time	1^{st}		2^{nd}		3^{rd}		4^{th}		1^{st}		2^{nd}		3^{rd}		4^{th}	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Surface	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2 meters	0	0	0	1	0	0	0	0	0	4	0	0	0	0	1	2
4 Meters	2	0	0	0	0	0	0	1	0	0	0	0	0	0	3	1
6 Meters	0	0	0	0	1	0	0	0	3	4	0	0	0	0	4	0
8 Meters	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
10 Meters	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1	1
12 Meters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Observation Periods - 1^{st}-4 AM, 2^{nd}-10 AM 3^{rd}-4 PM 4^{th}-10 PM

Figure 9A: Tender Bog

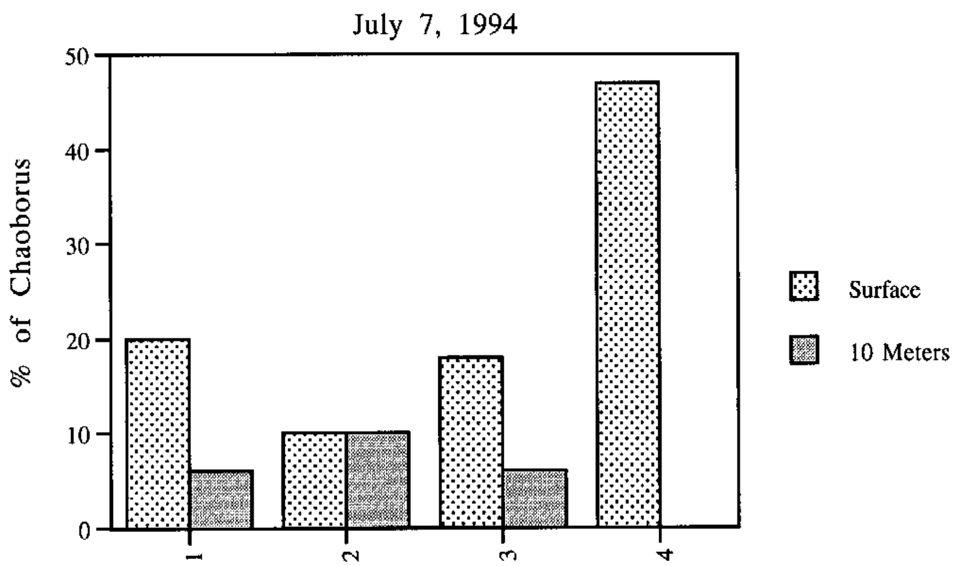


Observation Periods

1=6:20 AM 2=12:20 PM

3=6:20 PM 4=12:20 AM

Figure 9B: Tender Bog

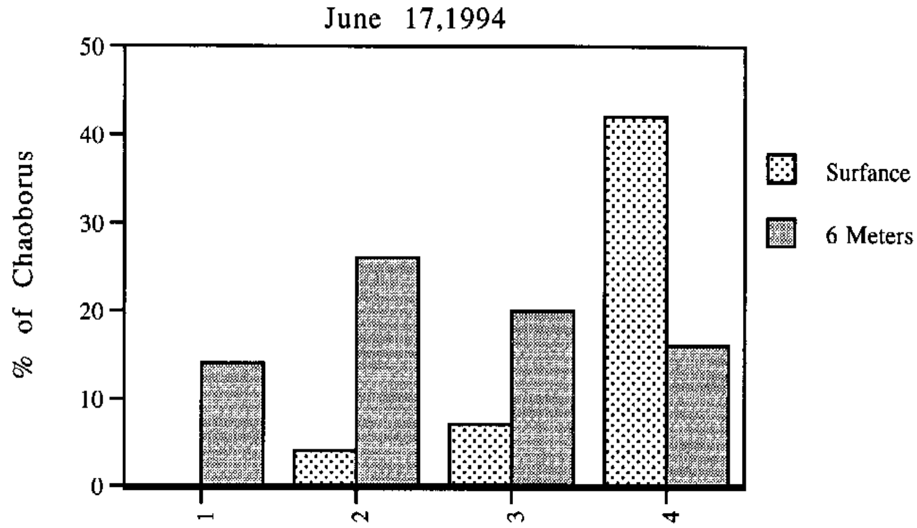


Observation Periods

1=6:20 AM 2=12:20 PM

3=6:20 PM 4=12:20 AM

Figure 10A: Ed's Bog

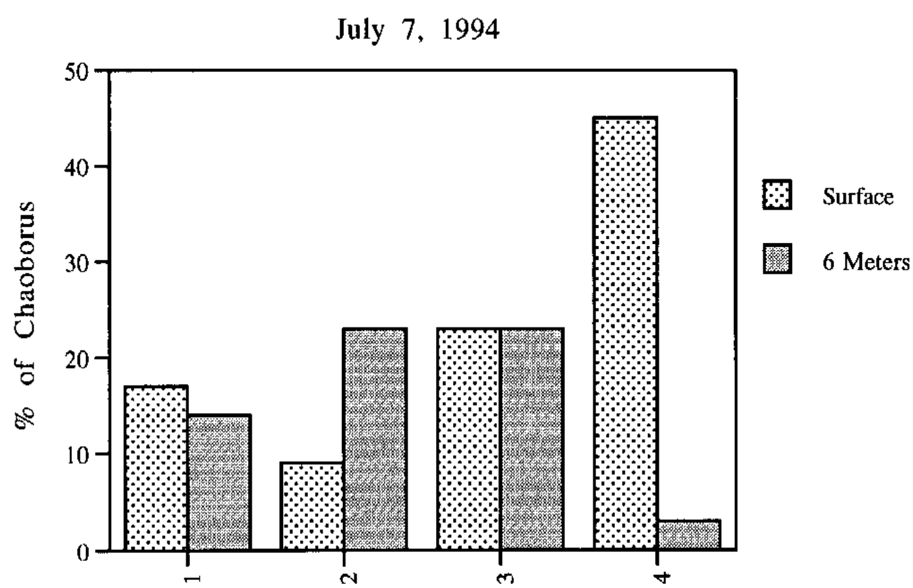


Observation Periods

1=5:45 AM 2=11:45 AM

