

**Cladoceran and Copepod Zooplankton Abundance and Body  
Size in Kezar Lake, Maine (MIDAS 0097)**

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## Introduction

The purpose of this report is to document the abundance, composition, and body size of cladoceran and copepod zooplankton in samples collected from Kezar Lake between 2004 and 2007. When a state-wide analysis of zooplankton is completed (target date of late summer of 2008) we will have a context to compare the August-September communities of Kezar Lake with other lakes of similar morphometry and chemistry in Maine. That interpretation will be provided as an addendum when the MS student finishes her thesis. In this report we document the sample collection and analysis methods, provide an overview of the cladoceran genera and copepod groups found in Kezar Lake, and provide the data on abundance and body size. Accompanying this report are (1) an excel spreadsheet (Kezar Zooplankton\_26FEB08.xls) with the raw and summary data and (2) the image files used for body size determination.

## Methods

### ***Sample collection:***

Zooplankton were collected by Scott Williams, Executive Director of the Maine Volunteer Lake Monitoring Program using a 13 cm diameter, 80  $\mu$  mesh Wisconsin plankton net. Eight samples were collected from Basin 1, the deep basin during the summers of 2004 through 2007. These were taken as vertical tows from ~40m to the surface; three tows were pooled into one sample bottle. In 2004, samples were collected in June, July and August; in 2006 samples were collected in July, August and

September; and in 2005 and 2007 samples were collected in mid-late August. In 2004, samples were also collected from the shallow basin 3. These were collected more as horizontal tows rather than as vertical tows. Sample volumes are thus approximate as are density estimates.

All zooplankton samples were stored in 70% ethanol in 250 mL pre-weighed plastic bottles. Prior to adding preservative, alka-seltzer tablets were added to narcotize the zooplankton and limit distention upon exposure to ethanol.

### ***Sample Analysis***

A total of 11 samples were collected and analyzed at the University of Maine, Orono laboratory located in Murray Hall. In the laboratory, samples were concentrated in order to weigh the sample accurately on the scale. Once the weight of the bottle with the sample was recorded, the entire sample was poured into a large dish and examined under the microscope to generally survey the zooplankton assemblage and estimate the subsample volume required. Sub-samples were taken with a Henson-Stempel large-bore pipette and placed in a Ward circular counting wheel. Using a Nikon SMZ800 dissecting microscope hooked up to a Nikon Coolpix 995 digital camera, the number of each cladoceran genus and each copepod groups (calanoids and cyclopoids) were counted in the subsample. If needed, additional subsamples were counted until a target of ~125 total individuals was reached. A target of 30 individuals of each cladoceran genus and copepod group were photographed. Using the computer program Image J, body length was measured from tip of the head to end of the carapace for cladocerans or to the end of the caudal ramus for copepods.

Raw counts were converted to the abundance in the lake in number per liter using information on the tow depth, number of tows, net diameter, sample volume and subsample volume. The average body length was determined for each cladoceran genus and copepod group. Using density data, a weighted average body length was determined for all cladocerans, all copepods, and all zooplankton.

We did observe colonial ciliates attached to several Cyclopoids and Calanoid copepods in the August 2006 samples. After meeting with Dr. Joyce Longcore, a research associate professor at the University of Maine who is an expert in the ecology of aquatic fungi, we concluded that these ciliates are using the copepods solely as a substrate for transportation and are unlikely harmful to them although they may possibly make the infected individuals more susceptible to predation.



**Colonial Ciliates:** The above picture shows the ciliates on the largest Cyclopoid to the left.

## **Data Summary**

The data summary section includes two parts. The first is a series of tables that provide the density and body size data for the cladocerans and copepods found in the Kezar Lake samples. The second part is a pictorial summary of the zooplankton taxa found in the Kezar Lake samples.

