# Aquatic Macroinvertebrates of the Kanuti National Wildlife Refuge

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# Abstract

Aquatic invertebrates were collected from 13 lakes on Kanuti National Wildlife Refuge in interior Alaska over a period of three years. All of the lakes were sampled in August of 1999 or 2000, and 5 of the lakes were resampled in June 2001. Invertebrates were collected using a semi-quantitave sampling approach along two transects in each lake. Water pH, color, temperature, and Secchi depth were also sampled at the center of each lake. Descriptive statistics were calculated for macroinvertebrate abundance and taxonomic composition. Statistical tests were performed to determine if there there were differences in taxa or relative abundance among lakes, between years or seasons, among geographic regions of the refuge, and between transects within a lake. Differences in water quality among lakes were also tested.

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# Introduction

Many of the National Wildlife Refuges in interior Alaska were protected for their water resources and ability to support large populations of breeding waterfowl and other wetland-dependent wildlife. Despite this, relatively little work has focused on inventorying and monitoring the basic biological components of refuge wetlands, except for research targeting wetland use by waterfowl and fish (Glesne 1986, Heglund 1988, 1992, Kafka 1988, Seppi 1993, Heglund et al. 1994, Wortham 1995, Corcoran 2005).

Kanuti National Wildlife Refuge (Kanuti NWR), located in north-central Alaska (Figure 1), conducted an inventory of aquatic macroinvertebrates from 1999 - 2001 to document baseline taxonomic diversity and relative abundance of invertebrates in select refuge lakes. Macroinvertebrates were selected to inventory because of their importance as food for fish and birds and their roles as indicators of water and habitat quality (Oswood et al. 2001, Rosenberg and Resh 1993). Two earlier studies on Kanuti NWR included aquatic invertebrate collections but primarily focused on waterfowl use of wetlands with and without beaver activity (Kafka 1988, Wortham 1995). Both studies occurred on wetlands associated with the Kanuti River in the southern portion of the refuge that were easily accessible from the refuge's administrative cabin on Kanuti Lake. The current study targeted lakes in other areas of the refuge, including ones only accessible by floatplane. A protocol for collecting aquatic invertebrates was developed during the project (Oswood et al. 2001). This report contains an analysis and discussion of macroinvertebrate data collected during this study.

## *Study Sites*

Kanuti NWR is located in north-central Alaska, straddling the Arctic Circle (Figure 1). The refuge extends from approximately 65º 59' to 66º 53' north latitude, and from 150º 58' to 152º 58' west longitude and encompasses approximately 663,684 ha. The Brooks Range lies 150 km to the north, and the foothills of the Ray Mountains form the refuge's southern boundary. Elevation on the refuge ranges between 122 m - 927 m. Much of the refuge consists of the Kanuti Flats, a lowland basin containing numerous lakes and wetlands that is drained by the Koyukuk River and its tributary, the Kanuti River.

The Refuge's climate is cold and continental, with slightly higher precipitation than other areas of interior Alaska. The closest weather station is in Bettles, just outside the refuge's northern boundary; however, conditions on the refuge are variable and some areas may not reflect data collected in Bettles. Temperature extremes in Bettles ranged from a low of -57º C to a high of 34º C in Bettles from 1951 – 2005, with an average annual temperature of -5º C. Annual precipitation during this time period was 36 cm, with an average March snow depth of 81 cm. The growing season is short, with green-up beginning in late May and leaf fall starting in mid-August.

Invertebrate collection focused on three geomorphic regions within the refuge, corresponding to the following drainages: a) the Kanuti River (southern region), b) the Kanuti Chalatna Creek (central region); and c) the Koyukuk River (northern region) (Figure 2). All lakes surveyed were connected to one of these drainages during periods of high water. However, some of these connections are weak and may not develop unless water levels are exceptionally high. All lakes were connected to one of these drainages at least in periods of high water, although some of the connections were weak and may not develop unless water levels are exceptionally high.

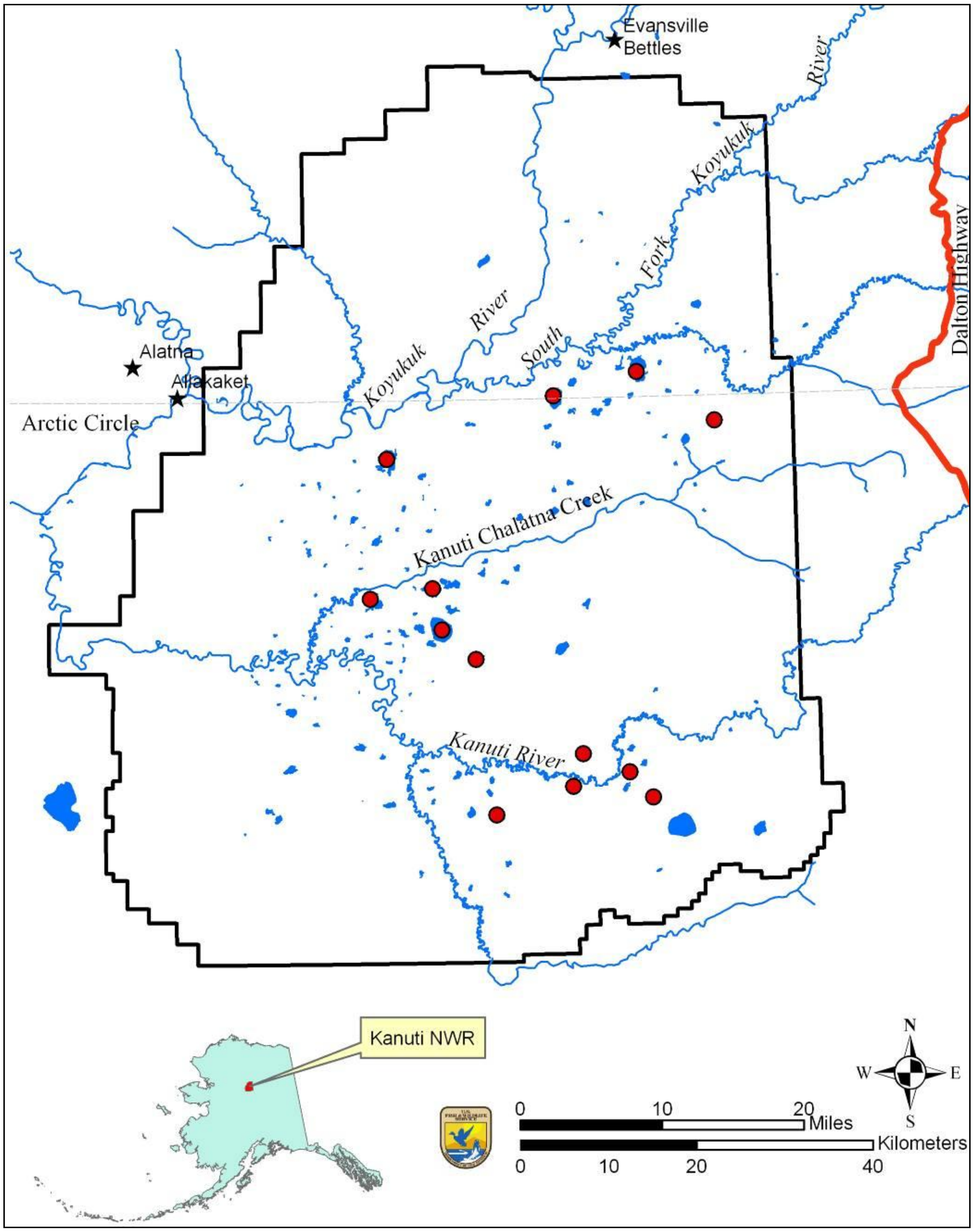
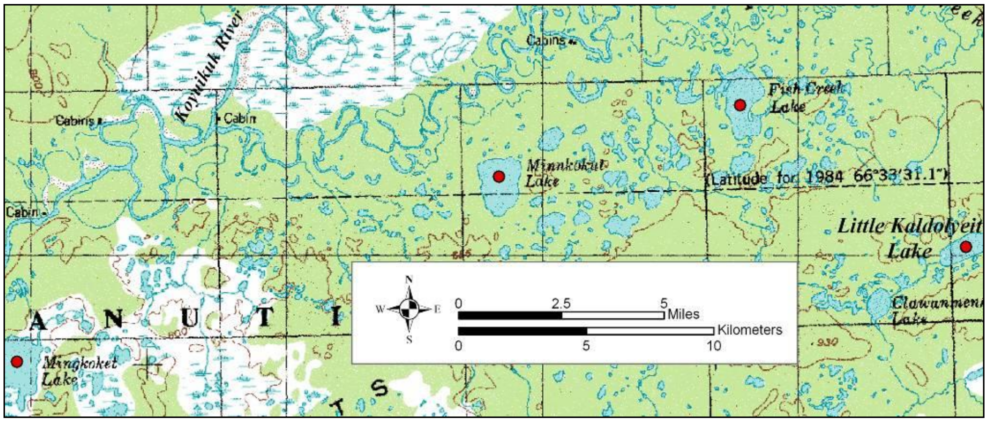
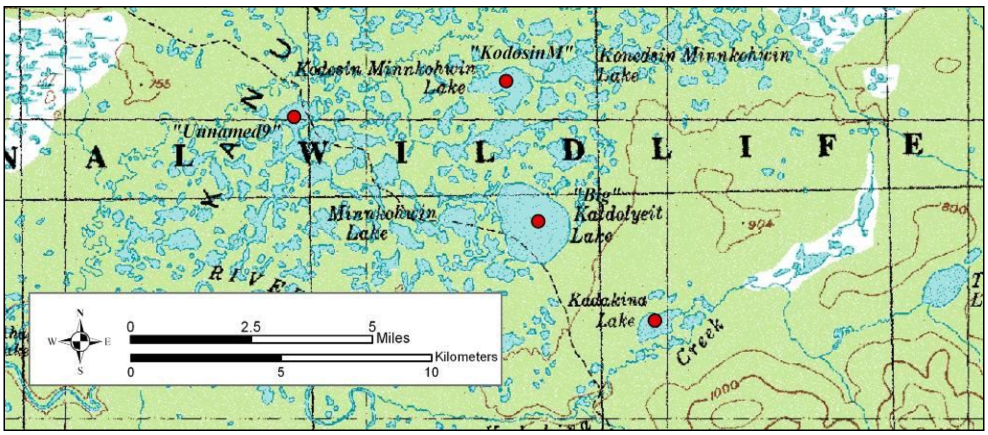


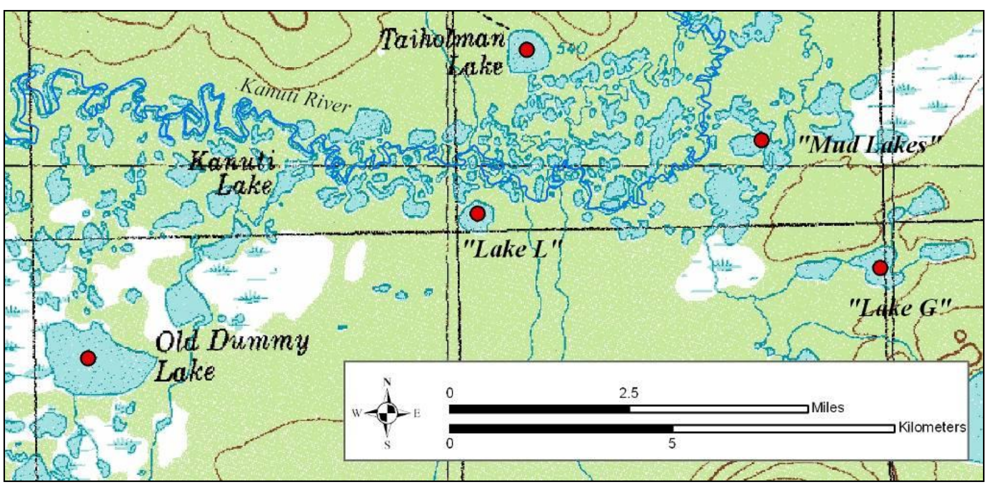

Figure 1. Location of invertebrate sampling lakes on Kanuti National Wildlife Refuge, Alaska, 1998 – 2001.




a. Northern region lakes




b. Central region lakes




c. Southern region lakes

Figure 2. Lakes sampled for invertebrates in the northern (a), central (b), and southern (c) portions of the Kanuti National Wildlife Refuge.

## *Macroinvertebrate Abundance*

Most studies of aquatic macroinvertebrates of include some measure of abundance. The simplest measure is presence or absence. Accurate identification of organisms is important, and identification to the lowest possible taxonomic level is highly recommended. However, not all individuals of each organism have to be identified or enumerated, thus saving time and effort. Also, samples can be collected qualitatively, since no comparisons other than presence/absence are planned. Qualitative sampling allows the collection effort to be focused on those habitat types that yield the largest number of species. This type of data is primarily useful in developing checklists of geographical regions (e.g., the Trichoptera of Alaska) or in reporting range extensions. Taxonomic and biogeographic experts are likely to be interested in these types of data. Presence/absence data of the macroinvertebrates of this study are listed in Appendix 14.

The next level of effort in abundance studies is numerical abundance of organisms in semi-quantitative samples. In a study of this type, all individuals are sorted from the sample, separated into different taxa, identified to the lowest possible level, and then counted. This involves much more time and effort (which equate to dollars), but is necessary if there are any comparisons planned (e.g., among lakes or among years). Samples must be taken using the same techniques, and it is beneficial that the sorting, identifying, and counting be done by the same laboratory or even the same person (see Oswood et al. 2001 for a more detailed discussion of this topic). This is the level of the present study.

Full quantitative sampling adds another level of complexity to the sampling and processing regime. Samples must be taken from a given and known amount of habitat. For instance, in stream sampling, the sample unit is usually 0.1 $m^2$ (the sampler has a delimiter about 33 cm on each side). Because the sampler collects from a smaller area than in a semi-quantitative method, many samples must be collected in order to maintain statistical power. This adds yet another level of time and effort. The benefit of this level of study is that quantitative comparisons can be made both within the study and to other studies in other regions. For instance, one could compare the number of invertebrates (or each Functional Feeding Group [FFG], or individual taxonomic groups) per square meter in lakes on the North Slope of Alaska to lakes in interior Alaska, as well as to lakes in south-central Alaska. These types of comparisons are not possible with qualitative or semi-quantitative studies.

Finally, numerical abundance is a good ecological measure only if all organisms are roughly the same size. If different organisms are widely disparate in size, biomass is a much better measure of the ecological role of each species (or genus, family, etc.) or functional group (see below). Among the several techniques to estimate biomass, the most common are ash-free dry mass (AFDM) and biovolume. In the former, all the individuals of a given taxon within a sample are oven-dried, weighed, incinerated, and then the leftover ash is weighed. By subtraction, the amount of organic matter composed of that taxon in that sample is estimated. (Ash-free calculations are done because many invertebrates ingest large amounts of inorganic material like sand and silt.) In the latter technique, biovolume is determined by estimating the amount of liquid displacement by all the individuals of a given group (taxa or FFG, for example) in each sample. Regressions can be calculated to convert biovolume into AFDM. Needless to say, this adds more time and effort to the study.

## *Taxonomic Diversity*

Taxonomic diversity is in the news a lot lately: "X number of species are going extinct in the tropical rainforest every day!" the headlines read. What is taxonomic diversity? Most people (including non-scientists) easily grasp the idea of species diversity (i.e., how many different species are found in a given area). But many organisms, especially aquatic invertebrates in their larval forms, cannot be identified to species. If organisms can only be identified to genus or family, how does one know how many different species are represented? This is a dilemma for any study investigating taxonomic diversity and for which there is no easy answer. The problem is compounded when organisms within a single study are identified to different levels. For example, in this study, insect taxa in 1999 were identified to family, while in 2000-01 they were identified to genus when possible. But non-insect taxa were often only identified to order (Cladocera, Copepoda), class (Oligochaeta, Hirudinea), or even phylum (Nematoda).

In this report, we have presented taxonomic diversity at several different levels because of the differing levels of identification. We present the levels of class, order, family, and "taxon" to allow the reader to draw his or her own conclusions. At the lower levels, all measures of diversity are likely to be underestimates. It is very unlikely that there is only one species of Oligochaeta (earthworms) or Nematoda (roundworms), for instance. The "taxon" level corresponds to the lowest level identified by the laboratory that processed the samples. As mentioned earlier, this can range from species in a monotypic insect genus (e.g., *Oligotricha lapponica*) to phylum (e.g., Nematoda). At the higher taxonomic levels, underestimates are less likely; nevertheless, there were three phyla identified in the 2000-01 data but not in the 1999 data (Platyhelminthes: Turbellaria [flatworms], Nematomorpha [horsehair worms], and Coelenterata [hydras]). This does not necessarily mean that the phyla were not present, but rather that the collection or sample processing techniques may have differed, or that identification expertise may have differed.

## *ETO Ratio*

The ratio of the sum of Ephemeroptera, Trichoptera, and Odonata, divided by the total number of individuals, is sometimes used as an indicator of water quality or pollution. These taxa are not very tolerant of pollution or low oxygen concentrations, and are often considered indicator organisms. The ETO ratio has no index, and therefore should only be used within a given study to compare lakes (Gerritsen et. al 1998). We report ETO ratio here for among-lake analyses, and for comparison with other semi-quantitative studies using similar methods in interior Alaska, such as at Yukon-Charley National Park.

# Methods

## *Sampling*

### Lakes Sampled

A total of 13 lakes in the Kanuti National Wildlife Refuge were sampled for aquatic macroinvertebrates over a period of three years by refuge personnel (Saperstein 2001, 2002). Lakes were chosen to broadly represent the three geomorphic regions found in the refuge (Saperstein, pers. comm., 2005). In August of 1999, 5 lakes were sampled. In August of 2000, 8 different lakes were sampled. Finally, in June 2001, 5 of the previously sampled lakes were resampled. The June sampling was intended to capture overwintering larvae that may have been too small to identify during August sampling events. Flooding of many lakes in June 2001 precluded resampling all of the lakes sampled in previous years. Of the 5 lakes sampled, 1 had been sampled in 1999 and 4 were originally sampled in 2000 (Table1).

Table 1. Lakes and years sampled in this project. The variable names used in the analyses are also listed. SiteType is based on a geomorphological gradient, which runs from south to north (S=south, N=north, C=central).

| Lake | Var Name | Site# | SiteType | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|
| Old Dummy Lake | OldDummy | 1 | S | X | | X |
| Unnamed Lake G | LakeG | 2 | S | X | | |
| Unnamed Lake L | LakeL | 3 | S | X | | |
| Mud Lake | MudLake | 4 | S | X | | |
| Taiholman Lake | Taiholman | 5 | S | X | | |
| Mingkoket | Mingkoket | 6 | N | | X | X |
| Fish Creek | FishCreek | 7 | N | | X | X |
| Little Kaldoyeit | LittleKald | 8 | N | | X | |
| Unnamed 4, 1-00, Minnkokut[1] | Minnkokut | 9 | N | | X | X |
| Big Kaldoyeit | BigKald | 10 | C | | X | X |
| Kodosin Minnkoken | KodosinM | 11 | C | | X | |
| Kadakina | Kodakina | 12 | C | | X | |
| Unnamed 9, 2-00[1] | Unnamed9 | 13 | C | | X | |

[1]Lakes given different names during different sampling efforts. Or in the case of Unnamed 9, referred to by different names within field notes and trip summaries.

### Invertebrate Sampling and Identification

Invertebrates were sampled in 1999, 2000, and 2001 using the techniques and protocols elucidated in Oswood et al. (2001); modifications to the protocols were reported in Saperstein (2001, 2002). In general, invertebrates were collected using a semi-quantitative protocol in order to facilitate comparisons among years and lakes within this study. Comparisons with quantitative studies are not possible due to sampling of an unknown benthic surface area or lake water volume. Likewise, comparisons with other semi-quantitative studies are eschewed due to potential differences in collection techniques.

All taxonomic analyses will be underestimates because taxa were identified to different levels. For example, Nematoda and Nematomorpha were only identified to Phylum, while some insects were identified to species. This does not imply that there is only one species of nematode–there are likely to be many, but the expertise for identification was not available.

### Water Quality Sampling

Three replicate water quality samples were collected near the center of each lake and analyzed for conductivity, pH, color, and temperature. Secchi depth was estimated at the same location (one replication only). Protocols followed Oswood et al. (2001).

## *Methods used for data manipulation*

Macroinvertebrate and water quality data were provided by the U. S. Fish and Wildlife Service, Kanuti NWR, in Microsoft Excel spreadsheet format. Because the 1999 and the 2000-01 data were identified and enumerated by different organizations (1999: River Run [RR], 2000-01: Alaska Biological Research [ABR]), formatting of the data files was quite disparate and required extensive manipulation to achieve a consistent format for statistical analysis. Some of the differences include:

- Families present in only one data set (this might represent a real change in fauna, or the presence or absence of rare taxa, but is more likely to be a difference in expertise in identifications). See tables 3 and 4 for a complete list of the taxa used in the analyses.
    - Families present in 1999 data set but not in 2000-01
        - Empididae
        - Ameletidae
        - Ephemerellidae
        - Veliidae
        - Conchostraca
    - Families present in 2000-01 data set, but not in 1999
        - Brachycera (probably terrestrial)
        - Corduliidae
        - Culicidae (mosquitoes -- uncertain whether it was a flying adult that snuck into the sample, or an aquatic larva).
        - Helodidae
        - Hydrophilidae
        - Hyallelidae (RR only identified to Amphipoda RR's Amphipoda in Hyallelidae included in the analyses).
        - Hydridae (hydras)
        - Leptoceridae
        - Nematomorpha
        - Phoridae
        - Physidae
        - Planorbidae
        - Polycentropodiae
        - Psychodidae
        - Saldidae
        - Sciomyzidae
        - Stratiomyidae
        - Sphaeridae
        - Tabanidae
        - Turbellaria

- The 1999 data were identified only to the family level, while the 2000-01 data were often identified to genus (occasionally to species) in the Insecta, and to varying levels for other taxonomic classes. Therefore, the analyses done on "Taxa" do not include the 1999 data.
- Data were placed in a different order in the two data files, and a composite data file had to be created. This was done at the family level (1999 data only being identified to family), and the "taxon" level data were then reordered to match this order.
- New data files based on the order and class taxonomic levels were created by combining (adding) cells from the family-level dataset.
- Another dataset was created for Functional Feeding Group (FFG) analyses by combining (adding) cells based on membership in one of the six FFGs.
- Midway through the analyses, it was discovered that the depth values were incorrect in the 2000-01 data. The values that were included were actually the distance from shore values. This discrepancy was discovered by comparing the values in the data file and the values in the trip reports (Saperstein 2001, 2002). Depth data were not analyzed statistically.

These datasets are all contained in separate worksheets within the MS Excel file called **1999_2001data_newdepth.xls**. Some of the graphs produced for this report are also found in this file, but most graphs are to be found in the file **graphs.xls**.

In the 1999 data, there were 38 aquatic taxa identified, generally at the family level (Table 3). Taxa that were not identified to family include most of the non-insect taxa: Crustaceans were identified to order (Amphipoda, Cladocera, Copepoda, Ostracoda), non-Arthropods generally identified to class (Hirudinea, Oligochaeta, Bivalvia [Pelecypoda], Gastropoda).

In the 2000-01 data, there were 62 aquatic taxa identified, often to the genus level in the insects (Table 4). Those insects identified to species belong to a monotypic genus. Non-insect taxa were generally identified to the same level as in the 1999 data, except in the Mollusca (identified to family rather than class).

In these two seasons, the lowest level of identification of aquatic macroinvertebrates was to genus (for insects), and occasionally to species when the genus was monotypic. Those insect taxa with names that end in "–idea" are identified to family only (probably because the organism was too small for accurate identification). Non-insect taxa were often analyzed at the phylum or class level, due to a lack of expertise in identification of those taxa.

Table 2. Variables used in the macroinvertebrate analyses (full data set).

| Variable Name | Values | Type | Comments |
|---|---|---|---|
| SiteName | See Table 1. | String | These are the site names, standardized as per discussion with the Refuge Biologist and abbreviated (see Table 1). |
| Site# | 1-13 | Nominal | Numeric codes are better recognized in stats packages. |
| Transect | 1-2 | Nominal | Two transects of 5 sweeps each were taken at each lake on each sampling date. |
| Sweep | 1-10 | Ordinal | Corresponds with replicate number or sample number. |
| Season | 1 = June, 2 = August, "-1" = not sampled in two seasons/years, and not included in the "Season" analyses. | Nominal | This variable is used to compare years/seasons. If the lake was only sampled once, the value of this variable was set to "missing"; only 5 lakes were sampled twice. |
| SiteType | S, C, N or<br>1, 2, 3 | Nominal | Based on talks with the Refuge Biologist, it is suspected that there are 3 geomorphic regions in Kanuti NWR. The values correspond with North, Central, and South regions and correspond to river drainages (see Figure 2). |
| Depth | (numerical) | Scale | Depth to lake bottom in cm. Not used in analyses |
| Year | 1999-2001 | Ordinal | Year the samples were taken. Not used in analyses. |
| Taxa names | (Various) | Scale | The name of each of the taxa found in the study. Depends on the taxonomic level being analyzed. |
| ETO | (Ratio) | Scale | Ratio of Ephemeroptera, Plecoptera, and Odonata individuals to the total number of individuals |
| Total | (number) | Scale | Total number of individuals found in each sample |
| Taxa | (number) | Scale | Number of different "taxa" found in each sample (only in the "taxa" analyses). |
| Families | (number) | Scale | Number of different families found in each sample (only in the "families" analyses). |
| Orders | (number) | Scale | Number of different orders found in each sample (only in the "orders" analyses). |
| Classes | (number) | Scale | Number of different classes found in each sample (only in the "classes" analyses). |
| FFGs | (number) | Scale | Number of different functional feeding groups found in each sample (only in the "FFGs" analyses). See Table 12. |

Table 3. Taxa list for the 1999 sampling season. In 1999, the lowest taxonomic level of identification of aquatic macroinvertebrates was to family (labeled "Taxon" here). Non-insect taxa were often analyzed at the phylum (e.g., Nematoda) or class level (e.g., Oligochaeta, Gastropoda), due to a lack of expertise in identification of those taxa. Stream data, collected from the Kanuti River, are included in this table.

| Phylum: | Class: | Order: | "Taxon" |
|---|---|---|---|
| Arthropoda | Insecta | Coleoptera | Dytiscidae |
| Arthropoda | Insecta | Coleoptera | Gyrinidae |
| Arthropoda | Insecta | Coleoptera | Haliplidae |
| Arthropoda | Insecta | Diptera | Ceratopogonidae |
| Arthropoda | Insecta | Diptera | Chironomidae |
| Arthropoda | Insecta | Diptera | Dixidae |
| Arthropoda | Insecta | Diptera | Empididae |
| Arthropoda | Insecta | Diptera | Simuliidae |
| Arthropoda | Insecta | Diptera | Tiplulidae |
| Arthropoda | Insecta | Ephemeroptera | Ameletidae |
| Arthropoda | Insecta | Ephemeroptera | Baetidae |
| Arthropoda | Insecta | Ephemeroptera | Caenidae |
| Arthropoda | Insecta | Ephemeroptera | Ephemerellidae |
| Arthropoda | Insecta | Ephemeroptera | Heptageniidae |
| Arthropoda | Insecta | Hemiptera | Corixidae |
| Arthropoda | Insecta | Hemiptera | Gerridae |
| Arthropoda | Insecta | Hemiptera | Veliidae |
| Arthropoda | Insecta | Odonata | Aeshnidae |
| Arthropoda | Insecta | Odonata | Coenagrionidae |
| Arthropoda | Insecta | Odonata | Libellulidae |
| Arthropoda | Insecta | Plecoptera | Chloroperlidae |
| Arthropoda | Insecta | Plecoptera | Perlodidae |
| Arthropoda | Insecta | Trichoptera | Brachycentridae |
| Arthropoda | Insecta | Trichoptera | Glossossomatidae |
| Arthropoda | Insecta | Trichoptera | Hydroptilidae |
| Arthropoda | Insecta | Trichoptera | Limnephilidae |
| Arthropoda | Insecta | Trichoptera | Phryganeidae |
| Arthropoda | Arachnoidea | Acariformes | "Hydracarina" |
| Arthropoda | Crustacea | Amphipoda | Amphipoda |
| Arthropoda | Crustacea | Cladocera | Cladocera |
| Arthropoda | Crustacea | Conchostraca | Conchostraca |
| Arthropoda | Crustacea | Copepoda | Copepoda |
| Arthropoda | Crustacea | Ostracoda | Ostracoda |
| Annelida | Hirudinea | | Hirudinea |
| Annelida | Oligochaeta | | Oligochaeta |
| Mollusca | Bivalvia | | Bivalvia |
| Mollusca | Gastropoda | | Gastropoda |
| Nematoda | | | Nematoda |

Table 4. Taxa list for the 2000 and 2001 sampling seasons. In these two seasons, the lowest taxonomic level of identification of aquatic macroinvertebrates was to genus (for insects), and occasionally to species when the genus was monotypic. Those insect taxa with names that end in "–dea" were identified to family only (probably because the organism was too small for accurate identification. Non-insect taxa were often analyzed at the phylum or class level, due to a lack of expertise in identification of those taxa.

| Phylum | Class | Order | Family | "Taxon" |
|---|---|---|---|---|
| Annelida | Hirudinea | | | Hirudinea |
| Annelida | Oligochaeta | | | Oligochaeta |
| Arthropoda | Arachnoidea | Acari | | Hydracarina |
| Arthropoda | Crustacea | Amphipoda | Hyallelidae | Hyalella azteca |
| Arthropoda | Crustacea | Cladocera | | Cladocera |
| Arthropoda | Crustacea | Copepoda | | Copepoda |
| Arthropoda | Crustacea | Ostracoda | | Ostracoda |
| Arthropoda | Insecta | Coleoptera | Dytiscidae | Dytiscidae |
| Arthropoda | Insecta | Coleoptera | Gyrinidae | Gyrinus |
| Arthropoda | Insecta | Coleoptera | Haliplidae | Haliplus |
| Arthropoda | Insecta | Coleoptera | Helodidae | Helodidae |
| Arthropoda | Insecta | Coleoptera | Hydrophilidae | Hydrobius |
| Arthropoda | Insecta | Coleoptera | Hydrophilidae | Hydrophilidae |
| Arthropoda | Insecta | Diptera | Brachycera | Brachycera |
| Arthropoda | Insecta | Diptera | Ceratopogonidae | Atrichopogon |
| Arthropoda | Insecta | Diptera | Ceratopogonidae | Dasyhelea |
| Arthropoda | Insecta | Diptera | Ceratopogonidae | Palpomyia |
| Arthropoda | Insecta | Diptera | Chironomidae | Chironomidae |
| Arthropoda | Insecta | Diptera | Culicidae | Culicidae |
| Arthropoda | Insecta | Diptera | Dixidae | Dixella |
| Arthropoda | Insecta | Diptera | Phoridae | Phoridae |
| Arthropoda | Insecta | Diptera | Psychodidae | Pericoma |
| Arthropoda | Insecta | Diptera | Psychodidae | Psychoda |
| Arthropoda | Insecta | Diptera | Sciomyzidae | Sciomyzidae |
| Arthropoda | Insecta | Diptera | Stratiomyidae | Stratiomyidae |
| Arthropoda | Insecta | Diptera | Tabanidae | Tabanidae |
| Arthropoda | Insecta | Diptera | Tipulidae | Limonia |
| Arthropoda | Insecta | Diptera | Tipulidae | Phalacrocera |
| Arthropoda | Insecta | Diptera | Tipulidae | Tipula |
| Arthropoda | Insecta | Diptera | Tipulidae | Tipulidae |
| Arthropoda | Insecta | Diptera | Tipulidae | Ulomorpha |
| Arthropoda | Insecta | Ephemeroptera | Baetidae | Acerpenna |
| Arthropoda | Insecta | Ephemeroptera | Baetidae | Callibaetis |
| Arthropoda | Insecta | Ephemeroptera | Baetidae | Centroptilum |
| Arthropoda | Insecta | Ephemeroptera | Caenidae | Caenis |
| Arthropoda | Insecta | Hemiptera | Corixidae | Corixidae |
| Arthropoda | Insecta | Hemiptera | Gerridae | Gerridae |
| Arthropoda | Insecta | Hemiptera | Gerridae | Mesovelia |
| Arthropoda | Insecta | Hemiptera | Gerridae | Microvelia |
| Arthropoda | Insecta | Hemiptera | Saldidae | Saldidae |
| Arthropoda | Insecta | Odonata | Aeshnidae | Aeshna |

| Table 4, continued. | | | | |
|---|---|---|---|---|
| **Phylum** | **Class** | **Order** | **Family** | **"Taxon"** |
| Arthropoda | Insecta | Odonata | Corduliidae | Somatochlora |
| Arthropoda | Insecta | Odonata | Libellulidae | Leucorrhinia |
| Arthropoda | Insecta | Odonata | Coenagrionidae | Coenagrion/Enallagma |
| Arthropoda | Insecta | Trichoptera | Hydroptilidae | Hydroptila |
| Arthropoda | Insecta | Trichoptera | Hydroptilidae | Oxyethira |
| Arthropoda | Insecta | Trichoptera | Leptoceridae | Ceraclea |
| Arthropoda | Insecta | Trichoptera | Leptoceridae | Mystacides |
| Arthropoda | Insecta | Trichoptera | Leptoceridae | Oecetis |
| Arthropoda | Insecta | Trichoptera | Leptoceridae | Triaenodes |
| Arthropoda | Insecta | Trichoptera | Limnephilidae | Grammotaulius |
| Arthropoda | Insecta | Trichoptera | Limnephilidae | Limnephilus |
| Arthropoda | Insecta | Trichoptera | Limnephilidae | Nemotaulius hostilis |
| Arthropoda | Insecta | Trichoptera | Phryganeidae | Oligotricha lapponica |
| Arthropoda | Insecta | Trichoptera | Polycentropidae | Polycentropus |
| Coelenterata | Hydrazoa | Hydroida | Hydridae | Hydra |
| Mollusca | Gastropoda | Gastropoda | Planorbidae | Planorbidae |
| Mollusca | Pelecypoda | Pelecypoda[1] | Physidae | Physidae |
| Mollusca | Pelecypoda | Pelecypoda | Sphaeriidae | Sphaeriidae |
| Nematoda | | | | Nematoda |
| Nematomorpha | | | | Nematomorpha |
| Platyhelminthes | Turbellaria | | | Turbellaria |

[1]Physidae was placed in the Pelecypoda (clams) by the identifier, but it actually belongs in the Gastropoda (snails). It was properly placed in Gastropoda in the statistical analyses

## *Statistical Analyses*

Data were analyzed using the SPSS for Windows, version 12.0, software package. Descriptive statistics were calculated and analyses of variance (ANOVA) were performed on a series of planned comparisons:

- Are there overall differences among lakes?
- Are there differences between years/seasons (we can't separate the two because sampling in 1999 and 2000 was in August, and sampling in 2001 was in June)?
- Are there differences among geomorphic regions (South, Central, North)?
- Is there any difference between the two transects taken at each lake?