3=5:45 PM 4=11:45 PM

Figure 10B: Ed's Bog

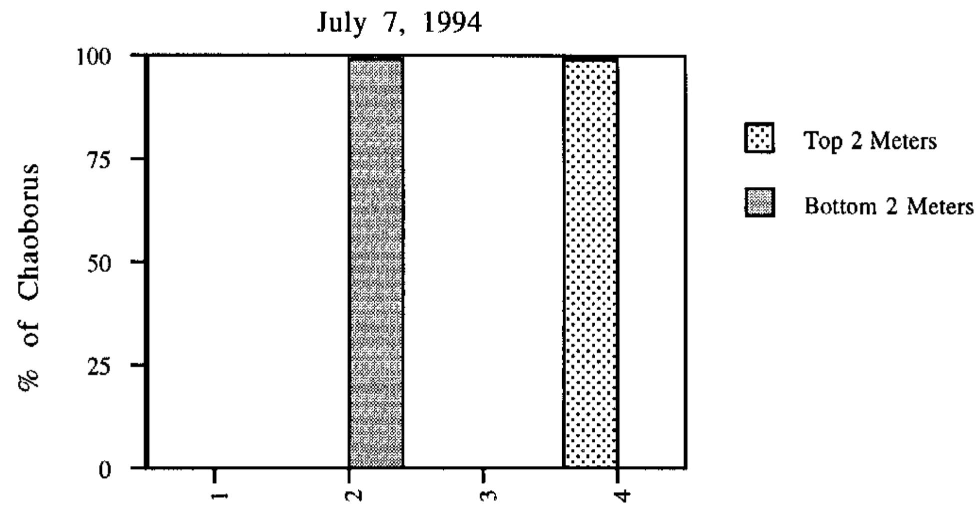


Observation Periods

1=5:45 AM 2=11:45 AM

3=5:45 PM 4=11:45 PM

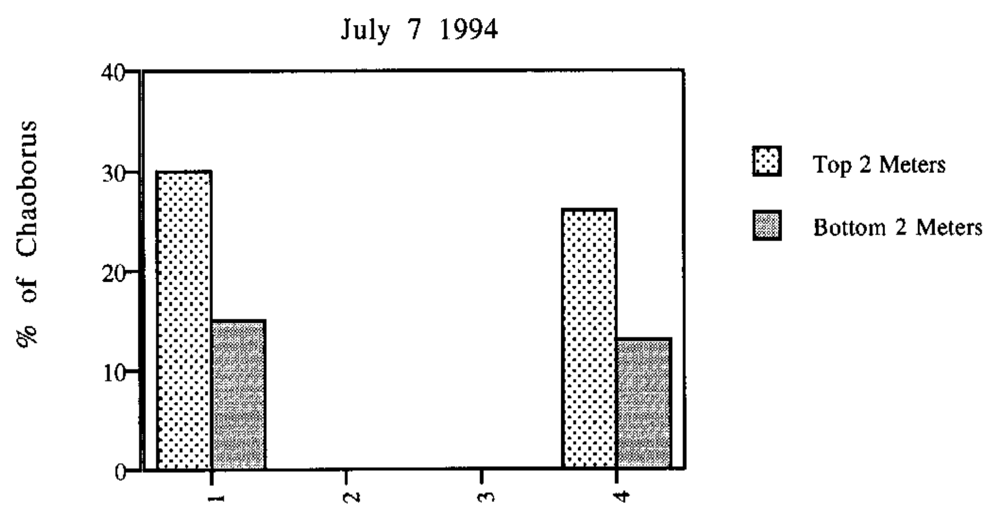
Figure 11: North Gate Bog



Observation Preiods
1=5:15 AM 2=11:15 AM

3=5:15 P M 4=11:15 PM

_Figure 12: Reddington Lake



Observation Periods
1=4 AM 2=10 AM

3=10 PM 3=10 PM

Discussion:

The results gathered in the traps raise several topics, the first is that neither the open water or the bog mat were more conducive to insect lava emergence, as illustrated in Figure 8. This is reasonable because the area's were very similar. The true difference was not the surface, as most traps ended setting on water, but what type of vegetation was present under the trap. Due to the nebulous and variable definition of a bog mat, the distinction between water and actual bog mat proved to be inconsequential and, as a result, the data was inconclusive.