*Part 1: Summary tables.*

**Table 1. Summary of density and weighted body length of total zooplankton, cladocerans, and copepods in Kezar Lake samples.**

<b>Date Sampled</b>	<b>Station</b>	<b>Density (Number/L)</b>	<b>Body Length (mm)</b>
<b>Total Zooplankton</b>			
6/24/2004	Basin 1	2.196	0.66
7/22/2004	Basin 1	3.193	0.66
8/24/2004	Basin 1	1.662	0.68
8/11/2005	Basin 1	0.775	0.76
7/26/2006	Basin 1	1.354	0.66
8/24/2006	Basin 1	1.679	0.66
9/22/2006	Basin 1	1.281	0.74
8/16/2007	Basin 1	1.669	0.80
6/24/2004	3 South	0.428	0.44
7/22/2004	3 South	2.024	0.40
8/24/2004	3 South	0.865	0.58
<b>Cladoceran</b>			
6/24/2004	Basin 1	0.873	0.75
7/22/2004	Basin 1	0.913	0.69
8/24/2004	Basin 1	0.370	0.74
8/11/2005	Basin 1	0.287	0.77
7/26/2006	Basin 1	0.541	0.64
8/24/2006	Basin 1	1.006	0.60
9/22/2006	Basin 1	0.362	0.75
8/16/2007	Basin 1	0.615	0.84
6/24/2004	3 South	0.123	0.36
7/22/2004	3 South	0.826	0.22
8/24/2004	3 South	0.133	0.45
<b>Copepod</b>			
6/24/2004	Basin 1	1.323	0.60
7/22/2004	Basin 1	2.280	0.64
8/24/2004	Basin 1	1.292	0.67
8/11/2005	Basin 1	0.488	0.76
7/26/2006	Basin 1	0.812	0.68
8/24/2006	Basin 1	0.673	0.74
9/22/2006	Basin 1	0.919	0.73
8/16/2007	Basin 1	1.054	0.77
6/24/2004	3 South	0.305	0.48
7/22/2004	3 South	1.197	0.53
8/24/2004	3 South	0.732	0.61

**Table 2. Density and mean body length for cladoceran genera and for total cladocerans.**

**Genus codes are:**

Di=*Diaphanasoma*; HO=*Holopedium*; PO=*Polyphemus*; Da=*Daphnia*; Bo=*Bosmina*; Ce=*Ceriodaphnia*; Sida=*Sida*; Chy=*Chydorus*; Le=*Leptodora*

**Density (#/L)**

Date Sampled	Station	Di	Ho	Po	Da	Bo	Ce	Sida	Chy	Le	Total
6/24/2004	Basin 1	0.113	0.000	0.000	0.493	0.084	0.000	0.183	0.000	0.000	0.873
6/24/2004	3 South	0.037	0.022	0.000	0.000	0.056	0.004	0.004	0.000	0.000	0.123
7/22/2004	Basin 1	0.095	0.047	0.000	0.551	0.173	0.000	0.047	0.000	0.000	0.913
7/22/2004	3 South	0.096	0.000	0.000	0.000	0.683	0.012	0.000	0.012	0.000	0.802
8/24/2004	Basin 1	0.091	0.033	0.000	0.206	0.008	0.000	0.033	0.000	0.000	0.370
8/24/2004	3 South	0.033	0.000	0.000	0.080	0.007	0.000	0.013	0.000	0.000	0.133
8/11/2005	Basin 1	0.035	0.035	0.000	0.165	0.044	0.000	0.009	0.000	0.000	0.287
7/26/2006	Basin 1	0.094	0.035	0.012	0.212	0.177	0.012	0.000	0.000	0.000	0.541
8/24/2006	Basin 1	0.650	0.023	0.000	0.008	0.209	0.116	0.000	0.000	0.000	1.006
9/22/2006	Basin 1	0.065	0.019	0.006	0.233	0.039	0.000	0.000	0.000	0.000	0.362
8/16/2007	Basin 1	0.000	0.066	0.011	0.307	0.154	0.000	0.055	0.000	0.011	0.604