All comparisons were done on total number of individuals, number of classes, number of orders, number of families, and number of "taxa" (Lowest Taxonomic Unit, roughly equivalent to genus in the insects, but order or class for the most of the non-insects). In addition, analyses on Functional Feeding Groups (FFG) and ETO ratio ((Ephemeroptera + Trichoptera + Odonata)/Total number of Individuals) were done.

Because the 1999 data were identified only to family, all analyses on the variable "Taxa" (roughly equivalent to genus) were done on 2000-01 data only. Therefore, seasonal and yearly comparisons of Taxa are less complete. In addition, six unknown Diptera taxa were included only in the analyses of Taxa, but not in other analyses.

# Results and Discussion

## *Descriptive Statistics*

### Total Macroinvertebrate Abundance and Taxonomic Composition

The macroinvertebrate fauna in 13 lakes of Kanuti NWR was dominated by the two Arthropod classes, Crustacea and Insecta (Figure 3). There was an average of 493.4 individuals per sample, but the variation among samples was very high (SD = 605.6) (Table 5). In fact, within site and year, standard deviations were almost always larger than the mean (Table 5, Appendix 2).

Overall, there were 11 taxonomic classes represented in the Kanuti lakes. There was an average of 5.44 classes (SD = 1.37) and a maximum of 8 represented in each sample (Table 5). Three classes were identified as present only in the samples analyzed by ABR (Hydrazoa, Nematomorpha, Turbellaria), suggesting that perhaps there may have been differences in sorting or identification techniques between the two contractors. This makes statistical comparisons of number of classes among lakes somewhat suspect.

There was an average of 9.93 orders per sample (minimum = 1, maximum = 16, SD = 2.69) in the Kanuti NWR lake samples. Orders were dominated by Diptera (Insecta) and Cladocera (Figure 4), with approximately 60% of the community represented by these two groups. There was an average of 12.9 families per sample (minimum = 1, maximum = 23, SD = 4.01), and an average of 13.4 "taxa" (minimum = 1, maximum = 26, SD = 4.61) (Table 5).

Table 5. Descriptive statistics for all lakes. Total = average total number of individuals per sample, Classes = number of classes per sample, etc.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total | 181 | 1 | 5090 | 493.38 | 605.610 |
| Classes | 181 | 1 | 8 | 5.44 | 1.367 |
| Orders | 181 | 1 | 16 | 9.93 | 2.691 |
| Families | 181 | 1 | 23 | 12.91 | 4.011 |
| Taxa | 131 | 1 | 26 | 13.39 | 4.609 |
| ETO | 181 | .0% | 39.0% | 5.417% | 5.8156% |

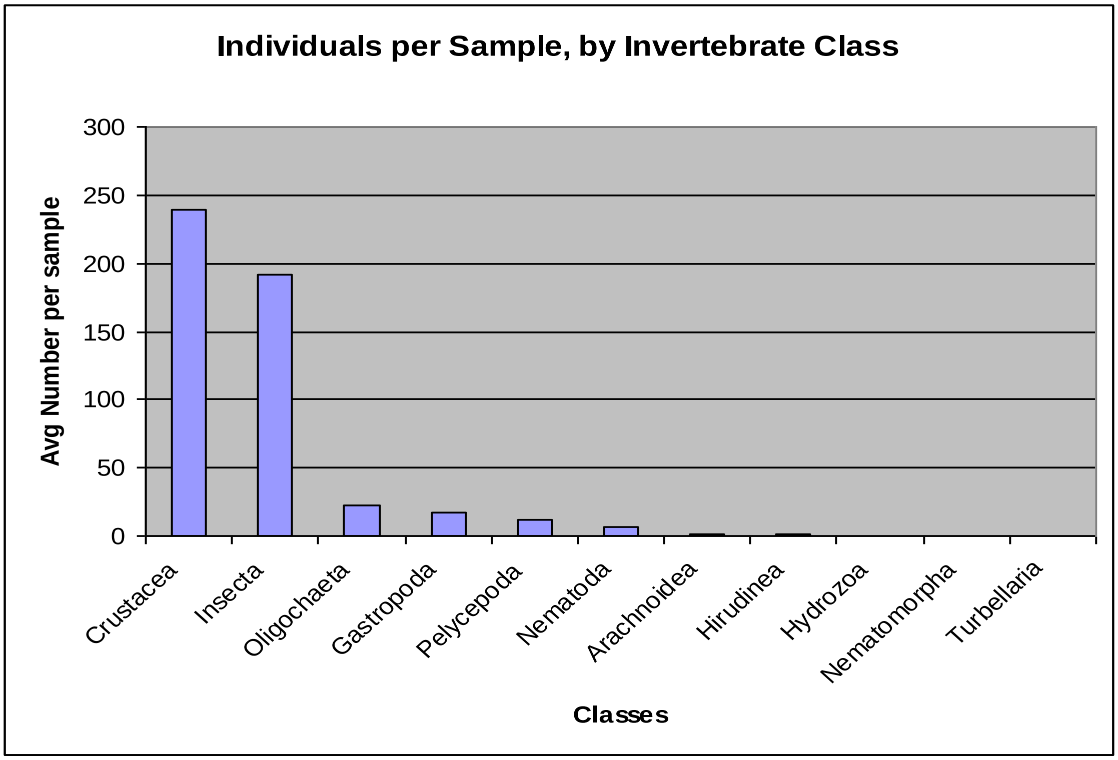



Figure 3. Average number of individuals in each taxonomic class present in samples from lakes within Kanuti NWR, averaged over all lakes and all years.

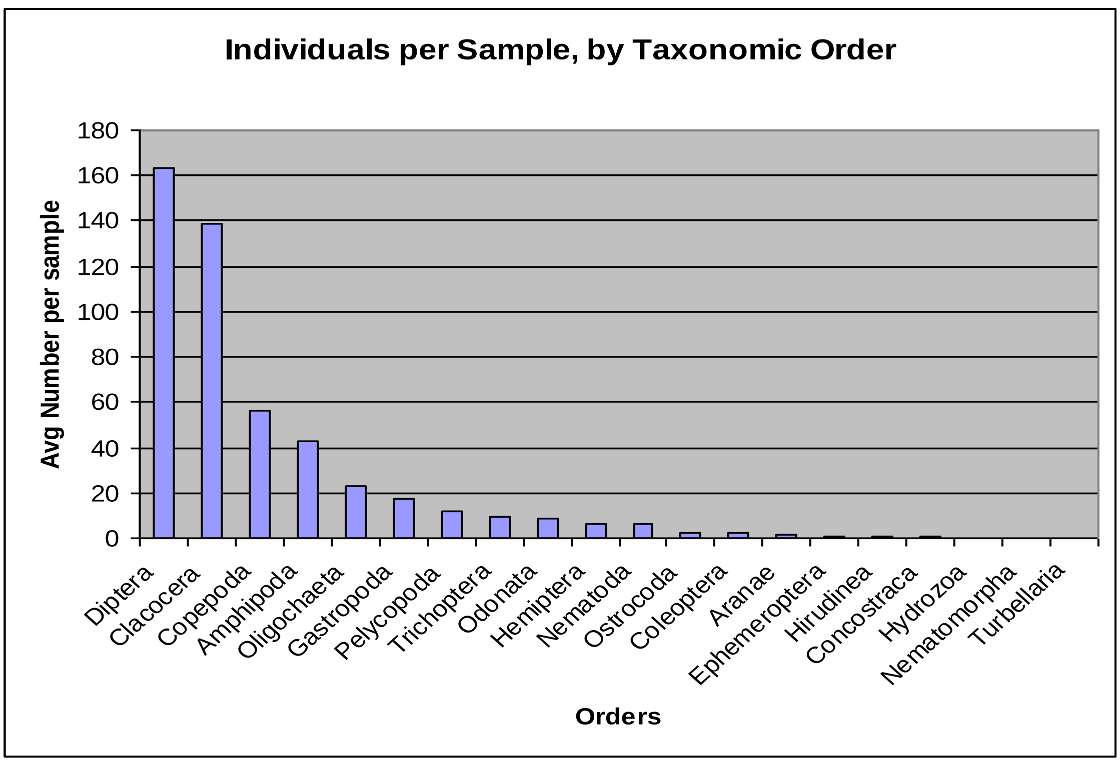



Figure 4. Average number of individuals in each taxonomic order present in samples from lakes within Kanuti NWR, averaged over all lakes and all years.

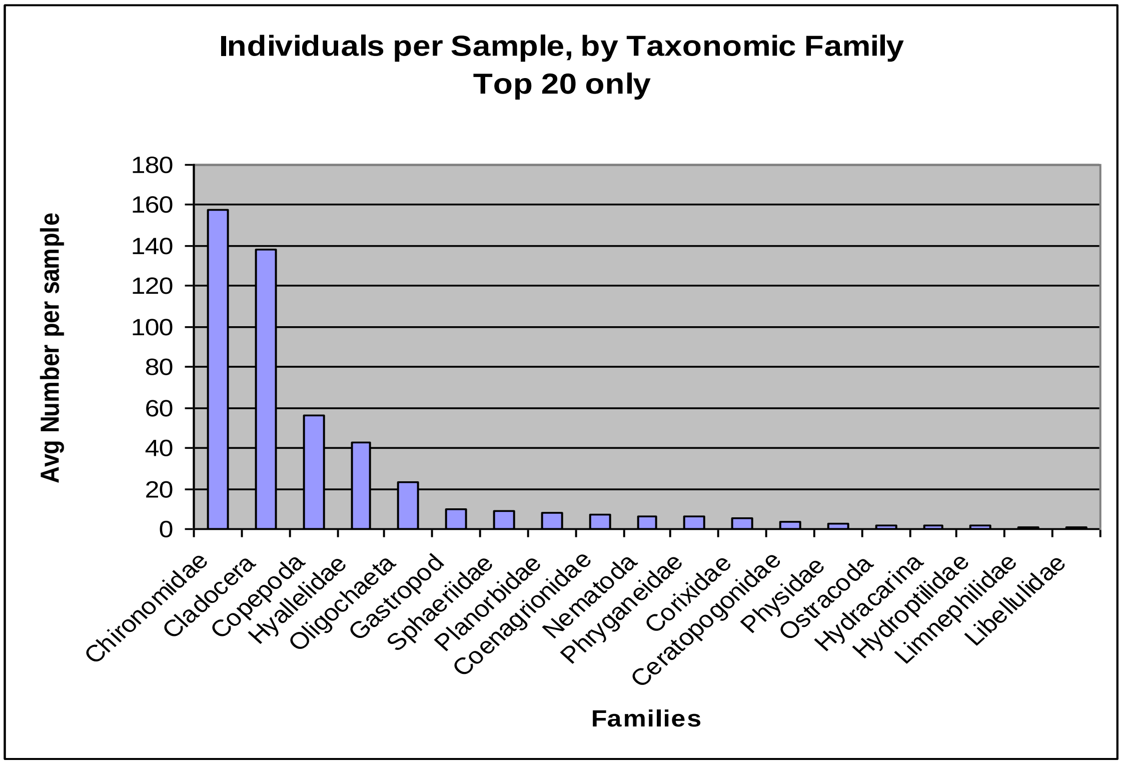



Figure 5. Average number of individuals in each of the top 20 taxonomic families present in samples from lakes within Kanuti NWR, averaged over all lakes and all years.

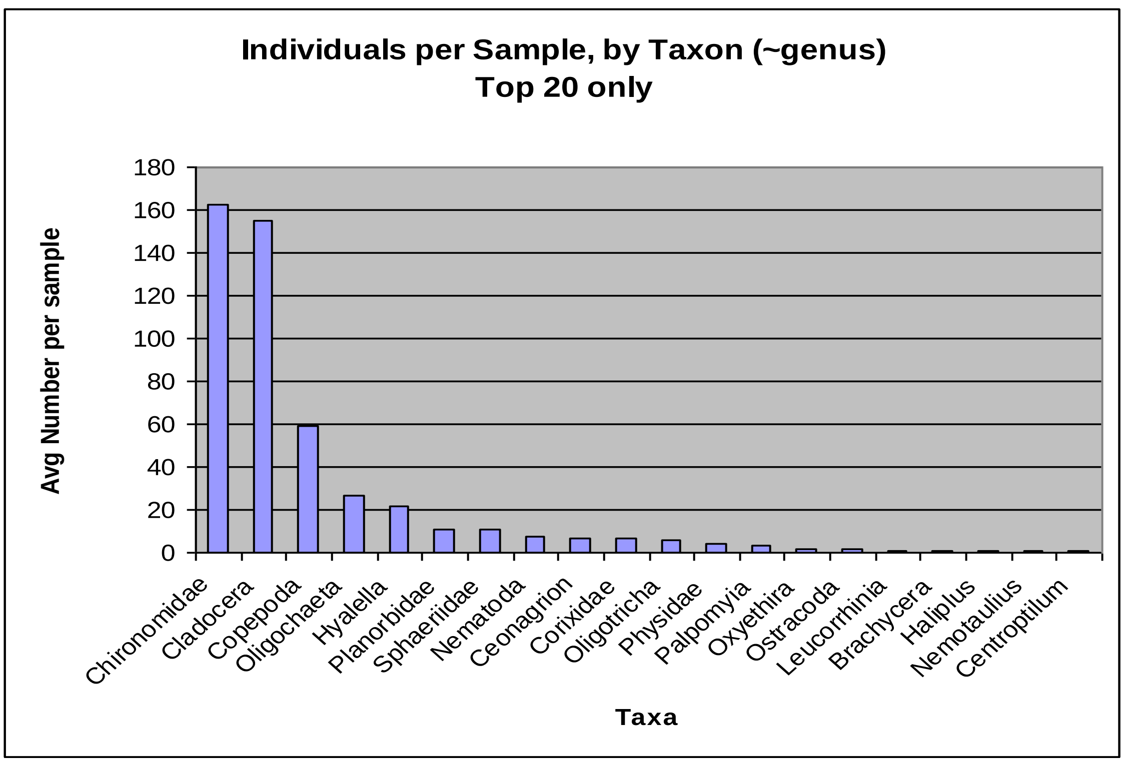



Figure 6. Average number of individuals in the 20 most abundant "taxa" (the lowest taxonomic level identified) present in samples from 13 lakes within Kanuti NWR, averaged over all lakes and all years.

## *Among Lakes comparisons*

Invertebrate abundance and taxonomic composition differed among lakes sampled within Kanuti NWR. Total number of individuals was highest in Little Kaldoyeit Lake (1403), while Mingkoket had the fewest (229) per sample (Figure 7, Appendix 4). Two-way ANOVA showed that the main effects of SiteName and Year were statistically significant. However, these data are somewhat skewed, as the 2001 samples were collected in spring and had much lower abundance. Therefore, the 2001 data were removed from the data set and the statistical analyses were re-run. Results from all years are presented graphically, but statistical analyses include only 1999 and 2000 data.

The pattern of taxonomic composition differed from that of abundance: Taiholman Lake and Lake G had the highest number of classes and orders, while Unnamed Lake 9 and Kadakina Lake (variable name = Kodakina) had the highest numbers of families and taxa. Mud Lake and Little Kaldoyeit Lake (variable name = LittleKald; had the highest average abundance of all lakes) had the lowest number of classes and orders, while Kadakina had the lowest ETO ratio, but was among the highest in abundance (ranked 4) and taxonomic diversity. Most of the abundance can be explained by large numbers of cladocerans, copepods, and chironomids, none of which are included in the ETO ratio.

Table 6. Statistics of ANOVA with lake name as the factor (SiteName). All data were used in these analyses. Just the main effect of SiteName is shown here; see Appendix 9 (available from Kanuti Refuge on request) for the full ANOVA tables.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Total | 16406931.955 | 12 | 1367244.330 | 4.630 | .000 |
| | Classes | 48.367 | 12 | 4.031 | 2.350 | .008 |
| | Orders | 306.754 | 12 | 25.563 | 4.310 | .000 |
| | Families | 1071.737 | 12 | 89.311 | 8.228 | .000 |
| | Taxa | 1167.150 | 8 | 145.894 | 11.166 | .000 |
| | ETO | 1217.585 | 12 | 101.465 | 3.500 | .000 |

Table 7. Statistics of ANOVA with lake name as the factor (SiteName). Only August data were used in these analyses. Just the main effect of SiteName is shown here; see Appendix 9 (available from Kanuti Refuge on request) for the full ANOVA tables.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Total | 13757243.802 | 12 | 1146436.983 | 3.211 | .001 |
| | Classes | 29.923 | 12 | 2.494 | 1.709 | .073 |
| | Orders | 76.092 | 12 | 6.341 | 1.990 | .031 |
| | Families | 548.692 | 12 | 45.724 | 6.885 | .000 |
| | Taxa | 309.550 | 7 | 44.221 | 6.363 | .000 |
| | ETO | .057 | 12 | .005 | 2.793 | .002 |

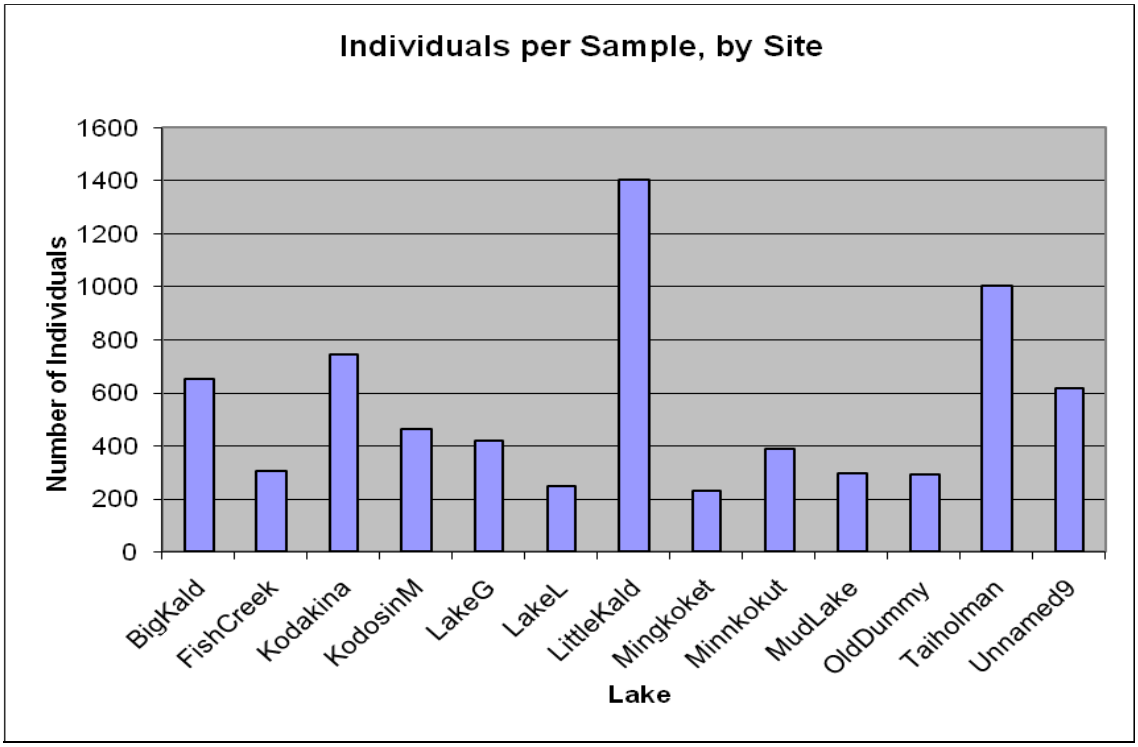



Figure 7. Total abundance of macroinvertebrates in each of the 13 lakes sampled within Kanuti NWR, averaged over all years.

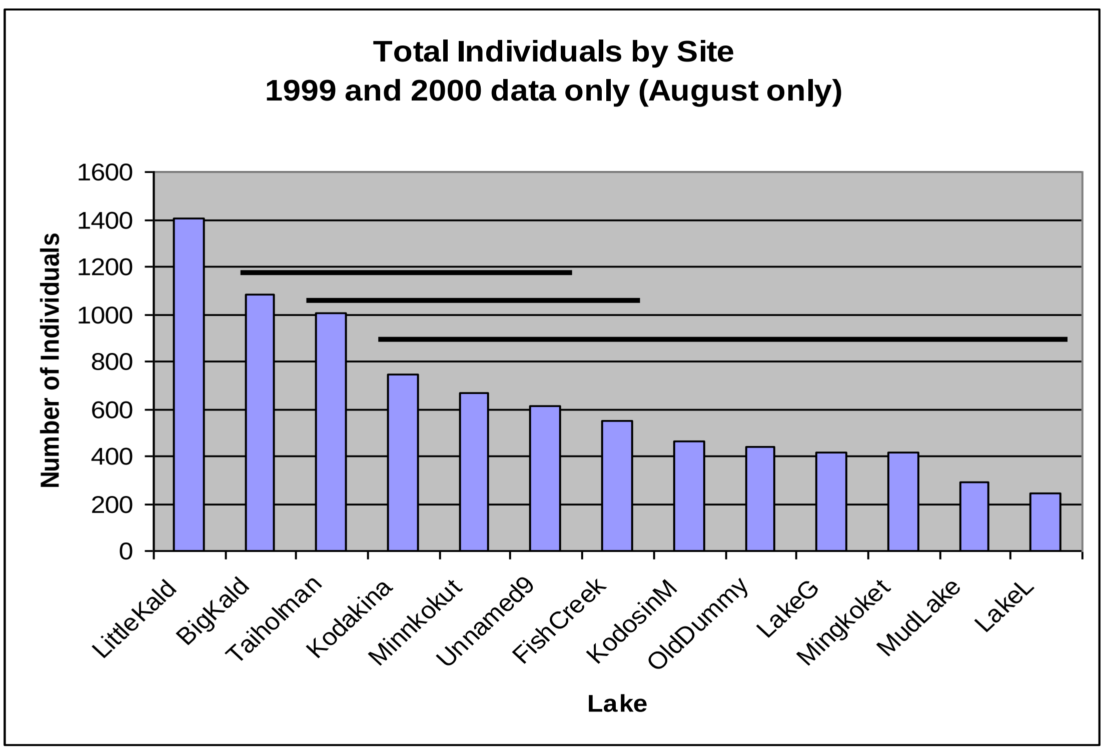



Figure 8. Total abundance of individuals in each of the 13 lakes sampled within Kanuti NWR (August data only). Bars connect lakes that are not significantly different (least significant difference post-hoc comparisons of means, see Appendix 9 [available from Kanuti Refuge on request] for complete statistical tables).

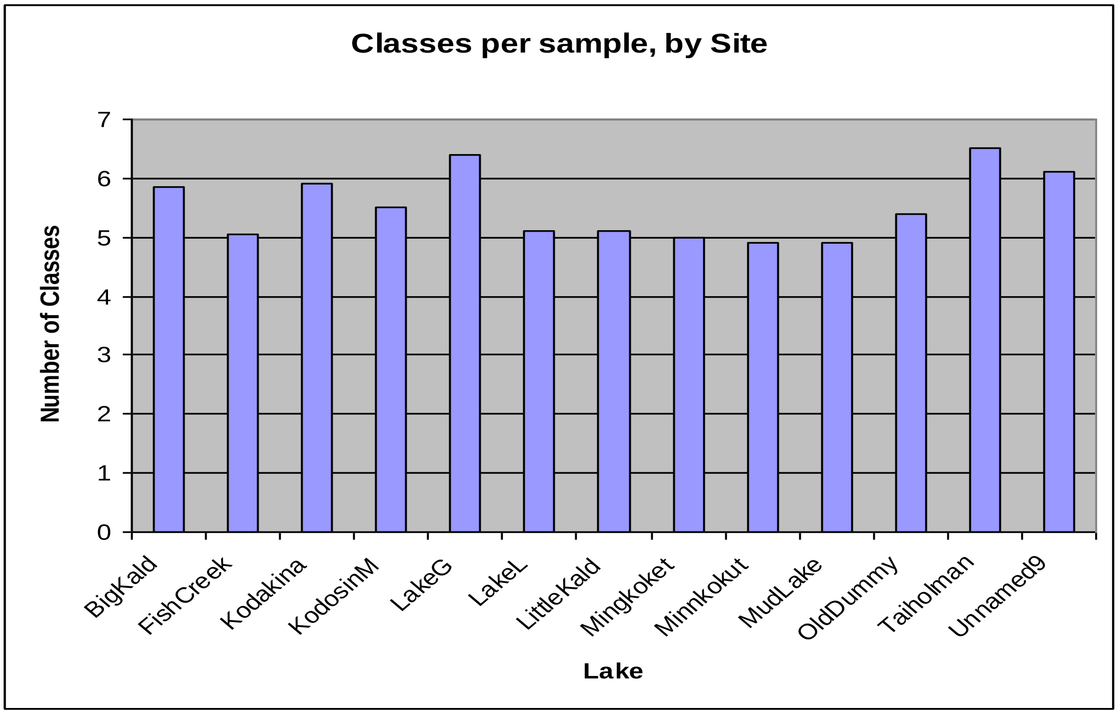



Figure 9. Number of classes in each of the 13 lakes sampled within Kanuti NWR, averaged over all years.

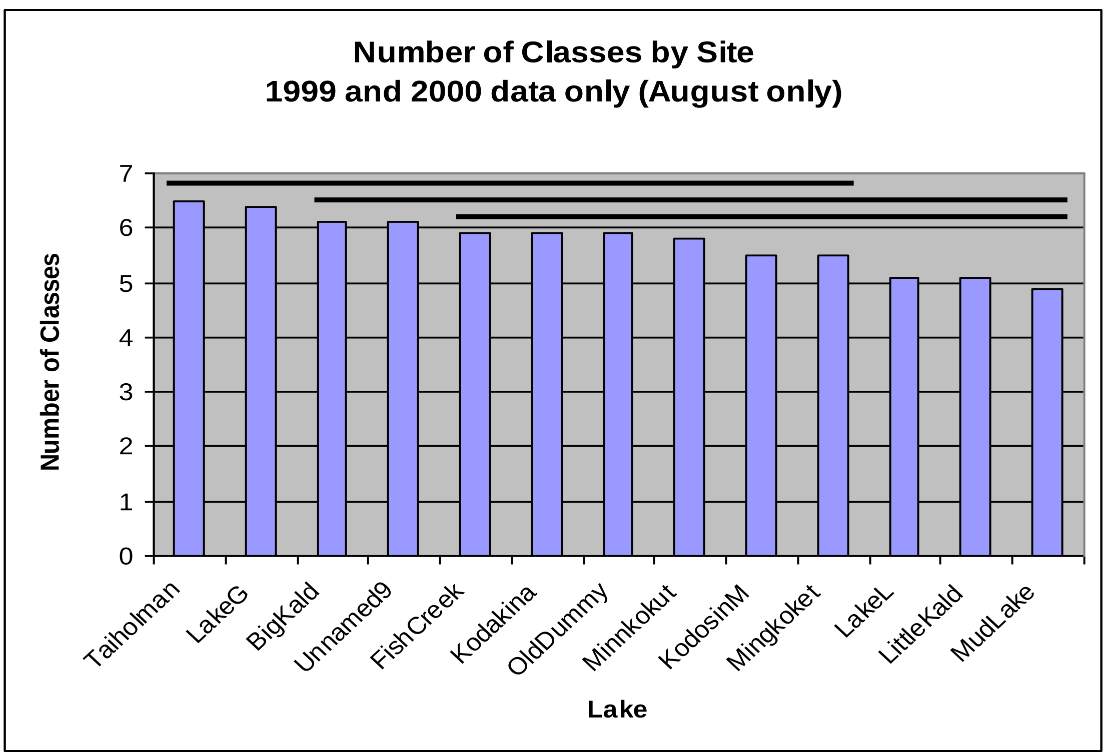



Figure 10. Number of classes in each of the 13 lakes sampled within Kanuti NWR (August data only). Bars connect lakes that are not significantly different (least significant difference post-hoc comparisons of means, see Appendix 9 [available from Kanuti Refuge on request] for complete statistical tables).

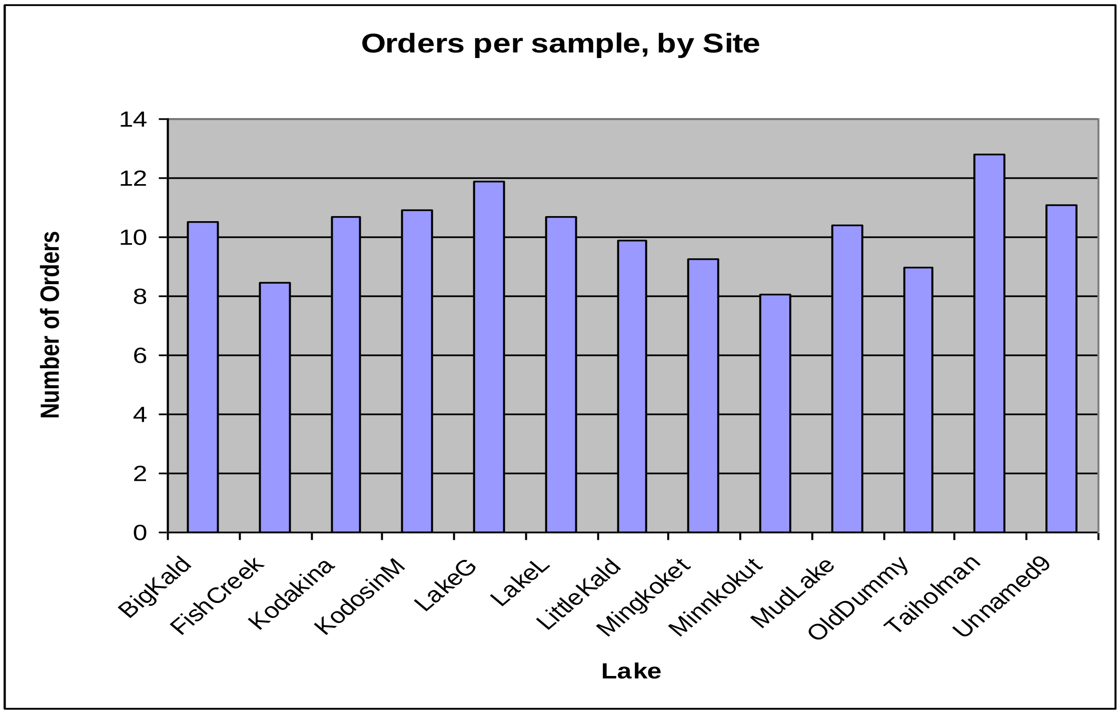



Figure 11. Number of orders in each of the 13 lakes sampled within Kanuti NWR, averaged over all years.