Another observation involved the relationship between taxonomic diversity and insect number. The difference in Chironomidae tribes, as illustrated in Figure 5, is for all purposes insignificant because sometimes it is only a single insect which causes the difference between habitats. For an accurate commentary, it would be necessary to identify down to genera. Also needed would be a more friendly trapping system so as to reduce the number of unidentifiable samples. Possible alternatives include checking more frequently or building in a preservative into the collection jars.

The main focus of the emergence survey was the relationship between overall insect family diversity and abundance is based on the logical idea that the more diverse a population, the larger it will be. Upon closer examination of Figures 6 and 7, however, the question arises as to why the harshest environment, Tender Bog has the largest numerical yield while the more neutral locations, Reddington lake, output is clearly reduced. Due to similarities between North Gate Bog and Ed's Bog, in both chemistry and insect abundance, the focus will be on Tender Bog, with a pH of 4.4 to 4.6, and Reddington Lake, with a pH of 5.9 to 6.2. Numerous studies on acidity and Chironomidae (Griffiths 1992, Dogherty and Morgan 1991) have found that both diversity and numbers decrease as pH decreases. They, and others, have concluded that increased acidification reduces the insect population, a finding in clear conflict with this study's findings.

A possible explanation is that most research into this balance has been conducted either on environments that varied by two plus pH points or on the short term results of a sudden change in acidity, both of which differ from the natural occurring,established atmosphere at UNDERC. A more substantial response is that the trophic status of the lake exerts a stronger influence on the insect population that the acid level, as suggested in recent studies.(Brodin and Gransberg 1993) This claim is substantiated due to unique characteristic and possible classification of merimectic. The stagnant water which would result from the lack of seasonal turnover and overall harsher chemical environment could account for the lesser insect presence.

A final consideration is the role of predation(Goyke and Hersey

1992) Reddington has a vertebrate population of mud minnows as established through observations and access to a lake with an extensive fish population. Tender Bog, however, has been recorded as fishless(VonEnde 1979) and appears to still be so. The predation presence in Reddington could account for the low marc-invertebrate presence while the lack of a true predator accounts for Tender Bog's abundant Dipteran population.

The second topic raised in the results involves the migration patterns of the family Chaoborus:Diptera. Its behavior, as revealed in Ed's Bog and to a lesser extent North Gate Bog and Reddington Lake corresponds to numerous published studies.(Wagner 1990, von Ende 1979) It is believed that once a threshold of light intensity is reached, the macro- invertebrate responds by either rising or sinking in the water column. The question that arises is why does Tender Bog's Chaorboridae population exhibit no such pattern. One explanation involves, again, the lack of predation. The motivation behind the sensitivity to light is to avoid being seen and attached by a predator, as demonstrated by other insect behavior. (Macchiusi and Baker 1992) Consequentially they hide in the darkness of the depths when the sun raises the light level. In Tender Bog, with no history of a predation threat, the larva are no longer on the defensive so they stay close to the surface to assist their feeding. This idea is substantiated in other bogs by the ekman results that, although scarce, revealed that larva do survive in the bottom sediment during the day light period.

An alternative explanation is that due to the humic stain in Tender Bog blocks light to the extent that it is permanently dark in the vast majority of the bog. No signs of this were revealed in the chemical tests preformed so further research would be needed to substantiate this unlikely possibility. Also, one discrepancy exist between this and a previous study done by Carl von Ende at the same location. The values of the Chaoboridae population at North Gate Bog differ to a surprising degree. In his research he included the environment as one with vibrant population while the current study found few if any larva present. In the future, a closer examination into this contrast is necessary to discover if it is easily explained by different technique or survey times or if it is an indication of a substantial shift in the bog's habitat.

Overall, a basic knowledge of the insect population, and its cations and behaviors, has been established for four bog lakes on the UNDERC property. Several ideas that merit further thought have been raised but further research, including the need to establish an accurate portrayal of the predator presence at each environment is necessary before a complete understanding of these unique environments can be reached.

Acknowledgement:

I would like to thank my Advisor, Dr. Ronald Hellenthal, for his guidance and assistance at all stages of this project. Dr. Martin Berg provided constant advice in the field, with out his patience this study would never have reached conclusion. Dan Thuente and Elizabeth Broghamer were invaluable partners as we together complete the physical tests and improvements on the bogs. The UNDERC class, TAs, and my brother Tom Kilbane who were ready to assist and accompany me though every component of the study. Lastly, to The Bernard J. Family Endowment, with out which I would never have never had the opportunity to conduct this study.

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