**Mean Body Length (mm)**

Date Sampled	Station	Di	Ho	Po	Da	Bo	Ce	Sida	Chy	Le
6/24/2004	Basin 1	0.69	.	.	0.67	0.46	.	1.14	.	.
6/24/2004	3 South	0.44	0.60	.	.	0.25	0.20	.	.	.
7/22/2004	Basin 1	0.48	0.62	.	0.80	0.39	.	1.00	.	.
7/22/2004	3 South	0.37	.	.	.	0.21	0.34	.	.	.
8/24/2004	Basin 1	0.50	1.19	.	0.72	0.24	.	1.19	.	.
8/24/2004	3 South	0.47	0.91	.	0.54	0.28	0.40	.	.	.
8/11/2005	Basin 1	0.56	0.94	.	0.87	0.38	.	1.00	.	.
7/26/2006	Basin 1	0.58	1.10	0.74	0.76	0.44	0.34	.	.	.
8/24/2006	Basin 1	0.75	.	.	0.84	0.53	.	1.38	.	.
9/22/2006	Basin 1	0.57	0.85	0.64	0.86	0.33	.	1.38	.	.
8/16/2007	Basin 1	.	0.95	1.00	0.98	0.39	.	1.52	.	.

**Cladoceran Mean Length (mm) - weighted**

Date Sampled	Station	Cladoc
6/24/2004	Basin 1	0.75
6/24/2004	3 South	0.36
7/22/2004	Basin 1	0.69
7/22/2004	3 South	0.23
8/24/2004	Basin 1	0.74
8/24/2004	3 South	0.45
8/11/2005	Basin 1	0.77
7/26/2006	Basin 1	0.64
8/24/2006	Basin 1	0.60
9/22/2006	Basin 1	0.75
8/16/2007	Basin 1	0.85

**Table 3. Density and mean body length for calanoid (Ca) and cyclopoids (Cy) copepods. Total copepod abundance and weighted average mean length are also provided.**

*Density (#/L)*

<b>Date Sampled</b>	<b>Station</b>	<b>Ca</b>	<b>Cy</b>	<b>Total Cop</b>
6/24/2004	Basin 1	1.14	0.18	1.32
6/24/2004	3 South	0.26	0.04	0.31
7/22/2004	Basin 1	1.07	1.21	2.28
7/22/2004	3 South	0.26	0.93	1.20
8/24/2004	Basin 1	0.86	0.43	1.29
8/24/2004	3 South	0.23	0.51	0.73
8/11/2005	Basin 1	0.18	0.30	0.49
7/26/2006	Basin 1	0.24	0.58	0.81
8/24/2006	Basin 1	0.60	0.08	0.67
9/22/2006	Basin 1	0.47	0.45	0.92
8/16/2007	Basin 1	0.49	0.56	1.05

*Mean Body Length (mm)*

<b>Date Sampled</b>	<b>Station</b>	<b>Ca</b>	<b>Cy</b>	<b>Tot_Cop</b>
6/24/2004	Basin 1	0.59	0.65	0.60
6/24/2004	3 South	0.48	0.44	0.48
7/22/2004	Basin 1	0.67	0.62	0.64
7/22/2004	3 South	0.73	0.47	0.53
8/24/2004	Basin 1	0.68	0.65	0.67
8/24/2004	3 South	0.51	0.65	0.61
8/11/2005	Basin 1	0.75	0.76	0.76
7/26/2006	Basin 1	0.76	0.64	0.68
8/24/2006	Basin 1	0.76	0.61	0.74
9/22/2006	Basin 1	0.77	0.69	0.73
8/16/2007	Basin 1	0.83	0.72	0.77



**Part 2: The zooplankton found in Kezar Lake. Information on different taxa is from <http://cfb.unh.edu/CFBkey/index.html>**

**Copepoda:** Copepods are micro-crustaceans found in most every freshwater environment and are typically the most abundant of all zooplankton. They are major food sources for whales, small fish, and seabirds. This group tends to be between 1 and 2 millimeters in length. Many of the smaller copepods feed on the smaller phytoplankton; however, there are some predatory copepods which feed on their smaller relatives. There were two classes of copepods counted in the Kezar Lake samples were cyclopoids and calanoids.

**Cyclopoid (CY):** Cyclopoids vary between 0.5 and 2.0 mm in length with the average length in Kezar being 0.6 mm. Their bodies are typically wider and antennae shorter than their relatives the Calanoids. Cyclopoids are common in the pelagic (or open water) zones of freshwater lakes. They are very important to the aquatic food chain because they can be consumers or predators on small zooplankton such as rotifers as well as providing a food source for small fish.