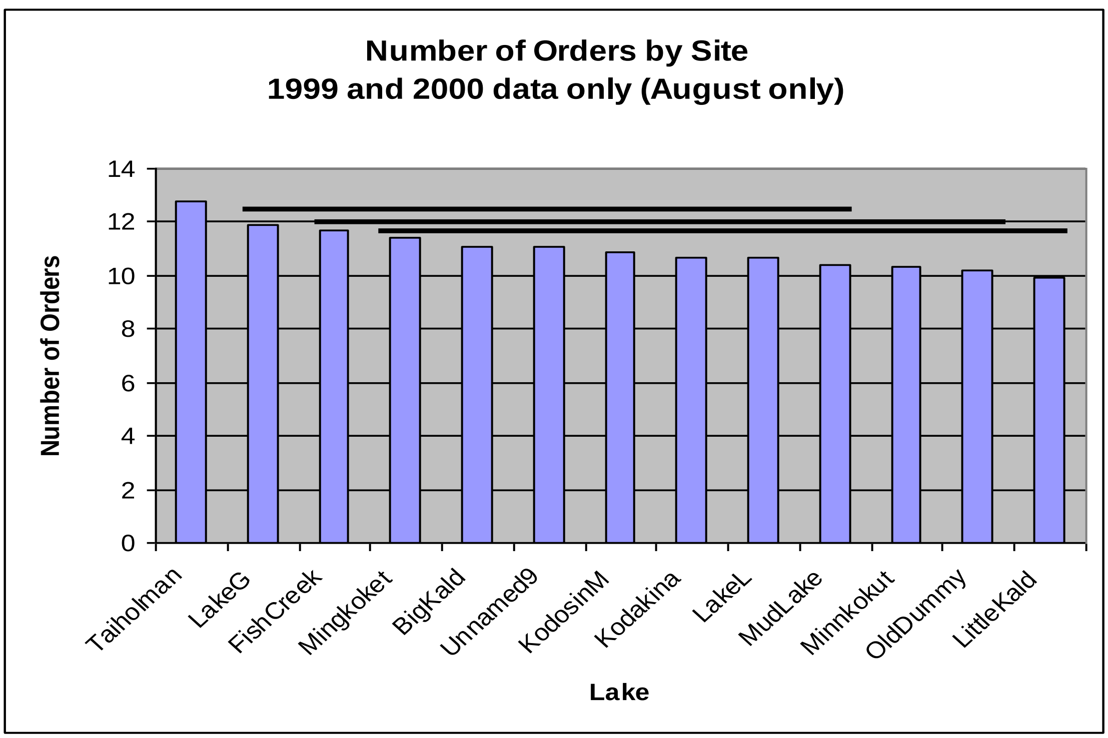



Figure 12. Number of orders in each of the 13 lakes sampled within Kanuti NWR (August data only). Bars connect lakes that are not significantly different (least significant difference post-hoc comparisons of means, see Appendix 9 [available from Kanuti Refuge on request] for complete statistical tables).

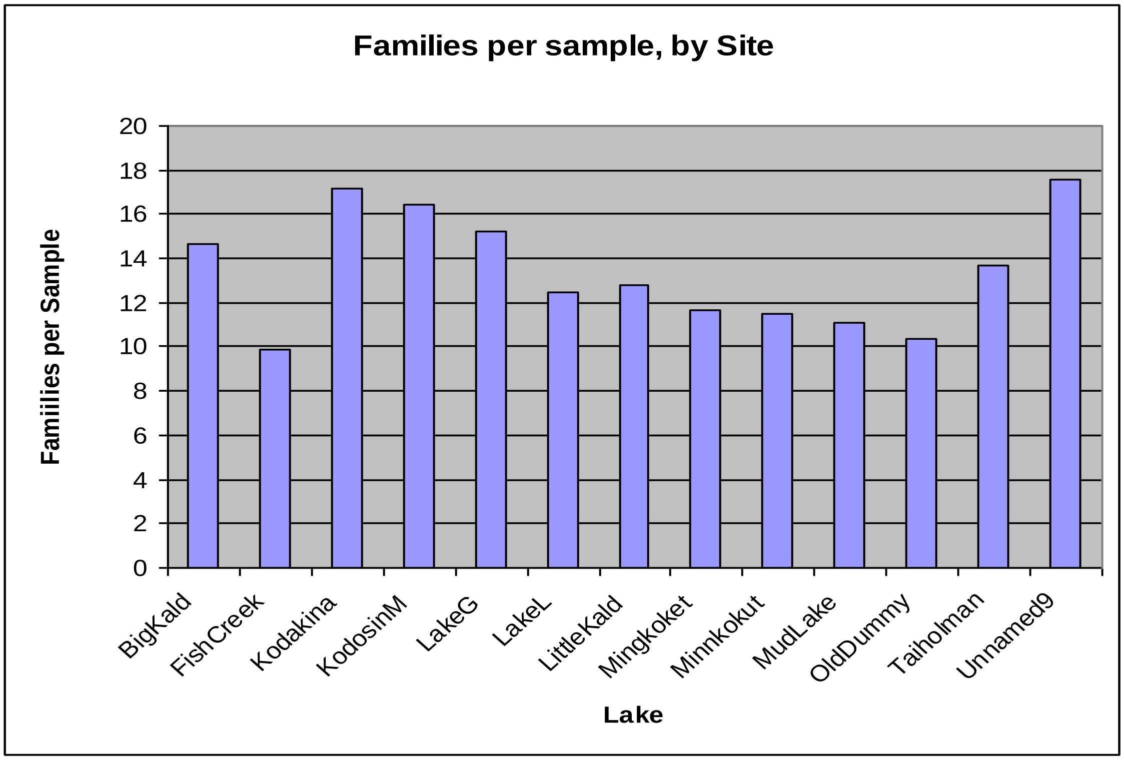



Figure 13. Number of families in each of the 13 lakes sampled within Kanuti NWR, averaged over all years.

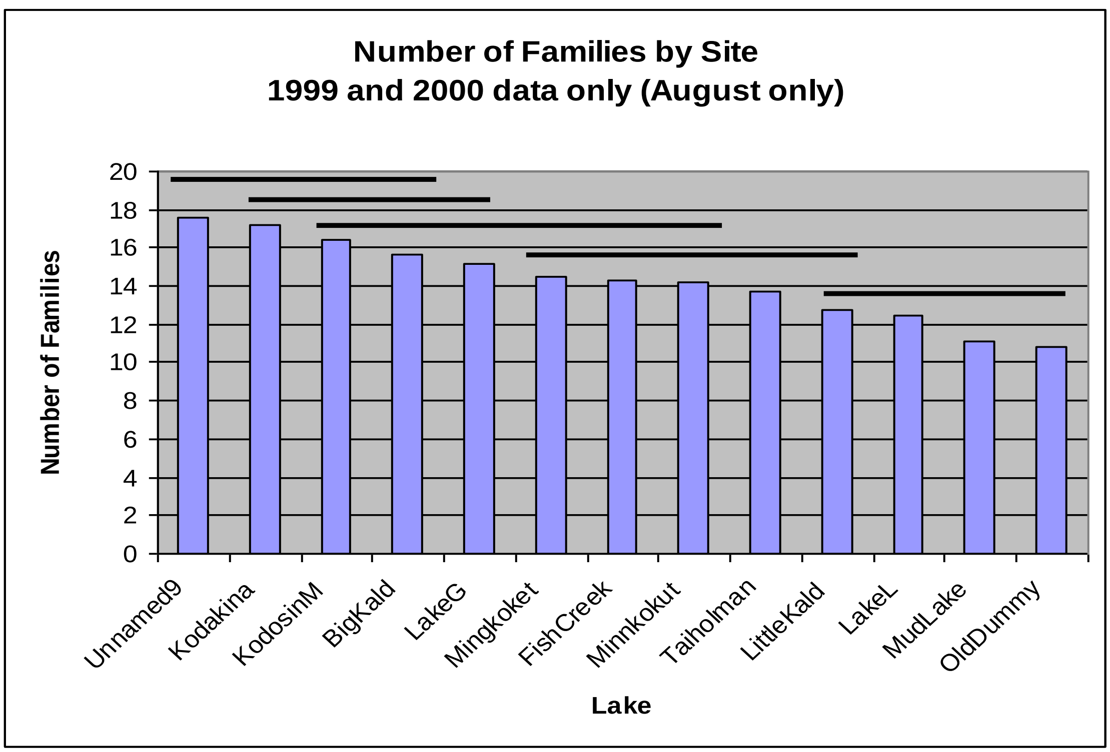



Figure 14. Number of families in each of the 13 lakes sampled within Kanuti NWR (August data only). Bars connect lakes that are not significantly different (least significant difference post-hoc comparisons of means, see Appendix 9 [available from Kanuti Refuge on request] for complete statistical tables).

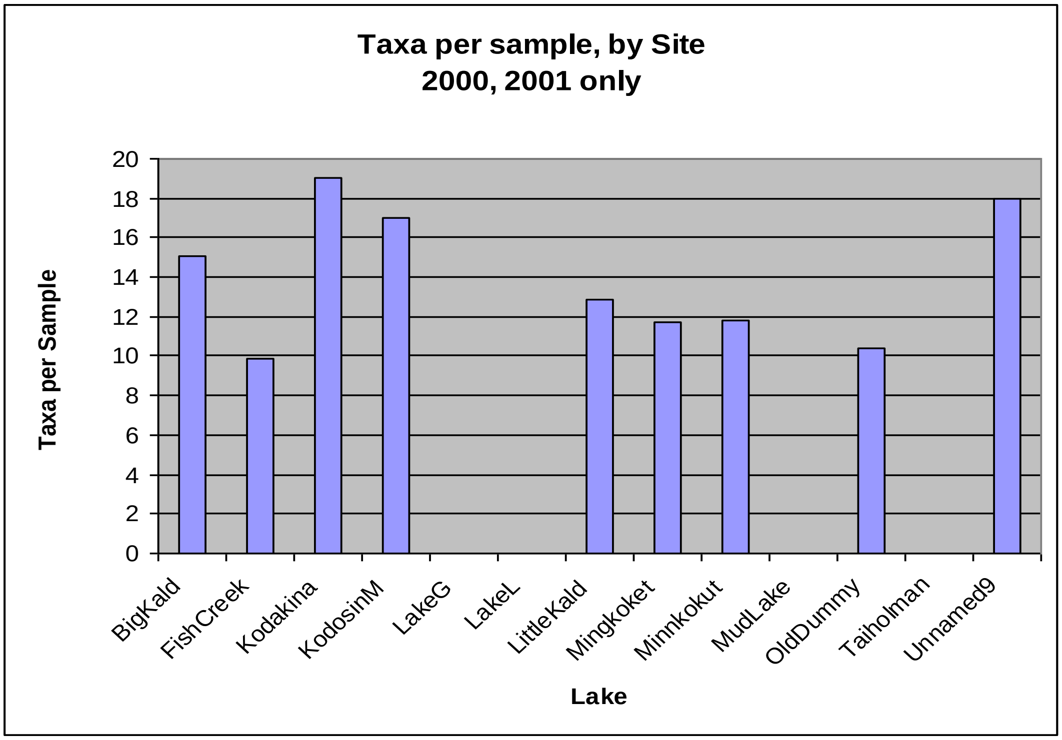



Figure 15. Number of "taxa" (the lowest taxonomic level identified) in each of the 13 lakes sampled within Kanuti NWR, averaged over 2000 and 2001.

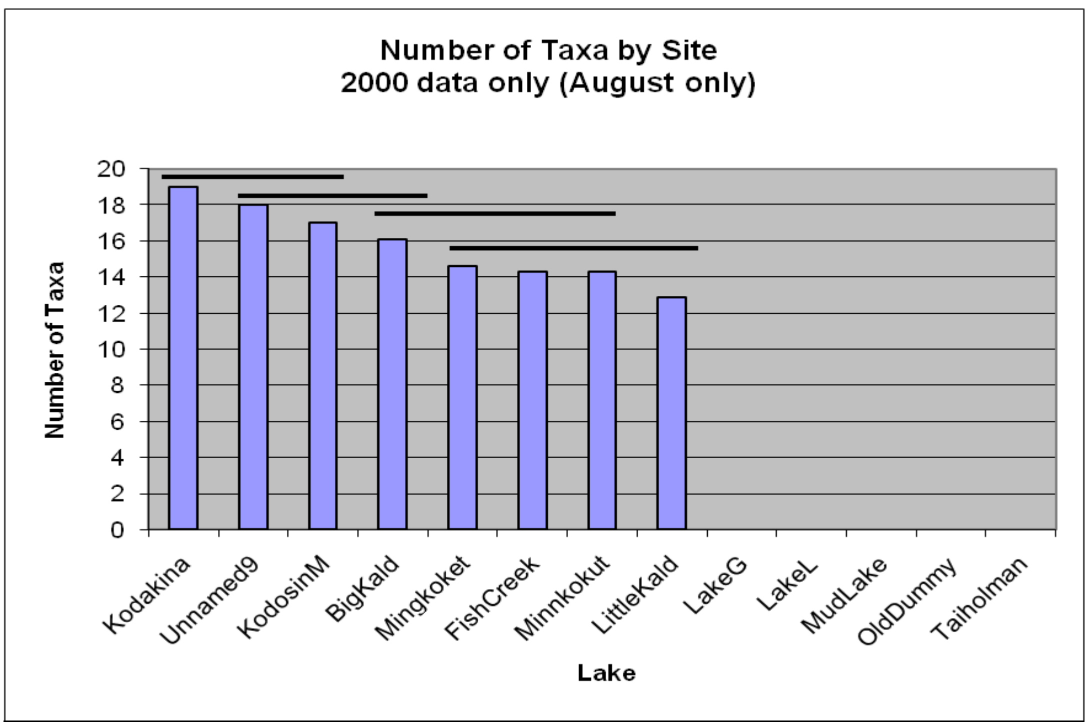



Figure 16. Number of "taxa" (the lowest taxonomic level identified) in each of the 13 lakes sampled within Kanuti NWR (August 2000 data only). Bars connect lakes that are not significantly different (least significant difference post-hoc comparisons of means, see Appendix 9 [available from Kanuti Refuge on request] for complete statistical tables).

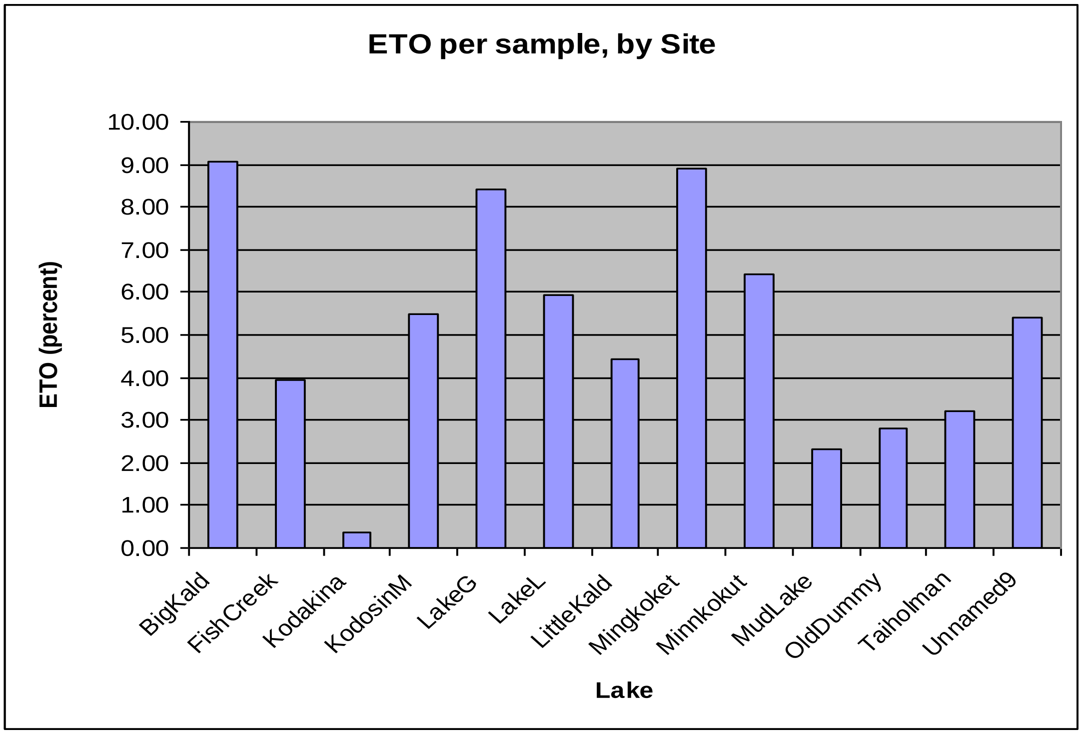



Figure 17. ETO ratio (sum of Ephemeroptera, Trichoptera, and Odonata, divided by total number of individuals) in each of the 13 lakes sampled within Kanuti NWR, averaged over all years.

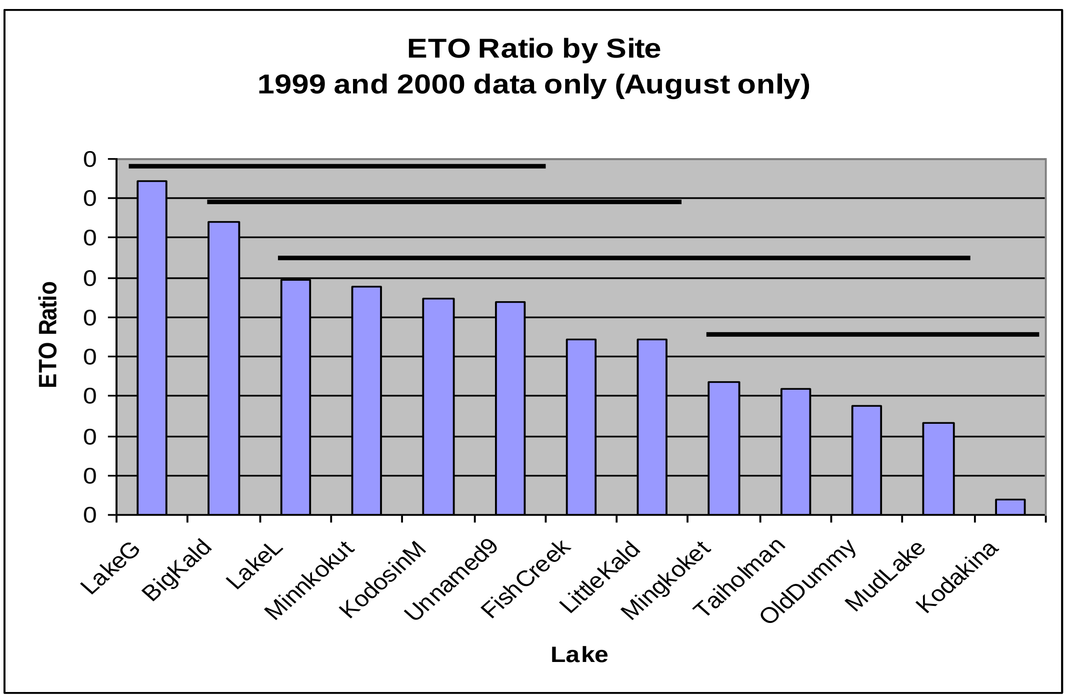



Figure 18. ETO ratio (sum of Ephemeroptera, Trichoptera, and Odonata, divided by total number of individuals) in each of the 13 lakes sampled within Kanuti NWR (August 1999 and 2000 data only). Bars connect lakes that are not significantly different (least significant difference post-hoc comparisons of means, see Appendix 9 [available from Kanuti Refuge on request] for complete statistical tables).

## *Year and Seasonal comparisons*

Because the spring samples were all taken in 2001, and the late summer samples all taken in 1999 or 2000, the effects of seasonal variation and annual variation cannot be truly separated in these analyses. However, one can compare the lakes that were re-sampled to see if there were differences between the two sampling dates. The differences were so large and consistent that the conclusion of a seasonal effect is unavoidable: spring (early June) samples, just after ice-out, are much more depauperate than late summer (August) samples.

There were large differences in both total numbers of indivduals (F = 62.70) and number of classes (F = 24.64; much greater than the among-lakes differences) among the lakes sampled in two years (Table 9). This is a result of very low numbers of invertebrates found in the spring samples (Figure 19).

Table 8. One-way Analysis of Variance of Year as main effect on abundance and taxonomic composition. This analysis includes all data.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Total | 12186946.949 | 2 | 6093473.474 | 20.149 | .000 |
| | Classes | 44.265 | 2 | 22.132 | 13.480 | .000 |
| | Orders | 535.178 | 2 | 267.589 | 62.017 | .000 |
| | Families | 1126.962 | 2 | 563.481 | 56.716 | .000 |
| | Taxa | 1169.548 | 1 | 1169.548 | 94.793 | .000 |
| | ETO | 337.565 | 2 | 168.782 | 5.225 | .006 |

Table 9. One-way Analysis of Variance of Season as main effect on abundance and taxonomic composition. In this analysis, only those lakes that were sampled in both seasons are included. Old Dummy Lake (sampled August 1999) is included in this analysis.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Total | 6673886.384 | 1 | 6673886.384 | 62.699 | .000 |
| | Classes | 35.930 | 1 | 35.930 | 24.639 | .000 |
| | Orders | 353.893 | 1 | 353.893 | 78.756 | .000 |
| | Families | 526.523 | 1 | 526.523 | 54.082 | .000 |
| | Taxa | 577.813 | 1 | 577.813 | 54.322 | .000 |
| | ETO | 205.068 | 1 | 205.068 | 4.992 | .028 |

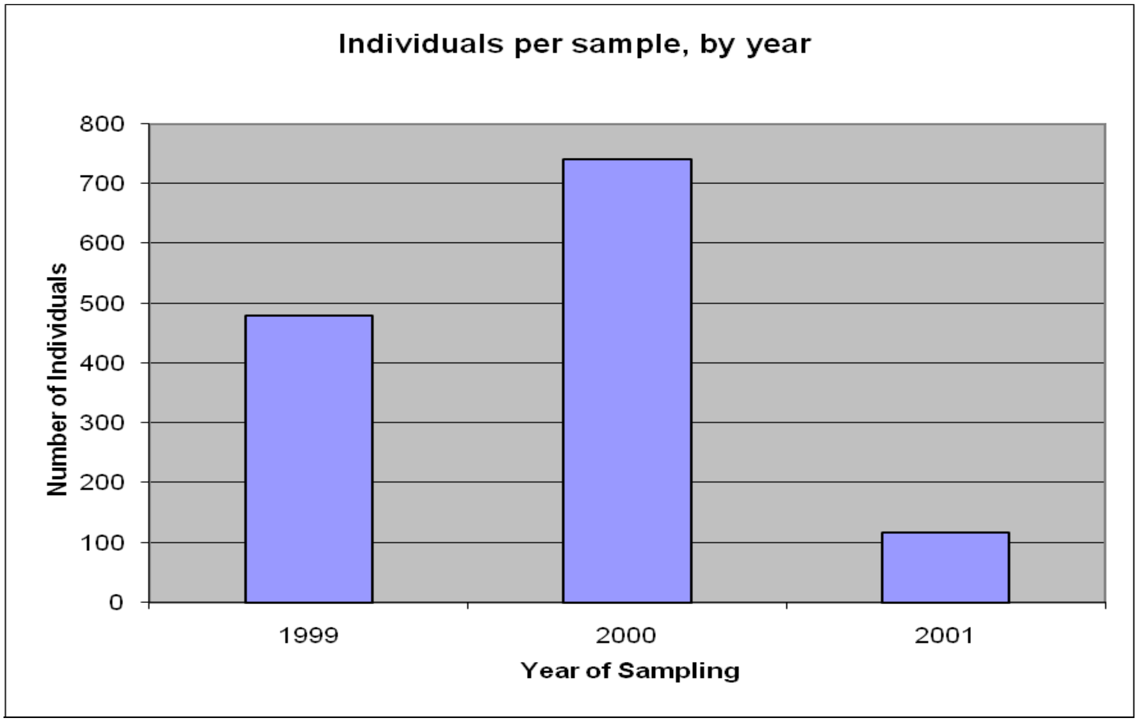



Figure 19. Total macroinvertebrate abundance per year, averaged over 13 lakes sampled within Kanuti NWR.

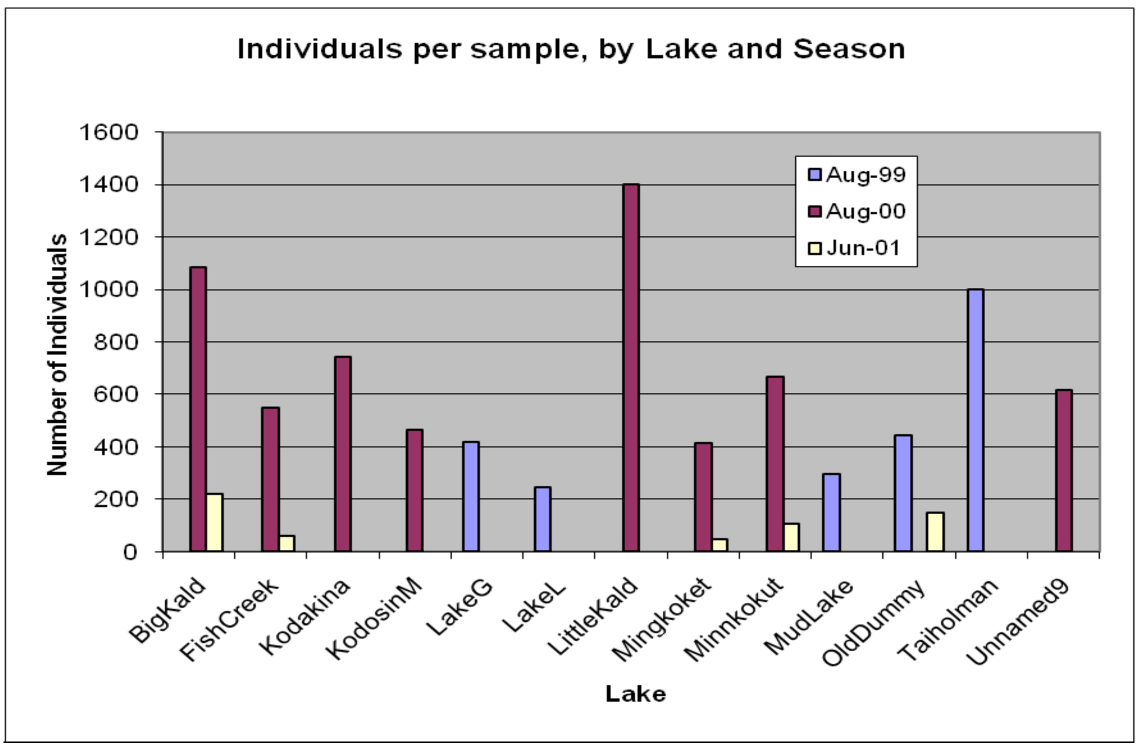



Figure 20. Total macroinvertebrate abundance per season/year, in each of the 13 lakes sampled within Kanuti NWR.

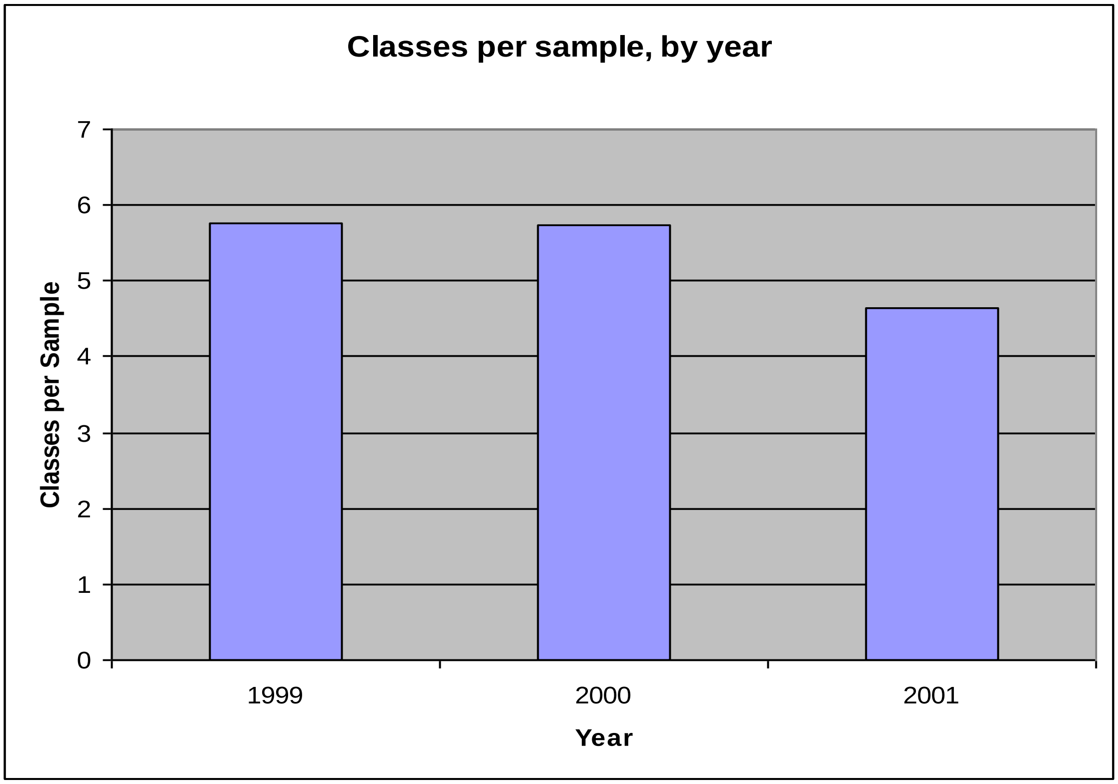



Figure 21. Number of macroinvertebrate classes per year, averaged over 13 lakes sampled within Kanuti NWR.

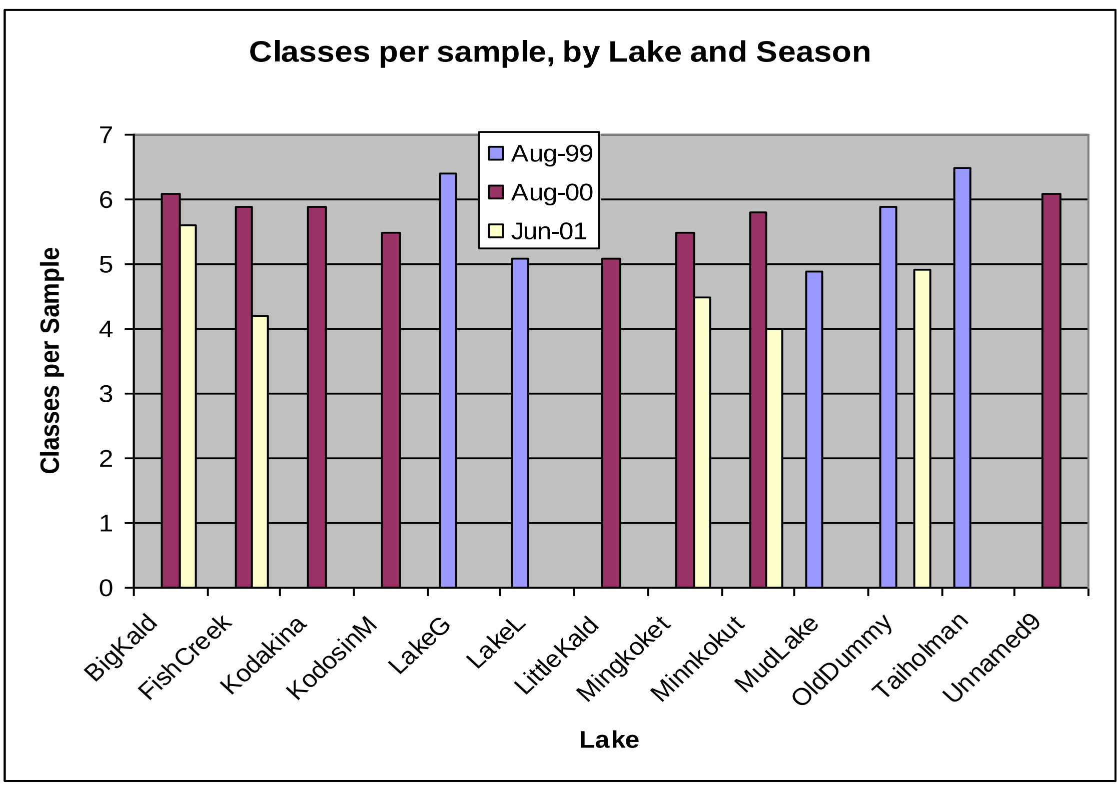



Figure 22. Number of macroinvertebrate classes per season/year, in each of the 13 lakes sampled within Kanuti NWR.

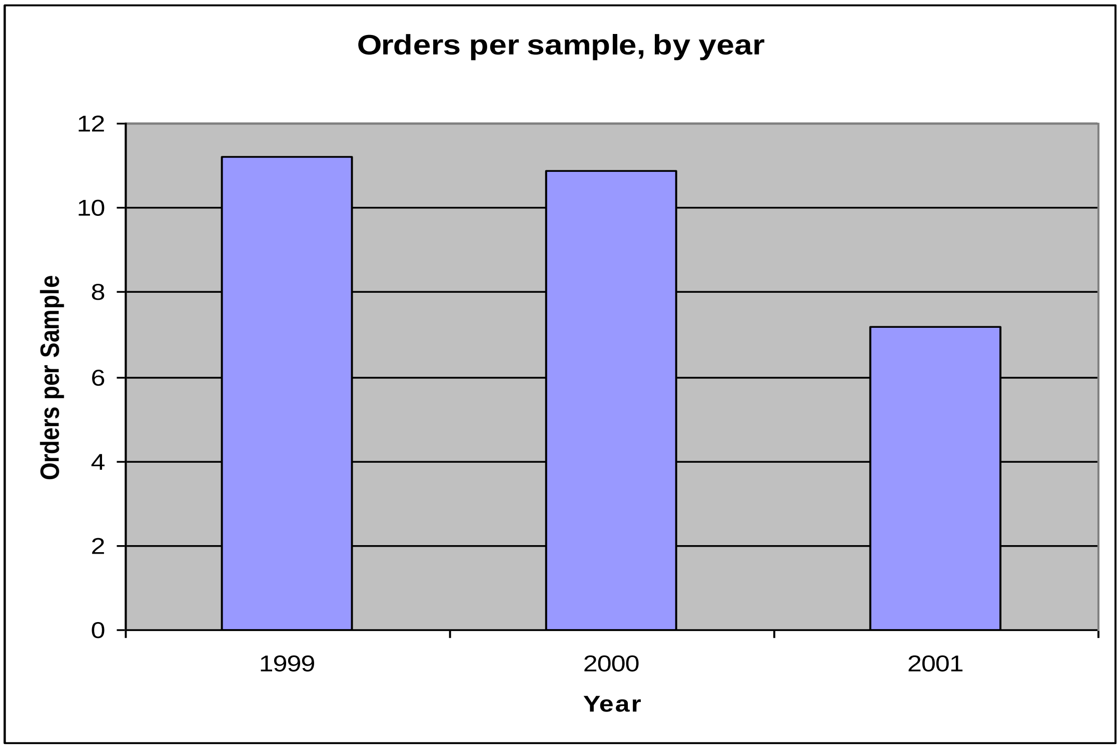



Figure 23. Number of macroinvertebrate orders per year, averaged over 13 lakes sampled within Kanuti NWR.

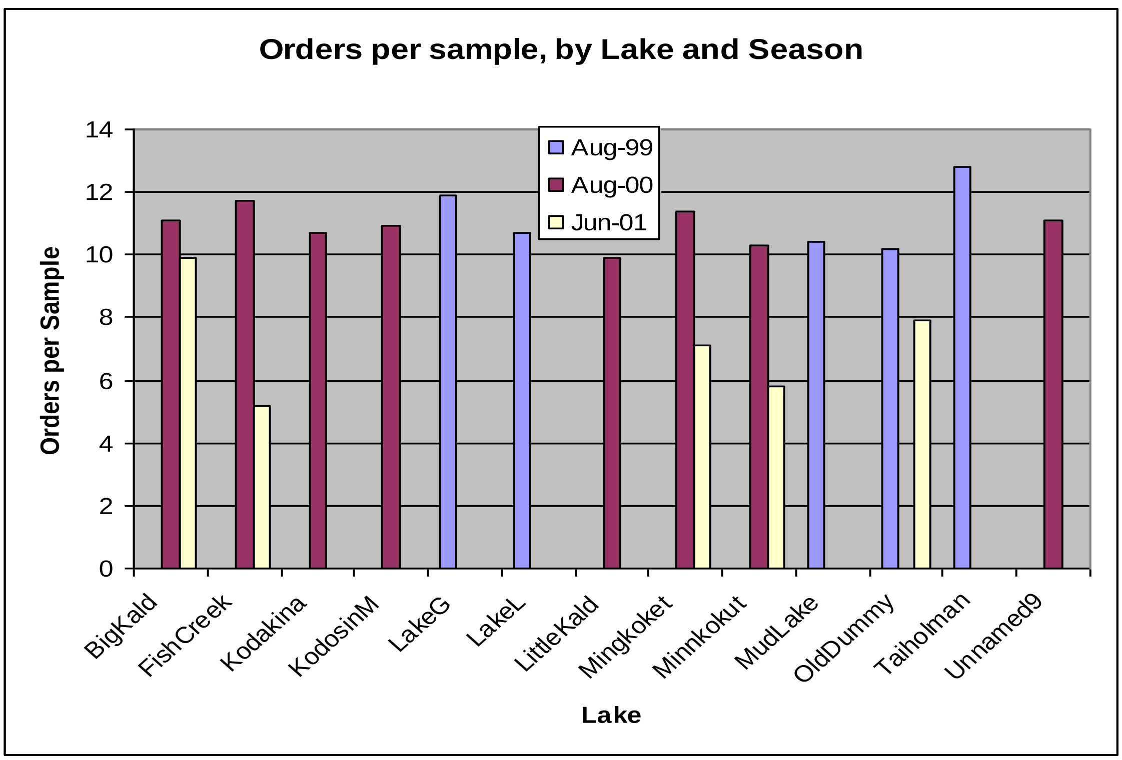



Figure 24. Number of macroinvertebrate orders per season/year, in each of the 13 lakes sampled within Kanuti NWR.

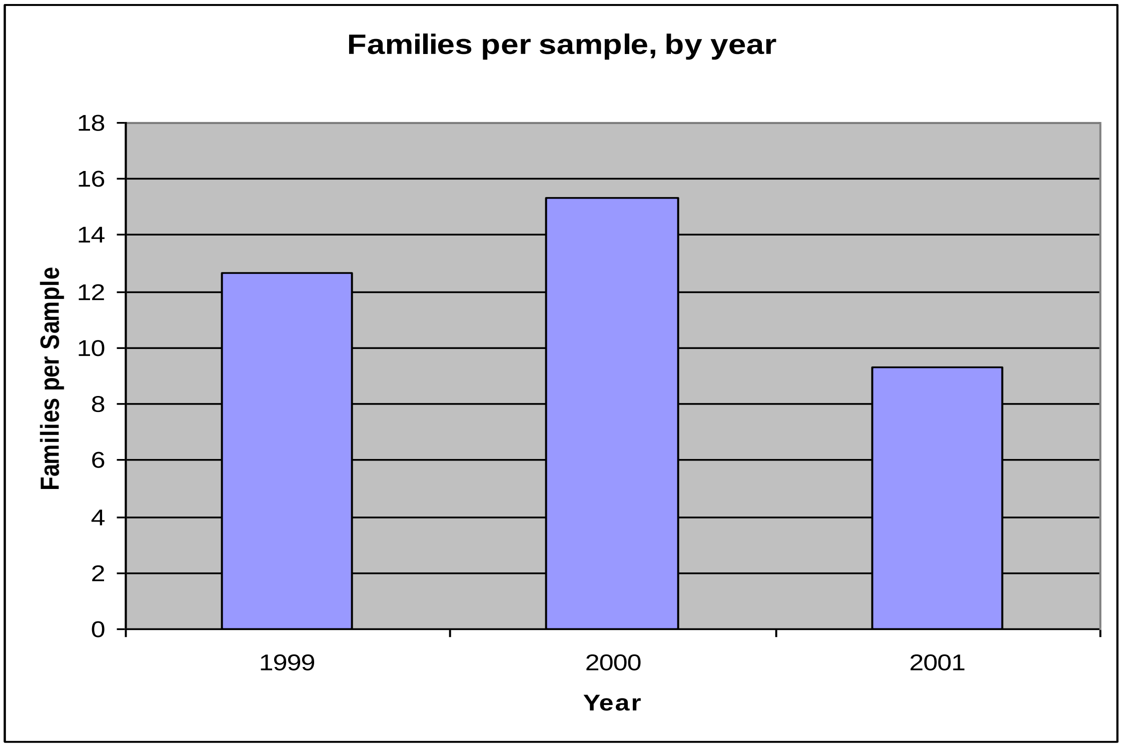



Figure 25. Number of macroinvertebrate families per year, averaged over 13 lakes sampled within Kanuti NWR.

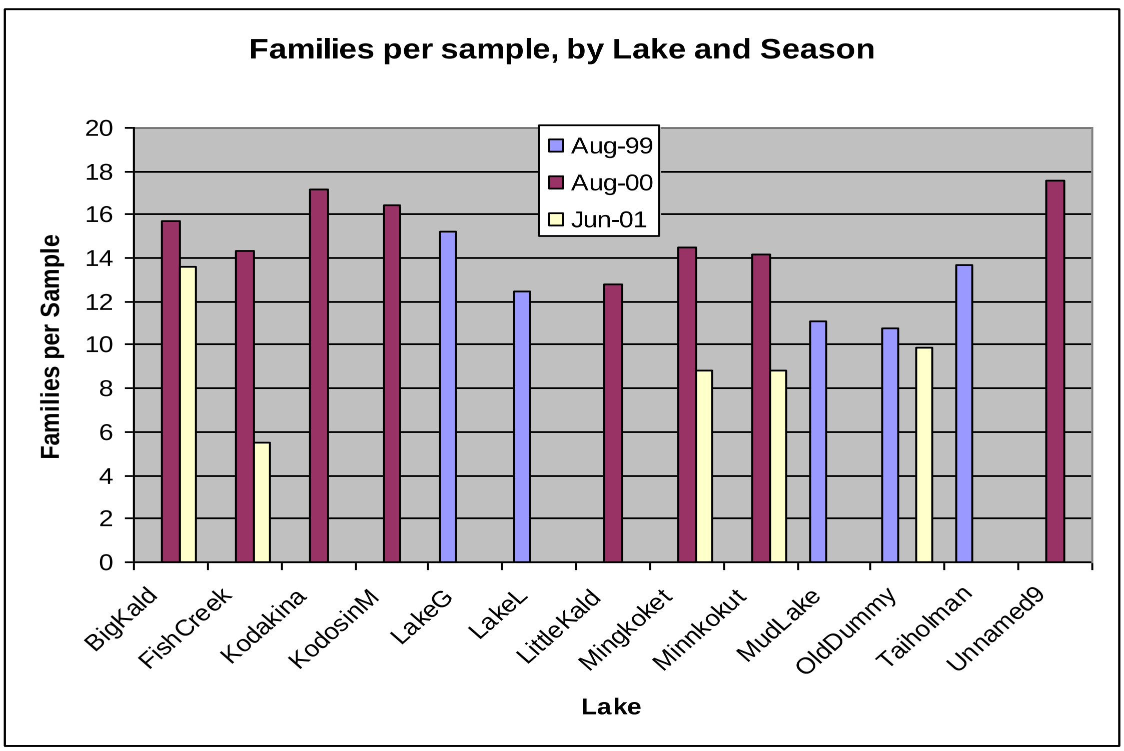



Figure 26. Number of macroinvertebrate families per season/year, in each of the 13 lakes sampled within Kanuti NWR.

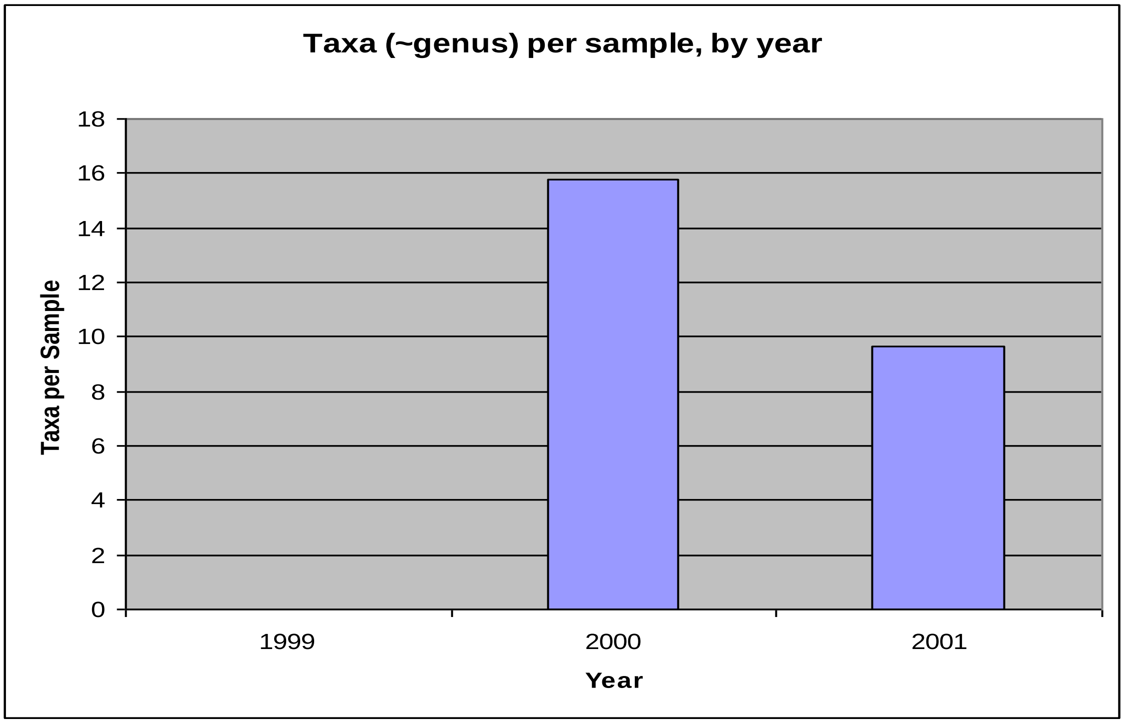



Figure 27. Number of macroinvertebrate "taxa" (the lowest taxonomic level identified) in each year sampled, averaged over 13 lakes sampled within Kanuti NWR. (August 1999 data were only identified to family and thus are not included in this analysis.)

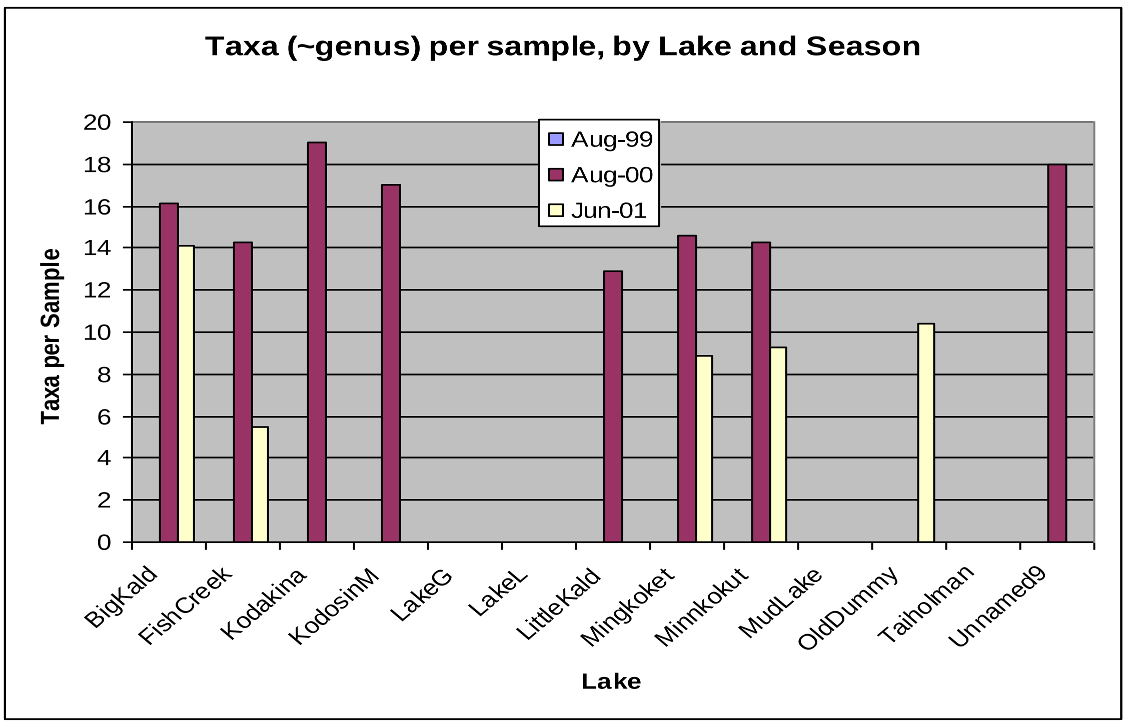



Figure 28. Number of macroinvertebrate "taxa" (the lowest taxonomic level identified) per season/year, in each of the 13 lakes sampled within Kanuti NWR. (August 1999 data were only identified to family and thus are not included in this analysis.)

## *Geomorphic Regions*

The macroinvertebrate data were divided into 3 geomorphic regions, based on conversations with the Refuge Biologist. These regions corresponded with major drainages (i.e., Kanuti River, Chalatna Creek, and Koyukuk River drainages) within the refuge, and are labeled South, Central and North respectively. See Table 1 for assignment of individual lakes into regions.

Total invertebrate abundance, although apparently higher in the southern region (Kanuti River drainage), did not vary statistically over geomorphic regions of Kanuti NWR ($P = 0.18$) (Table 10, Figures 29 and 30). Very large within-site and within-region (Figure 30) variance likely caused the lack of statistical significance.

Taxonomic composition varied over the geomorphic regions, with all taxonomic levels significantly different. The pattern of variation was different, however, depending on which taxonomic level was analyzed. The number of classes and orders found was lower in the north than in the other two regions. In the family and taxa analyses, the central region was higher than both the north and the south (Table 10, Figures 29-40, Appendix 11 [available from Kanuti Refuge on request]). The ETO ratio did not vary with region (Table 10, Figures 39 and 40).

Table 10. Statistical significance of the effect of geomorphic region (major drainage basin) on total abundance and taxonomic composition in 13 lakes sampled within Kanuti NWR.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| | Total | 1255487.534 | 2 | 627743.767 | 1.725 | .181 |
| | Classes | 23.242 | 2 | 11.621 | 6.603 | .002 |
| | Orders | 154.684 | 2 | 77.342 | 11.987 | .000 |
| | Families | 730.700 | 2 | 365.350 | 30.042 | .000 |
| | Taxa | 973.080 | 2 | 486.540 | 34.829 | .000 |
| | ETO | 132.923 | 2 | 66.462 | 1.987 | .140 |

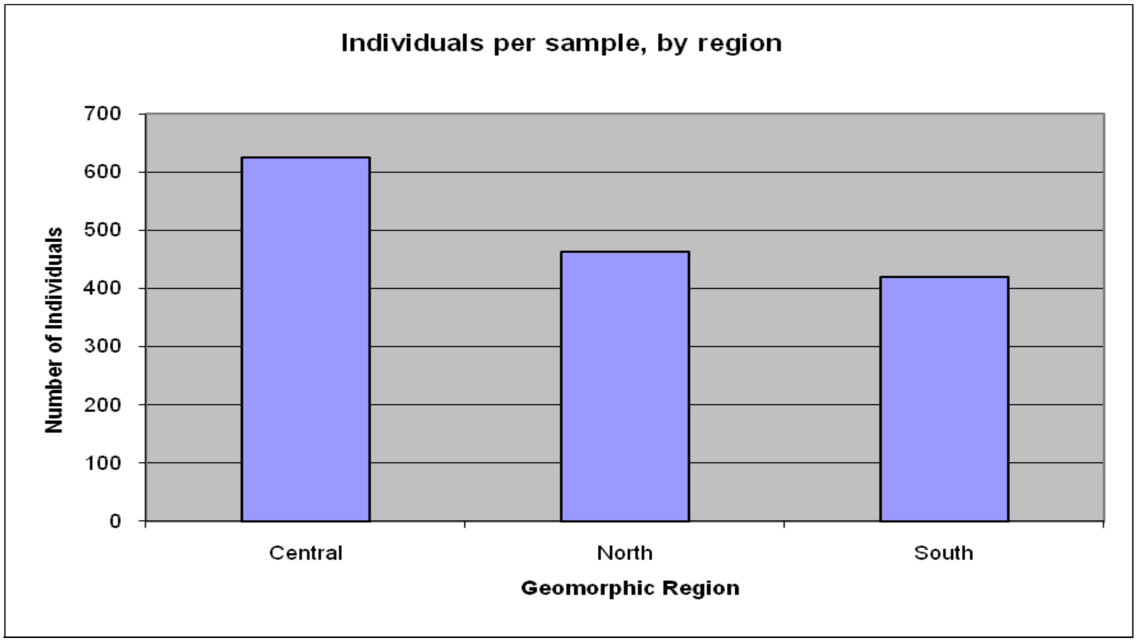



Figure 29. Total macroinvertebrate abundance, averaged over river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

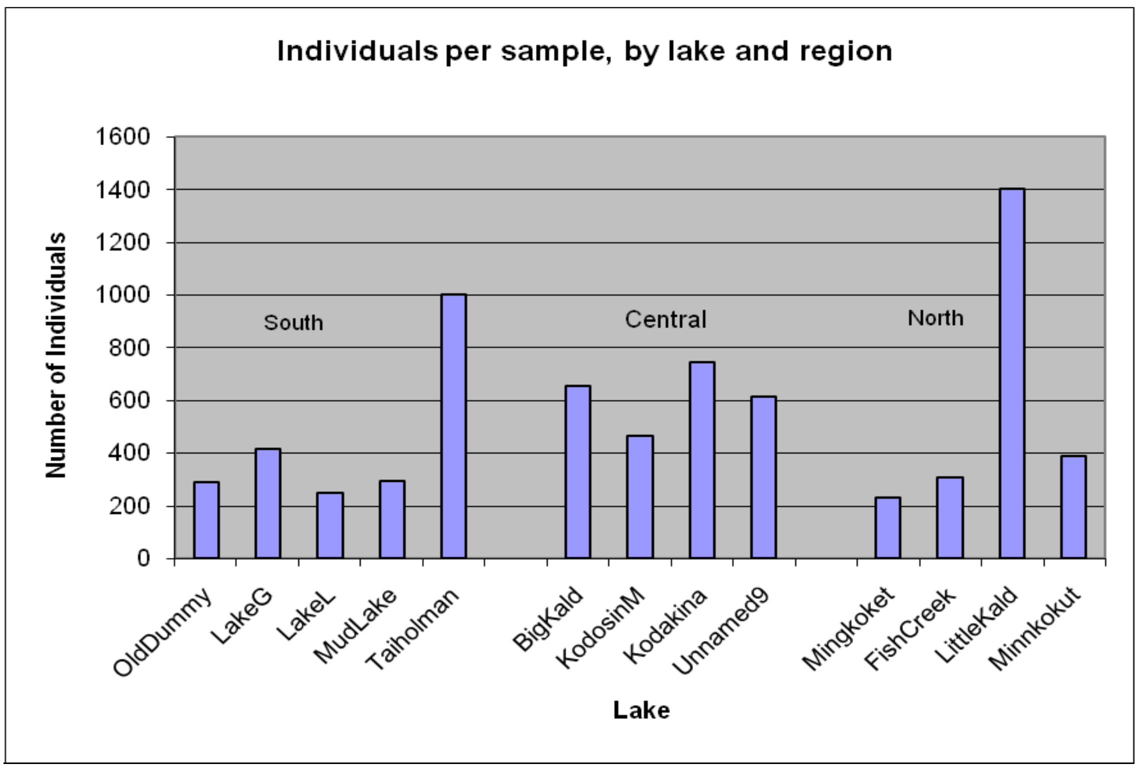



Figure 30. Total macroinvertebrate abundance in each lake, grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

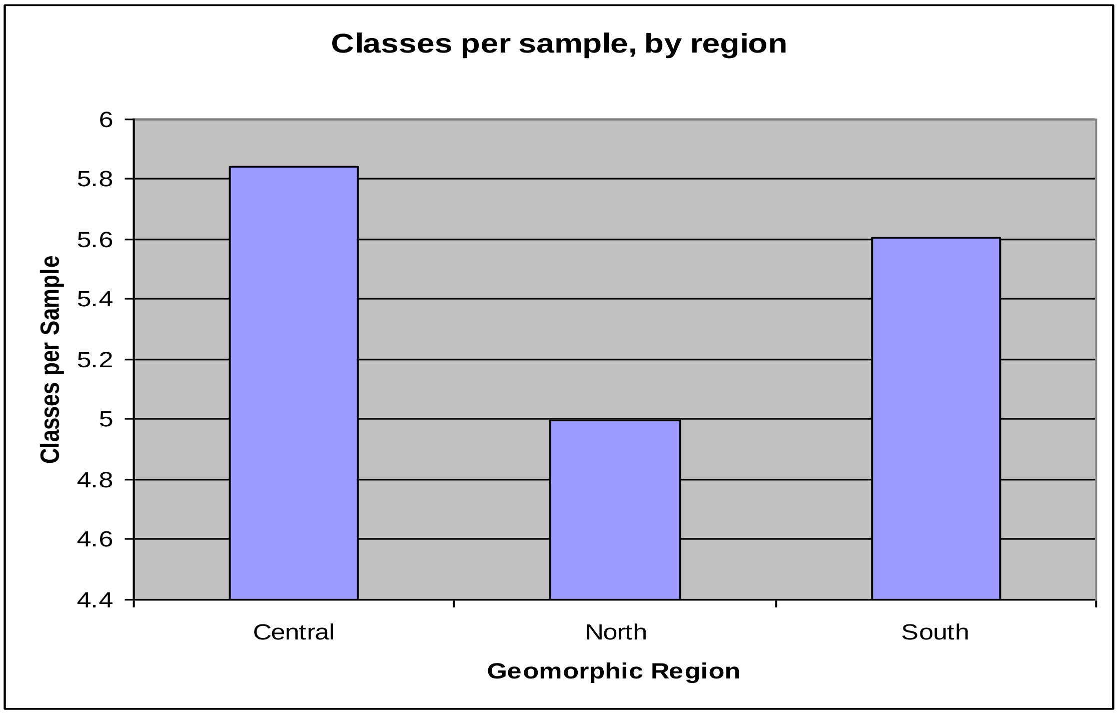



Figure 31. Number of macroinvertebrate classes, averaged over river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

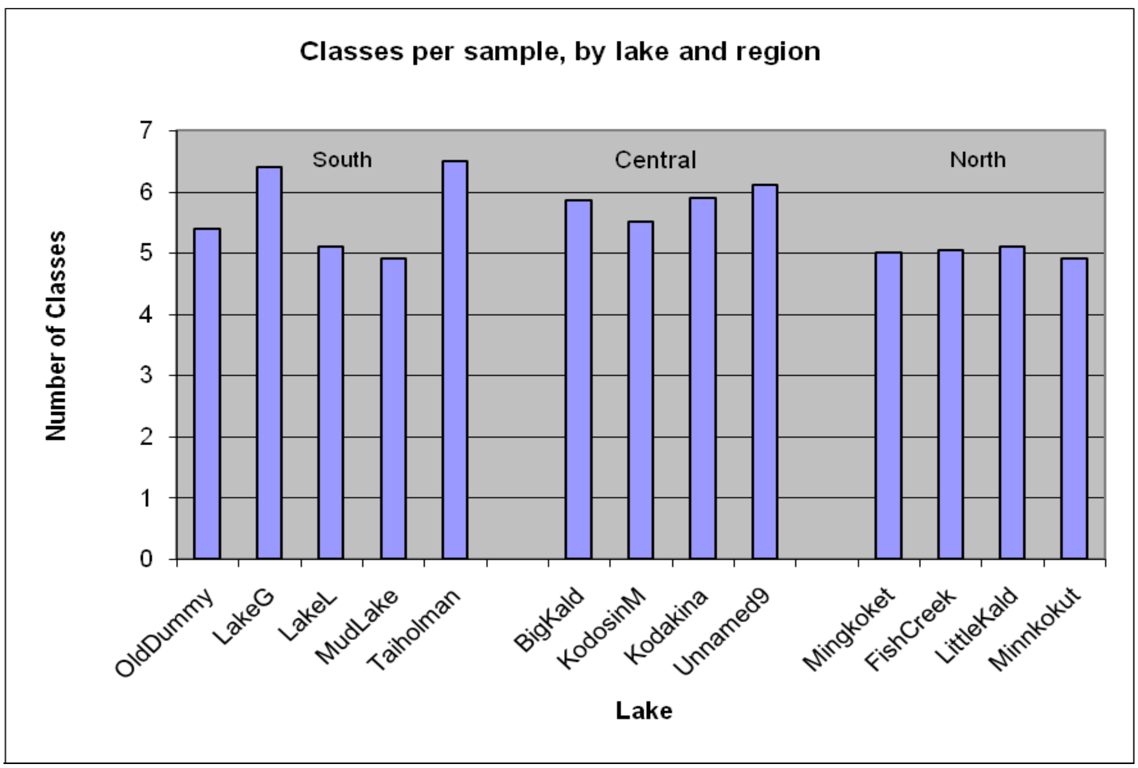



Figure 32. Number of macroinvertebrate classes in each lake, grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

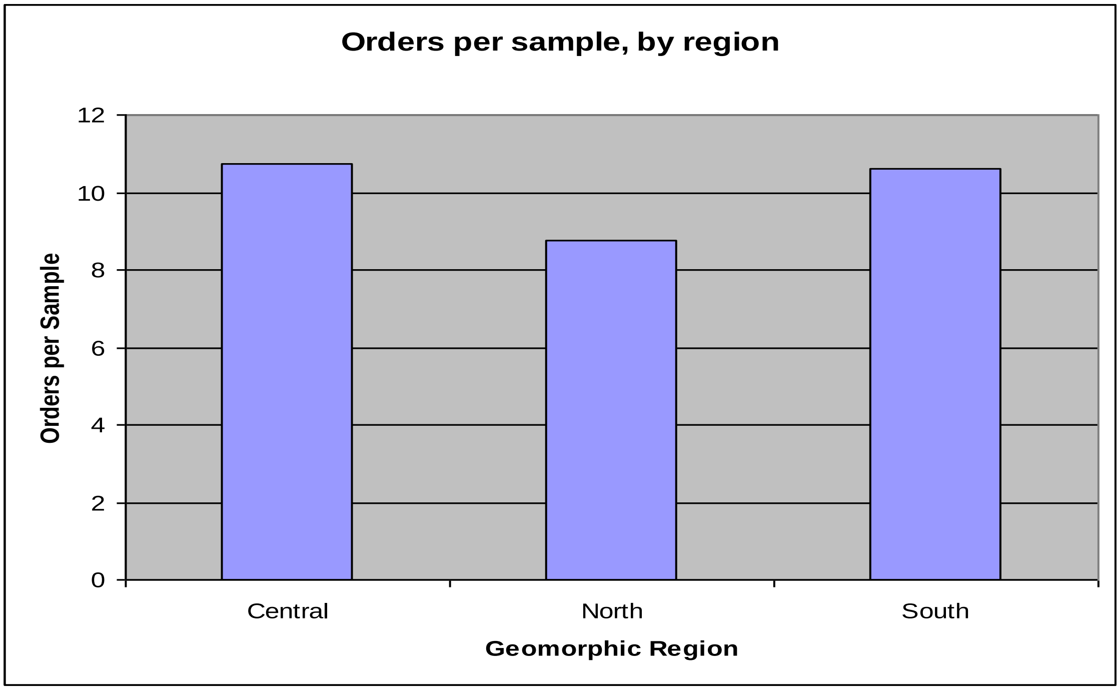



Figure 33. Number of macroinvertebrate orders, averaged over river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

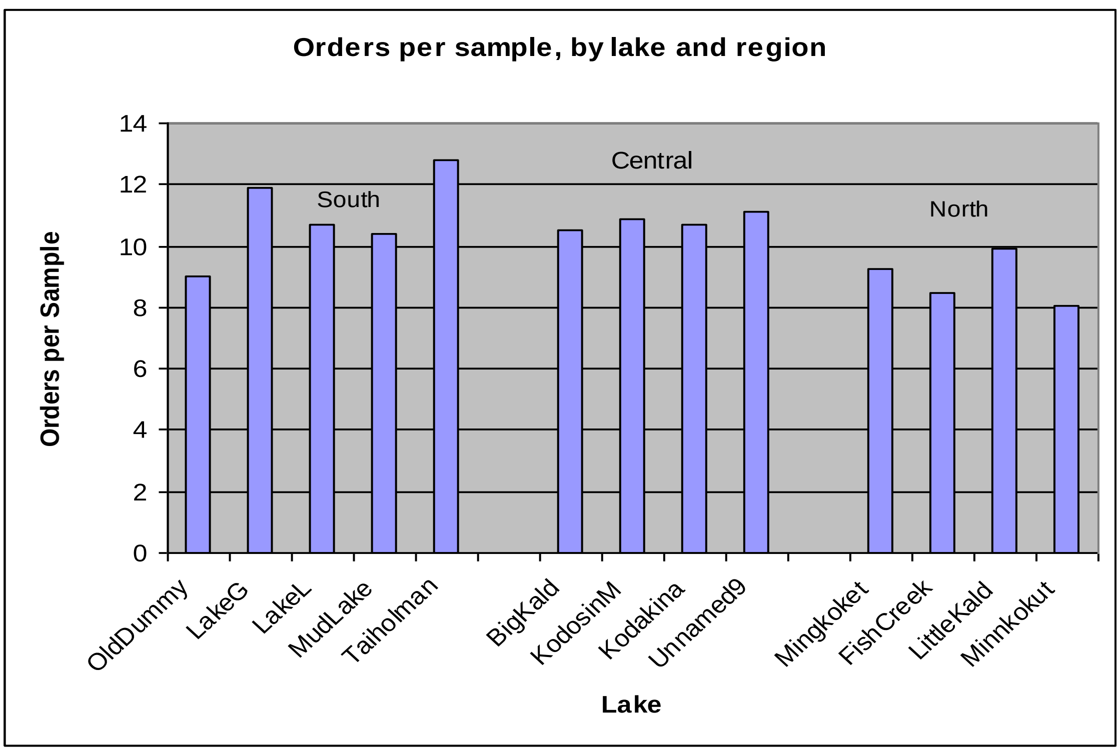



Figure 34. Number of macroinvertebrate orders in each lake, grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