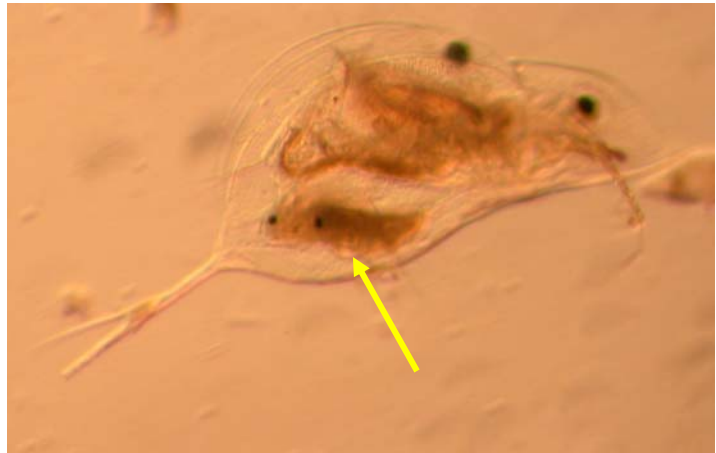


**Calanoids (CA):** Calanoids have a similar range in length as Cyclopoids. The average length in Kezar for Calanoids was 0.6 mm as well. Their distinguishing features are most often their longer antennae and slimmer body. Calanoids also have one central egg sac when reproducing while Cyclopoids have two, one at each side of the caudal region. Calanoids are successful in all parts of the pelagic environment in many aquatic habitats. These copepods are consumers of many types of phytoplankton.



**Cladocera:** Cladocerans, commonly called water fleas because of their small size and jerky swimming motions, are also micro-crustaceans. They are mainly herbivorous feeders but some can be predatory. Cladocerans are essential to the aquatic food web because they consume phytoplankton and also are preyed upon by many fish and larger invertebrates. Algal consumption is more efficient in larger-bodied genera. The following cladoceran genera were observed in the Kezar samples.

**Daphnia (DA):** *Daphnia* are very important members of pelagic lake food chains because they are efficient grazers on algae and are an important source of food for fish. They are large-bodied (average of 0.8 mm in length with a maximum of 1.61 mm in Kezar) and are easily identifiable by their long tail spines. Note, in this picture, the newly hatched offspring are still under the carapace (see arrow).



**Bosmina (BO):** *Bosmina* are common in the open waters of lakes and ponds. Like daphnia, *Bosmina* are filter feeders of algae, but their smaller size makes them less efficient as well as less susceptible to predation by fish. They averaged 0.4 mm in length in Kezar samples. The best way to identify *Bosmina* besides their small size is their antennae which is large and fixed to its head and shaped like a trunk.



**Diaphanasoma (DI):** The Identifying characteristics of *Diaphanasoma* are an anterior eye and a head that is roughly half the size of its entire body. *Diaphanasoma* are efficient filter feeders of algae. An average length in Kezar of 0.5 mm was observed.



**Holopedium (HO):** The filter feeder *Holopedium* typically has a large gelatinous sheath surrounding its body and its appendages have fine spines at the end. *Holopedium* tend to be between 0.5 and 2 mm in length.



**Ceriodaphnia (CE):** The filter feeder *Ceriodaphnia* has a small and depressed head with no evidence of a rostrum. They tend to be between .4 and .6 mm in length.



**Sida (SI):** *Sida* appears similar to its relative *Daphnia* only there is an absence of a tail spine. Their average length in Kezar was 1.23 mm with a maximum length of 2.090 mm. It is also similar to *Diaphanosoma* but its appendages have three segments instead of two. This filter feeder is extremely efficient due to their large size.



**Polyphemus (PO):** *Polyphemus* is a predatory zooplankton with one very large compound eye. It also has a slender tail which is less than the length of its body. This predatory zooplankton ranges from 0.45– 0.94 mm is rarely viewed in samples because its large compound eye makes it susceptible prey to fish.