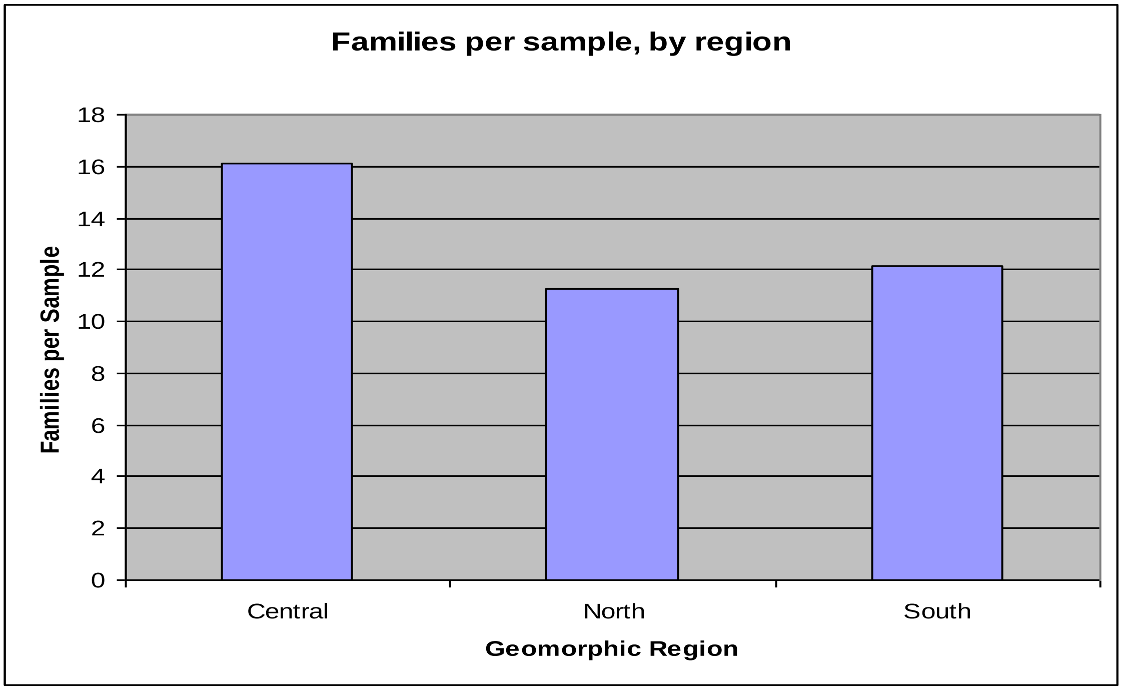



Figure 35. Number of macroinvertebrate families, averaged over river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

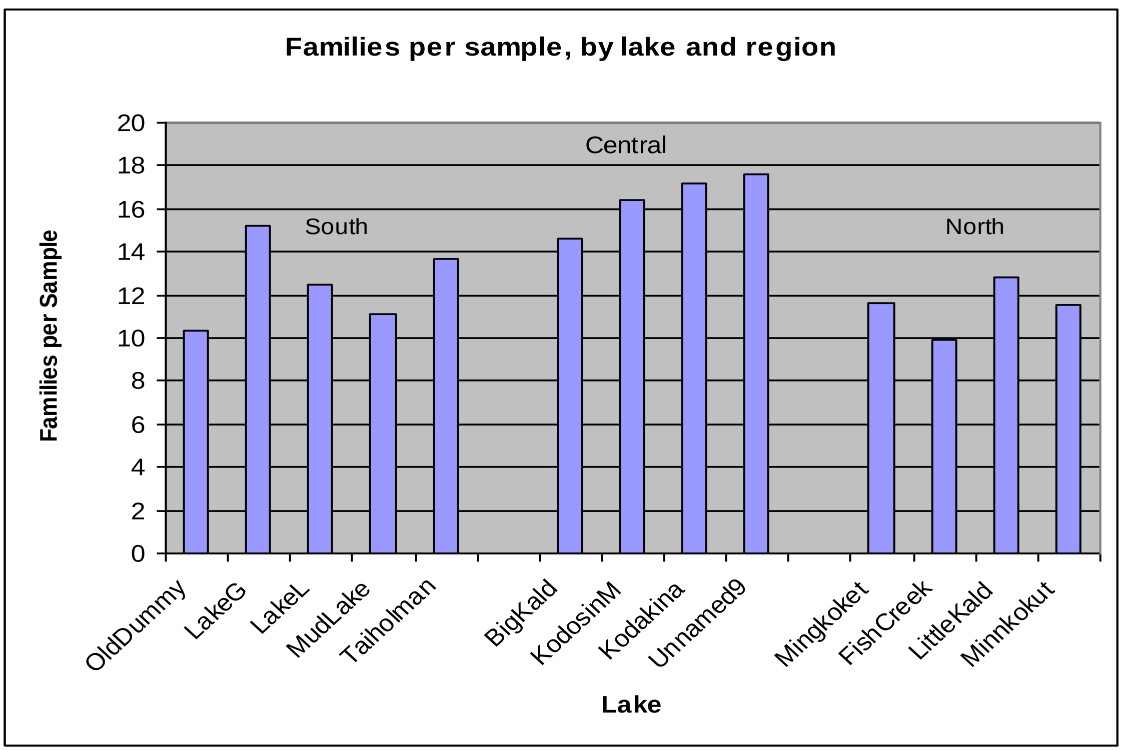



Figure 36. Number of macroinvertebrate families in each lake, grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

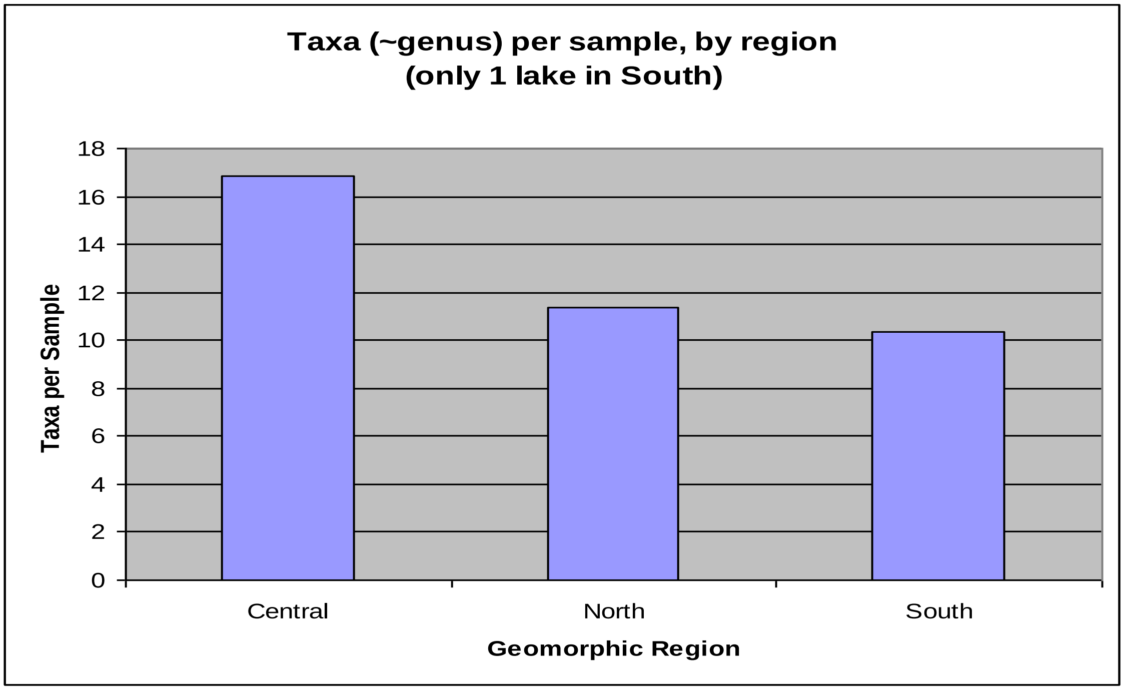



Figure 37. Number of "taxa" (the lowest taxonomic level identified) of macroinvertebrates, averaged over river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

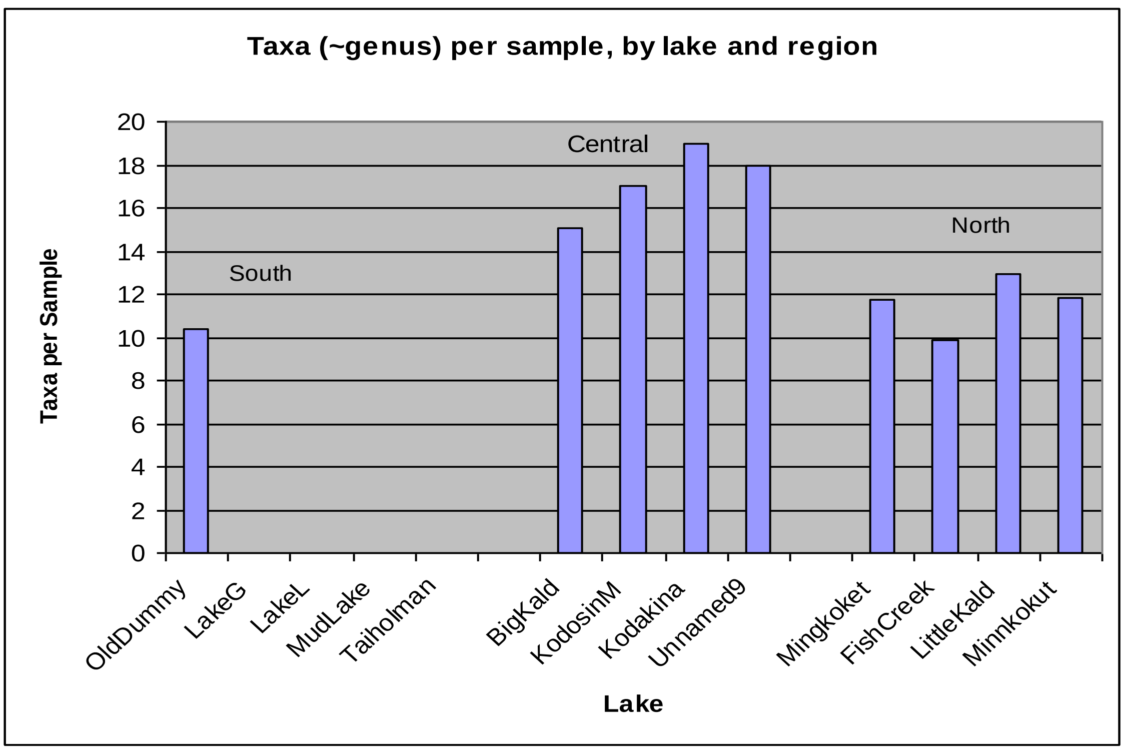



Figure 38. Number of macroinvertebrate "taxa" (the lowest taxonomic level identified) in each lake, grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

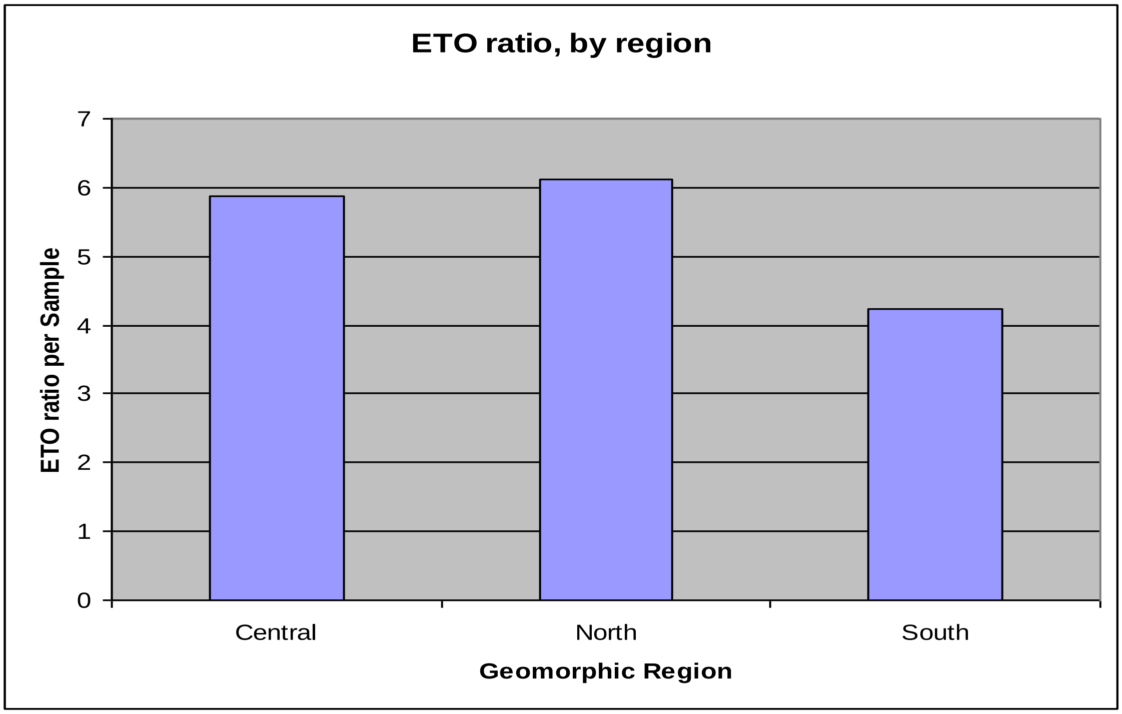



Figure 39. ETO ratio (sum of Ephemeroptera, Trichoptera, and Odonata, divided by total number of individuals), averaged over river basins: Kanuti (South), Chalatna (Central), and Koyukuk (Koyukuk (North).

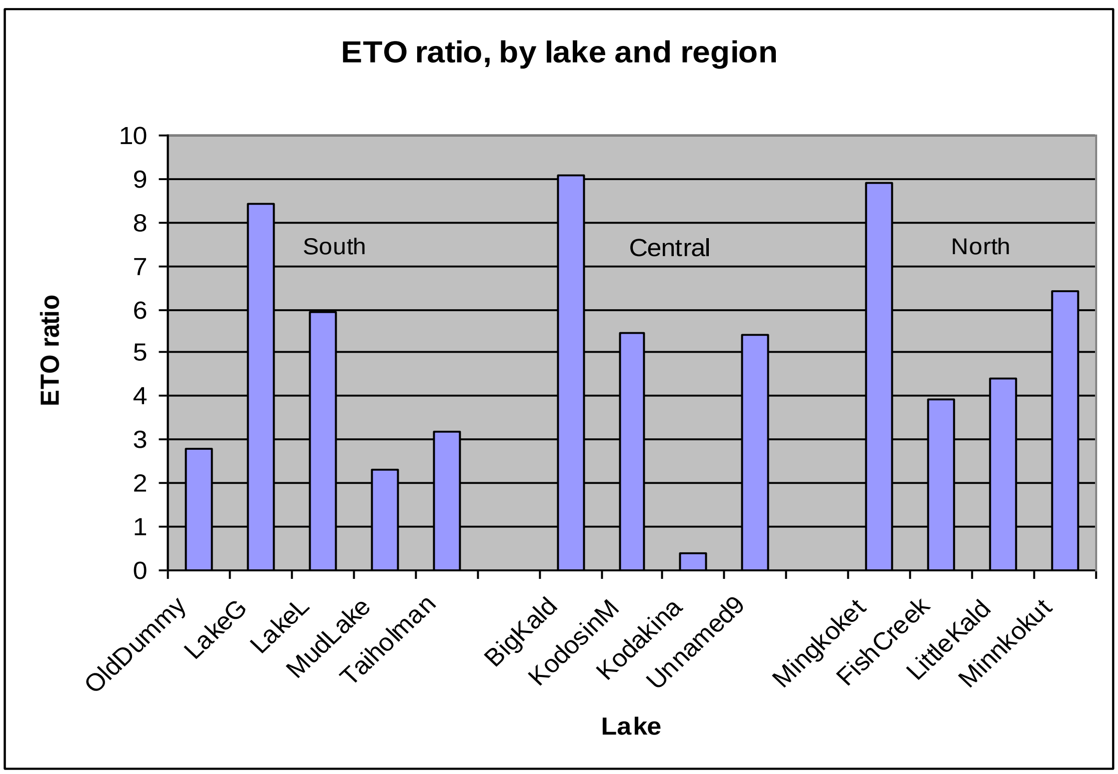



Figure 40. ETO ratio (sum of Ephemeroptera, Trichoptera, and Odonata, divided by total number of individuals) in each lake sampled within Kanuti NWR, averaged over years and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (Koyukuk (North).

## *Functional Feeding Groups*

The concept of functional feeding groups (FFG), or feeding guilds, has been successful in describing the ecological relationships among aquatic insects (Table 11, Merritt and Cummins 1984). It does not, however, equate to trophic status because the FFGs are based on how the animal eats and the construction of its mouthparts. Therefore, members of a particular functional group might eat foods that belong to more than one trophic level. For instance, a shredder might consume both living and dead plant material, and may also ingest small animals that live on or among leaves. Likewise, a filter-feeder may capture and consume both plant and animal material. It is therefore recommended that this analysis be considered just a rough approximation to the trophic ecology of the lakes.

Table 11. Comparison of functional feeding groups and trophic levels (Taken from Merritt and Cummins 1984, page 63).

| **Functional Feeding Group** | **Trophic level based on ingestion**[1] |
|---|---|
| Shredders (live plant or dead plant) | Detritivores<br>Herbivores<br>(Carnivores) |
| Collectors<br>Filtering (suspension feeders)<br><br><br><br>Gathering (deposit feeders) | <br>Detritivores<br>Herbivores<br>(Carnivores)<br><br>Detritivores<br>Herbivores<br>(Carnivores) |
| Scrapers (grazers) | Herbivores<br>Detritivores |
| Predators (engulfers) | Carnivores<br>(Detritivores) |
| Piercers (plant or animal) | Unrecognizable fluids |

[1]The occasional or minor component (on a biomass basis) of the trophic classification is shown in parentheses.

Table 12. Functional feeding groups (FFGs) of the taxa found in 13 lakes sampled within Kanuti National Wildlife Refuge in 1999-2001.

| Taxon | FFG | Variable Name |
|---|---|---|
| Acari | Predator | Pred |
| Acerpenna | Collector-Gatherer | CollGath |
| Aeshna | Predator | Pred |
| Atrichopogon | Collector-Gatherer | CollGath |
| Brachycera | Unknown | Unknown |
| Caenis | Collector-Gatherer | CollGath |
| Callibaetis | Collector-Gatherer | CollGath |
| Centroptilum | Collector-Gatherer | CollGath |
| Ceraclea | Collector-Gatherer | CollGath |
| Chironomidae | Collector-Gatherer | CollGath |
| Cladocera | Collector-Filterfeeder | CollFF |
| Coenagrion/Enallagma | Predator | Pred |
| Copepoda | Collector-Filterfeeder | CollFF |
| Corixidae | Piercer (animal) | PiercerA |
| Culicidae | Collector-Filterfeeder | CollFF |
| Dasyhelea | Collector-Gatherer | CollGath |
| DipteraA | Unknown | Unknown |
| DipteraB | Unknown | Unknown |
| DipteraC | Unknown | Unknown |
| DipteraD | Unknown | Unknown |
| DipteraE | Unknown | Unknown |
| Dixella | Collector-Gatherer | CollGath |
| Dytiscidae | Predator | Pred |
| Gerridae | Piercer (animal) | PiercerA |
| Grammotaulius | Shredder | Shred |
| Gyrinus | Predator | Pred |
| Haliplus | Shredder | Shred |
| Helodidae | Scraper | Scrap |
| Hirudinea | Predator | Pred |
| Hyalella | Shredder | Shred |
| Hydra | Predator | Pred |
| Hydrobius | Predator | Pred |
| Hydrophilidae | Predator | Pred |
| Hydroptila | Piercer (herbivore) | PiercerH |
| Leucorrhinia | Predator | Pred |
| Libellulidae | Predator | Pred |
| Limnephilidae | Shredder | Shred |
| Limnephilus | Shredder | Shred |
| Limonia | Shredder | Shred |
| Mesovelia | Piercer (animal) | PiercerA |
| Microvelia | Piercer (animal) | PiercerA |
| Mystacides | Collector-Gatherer | CollGath |
| Nematoda | Collector-Gatherer | CollGath |
| Nematomorpha | Collector-Gatherer | CollGath |
| Nemotaulius | Shredder | Shred |

Table 12, continued. Functional feeding groups (FFGs) of the taxa found in 13 lakes sampled within Kanuti National Wildlife Refuge in 1999-2001.

| **Taxon** | **FFG** | **Variable Name** |
|---|---|---|
| Oecetis | Predator | Pred |
| Oligochaeta | Collector-Gatherer | CollGath |
| Oligotricha | Predator | Pred |
| Ostracoda | Collector-Filterfeeder | CollFF |
| Oxyethira | Piercer (herbivore) | PiercerH |
| Palpomyia | Predator | Pred |
| Pericoma | Collector-Gatherer | CollGath |
| Phalacrocera | Shredder | Shred |
| Phoridae | Predator | Pred |
| Physidae | Scraper | Scrap |
| Planorbidae | Scraper | Scrap |
| Polycentropus | Predator | Pred |
| Psychoda | Collector-Gatherer | CollGath |
| Saldidae | Piercer (animal) | PiercerA |
| Sciomyzidae | Predator | Pred |
| Somatochlora | Predator | Pred |
| Sphaeriidae | Collector-Filterfeeder | CollFF |
| Stratiomyidae | Collector-Gatherer | CollGath |
| Tabanidae | Piercer (animal) | PiercerA |
| Tipula | Shredder | Shred |
| Tipulidae | Shredder | Shred |
| Triaenodes | Shredder | Shred |
| Turbellaria | Predator | Pred |
| Ulomorpha | Predator | Pred |

Macroinvertebrates in the sampled lakes were predominantly in the Collector-Filter Feeder and Collector-Gatherer Functional Feeding Groups (Table 12, Figure 41). The collector-filter feeders were primarily Cladocera and Copepoda, small planktonic crustaceans, and the collector-gatherers were primarily Chironomidae, small non-biting midge larvae. If biomass data were available, it is likely that the prominence of these two FFGs would be much less, as many predators (e.g., Oligotricha, Gerridae), shredders (e.g., Limnephilidae), and scrapers (e.g., Gastropoda) are much larger than the cladocerans, copepods, and chironomids.

FFG composition (as a percentage of the total) differed among lakes (Table 13). In two-way analyses of variance with SiteName and Year as the factors, and each of the FFGs as the response variable, both main effects were significant ($P$ <0.01), except Year was not significant in PiercerH ($P$ = 0.16). The SiteName x Year interaction was significant ($P$ <0.05) in all tests except Predators ($P$ = 0.14) and Scrapers ($P$ = 0.23) (Appendix 11, available from Kanuti Refuge on request).

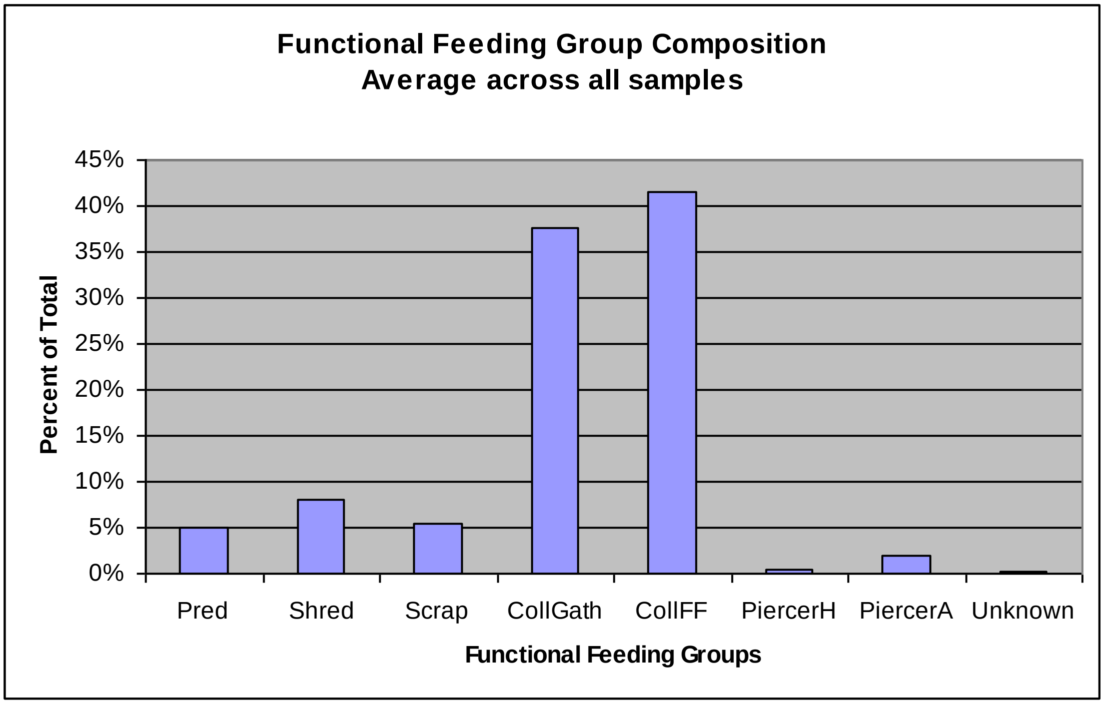



Figure 41. Functional feeding group composition of 13 lakes sampled within Kanuti NWR. Abbreviations: Pred=Engulfing Predator, Shred=Shredder, Scrap=Scraper/Grazer, CollGath=Collector-Gatherer, CollFF=Collector-Filter Feeder, PiercerH=Piercer-Herbivore, PiercerA=Piercer-Animal.

Table 13. One-way ANOVA on each of the FFGs, with SiteName as the factor.

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Pred% | .093 | 12 | .008 | 3.326 | .000 |
| Shred% | .954 | 12 | .080 | 4.034 | .000 |
| Scrap% | .338 | 12 | .028 | 8.087 | .000 |
| CollGath% | 4.211 | 12 | .351 | 6.856 | .000 |
| CollFF% | 4.501 | 12 | .375 | 9.567 | .000 |
| PiercerH% | .006 | 12 | .000 | 3.792 | .000 |
| PiercerA% | .057 | 12 | .005 | 2.976 | .001 |
| Unknown% | .002 | 12 | .000 | 2.226 | .013 |

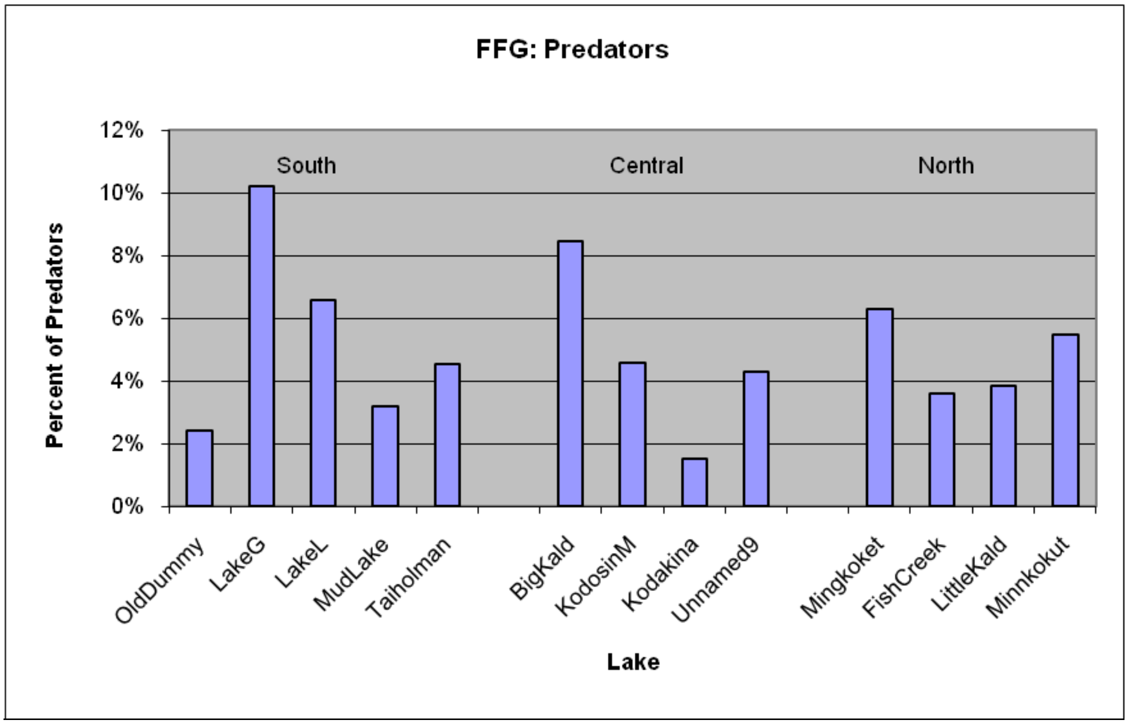



Figure 42. Percent of predators found in each of 13 lakes sampled within Kanuti NWR, averaged over years, and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

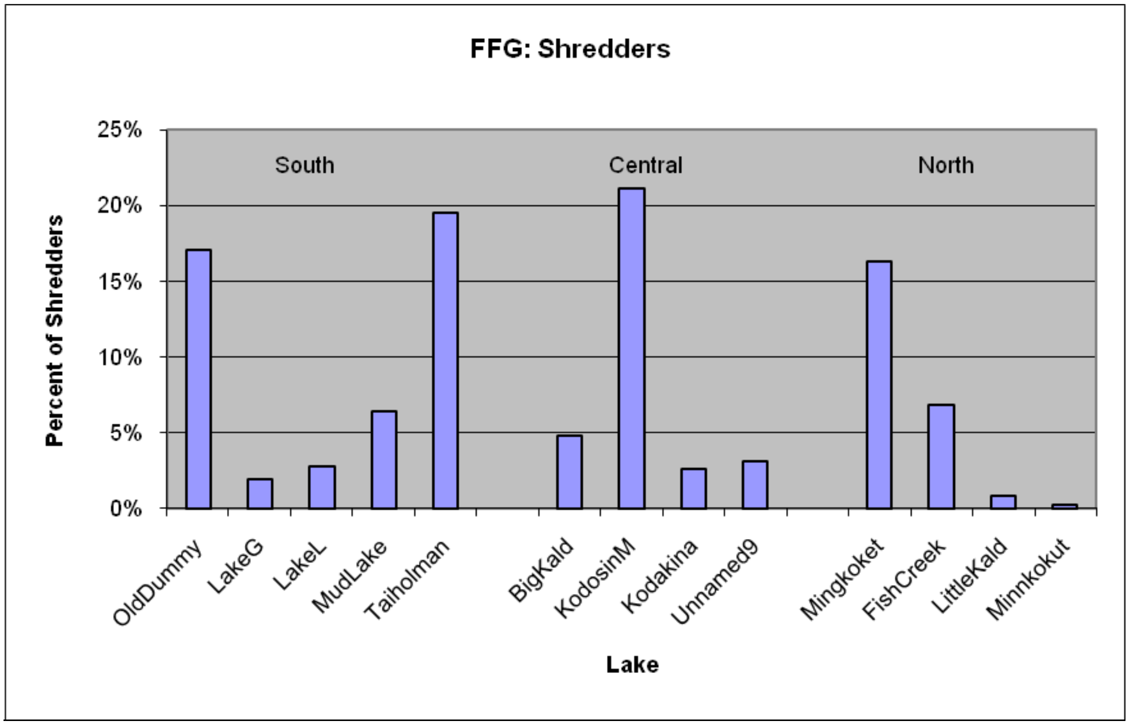



Figure 43. Percent of shredders found in each of 13 lakes sampled within Kanuti NWR, averaged over years, and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

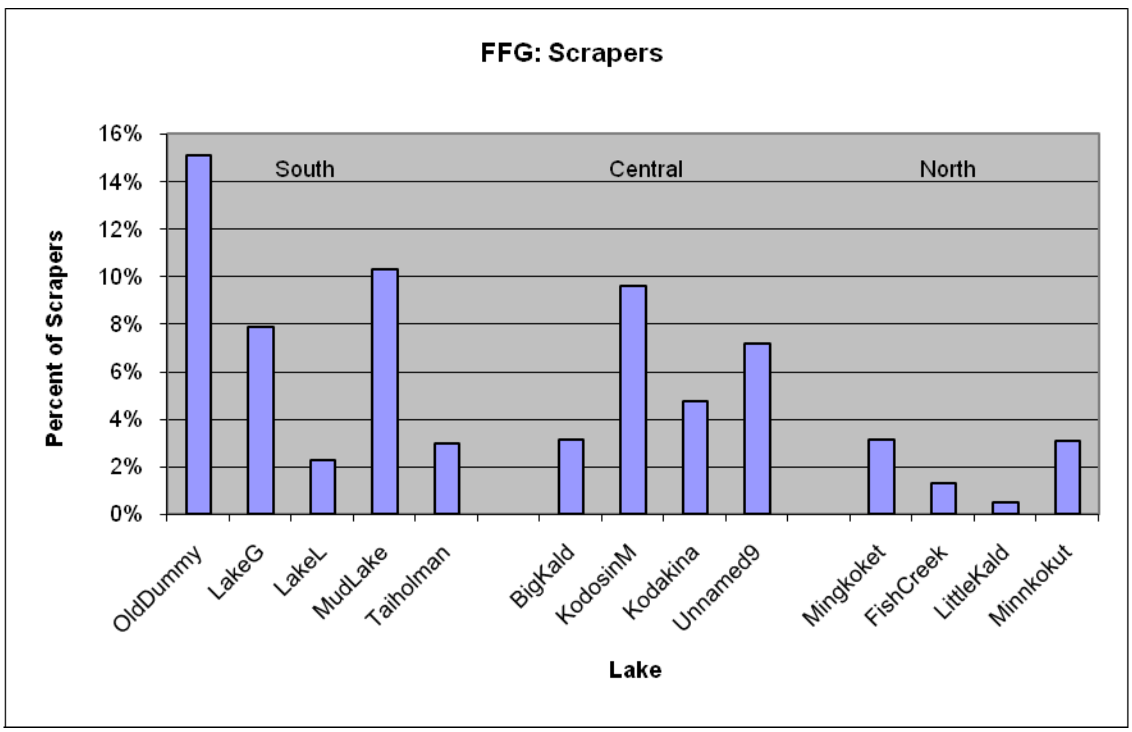



Figure 44. Percent of scrapers found in each of 13 lakes sampled within Kanuti NWR, averaged over years, and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

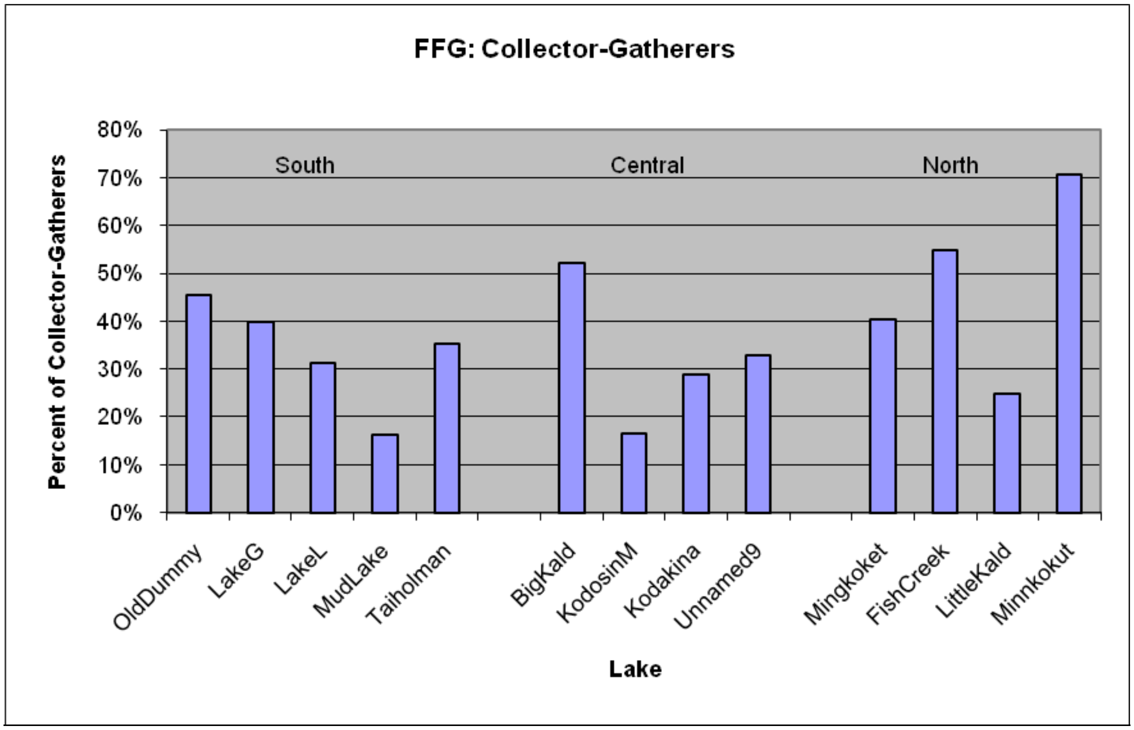



Figure 45. Percent of collector-gatherers found in each of 13 lakes sampled within Kanuti NWR, averaged over years, grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

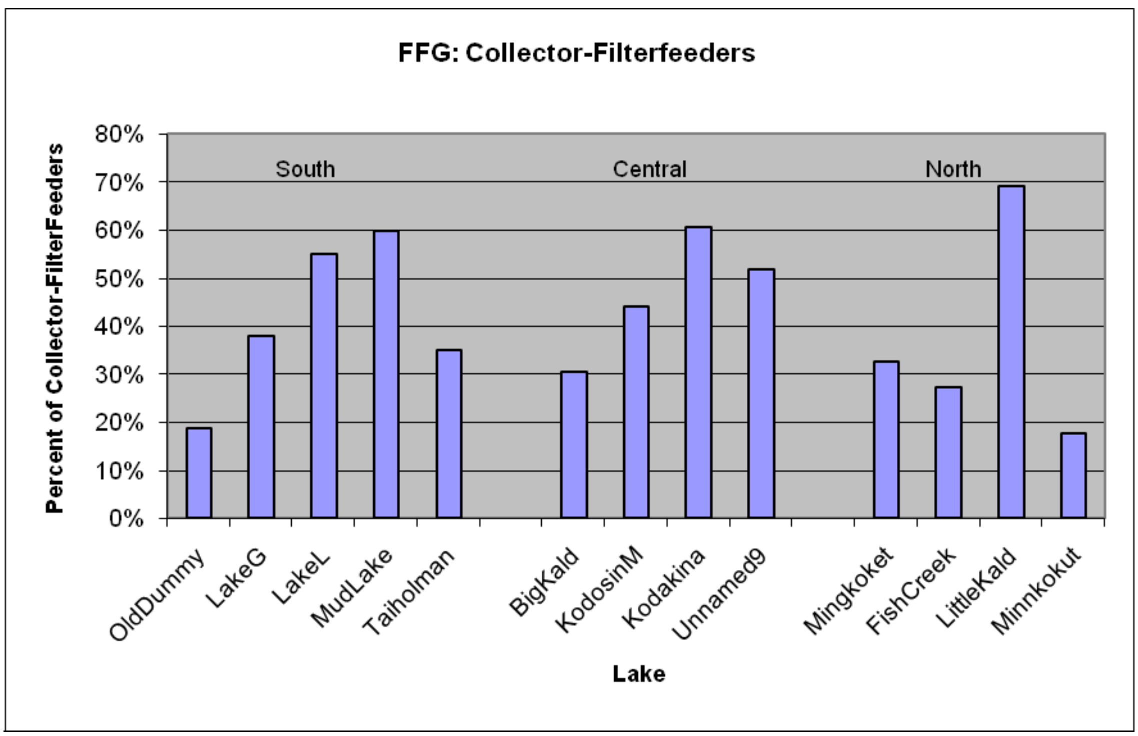



Figure 46. Percent of collector-filterfeeders found in each of 13 lakes sampled within Kanuti NWR, averaged over years, and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

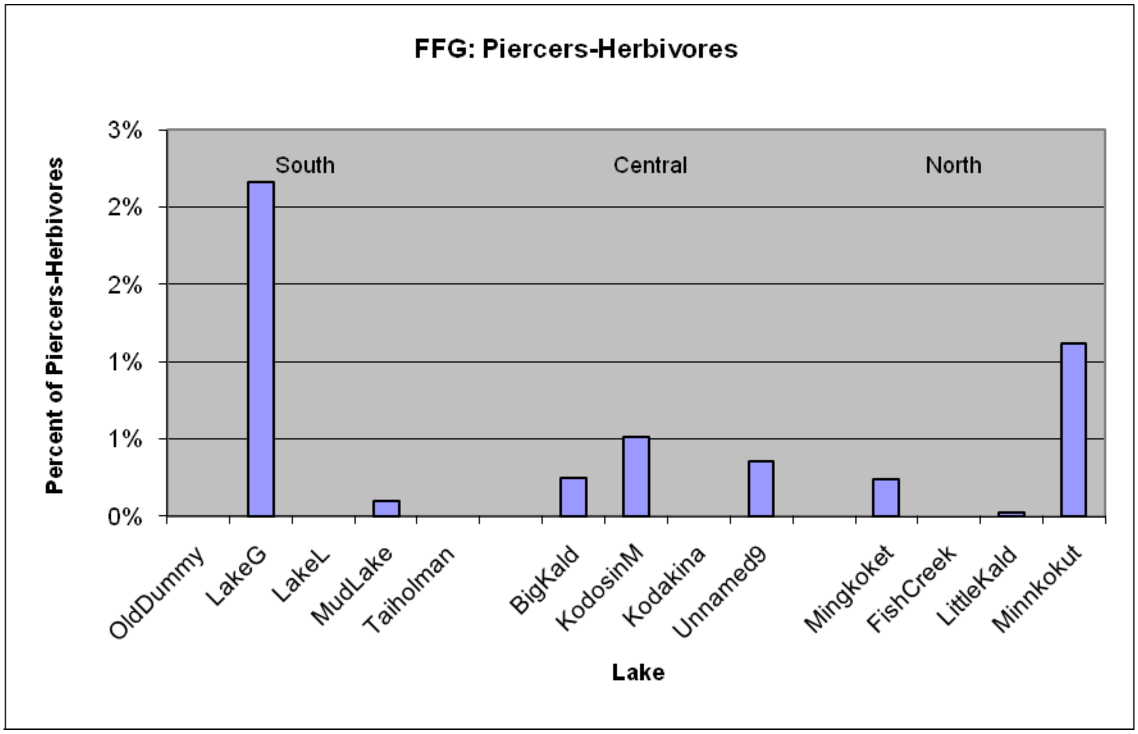


Figure 47. Percent of piercers-herbivores found in each of 13 lakes sampled within Kanuti NWR, averaged over years, and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

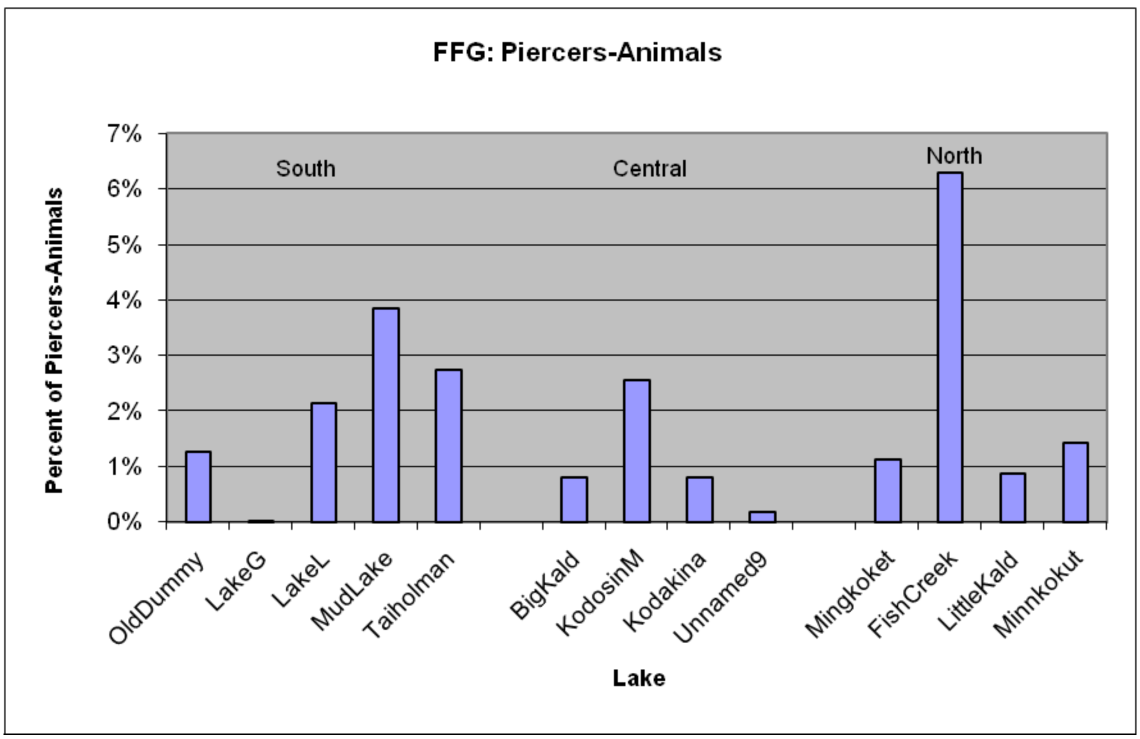


Figure 48. Percent of piercer-animals found in each of 13 lakes sampled within Kanuti NWR, averaged over years, and grouped by river basins: Kanuti (South), Chalatna (Central), and Koyukuk (North).

## *Water Quality*

Five water quality variables were measured, although not in all years or at all sites. All variables were significantly different among lakes and among years, as well as among the interaction between lakes and years (Tables 14 - 18). The amount of variation explained by the two-way analyses was very large (>90%) because the within-site variation was very low.

## Temperature

Temperature varied among lakes and among years (Table 14, Figure 49). It is not surprising that temperature would vary among years, as the lakes that were sampled twice were sampled in early June (just after ice-out on most lakes) and in early August (late summer). Large diel and seasonal differences in water temperature of shallow lakes make a single measurement at each lake difficult to analyze meaningfully. The five lakes sampled in 1999 had an average temperature of 17.9°C, with a high of 19.2°C and a low of 6.9°C (see Appendix 8 [available from Kanuti Refuge on request] for summary data).

Table 14. Two-way ANOVA of SiteName x Year, on Water Temperature.

| **Source** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| Corrected Model | 596.494(a) | 17 | 35.088 | 163.274 | .000 |
| Intercept | 7460.163 | 1 | 7460.163 | 34714.262 | .000 |
| SiteName | 63.052 | 12 | 5.254 | 24.450 | .000 |
| Year | 60.287 | 2 | 30.144 | 140.266 | .000 |
| SiteName * Year | 61.461 | 3 | 20.487 | 95.332 | .000 |
| Error | 7.307 | 34 | .215 | | |
| Total | 8965.500 | 52 | | | |
| Corrected Total | 603.801 | 51 | | | |

$R^2 = .988$ (Adjusted $R^2 = .982$)

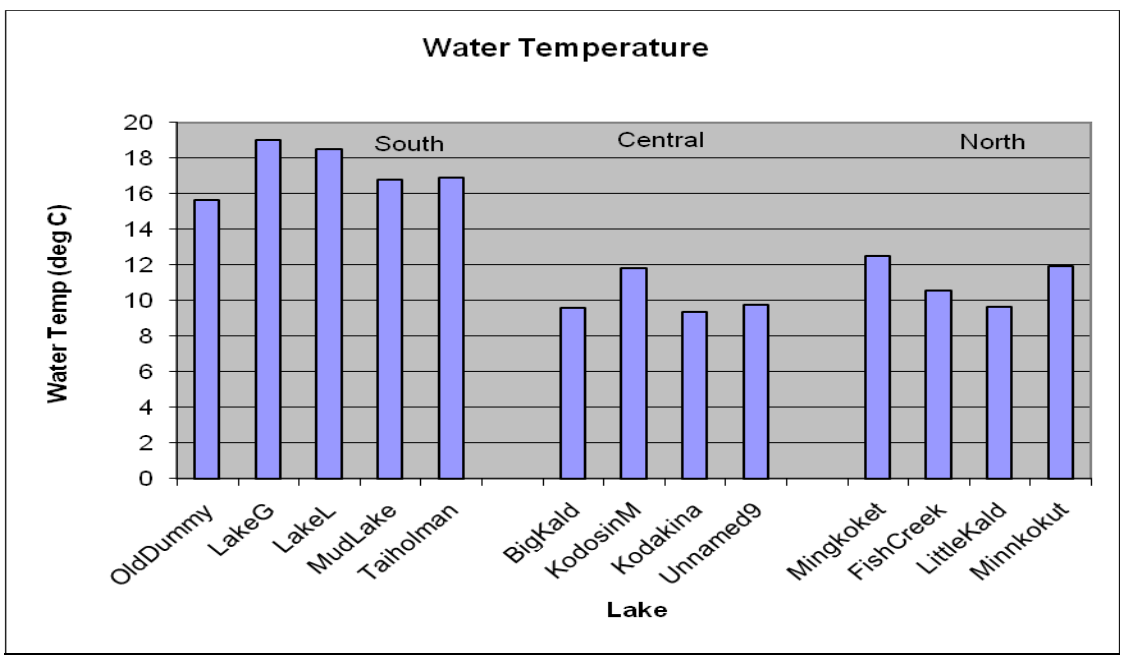



Figure 49. Mean water temperature at 13 lakes sampled within Kanuti NWR (averaged over both years, if the lake was sampled twice).

## Water pH

The pH of the water ranged from 6.0 in Little Kaldoyeit Lake to 9.0 in Kadakina Lake (Table 15, Figure 50).

Table 15. Two-way ANOVA of SiteName x Year, on pH.

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 21.104(a) | 12 | 1.759 | 134.273 | .000 |
| Intercept | 1793.300 | 1 | 1793.300 | 136919.936 | .000 |
| SiteName | 20.449 | 8 | 2.556 | 195.165 | .000 |
| Year | .269 | 1 | .269 | 20.524 | .000 |
| SiteName * Year | .646 | 3 | .215 | 16.438 | .000 |
| Error | .341 | 26 | .013 | | |
| Total | 1937.487 | 39 | | | |
| Corrected Total | 21.444 | 38 | | | |

$R^2 = .984$ (Adjusted $R^2 = .977$)

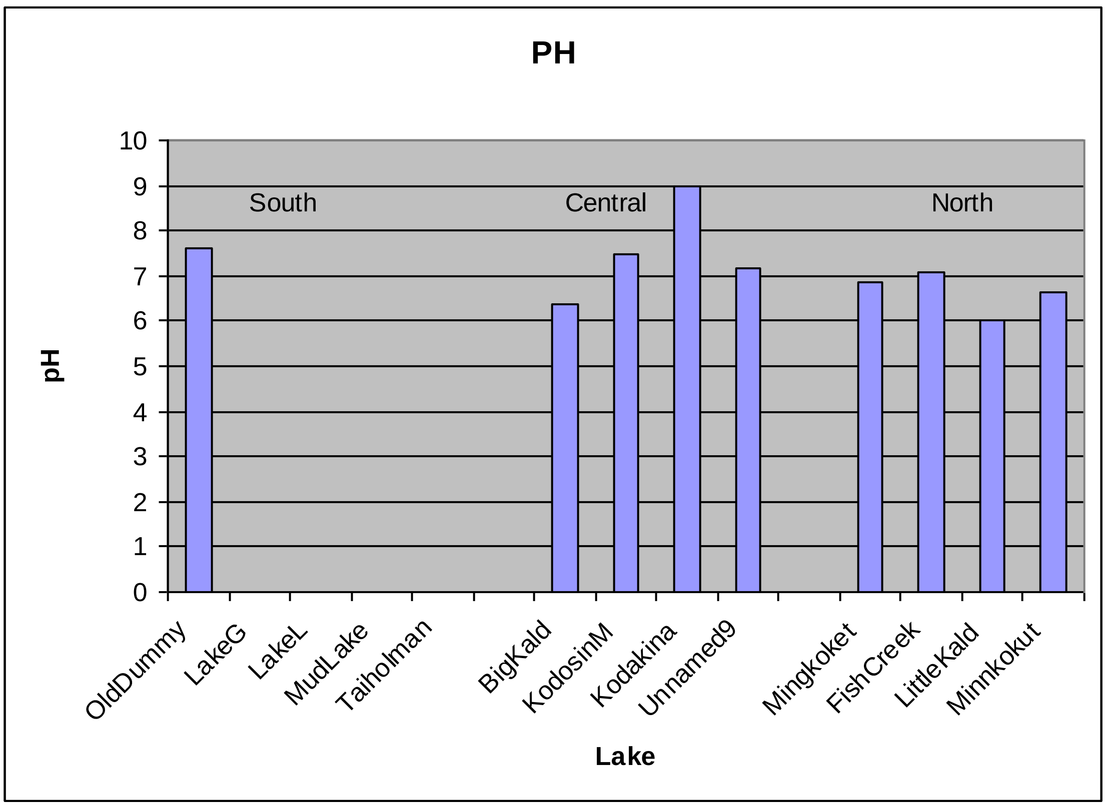



Figure 50. Mean pH of 9 lakes sampled within Kanuti NWR (averaged over both years sampled, if the lake was sampled twice). pH was not collected at Lake G, Lake L, Mud Lake, or Taiholman Lake.

## Water Color

Water color varied among lakes and among years (Table 16, Figure 51).

**Tests of Between-Subjects Effects**

Table 16. Two-way ANOVA of SiteName x Year, on Water Color

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 71246.980(a) | 17 | 4190.999 | 2440.641 | .000 |
| Intercept | 149847.372 | 1 | 149847.372 | 87264.058 | .000 |
| SiteName | 25951.650 | 12 | 2162.637 | 1259.418 | .000 |
| Year | 11606.667 | 2 | 5803.333 | 3379.588 | .000 |
| SiteName * Year | 4032.333 | 3 | 1344.111 | 782.747 | .000 |
| Error | 56.667 | 33 | 1.717 | | |
| Total | 240786.000 | 51 | | | |
| Corrected Total | 71303.647 | 50 | | | |

$R^2$ = .999 (Adjusted $R^2$ = .999)

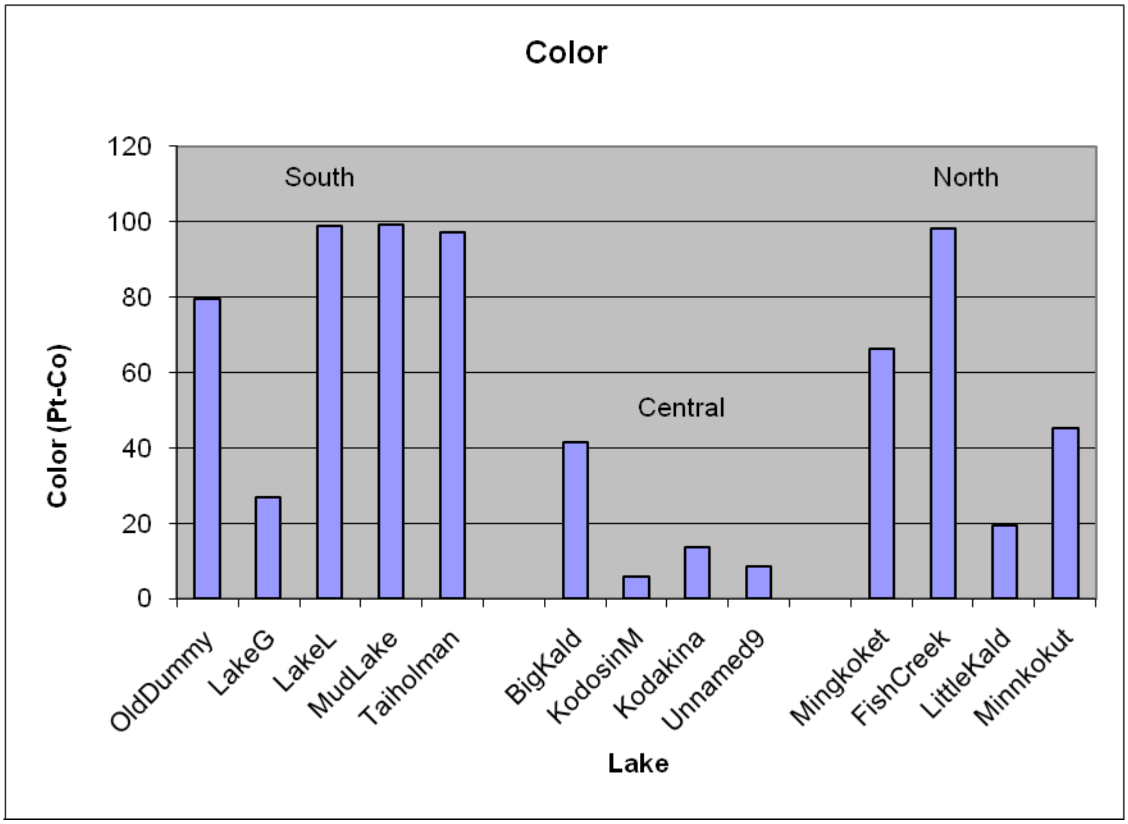



Figure 51. Mean water color at 13 lakes sampled within Kanuti NWR(averaged over both years, if the lake was sampled twice).

## Conductivity

Conductivity, or specific conductance, is a measure of how well the water can carry an electric current. This provides a measure of the ionic concentrations of the water, and is often used as a surrogate for the amount of dissolved nutrients present, such as nitrate or phosphate. In general, higher conductivity means a more productive lake (Table 17, Figure 52).

**Tests of Between-Subjects Effects**

Table 17. Two-way ANOVA of SiteName x Year, on Conductivity

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 39345.000(a) | 17 | 2314.412 | 3079.185 | .000 |
| Intercept | 105233.331 | 1 | 105233.331 | 140006.571 | .000 |
| SiteName | 17962.140 | 12 | 1496.845 | 1991.462 | .000 |
| Year | 446.320 | 2 | 223.160 | 296.901 | .000 |
| SiteName * Year | 27.020 | 3 | 9.007 | 11.983 | .000 |
| Error | 25.555 | 34 | .752 | | |
| Total | 126825.200 | 52 | | | |
| Corrected Total | 39370.555 | 51 | | | |

a $R^2$ = .999 (Adjusted $R^2$ = .999)

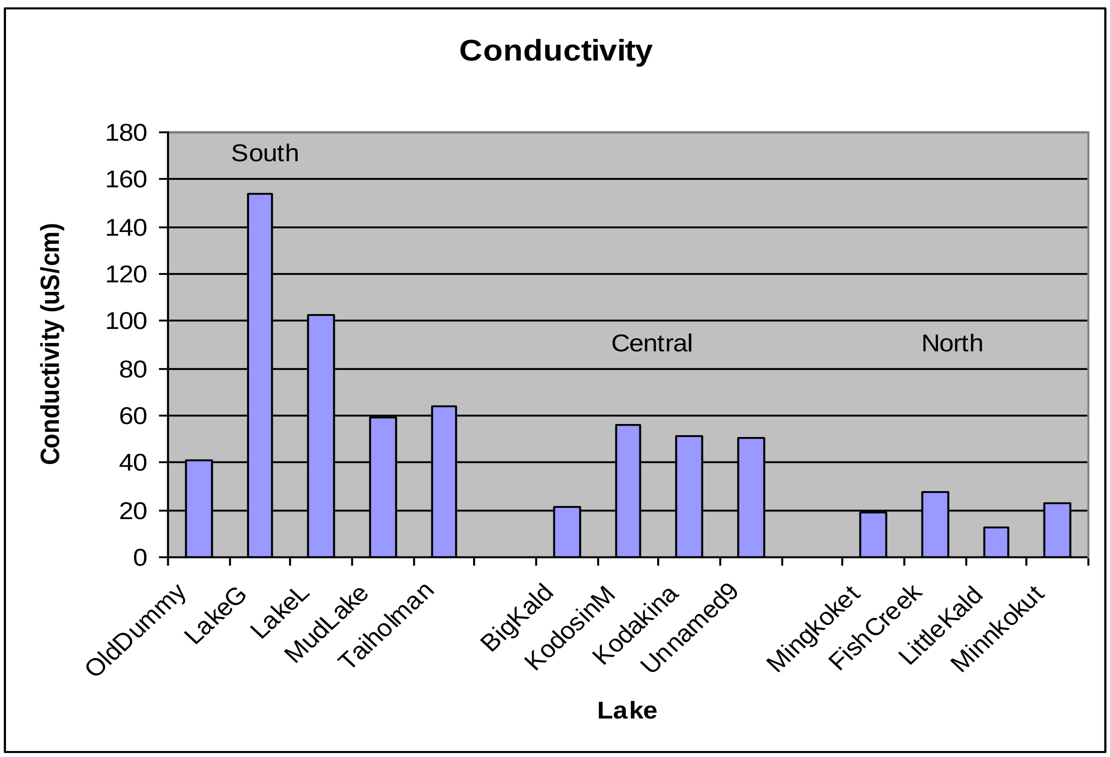



Figure 52. Mean conductivity at 13 lakes sampled within Kanuti NWR (averaged over both years, if the lake was sampled twice).

## Secchi Depth

Secchi depth is a measure of the lake's ability to transmit light; the higher the value, the deeper into the lake light will penetrate (Table 18, Figure 53).

**Tests of Between-Subjects Effects**

Table 18. Two-way ANOVA of SiteName x Year, on Secchi Depth

| **Source** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| Corrected Model | 2.984(a) | 12 | .249 | 41.449 | .000 |
| Intercept | 29.538 | 1 | 29.538 | 4922.976 | .000 |
| SiteName | .934 | 8 | .117 | 19.461 | .000 |
| Year | .035 | 1 | .035 | 5.868 | .036 |
| SiteName * Year | .764 | 3 | .255 | 42.442 | .000 |
| Error | .060 | 10 | .006 | | |
| Total | 37.620 | 23 | | | |
| Corrected Total | 3.044 | 22 | | | |

$R^2 = .980$ (Adjusted $R^2 = .957$)

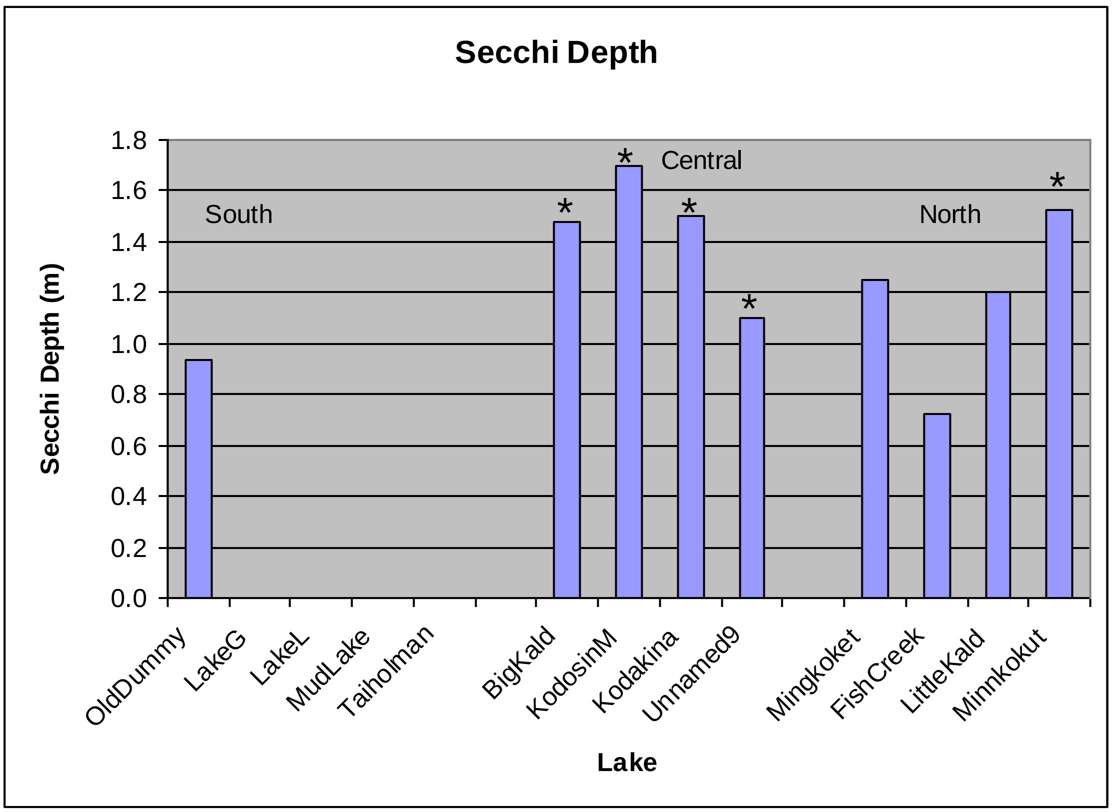



Figure 53. Secchi depth at 9 lakes sampled within Kanuti NWR (averaged over both years, if the lake was sampled twice). Lakes with an asterisk above the bar were too shallow to determine Secchi Depth (i.e., the disk hit the bottom before going out of site).

# Conclusions

## *Summary of Kanuti NWR lakes*

Conclusions about the aquatic invertebrate fauna sampled within lakes of Kanuti National Wildlife Refuge are hard to draw because of several limitations inherent in the sample collection and invertebrate identification.

- Because two different organizations (River Run and ABR) with differing expertise in sorting and identifying were used to process the invertebrate samples, perceived differences among lakes may be due to a laboratory effect rather than a lake effect. For instance, the total number of orders and families found by ABR and River Run differed; therefore, differences among the lakes in number of families may be largely due to differences in identification.
- Because some lakes were sampled both in spring (low abundance) and summer (high abundance), while others were sampled only in summer, differences in abundance may be due to the sampling schedule rather than true differences in abundance. In the among-lakes analyses, only August data were used in an attempt to remove this problem.

In a study like this, in which there are not available resources for identifying all taxa to the same taxonomic level, the family level is probably the best compromise. It is extremely time-consuming (and thus expensive) to identify Chironomidae to genus, and this family is usually the most abundant insect family. Cladocera and Copepoda, the other most abundant taxa, are not difficult to identify to family using the keys provided by Thorp and Covich (1991), and even genus is possible for all the crustacean orders using this reference. Mollusks are likewise identifiable to family. Therefore, with the exception of flatworms, roundworms, and segmented worms, it is the authors' belief that most important taxa could be identified to family. The worm phyla (with the possible exception of the Oligochaeta) often require dissection and compound microscope techniques, as well as expertise that is uncommon, making family-level identification too costly.

Analyses based on numerical abundance can be misleading, especially with taxa of widely divergent sizes, such as found in this study. Cladocera and Copepoda are small planktonic crustaceans that are commonly in the 1-2 mm or smaller size range. Likewise, Chironomidae are small, slender dipterans, often less than 5 mm long. These three groups made up more than 60% of the individuals found in this study. On the other hand, a mature Dytiscidae beetle larva can be as long as 70 mm, and Phryganeidae larvae are 20-40 mm (McCafferty 1981). Therefore, an analysis based on biomass or biovolume would be a more accurate measure of the relative importance of each of the taxa. Biomass data were unfortunately beyond the scope of this project.

These size differences will also skew the results of Functional Feeding Group analyses. Cladocera and Copepoda are collector-filterers and Chironomidae are collector-gatherers. Therefore, large numbers of very small individuals would lead one to believe that the trophic ecology of these lakes is based on a detritus food web. However, if it were possible to do the same analysis on invertebrate biomass, the shredder, scraper, and predator FFGs would assume much greater importance, perhaps changing the conclusions about the trophic base of the food web.

A potential cause of some of the large variation in total abundance and taxonomic composition of macroinvertebrates is the presence or absence of fish. Small fish, such as fingerling salmonids (grayling, whitefish, and salmon) feed extensively on aquatic invertebrates. Presence of small fish will reduce the abundance of invertebrates. Taxa differ in desirability and availability to the predator: benthic taxa such as chironomids are buried in the bottom sediments, and are harder to obtain by the fish (although more susceptible to bottom feeders such as small burbot and slimy sculpin). Meanwhile planktonic taxa such as cladocerans and copepods are in the water column and readily available to juvenile salmonids. The presence or absence of fish is not known for all 13 sampled lakes, so analysis was not possible. We believe that the lakes with the highest abundance of Cladocera and Copepoda are most likely to be fish-free. Another possible scenario for a high abundance of plankton is the presence of many piscivorous fish such as northern pike that would keep the numbers of planktivorous fish low.

Another potential set of causes of variation in macroinvertebrate numbers, especially when most taxa are planktonic, are the immediate environmental conditions. Wind will create chop that causes planktonic taxa to seek refuge in deeper water or in the benthos. Bright sun and water temperature can also cause vertical migration of plankton that can affect the number collected. Although it would be ideal to collect samples during identical weather conditions, the probability of that is vanishingly small in interior Alaska! Keeping records of those conditions might help explain anomalous abundances, however.

The lakes chosen for this study seem to represent a good range of water quality. Conductivity (often used as a surrogate for potential productivity) ranged from about 12 to 50 µS/cm. Although the other water quality measures did not provide much explanatory statistical power, they did provide a general characterization of the lakes as relatively typical shallow taiga lakes, highly influenced by dissolved organic carbon derived from peat in the surrounding drainage basin. Kadakina Lake had an unusually high pH (9.0), but other variables did not seem out of the ordinary.

Despite all the caveats, this study provides valuable baseline data for future studies of the lakes of Kanuti NWR. The study provided a taxa list for 13 lakes (with the caveat that some identifications should be confirmed by experts) which can be used to plan further studies.

## *Recommendations for future aquatic biomonitoring*

It is recommended that the biomonitoring program in Kanuti NWR be continued. Alaska is a huge and diverse piece of geography, with at least 20 ecoregions and covering over 145,686,831 hectares. Little is known about the aquatic biota of regions that are off the road system. Continuing this sampling program may have both intended and unintended benefits:

- It will provide the basis of one part of an inventory of the biota of Kanuti National Wildlife Refuge. This type of endeavor is being done in the National Park System, and is a good idea for all government-managed land areas. It is hard to tell if a species goes missing, if an adequate inventory does not already exist.
- It may provide data to help in comparisons of different land areas within the same ecoregion (e.g., Yukon Flats NWR, Minto Flats, Yukon-Charley National Preserve). A standardized protocol for sampling, sorting, and identifying invertebrates to be used by all regions is a must need for this type of analysis.
- It may provide data for comparison with similar habitat types in other ecoregions (e.g., south-central Alaska taiga lakes, north slope tundra lakes), perhaps along a latitudinal gradient. A study like this might be of interest to the Long-term Ecological Research program at the Univerity of Alaska Fairbanks. As previously mentioned, a standardized protocol for sampling, sorting, and identifying invertebrates to be used by all regions is necessary for this type of analysis.

- It may provide baseline data for year-to-year variations that may become more pronounced as global climate change continues, although a standardized taxonomy is essential for this type of study (see below).

If there are significant financial constraints, then we recommend that a decision be made on whether to focus on year-to-year or within-year variations. With the existing data set, those two questions cannot be separated, and even among-lakes comparisons are compromised.

Therefore, the most important recommendation is to design future studies to be fully balanced. For example, if one of the questions is how lakes vary from year to year, then all lakes in the study should be sampled in all years of the study. Likewise, if seasonal variations are of interest, then all lake should be sampled in all seasons. It bears repeating that all samples at a minimum should be identified using the same protocols and the same taxonomic references (the new edition of Merritt and Cummins for insects and Thorp and Covich for non-insects are recommended), if not the same personnel at the same laboratory. Additionally, taxa should be identified to the same taxonomic levels (we recommend family for statistical analysis, and genus for insects to provide presence/absence and biogeographic data and possible range extensions).

Other recommendations are as follows:

- Use a standardized database for data entry, either a true relational database (e.g., MS Access) or a spreadsheet (e.g,. MS Excel). If the spreadsheets are standardized, then less time will have to be spent reformatting the data for statistical analysis.
    - A relational database is preferable, because it can output data files for the different taxonomic levels. A lot of time was spent creating the Families, Orders, Classes, FFGs data files.
    - Having the taxa in the same order would also save time. The 1999 data was ordered alphabetically within each taxonomic level, while the 2000-2001 data were ordered alphabetically by the lowest taxonomic level.
    - Identifications to the same taxonomic level would allow more comparisons. For instance, clams were identified to snails (Gastropoda) in 1999, but to family (Planorbidae and Physidae, although the physids were incorrectly called clams [Pelycepoda] by the identifier) in 2000-01. There are several other instances of this.
    - Because the National Park Service is using a Microsoft Access database, perhaps that would be a good standard.
- Given that biomass or biovolume estimates would allow for better ecological conclusions, pursuit of such is desirable where possible. Ecologically, the impact of an organism on its environment is more related to the amount of biomass present than to the number of individuals present. For example, a given amount of biomass might be made up of one large shredder Limnephilid caddisfly or by 500 small copepods.

  Obtaining biomass estimates, however, would add to the cost of processing and identifying the invertebrates. A low cost compromise might be to develop correction factors. For taxa that tend to all be roughly the same size (e.g., Cladocera, Copepoda), a mean-size correction could be developed. For insects, which grow through several instars, a length to biomass regression could be developed. The first technique requires a substantial, one-time investment up front, but then all numbers could be multiplied by the transformation factor. In the second technique, however, every individual identified for that taxon would have to also be measured or put into a size class. This could add substantial time and cost to the invertebrate sample processing contract.

- Hach makes a good, portable field lab that might allow more detailed water quality analyses. Model DREL-2000 was about $2500; it includes a rugged spectrophotometer that allows many different tests, such as nitrate, phosphate and the like.

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## Appendices

Appendix 1 covers the taxa that are questionably identified, and presents the solution used in this report.
Appendix 1a: Computer directories and files provided as part of this report

Appendices 2-7 present the descriptive statistics calculated from the raw data:



Appendices 8-13 present the results of statistical analyses based on the data in appendices 2-7. Available from Kanuti NWR on request; not included in this report.

8. : Total abundance, total number of each taxonomic level, and number of the various taxa.
9. : ANOVAs testing the effect of lake (SiteName), with post-hoc tests of least significant difference (LSD) to see which lakes differ from which.
10. : One-way and two-way ANOVAs on Year or Season by Site, with post-hoc tests for difference between means.
11. : ANOVAs on geomorphic regions (major drainage basins).
12. : ANOVAs on functional feeding groups.
13. : ANOVAs on water quality data.

## *Appendix 1: Taxa present*

### Questionable taxa in the macroinvertebrate identifications.

If there is no reason given, then it is just because I have never seen it in interior Alaska. That doesn't mean that it isn't here, just that I have never seen it. These questionable taxa were all left in for the analyses, on the assumption that even if the IDs were wrong, they were probably a different taxon from all the others. Because the River Run data were only identified to family, there are fewer questionable taxa in that data set. M&C refers to Merritt and Cummins (1984).

- *Acerpenna* (Ephemeroptera) – not found in M&C. Internet research suggests that it used to be a *Baetis* species, but has recently been elevated to genus.
- *Callibaetis* (Ephemeroptera)
- *Centroptilum* (Ephemeroptera)
- *Ceraclea* (Trichoptera) – never seen it, but could be here.
- *Grammotaulius* (Trichoptera)
- *Haliplus* (Coleoptera)
- Helodidae (Coleoptera)
- *Hydrobius* (Coleoptera) – found in the east (M&C)
- Limnephilidae (early instar) – I counted this as a separate taxon, because the site with the most abundance did not have the other 3 limnephilids. Therefore, I think it might be a different species with a later life cycle that was too small to ID to species.
- *Limonia* (Tipulidae)
- *Mesovelia* (Gerridae) – although the ABR identifier put this genus in Gerridae, M&C put it in Mesoveliidae.
- *Microvelia* (Gerridae) – although the ABR identifier put this genus in Gerridae, M&C put it in Veliidae.
- *Nemotaulius hostilis* (Limnephilidae) – I was going to say "how did they get this to species," but it is a monotypic genus.
- *Oecetis* (Leptoceridae) – this one may be okay
- *Phalacocera* (Tipulidae)
- Phoridae (Diptera) – M&C say widespread, but I have never seen it (or heard of it) in Alaska.

1999 data (not present in 2000-01)

- Ephemerellidae (normally found in rivers)
- Ameletidae (normally found in rivers)
- Veliidae (might be confused with Gerridae, but both ABR and RR found it).
- Conchostraca (clam shrimps) – could be confused with Ostracoda (seed shrimps). Clam shrimps usually live in temporary pools or ponds, rather than permanent lakes.

### Terrestrial taxa eliminated from analysis

- Carabidae (Coleoptera: predaceous ground beetles). Terrestrial species that are often found on the emergent portions of macrophytes. There are 2 species that are marine and associated with rocky coasts of the Pacific, but these are most likely terrestrials.

- Chrysomelidae (Coleoptera: leaf beetles). There are a few genera of aquatic leaf beetles, but these were likely terrestrials that fell into the sample. [Late in the analyses, I discovered that there is an aquatic species of Galerucella found in interior Alaska, associated with pond lilies. I did not have the time to re-do the analyses, but the conclusions are not likely to change.]
- Climacia (Neuroptera: spongilla flies). This genus feeds as larvae on aquatic sponges. While possibly found in Kanuti NWR, my best guess is that this is a mis-identification.
- Muscidae (Diptera) – some species will use rotting salmon carcasses as larval food, but not likely the case in a lake. Probably fell in during sampling.
- Staphylinidae (Coleoptera). Primarily a terrestrial family, many species live on the plants that grow immediately adjacent to water bodies, or on the terrestrial portion of emergent aquatic macrophytes.
- Unknown Diptera were included in analyses of Classes and Orders (and combined with Insecta and Diptera, respectively), but not Families and Taxa, since they were probably members of one of the families already included in the analyses.
- I DID include Brachycera in the family analyses, even though it is a suborder. I guessed that it was probably different than the other families. However, it is equally likely that it was a terrestrial that fell into the sample.

## Appendix 1a. Computer directories and files provided as part of this report (bold files are this report and the final data files)

Archive-Original Files
- 02-415 Data 10-31-02.xls
- 02-415 report memo 9-30-02.doc
- invertsample2000.pdf
- Kanuti Invertebrate Data-Riverrun Contract.xls
- KanutiLimnology.xls
- trAquaticInvert2001.pdf

archive-intermediate files
- 02-415 Data 10-31-02.xls
- 1999_2001data.xls
- 1999data.xls
- 1999data_720.xls
- 2000_2001data.xls
- datafile_2spss (version 1).xls
- datafile_2spss.xls
- datafile_7_18.xls
  - depth_taxa.xls
- graphs.xls
- Kanuti Invertebrate Data-Riverrun Contract.xls
- KanutiLimnology.xls

Documents
- 02-415 report memo 9-30-02.doc
- invertsample2000.pdf
- INVOICE.doc
- milner_oswood.pdf
- trAquaticInvert2001.pdf

Excel files
- **1999_2001data_newdepth.xls**
- FWSHours.xls
- **graphs.xls**
- **presence_absence.xls**
- **water_quality.xls**

PC-ORD files
- 1999fam.txt
- fam1999.sav
- fam1999.wk1
- taxa.wk1

Report
- **Appendix 02 - Desc-Total, Taxa.doc**
- **Appendix 03 - Desc-Lakes.doc**
- **Appendix 04 - Desc-Year_Season.doc**
- **Appendix 05 - Desc-Region.doc**
- **Appendix 06 - Desc-FFG.doc**
- **Appendix 07 - Desc-WQ.doc**
- **Appendix 08 - Stat-Total_taxa.doc**
- **Appendix 09 - Stat-Lakes_posthoc.doc**
- **Appendix 10 - Stat-Year_Season.doc**
- **Appendix 11 - Stat-Region.doc**
- **Appendix 12 - Stat-FFG.doc**
- **Appendix 13 - Stat-WaterQual.doc**
- **Appendix 14 - Presence_Absence.doc**
- **Draft Report.doc**
- notes.doc

SPSS files

**classes.sav**
**depth_new.sav**
**families.sav**
**ffg-fam.sav**
**ffg-taxa.sav**
**orders.sav**
**taxa.sav**
**water_quality.sav**

SPSS output files

anova_classes.spo
anova_ETO.spo
anova_families.spo
anova_ffg_fam.spo
anova_orders.spo
anova_taxa.spo
anova_total.spo
anovas_august.spo
descr_classes_total.spo
descr_families.spo
descr_ffg.spo
descr_ffg_fam.spo
descr_orders.spo
descr_taxa.spo
water_quality.spo

**Appendix 2: Descriptive statistics for total abundance of individuals and taxonomic levels.**

Table 1. Descriptive Statistics on total number of individuals, number of classes per sample, and each class present.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total | 181 | 1 | 5090 | 493.38 | 605.610 |
| Classes | 181 | 1 | 8 | 5.44 | 1.367 |
| Arachnoidea | 181 | 0 | 48 | 1.93 | 5.512 |
| Crustacea | 181 | 0 | 3670 | 239.78 | 431.956 |
| Gastropoda | 181 | 0 | 330 | 17.51 | 33.664 |
| Hirudinea | 181 | 0 | 24 | .76 | 2.615 |
| Hydrozoa | 181 | 0 | 3 | .03 | .234 |
| Insecta | 181 | 1 | 1690 | 191.96 | 273.902 |
| Nematoda | 181 | 0 | 277 | 6.24 | 29.089 |
| Nematomorpha | 181 | 0 | 3 | .03 | .246 |
| Oligochaeta | 181 | 0 | 430 | 22.85 | 48.561 |
| Pelycepoda | 181 | 0 | 112 | 12.29 | 19.496 |
| Turbellaria | 181 | 0 | 2 | .01 | .149 |
| Valid N (listwise) | 181 | | | | |

Table 2. Descriptive Statistics on total number of individuals, number of orders per sample, ETO ratio, and each order present. The ETO ratio is the sum of Ephemeroptera, Trichoptera, and Odonata, divided by the total number in the sample.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total | 181 | 1 | 5090 | 493.38 | 605.610 |
| Orders | 181 | 1 | 16 | 9.93 | 2.691 |
| ETO | 181 | .0% | 39.0% | 5.417% | 5.8156% |
| Amphipoda | 181 | 0 | 3612 | 42.70 | 273.034 |
| Aranae | 181 | 0 | 48 | 1.93 | 5.512 |
| Clacocera | 181 | 0 | 3470 | 138.42 | 312.246 |
| Coleoptera | 181 | 0 | 36 | 2.05 | 4.807 |
| Concostraca | 181 | 0 | 17 | .51 | 2.243 |
| Copepoda | 181 | 0 | 1324 | 56.09 | 133.917 |
| Diptera | 181 | 1 | 1590 | 163.40 | 258.830 |
| Ephemeroptera | 181 | 0 | 46 | 1.14 | 4.429 |
| Gastropoda | 181 | 0 | 330 | 17.51 | 33.664 |
| Hemiptera | 181 | 0 | 136 | 6.61 | 16.521 |
| Hirudinea | 181 | 0 | 24 | .76 | 2.615 |
| Hydrozoa | 181 | 0 | 3 | .03 | .234 |
| Nematoda | 181 | 0 | 277 | 6.24 | 29.089 |
| Nematomorpha | 181 | 0 | 3 | .03 | .246 |
| Odonata | 181 | 0 | 75 | 9.00 | 13.637 |
| Oligochaeta | 181 | 0 | 430 | 22.85 | 48.561 |
| Ostrocoda | 181 | 0 | 70 | 2.05 | 7.569 |
| Pelycopoda | 181 | 0 | 112 | 12.29 | 19.496 |
| Trichoptera | 181 | 0 | 129 | 9.76 | 17.106 |
| Turbellaria | 181 | 0 | 2 | .01 | .149 |
| Valid N (listwise) | 181 | | | | |

Table 3. Descriptive Statistics on total number of individuals, number of families per sample, and each family present.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total | 181 | 1 | 5090 | 493.20 | 605.539 |
| Families | 181 | 1 | 23 | 12.91 | 4.011 |
| Aeshnidae | 181 | 0 | 20 | .57 | 1.868 |
| Ameletidae | 181 | 0 | 1 | .02 | .128 |
| Baetidae | 181 | 0 | 46 | .71 | 4.246 |
| Brachycera | 181 | 0 | 36 | .66 | 3.550 |
| Caenidae | 181 | 0 | 9 | .40 | 1.283 |
| Ceratopogonidae | 181 | 0 | 52 | 3.18 | 6.917 |
| Chironomidae | 181 | 1 | 1575 | 157.74 | 256.045 |
| Cladocera | 181 | 0 | 3470 | 138.42 | 312.246 |
| Coenagrionidae | 181 | 0 | 70 | 7.45 | 12.310 |
| Conchostraca | 181 | 0 | 17 | .51 | 2.243 |
| Copepoda | 181 | 0 | 1324 | 56.09 | 133.917 |
| Corduliidae | 181 | 0 | 4 | .06 | .451 |
| Corixidae | 181 | 0 | 136 | 5.68 | 16.533 |
| Culicidae | 181 | 0 | 10 | .10 | .813 |
| Dixidae | 181 | 0 | 27 | .50 | 2.577 |
| Dytiscidae | 181 | 0 | 9 | .55 | 1.353 |
| Empididae | 181 | 0 | 3 | .03 | .256 |
| Ephemerellidae | 181 | 0 | 1 | .01 | .074 |
| Gastropod | 181 | 0 | 330 | 9.40 | 32.824 |
| Gyrinidae | 181 | 0 | 5 | .14 | .604 |
| Gerridae | 181 | 0 | 15 | .47 | 1.925 |
| Haliplidae | 181 | 0 | 32 | .90 | 3.224 |
| Helodidae | 181 | 0 | 18 | .14 | 1.434 |
| Hirudinea | 181 | 0 | 24 | .76 | 2.615 |
| Hyallelidae | 181 | 0 | 3612 | 42.70 | 273.034 |
| Hydracarina | 181 | 0 | 48 | 1.93 | 5.512 |
| Hydridae | 181 | 0 | 3 | .03 | .234 |
| Hydrophilidae | 181 | 0 | 18 | .32 | 1.722 |
| Hydroptilidae | 181 | 0 | 46 | 1.67 | 5.616 |
| Leptoceridae | 181 | 0 | 10 | .40 | 1.291 |
| Libellulidae | 181 | 0 | 13 | .92 | 2.262 |
| Limnephilidae | 181 | 0 | 15 | 1.26 | 2.284 |
| Nematoda | 181 | 0 | 277 | 6.24 | 29.089 |
| Nematomorpha | 181 | 0 | 3 | .03 | .246 |
| Oligochaeta | 181 | 0 | 430 | 22.85 | 48.561 |
| Ostracoda | 181 | 0 | 70 | 2.05 | 7.569 |
| Phoridae | 181 | 0 | 2 | .01 | .149 |
| Phryganeidae | 181 | 0 | 123 | 5.91 | 15.257 |
| Physidae | 181 | 0 | 33 | 2.97 | 6.349 |
| Planorbidae | 181 | 0 | 74 | 8.11 | 14.460 |
| Polycentropidae | 181 | 0 | 30 | .50 | 2.626 |
| Psychodidae | 181 | 0 | 12 | .23 | 1.212 |
| Saldidae | 181 | 0 | 8 | .24 | 1.032 |

| Appendix 2, Table 3, continued. Descriptive Statistics on total number of individuals, number of families per sample, and each family present. | | | | | |
|---|---|---|---|---|---|
| | N | Minimum | Maximum | Mean | Std. Deviation |
| Sciomyzidae | 181 | 0 | 6 | .14 | .741 |
| Stratiomyidae | 181 | 0 | 22 | .40 | 2.334 |
| Sphaeriidae | 181 | 0 | 84 | 9.32 | 15.484 |
| Tabanidae | 181 | 0 | 10 | .09 | .770 |
| Tipulidae | 181 | 0 | 6 | .14 | .626 |
| Turbellaria | 181 | 0 | 2 | .01 | .149 |
| Veliidae | 181 | 0 | 10 | .22 | 1.222 |
| Valid N (listwise) | 181 | | | | |

Table 4. Descriptive Statistics on total number of individuals, number of taxa per sample, and each taxon present.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total | 131 | 1 | 5090 | 498.72 | 593.647 |
| Taxa | 131 | 1 | 26 | 13.39 | 4.609 |
| Acari | 131 | 0 | 12 | .69 | 1.764 |
| Acerpenna | 131 | 0 | 6 | .05 | .531 |
| Aeshna | 131 | 0 | 20 | .62 | 2.039 |
| Atrichopogon | 131 | 0 | 6 | .06 | .537 |
| Brachycera | 131 | 0 | 36 | .93 | 4.148 |
| Caenis | 131 | 0 | 9 | .49 | 1.451 |
| Callibaetis | 131 | 0 | 2 | .07 | .342 |
| Centroptilum | 131 | 0 | 46 | .82 | 4.952 |
| Ceraclea | 131 | 0 | 0 | .00 | .000 |
| Chironomidae | 131 | 1 | 1575 | 162.82 | 259.618 |
| Cladocera | 131 | 0 | 3470 | 154.77 | 360.037 |
| Ceonagrion | 131 | 0 | 70 | 6.84 | 11.741 |
| Copepoda | 131 | 0 | 1324 | 59.42 | 151.185 |
| Corixidae | 131 | 0 | 136 | 6.37 | 19.236 |
| Culicidae | 131 | 0 | 10 | .15 | .954 |
| Dasyhelea | 131 | 0 | 19 | .62 | 2.487 |
| DipteraA | 131 | 0 | 8 | .08 | .724 |
| DipteraB | 131 | 0 | 4 | .03 | .349 |
| DipteraC | 131 | 0 | 5 | .08 | .536 |
| DipteraD | 131 | 0 | 5 | .04 | .437 |
| DipteraE | 131 | 0 | 0 | .00 | .000 |
| Dixella | 131 | 0 | 4 | .14 | .634 |
| Dytiscidae | 131 | 0 | 9 | .49 | 1.440 |
| Gerridae | 131 | 0 | 6 | .18 | .756 |
| Grammotaulius | 131 | 0 | 1 | .01 | .087 |
| Gyrinus | 131 | 0 | 5 | .17 | .692 |
| Haliplus | 131 | 0 | 24 | .89 | 2.567 |
| Helodidae | 131 | 0 | 18 | .20 | 1.684 |
| Hirudinea | 131 | 0 | 16 | .62 | 1.820 |

Appendix 2, Table 4., continued. Descriptive Statistics on total number of individuals, number of taxa per sample, and each taxon present.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Hyalella | 131 | 0 | 348 | 21.37 | 46.802 |
| Hydra | 131 | 0 | 3 | .04 | .275 |
| Hydrobius | 131 | 0 | 1 | .02 | .152 |
| Hydrophilidae | 131 | 0 | 18 | .42 | 2.004 |
| Hydroptila | 131 | 0 | 7 | .10 | .730 |
| Leucorrhinia | 131 | 0 | 13 | 1.13 | 2.571 |
| Libellulidae | 131 | 0 | 1 | .02 | .123 |
| Limnephilidae | 131 | 0 | 15 | .57 | 1.851 |
| Limnephilus | 131 | 0 | 10 | .31 | 1.107 |
| Limonia | 131 | 0 | 2 | .03 | .213 |
| Mesovelia | 131 | 0 | 8 | .17 | .872 |
| Microvelia | 131 | 0 | 14 | .30 | 1.538 |
| Mystacides | 131 | 0 | 8 | .29 | 1.007 |
| Nematoda | 131 | 0 | 277 | 7.89 | 34.012 |
| Nematomorpha | 131 | 0 | 3 | .04 | .288 |
| Nemotaulius | 131 | 0 | 10 | .84 | 1.776 |
| Oecetis | 131 | 0 | 10 | .26 | 1.060 |
| Oligochaeta | 131 | 0 | 430 | 26.57 | 55.848 |
| Oligotricha | 131 | 0 | 123 | 5.84 | 15.193 |
| Ostracoda | 131 | 0 | 70 | 1.49 | 7.232 |
| Oxyethira | 131 | 0 | 46 | 1.67 | 5.955 |
| Palpomyia | 131 | 0 | 42 | 3.04 | 6.285 |
| Pericoma | 131 | 0 | 2 | .02 | .158 |
| Phalacrocera | 131 | 0 | 1 | .01 | .087 |
| Phoridae | 131 | 0 | 2 | .02 | .175 |
| Physidae | 131 | 0 | 33 | 4.10 | 7.150 |
| Planorbidae | 131 | 0 | 74 | 11.20 | 15.956 |
| Polycentropus | 131 | 0 | 30 | .70 | 3.068 |
| Psychoda | 131 | 0 | 12 | .29 | 1.374 |
| Saldidae | 131 | 0 | 8 | .33 | 1.202 |
| Sciomyzidae | 131 | 0 | 6 | .20 | .866 |
| Somatochlora | 131 | 0 | 4 | .08 | .528 |
| Sphaeriidae | 131 | 0 | 84 | 10.90 | 17.012 |
| Stratiomyidae | 131 | 0 | 22 | .55 | 2.731 |
| Tabanidae | 131 | 0 | 10 | .12 | .904 |
| Tipula | 131 | 0 | 2 | .05 | .274 |
| Tipulidae | 131 | 0 | 2 | .01 | .146 |
| Triaenodes | 131 | 0 | 1 | .02 | .123 |
| Turbellaria | 131 | 0 | 2 | .02 | .175 |
| Ulomorpha | 131 | 0 | 6 | .07 | .558 |
| Valid N (listwise) | 131 | | | | |

**Appendix 3: Descriptive statistics for among-lake comparisons at each taxonomic level. Total is included with Classes, and ETO is included with Orders.**

Table 1. Descriptive Statistics on total number of individuals and number of classes per sample in each of the Kanuti NWR lakes.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| BigKald | Total | 20 | 101 | 2295 | 651.88 | 584.686 |
| | Classes | 20 | 4 | 8 | 5.85 | 1.137 |
| | Valid N (listwise) | 20 | | | | |
| FishCreek | Total | 20 | 1 | 916 | 305.44 | 292.943 |
| | Classes | 20 | 1 | 8 | 5.05 | 1.669 |
| | Valid N (listwise) | 20 | | | | |
| Kodakina | Total | 10 | 344 | 1579 | 742.12 | 350.429 |
| | Classes | 10 | 4 | 7 | 5.90 | 1.101 |
| | Valid N (listwise) | 10 | | | | |
| KodosinM | Total | 10 | 228 | 885 | 463.17 | 239.783 |
| | Classes | 10 | 2 | 8 | 5.50 | 1.780 |
| | Valid N (listwise) | 10 | | | | |
| LakeG | Total | 10 | 130 | 1599 | 415.90 | 429.447 |
| | Classes | 10 | 6 | 8 | 6.40 | .699 |
| | Valid N (listwise) | 10 | | | | |
| LakeL | Total | 10 | 50 | 624 | 245.70 | 158.979 |
| | Classes | 10 | 3 | 7 | 5.10 | 1.524 |
| | Valid N (listwise) | 10 | | | | |
| LittleKald | Total | 10 | 180 | 5090 | 1402.90 | 1439.493 |
| | Classes | 10 | 3 | 6 | 5.10 | .994 |
| | Valid N (listwise) | 10 | | | | |
| Mingkoket | Total | 20 | 18 | 938 | 229.08 | 280.515 |
| | Classes | 20 | 3 | 7 | 5.00 | 1.026 |
| | Valid N (listwise) | 20 | | | | |
| Minnkokut | Total | 20 | 38 | 1060 | 386.70 | 340.550 |
| | Classes | 20 | 2 | 7 | 4.90 | 1.553 |
| | Valid N (listwise) | 20 | | | | |
| MudLake | Total | 10 | 70 | 494 | 293.60 | 141.753 |
| | Classes | 10 | 4 | 6 | 4.90 | .738 |
| | Valid N (listwise) | 10 | | | | |
| OldDummy | Total | 21 | 45 | 1695 | 288.29 | 398.265 |
| | Classes | 21 | 3 | 7 | 5.38 | 1.117 |
| | Valid N (listwise) | 21 | | | | |
| Taiholman | Total | 10 | 45 | 3796 | 1000.30 | 1144.591 |
| | Classes | 10 | 3 | 8 | 6.50 | 1.841 |
| | Valid N (listwise) | 10 | | | | |
| Unnamed9 | Total | 10 | 190 | 930 | 614.91 | 231.659 |
| | Classes | 10 | 5 | 8 | 6.10 | 1.101 |
| | Valid N (listwise) | 10 | | | | |

Table 2. Descriptive Statistics on total number of individuals, ETO ratio, and number of orders per sample in each of the Kanuti NWR lakes.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| BigKald | Total | 20 | 101 | 2295 | 651.88 | 584.686 |
| | Orders | 20 | 9 | 13 | 10.50 | 1.235 |
| | ETO | 20 | .2% | 20.4% | 9.067% | 6.3395% |
| | Valid N (listwise) | 20 | | | | |
| FishCreek | Total | 20 | 1 | 916 | 305.44 | 292.943 |
| | Orders | 20 | 1 | 14 | 8.45 | 3.776 |
| | ETO | 20 | .0% | 21.4% | 3.935% | 5.2833% |
| | Valid N (listwise) | 20 | | | | |
| Kodakina | Total | 10 | 344 | 1579 | 742.12 | 350.429 |
| | Orders | 10 | 8 | 13 | 10.70 | 1.567 |
| | ETO | 10 | .0% | 1.1% | .375% | .4531% |
| | Valid N (listwise) | 10 | | | | |
| KodosinM | Total | 10 | 228 | 885 | 463.17 | 239.783 |
| | Orders | 10 | 8 | 15 | 10.90 | 2.132 |
| | ETO | 10 | 1.3% | 21.0% | 5.474% | 5.8057% |
| | Valid N (listwise) | 10 | | | | |
| LakeG | Total | 10 | 130 | 1599 | 415.90 | 429.447 |
| | Orders | 10 | 10 | 15 | 11.90 | 1.370 |
| | ETO | 10 | 1.7% | 27.6% | 8.425% | 7.9416% |
| | Valid N (listwise) | 10 | | | | |
| LakeL | Total | 10 | 50 | 624 | 245.70 | 158.979 |
| | Orders | 10 | 7 | 15 | 10.70 | 2.983 |
| | ETO | 10 | .0% | 14.0% | 5.933% | 3.8526% |
| | Valid N (listwise) | 10 | | | | |
| LittleKald | Total | 10 | 180 | 5090 | 1402.90 | 1439.493 |
| | Orders | 10 | 7 | 12 | 9.90 | 1.524 |
| | ETO | 10 | 1.6% | 13.9% | 4.429% | 3.6450% |
| | Valid N (listwise) | 10 | | | | |
| Mingkoket | Total | 20 | 18 | 938 | 229.08 | 280.515 |
| | Orders | 20 | 5 | 14 | 9.25 | 2.573 |
| | ETO | 20 | 1.5% | 39.0% | 8.897% | 9.6650% |
| | Valid N (listwise) | 20 | | | | |
| Minnkokut | Total | 20 | 38 | 1060 | 386.70 | 340.550 |
| | Orders | 20 | 3 | 12 | 8.05 | 2.946 |
| | ETO | 20 | .0% | 16.8% | 6.406% | 4.2856% |
| | Valid N (listwise) | 20 | | | | |
| MudLake | Total | 10 | 70 | 494 | 293.60 | 141.753 |
| | Orders | 10 | 8 | 13 | 10.40 | 1.578 |
| | ETO | 10 | .0% | 8.5% | 2.333% | 2.7001% |
| | Valid N (listwise) | 10 | | | | |
| OldDummy | Total | 21 | 45 | 1695 | 288.29 | 398.265 |
| | Orders | 21 | 5 | 15 | 9.00 | 2.627 |
| | ETO | 21 | .0% | 10.6% | 2.797% | 3.1418% |
| | Valid N (listwise) | 21 | | | | |

Appendix 3, Table 2., continued

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| Taiholman | Total | 10 | 45 | 3796 | 1000.30 | 1144.591 |
| | Orders | 10 | 8 | 16 | 12.80 | 2.394 |
| | ETO | 10 | .0% | 6.2% | 3.201% | 2.3473% |
| | Valid N (listwise) | 10 | | | | |
| Unnamed9 | Total | 10 | 190 | 930 | 614.91 | 231.659 |
| | Orders | 10 | 10 | 13 | 11.10 | 1.197 |
| | ETO | 10 | 4.0% | 7.2% | 5.400% | 1.2411% |
| | Valid N (listwise) | 10 | | | | |

Table 3. Descriptive Statistics on number of families per sample in each of the Kanuti NWR lakes.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| BigKald | Families | 20 | 10 | 18 | 14.65 | 2.007 |
| | Valid N (listwise) | 20 | | | | |
| FishCreek | Families | 20 | 1 | 18 | 9.90 | 5.004 |
| | Valid N (listwise) | 20 | | | | |
| Kodakina | Families | 10 | 13 | 23 | 17.20 | 3.521 |
| | Valid N (listwise) | 10 | | | | |
| KodosinM | Families | 10 | 13 | 21 | 16.40 | 3.134 |
| | Valid N (listwise) | 10 | | | | |
| LakeG | Families | 10 | 12 | 22 | 15.20 | 3.425 |
| | Valid N (listwise) | 10 | | | | |
| LakeL | Families | 10 | 7 | 17 | 12.50 | 3.064 |
| | Valid N (listwise) | 10 | | | | |
| LittleKald | Families | 10 | 10 | 19 | 12.80 | 2.573 |
| | Valid N (listwise) | 10 | | | | |
| Mingkoket | Families | 20 | 5 | 17 | 11.65 | 3.422 |
| | Valid N (listwise) | 20 | | | | |
| Minnkokut | Families | 20 | 3 | 17 | 11.50 | 4.007 |
| | Valid N (listwise) | 20 | | | | |
| MudLake | Families | 10 | 8 | 14 | 11.10 | 2.132 |
| | Valid N (listwise) | 10 | | | | |
| OldDummy | Families | 21 | 7 | 17 | 10.33 | 2.576 |
| | Valid N (listwise) | 21 | | | | |
| Taiholman | Families | 10 | 8 | 18 | 13.70 | 2.908 |
| | Valid N (listwise) | 10 | | | | |
| Unnamed9 | Families | 10 | 14 | 21 | 17.60 | 2.221 |
| | Valid N (listwise) | 10 | | | | |

Table 4. Descriptive Statistics on number of taxa per sample in each of the Kanuti NWR lakes.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| BigKald | Total | 20 | 101 | 2295 | 651.88 | 584.686 |
| | Taxa | 20 | 10 | 19 | 15.10 | 2.337 |
| | Valid N (listwise) | 20 | | | | |
| FishCreek | Total | 20 | 1 | 916 | 305.44 | 292.943 |
| | Taxa | 20 | 1 | 18 | 9.90 | 5.004 |
| | Valid N (listwise) | 20 | | | | |
| Kodakina | Total | 10 | 344 | 1579 | 742.12 | 350.429 |
| | Taxa | 10 | 14 | 26 | 19.00 | 4.028 |
| | Valid N (listwise) | 10 | | | | |
| KodosinM | Total | 10 | 228 | 885 | 463.17 | 239.783 |
| | Taxa | 10 | 13 | 23 | 17.00 | 3.651 |
| | Valid N (listwise) | 10 | | | | |
| LittleKald | Total | 10 | 180 | 5090 | 1402.90 | 1439.493 |
| | Taxa | 10 | 10 | 19 | 12.90 | 2.601 |
| | Valid N (listwise) | 10 | | | | |
| Mingkoket | Total | 20 | 18 | 938 | 229.08 | 280.515 |
| | Taxa | 20 | 5 | 17 | 11.75 | 3.492 |
| | Valid N (listwise) | 20 | | | | |
| Minnkokut | Total | 20 | 38 | 1060 | 386.70 | 340.550 |
| | Taxa | 20 | 3 | 18 | 11.80 | 4.073 |
| | Valid N (listwise) | 20 | | | | |
| OldDummy | Total | 11 | 45 | 269 | 149.00 | 72.606 |
| | Taxa | 11 | 7 | 15 | 10.36 | 2.942 |
| | Valid N (listwise) | 11 | | | | |
| Unnamed9 | Total | 10 | 190 | 930 | 614.91 | 231.659 |
| | Taxa | 10 | 14 | 21 | 18.00 | 2.449 |
| | Valid N (listwise) | 10 | | | | |

## *Appendix 4: Seasonal/Annual comparisons*

### Total, Classes

**Descriptive Statistics: Year**

| Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| 1999 | Total | 50 | 45 | 3796 | 479.40 | 641.901 |
| | Classes | 50 | 3 | 8 | 5.76 | 1.349 |
| | Valid N (listwise) | 50 | | | | |
| 2000 | Total | 80 | 99 | 5090 | 742.11 | 648.483 |
| | Classes | 80 | 2 | 8 | 5.74 | 1.188 |
| | Valid N (listwise) | 80 | | | | |
| 2001 | Total | 51 | 1 | 355 | 116.92 | 91.523 |
| | Classes | 51 | 1 | 8 | 4.65 | 1.354 |
| | Valid N (listwise) | 51 | | | | |

**Descriptive Statistics: Year within Lake**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| BigKald | 2000 | Total | 10 | 618 | 2295 | 1082.85 | 552.187 |
| | | Classes | 10 | 4 | 8 | 6.10 | 1.101 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Total | 10 | 101 | 300 | 220.90 | 63.513 |
| | | Classes | 10 | 4 | 8 | 5.60 | 1.174 |
| | | Valid N (listwise) | 10 | | | | |
| FishCreek | 2000 | Total | 10 | 262 | 916 | 550.89 | 190.233 |
| | | Classes | 10 | 4 | 8 | 5.90 | 1.287 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Total | 10 | 1 | 355 | 60.00 | 105.380 |
| | | Classes | 10 | 1 | 7 | 4.20 | 1.619 |
| | | Valid N (listwise) | 10 | | | | |
| Kodakina | 2000 | Total | 10 | 344 | 1579 | 742.12 | 350.429 |
| | | Classes | 10 | 4 | 7 | 5.90 | 1.101 |
| | | Valid N (listwise) | 10 | | | | |
| KodosinM | 2000 | Total | 10 | 228 | 885 | 463.17 | 239.783 |
| | | Classes | 10 | 2 | 8 | 5.50 | 1.780 |
| | | Valid N (listwise) | 10 | | | | |
| LakeG | 1999 | Total | 10 | 130 | 1599 | 415.90 | 429.447 |
| | | Classes | 10 | 6 | 8 | 6.40 | .699 |
| | | Valid N (listwise) | 10 | | | | |
| LakeL | 1999 | Total | 10 | 50 | 624 | 245.70 | 158.979 |
| | | Classes | 10 | 3 | 7 | 5.10 | 1.524 |
| | | Valid N (listwise) | 10 | | | | |

**Appendix 4, Descriptive Statistics: Year within Lake, continued**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| LittleKald | 2000 | Total | 10 | 180 | 5090 | 1402.90 | 1439.493 |
| | | Classes | 10 | 3 | 6 | 5.10 | .994 |
| | | Valid N (listwise) | 10 | | | | |
| Mingkoket | 2000 | Total | 10 | 99 | 938 | 412.66 | 301.161 |
| | | Classes | 10 | 4 | 7 | 5.50 | .972 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Total | 10 | 18 | 97 | 45.50 | 22.979 |
| | | Classes | 10 | 3 | 6 | 4.50 | .850 |
| | | Valid N (listwise) | 10 | | | | |
| Minnkokut | 2000 | Total | 10 | 311 | 1060 | 667.40 | 259.618 |
| | | Classes | 10 | 4 | 7 | 5.80 | 1.033 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Total | 10 | 38 | 189 | 106.00 | 48.380 |
| | | Classes | 10 | 2 | 7 | 4.00 | 1.491 |
| | | Valid N (listwise) | 10 | | | | |
| MudLake | 1999 | Total | 10 | 70 | 494 | 293.60 | 141.753 |
| | | Classes | 10 | 4 | 6 | 4.90 | .738 |
| | | Valid N (listwise) | 10 | | | | |
| OldDummy | 1999 | Total | 10 | 52 | 1695 | 441.50 | 544.817 |
| | | Classes | 10 | 5 | 7 | 5.90 | .876 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Total | 11 | 45 | 269 | 149.00 | 72.606 |
| | | Classes | 11 | 3 | 7 | 4.91 | 1.136 |
| | | Valid N (listwise) | 11 | | | | |
| Taiholman | 1999 | Total | 10 | 45 | 3796 | 1000.30 | 1144.591 |
| | | Classes | 10 | 3 | 8 | 6.50 | 1.841 |
| | | Valid N (listwise) | 10 | | | | |
| Unnamed9 | 2000 | Total | 10 | 190 | 930 | 614.91 | 231.659 |
| | | Classes | 10 | 5 | 8 | 6.10 | 1.101 |
| | | Valid N (listwise) | 10 | | | | |

**Descriptive Statistics: Season (including Old Dummy)**

| Season | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Total | 80 | 45 | 5090 | 647.32 | 758.146 |
| | Classes | 80 | 2 | 8 | 5.69 | 1.365 |
| | Valid N (listwise) | 80 | | | | |
| 1 | Total | 51 | 1 | 355 | 116.92 | 91.523 |
| | Classes | 51 | 1 | 8 | 4.65 | 1.354 |
| | Valid N (listwise) | 51 | | | | |
| 2 | Total | 50 | 52 | 2295 | 631.06 | 454.437 |
| | Classes | 50 | 4 | 8 | 5.84 | 1.037 |
| | Valid N (listwise) | 50 | | | | |

**Descriptive Statistics: Season (not including Old Dummy)**

| Season2 | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Total | 101 | 45 | 5090 | 572.67 | 712.212 |
| | Classes | 101 | 2 | 8 | 5.62 | 1.318 |
| | Valid N (listwise) | 101 | | | | |
| 1 | Total | 40 | 1 | 355 | 108.10 | 94.959 |
| | Classes | 40 | 1 | 8 | 4.58 | 1.412 |
| | Valid N (listwise) | 40 | | | | |
| 2 | Total | 40 | 99 | 2295 | 678.45 | 423.615 |
| | Classes | 40 | 4 | 8 | 5.82 | 1.083 |
| | Valid N (listwise) | 40 | | | | |

## Orders, ETO

**Descriptive Statistics: Year**

| Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| 1999 | Orders | 50 | 7 | 16 | 11.20 | 2.321 |
| | ETO | 50 | .0% | 27.6% | 4.527% | 4.8520% |
| | Valid N (listwise) | 50 | | | | |
| 2000 | Orders | 80 | 7 | 15 | 10.89 | 1.518 |
| | ETO | 80 | .0% | 21.0% | 4.584% | 4.2204% |
| | Valid N (listwise) | 80 | | | | |
| 2001 | Orders | 51 | 1 | 13 | 7.20 | 2.538 |
| | ETO | 51 | .0% | 39.0% | 7.597% | 7.9869% |
| | Valid N (listwise) | 51 | | | | |

**Descriptive Statistics: Year within Lake**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| BigKald | 2000 | Orders | 10 | 10 | 12 | 11.10 | .876 |
| | | ETO | 10 | .2% | 20.4% | 7.402% | 6.9730% |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Orders | 10 | 9 | 13 | 9.90 | 1.287 |
| | | ETO | 10 | 4.0% | 19.5% | 10.732% | 5.4824% |
| | | Valid N (listwise) | 10 | | | | |
| FishCreek | 2000 | Orders | 10 | 10 | 14 | 11.70 | 1.418 |
| | | ETO | 10 | .5% | 11.0% | 4.436% | 3.6930% |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Orders | 10 | 1 | 8 | 5.20 | 2.150 |
| | | ETO | 10 | .0% | 21.4% | 3.434% | 6.6882% |
| | | Valid N (listwise) | 10 | | | | |
| Kodakina | 2000 | Orders | 10 | 8 | 13 | 10.70 | 1.567 |
| | | ETO | 10 | .0% | 1.1% | .375% | .4531% |
| | | Valid N (listwise) | 10 | | | | |
| KodosinM | 2000 | Orders | 10 | 8 | 15 | 10.90 | 2.132 |
| | | ETO | 10 | 1.3% | 21.0% | 5.474% | 5.8057% |
| | | Valid N (listwise) | 10 | | | | |
| LakeG | 1999 | Orders | 10 | 10 | 15 | 11.90 | 1.370 |
| | | ETO | 10 | 1.7% | 27.6% | 8.425% | 7.9416% |
| | | Valid N (listwise) | 10 | | | | |
| LakeL | 1999 | Orders | 10 | 7 | 15 | 10.70 | 2.983 |
| | | ETO | 10 | .0% | 14.0% | 5.933% | 3.8526% |
| | | Valid N (listwise) | 10 | | | | |
| LittleKald | 2000 | Orders | 10 | 7 | 12 | 9.90 | 1.524 |
| | | ETO | 10 | 1.6% | 13.9% | 4.429% | 3.6450% |
| | | Valid N (listwise) | 10 | | | | |
| Mingkoket | 2000 | Orders | 10 | 9 | 14 | 11.40 | 1.506 |
| | | ETO | 10 | 1.5% | 5.5% | 3.364% | 1.3868% |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Orders | 10 | 5 | 9 | 7.10 | 1.197 |
| | | ETO | 10 | 4.1% | 39.0% | 14.429% | 11.2808% |
| | | Valid N (listwise) | 10 | | | | |
| Minnkokut | 2000 | Orders | 10 | 8 | 12 | 10.30 | 1.337 |
| | | ETO | 10 | 2.1% | 12.6% | 5.790% | 3.1589% |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Orders | 10 | 3 | 10 | 5.80 | 2.300 |
| | | ETO | 10 | .0% | 16.8% | 7.022% | 5.2869% |
| | | Valid N (listwise) | 10 | | | | |
| MudLake | 1999 | Orders | 10 | 8 | 13 | 10.40 | 1.578 |
| | | ETO | 10 | .0% | 8.5% | 2.333% | 2.7001% |
| | | Valid N (listwise) | 10 | | | | |

**Appendix 4, Descriptive Statistics: Year within Lake, continued**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| OldDummy | 1999 | Orders | 10 | 7 | 15 | 10.20 | 2.201 |
| | | ETO | 10 | .6% | 9.5% | 2.745% | 2.7490% |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Orders | 11 | 5 | 12 | 7.91 | 2.587 |
| | | ETO | 11 | .0% | 10.6% | 2.844% | 3.5966% |
| | | Valid N (listwise) | 11 | | | | |
| Taiholman | 1999 | Orders | 10 | 8 | 16 | 12.80 | 2.394 |
| | | ETO | 10 | .0% | 6.2% | 3.201% | 2.3473% |
| | | Valid N (listwise) | 10 | | | | |
| Unnamed9 | 2000 | Orders | 10 | 10 | 13 | 11.10 | 1.197 |
| | | ETO | 10 | 4.0% | 7.2% | 5.400% | 1.2411% |
| | | Valid N (listwise) | 10 | | | | |

**Descriptive Statistics: Season (including Old Dummy)**

| Season | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Orders | 80 | 7 | 16 | 11.05 | 2.031 |
| | ETO | 80 | .0% | 27.6% | 4.446% | 4.6129% |
| | Valid N (listwise) | 80 | | | | |
| 1 | Orders | 51 | 1 | 13 | 7.20 | 2.538 |
| | ETO | 51 | .0% | 39.0% | 7.597% | 7.9869% |
| | Valid N (listwise) | 51 | | | | |
| 2 | Orders | 50 | 7 | 15 | 10.94 | 1.583 |
| | ETO | 50 | .2% | 20.4% | 4.747% | 4.2306% |
| | Valid N (listwise) | 50 | | | | |

**Descriptive Statistics: Season (not including Old Dummy)**

| Season2 | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Orders | 101 | 5 | 16 | 10.62 | 2.310 |
| | ETO | 101 | .0% | 27.6% | 4.103% | 4.3860% |
| | Valid N (listwise) | 101 | | | | |
| 1 | Orders | 40 | 1 | 13 | 7.00 | 2.522 |
| | ETO | 40 | .0% | 39.0% | 8.905% | 8.3870% |
| | Valid N (listwise) | 40 | | | | |
| 2 | Orders | 40 | 8 | 14 | 11.13 | 1.362 |
| | ETO | 40 | .2% | 20.4% | 5.248% | 4.4111% |
| | Valid N (listwise) | 40 | | | | |

## Families

**Descriptive Statistics: Year**

| Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| 1999 | Families | 50 | 7 | 22 | 12.66 | 3.211 |
| | Valid N (listwise) | 50 | | | | |
| 2000 | Families | 80 | 10 | 23 | 15.34 | 2.756 |
| | Valid N (listwise) | 80 | | | | |
| 2001 | Families | 51 | 1 | 16 | 9.33 | 3.642 |
| | Valid N (listwise) | 51 | | | | |

**Descriptive Statistics: Year within Lake**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| BigKald | 2000 | Families | 10 | 13 | 18 | 15.70 | 1.418 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Families | 10 | 10 | 16 | 13.60 | 2.011 |
| | | Valid N (listwise) | 10 | | | | |
| FishCreek | 2000 | Families | 10 | 12 | 18 | 14.30 | 1.947 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Families | 10 | 1 | 10 | 5.50 | 2.461 |
| | | Valid N (listwise) | 10 | | | | |
| Kodakina | 2000 | Families | 10 | 13 | 23 | 17.20 | 3.521 |
| | | Valid N (listwise) | 10 | | | | |
| KodosinM | 2000 | Families | 10 | 13 | 21 | 16.40 | 3.134 |
| | | Valid N (listwise) | 10 | | | | |
| LakeG | 1999 | Families | 10 | 12 | 22 | 15.20 | 3.425 |
| | | Valid N (listwise) | 10 | | | | |
| LakeL | 1999 | Families | 10 | 7 | 17 | 12.50 | 3.064 |
| | | Valid N (listwise) | 10 | | | | |
| LittleKald | 2000 | Families | 10 | 10 | 19 | 12.80 | 2.573 |
| | | Valid N (listwise) | 10 | | | | |
| Mingkoket | 2000 | Families | 10 | 12 | 17 | 14.50 | 1.650 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Families | 10 | 5 | 12 | 8.80 | 1.989 |
| | | Valid N (listwise) | 10 | | | | |
| Minnkokut | 2000 | Families | 10 | 12 | 17 | 14.20 | 1.687 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Families | 10 | 3 | 15 | 8.80 | 3.853 |
| | | Valid N (listwise) | 10 | | | | |
| MudLake | 1999 | Families | 10 | 8 | 14 | 11.10 | 2.132 |
| | | Valid N (listwise) | 10 | | | | |

**Appendix 4, Descriptive Statistics: Year within Lake, continued**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| OldDummy | 1999 | Families | 10 | 7 | 17 | 10.80 | 2.658 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Families | 11 | 7 | 13 | 9.91 | 2.548 |
| | | Valid N (listwise) | 11 | | | | |
| Taiholman | 1999 | Families | 10 | 8 | 18 | 13.70 | 2.908 |
| | | Valid N (listwise) | 10 | | | | |
| Unnamed9 | 2000 | Families | 10 | 14 | 21 | 17.60 | 2.221 |
| | | Valid N (listwise) | 10 | | | | |

**Descriptive Statistics Season (including Old Dummy)**

| Season | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Families | 80 | 7 | 23 | 14.56 | 3.579 |
| | Valid N (listwise) | 80 | | | | |
| 1 | Families | 51 | 1 | 16 | 9.33 | 3.642 |
| | Valid N (listwise) | 51 | | | | |
| 2 | Families | 50 | 7 | 18 | 13.90 | 2.476 |
| | Valid N (listwise) | 50 | | | | |

**Descriptive Statistics: Season (not including Old Dummy)**

| Season2 | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Families | 101 | 7 | 23 | 13.68 | 3.797 |
| | Valid N (listwise) | 101 | | | | |
| 1 | Families | 40 | 1 | 16 | 9.17 | 3.902 |
| | Valid N (listwise) | 40 | | | | |
| 2 | Families | 40 | 12 | 18 | 14.68 | 1.730 |
| | Valid N (listwise) | 40 | | | | |

## Taxa

**Descriptive Statistics: Year**

| Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| 2000 | Total | 80 | 99 | 5090 | 742.11 | 648.483 |
| | Taxa | 80 | 10 | 26 | 15.78 | 3.202 |
| | Valid N (listwise) | 80 | | | | |
| 2001 | Total | 51 | 1 | 355 | 116.92 | 91.523 |
| | Taxa | 51 | 1 | 19 | 9.65 | 3.954 |
| | Valid N (listwise) | 51 | | | | |

**Descriptive Statistics: Year within Lake**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| BigKald | 2000 | Taxa | 10 | 13 | 19 | 16.10 | 1.729 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Taxa | 10 | 10 | 19 | 14.10 | 2.514 |
| | | Valid N (listwise) | 10 | | | | |
| FishCreek | 2000 | Taxa | 10 | 12 | 18 | 14.30 | 1.947 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Taxa | 10 | 1 | 10 | 5.50 | 2.461 |
| | | Valid N (listwise) | 10 | | | | |
| Kodakina | 2000 | Taxa | 10 | 14 | 26 | 19.00 | 4.028 |
| | | Valid N (listwise) | 10 | | | | |
| KodosinM | 2000 | Taxa | 10 | 13 | 23 | 17.00 | 3.651 |
| | | Valid N (listwise) | 10 | | | | |
| LittleKald | 2000 | Taxa | 10 | 10 | 19 | 12.90 | 2.601 |
| | | Valid N (listwise) | 10 | | | | |
| Mingkoket | 2000 | Taxa | 10 | 12 | 17 | 14.60 | 1.713 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Taxa | 10 | 5 | 13 | 8.90 | 2.183 |
| | | Valid N (listwise) | 10 | | | | |
| Minnkokut | 2000 | Taxa | 10 | 12 | 18 | 14.30 | 1.889 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Taxa | 10 | 3 | 17 | 9.30 | 4.191 |
| | | Valid N (listwise) | 10 | | | | |
| OldDummy | 2001 | Taxa | 11 | 7 | 15 | 10.36 | 2.942 |
| | | Valid N (listwise) | 11 | | | | |
| Unnamed9 | 2000 | Taxa | 10 | 14 | 21 | 18.00 | 2.449 |
| | | Valid N (listwise) | 10 | | | | |

**Descriptive Statistics Season (including Old Dummy)**

| Season | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| -1 | Taxa | 51 | 7 | 26 | 15.35 | 4.542 |
| | Valid N (listwise) | 51 | | | | |
| 1 | Taxa | 40 | 1 | 19 | 9.45 | 4.200 |
| | Valid N (listwise) | 40 | | | | |
| 2 | Taxa | 40 | 12 | 19 | 14.83 | 1.907 |
| | Valid N (listwise) | 40 | | | | |

**Descriptive Statistics: Season (not including Old Dummy)**

| SiteType | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| C | Taxa | 50 | 10 | 26 | 16.84 | 3.334 |
| | Valid N (listwise) | 50 | | | | |
| N | Taxa | 70 | 1 | 19 | 11.40 | 4.095 |
| | Valid N (listwise) | 70 | | | | |
| S | Taxa | 11 | 7 | 15 | 10.36 | 2.942 |
| | Valid N (listwise) | 11 | | | | |

## *Appendix 5: Geomorphic Regions.  Abbreviations: S=south (Chalatna), C=central (Kanuti), N=north (Koyokuk)*

## Total, Classes

**Descriptive Statistics**

| Geomorphic Region | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| Central | Total | 50 | 101 | 2295 | 624.79 | 428.940 |
| | Classes | 50 | 2 | 8 | 5.84 | 1.251 |
| | Valid N (listwise) | 50 | | | | |
| North | Total | 70 | 1 | 5090 | 463.62 | 707.309 |
| | Classes | 70 | 1 | 8 | 5.00 | 1.362 |
| | Valid N (listwise) | 70 | | | | |
| South | Total | 61 | 45 | 3796 | 419.82 | 594.794 |
| | Classes | 61 | 3 | 8 | 5.61 | 1.345 |
| | Valid N (listwise) | 61 | | | | |

**Descriptive Statistics**

| Geomorphic Region | SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| Central | BigKald | Total | 20 | 101 | 2295 | 651.88 | 584.686 |
| | | Classes | 20 | 4 | 8 | 5.85 | 1.137 |
| | | Valid N (listwise) | 20 | | | | |
| | Kodakina | Total | 10 | 344 | 1579 | 742.12 | 350.429 |
| | | Classes | 10 | 4 | 7 | 5.90 | 1.101 |
| | | Valid N (listwise) | 10 | | | | |
| | KodosinM | Total | 10 | 228 | 885 | 463.17 | 239.783 |
| | | Classes | 10 | 2 | 8 | 5.50 | 1.780 |
| | | Valid N (listwise) | 10 | | | | |
| | Unnamed9 | Total | 10 | 190 | 930 | 614.91 | 231.659 |
| | | Classes | 10 | 5 | 8 | 6.10 | 1.101 |
| | | Valid N (listwise) | 10 | | | | |
| North | FishCreek | Total | 20 | 1 | 916 | 305.44 | 292.943 |
| | | Classes | 20 | 1 | 8 | 5.05 | 1.669 |
| | | Valid N (listwise) | 20 | | | | |
| | LittleKald | Total | 10 | 180 | 5090 | 1402.90 | 1439.493 |
| | | Classes | 10 | 3 | 6 | 5.10 | .994 |
| | | Valid N (listwise) | 10 | | | | |
| | Mingkoket | Total | 20 | 18 | 938 | 229.08 | 280.515 |
| | | Classes | 20 | 3 | 7 | 5.00 | 1.026 |
| | | Valid N (listwise) | 20 | | | | |
| | Minnkokut | Total | 20 | 38 | 1060 | 386.70 | 340.550 |
| | | Classes | 20 | 2 | 7 | 4.90 | 1.553 |
| | | Valid N (listwise) | 20 | | | | |
| South | LakeG | Total | 10 | 130 | 1599 | 415.90 | 429.447 |
| | | Classes | 10 | 6 | 8 | 6.40 | .699 |

**Appendix 5, Descriptive Statistics, continued**

| Geomorphic Region | SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| | | Valid N (listwise) | 10 | | | | |
| | LakeL | Total | 10 | 50 | 624 | 245.70 | 158.979 |
| | | Classes | 10 | 3 | 7 | 5.10 | 1.524 |
| | | Valid N (listwise) | 10 | | | | |
| | MudLake | Total | 10 | 70 | 494 | 293.60 | 141.753 |
| | | Classes | 10 | 4 | 6 | 4.90 | .738 |
| | | Valid N (listwise) | 10 | | | | |
| | OldDummy | Total | 21 | 45 | 1695 | 288.29 | 398.265 |
| | | Classes | 21 | 3 | 7 | 5.38 | 1.117 |
| | | Valid N (listwise) | 21 | | | | |
| | Taiholman | Total | 10 | 45 | 3796 | 1000.30 | 1144.591 |
| | | Classes | 10 | 3 | 8 | 6.50 | 1.841 |
| | | Valid N (listwise) | 10 | | | | |

## Orders, ETO

**Descriptive Statistics**

| SiteType | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| C | Orders | 50 | 8 | 15 | 10.74 | 1.482 |
| | ETO | 50 | .0% | 21.0% | 5.877% | 5.7014% |
| | Valid N (listwise) | 50 | | | | |
| N | Orders | 70 | 1 | 14 | 8.77 | 2.979 |
| | ETO | 70 | .0% | 39.0% | 6.129% | 6.6524% |
| | Valid N (listwise) | 70 | | | | |
| S | Orders | 61 | 5 | 16 | 10.61 | 2.673 |
| | ETO | 61 | .0% | 27.6% | 4.224% | 4.6699% |
| | Valid N (listwise) | 61 | | | | |

**Orders, ETO continued** **Descriptive Statistics**

| SiteType | SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| C | BigKald | Orders | 20 | 9 | 13 | 10.50 | 1.235 |
| | | ETO | 20 | .2% | 20.4% | 9.067% | 6.3395% |
| | | Valid N (listwise) | 20 | | | | |
| | Kodakina | Orders | 10 | 8 | 13 | 10.70 | 1.567 |
| | | ETO | 10 | .0% | 1.1% | .375% | .4531% |
| | | Valid N (listwise) | 10 | | | | |
| | KodosinM | Orders | 10 | 8 | 15 | 10.90 | 2.132 |
| | | ETO | 10 | 1.3% | 21.0% | 5.474% | 5.8057% |
| | | Valid N (listwise) | 10 | | | | |
| | Unnamed9 | Orders | 10 | 10 | 13 | 11.10 | 1.197 |
| | | ETO | 10 | 4.0% | 7.2% | 5.400% | 1.2411% |
| | | Valid N (listwise) | 10 | | | | |
| N | FishCreek | Orders | 20 | 1 | 14 | 8.45 | 3.776 |
| | | ETO | 20 | .0% | 21.4% | 3.935% | 5.2833% |
| | | Valid N (listwise) | 20 | | | | |
| | LittleKald | Orders | 10 | 7 | 12 | 9.90 | 1.524 |
| | | ETO | 10 | 1.6% | 13.9% | 4.429% | 3.6450% |
| | | Valid N (listwise) | 10 | | | | |
| | Mingkoket | Orders | 20 | 5 | 14 | 9.25 | 2.573 |
| | | ETO | 20 | 1.5% | 39.0% | 8.897% | 9.6650% |
| | | Valid N (listwise) | 20 | | | | |
| | Minnkokut | Orders | 20 | 3 | 12 | 8.05 | 2.946 |
| | | ETO | 20 | .0% | 16.8% | 6.406% | 4.2856% |
| | | Valid N (listwise) | 20 | | | | |
| S | LakeG | Orders | 10 | 10 | 15 | 11.90 | 1.370 |
| | | ETO | 10 | 1.7% | 27.6% | 8.425% | 7.9416% |
| | | Valid N (listwise) | 10 | | | | |
| | LakeL | Orders | 10 | 7 | 15 | 10.70 | 2.983 |
| | | ETO | 10 | .0% | 14.0% | 5.933% | 3.8526% |
| | | Valid N (listwise) | 10 | | | | |
| | MudLake | Orders | 10 | 8 | 13 | 10.40 | 1.578 |
| | | ETO | 10 | .0% | 8.5% | 2.333% | 2.7001% |
| | | Valid N (listwise) | 10 | | | | |
| | Taiholman | Orders | 21 | 5 | 15 | 9.00 | 2.627 |
| | | ETO | 21 | .0% | 10.6% | 2.797% | 3.1418% |
| | | Valid N (listwise) | 21 | | | | |
| | Old Dummy | Orders | 10 | 8 | 16 | 12.80 | 2.394 |
| | | ETO | 10 | .0% | 6.2% | 3.201% | 2.3473% |
| | | Valid N (listwise) | 10 | | | | |

## Families

**Descriptive Statistics**

| SiteType | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| C | Families | 50 | 10 | 23 | 16.10 | 2.852 |
| | Valid N (listwise) | 50 | | | | |
| N | Families | 70 | 1 | 19 | 11.27 | 4.043 |
| | Valid N (listwise) | 70 | | | | |
| S | Families | 61 | 7 | 22 | 12.16 | 3.262 |
| | Valid N (listwise) | 61 | | | | |

**Descriptive Statistics**

| SiteType | SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| C | BigKald | Families | 20 | 10 | 18 | 14.65 | 2.007 |
| | | Valid N (listwise) | 20 | | | | |
| | Kodakina | Families | 10 | 13 | 23 | 17.20 | 3.521 |
| | | Valid N (listwise) | 10 | | | | |
| | KodosinM | Families | 10 | 13 | 21 | 16.40 | 3.134 |
| | | Valid N (listwise) | 10 | | | | |
| | Unnamed9 | Families | 10 | 14 | 21 | 17.60 | 2.221 |
| | | Valid N (listwise) | 10 | | | | |
| N | FishCreek | Families | 20 | 1 | 18 | 9.90 | 5.004 |
| | | Valid N (listwise) | 20 | | | | |
| | LittleKald | Families | 10 | 10 | 19 | 12.80 | 2.573 |
| | | Valid N (listwise) | 10 | | | | |
| | Mingkoket | Families | 20 | 5 | 17 | 11.65 | 3.422 |
| | | Valid N (listwise) | 20 | | | | |
| | Minnkokut | Families | 20 | 3 | 17 | 11.50 | 4.007 |
| | | Valid N (listwise) | 20 | | | | |
| S | LakeG | Families | 10 | 12 | 22 | 15.20 | 3.425 |
| | | Valid N (listwise) | 10 | | | | |
| | LakeL | Families | 10 | 7 | 17 | 12.50 | 3.064 |
| | | Valid N (listwise) | 10 | | | | |
| | MudLake | Families | 10 | 8 | 14 | 11.10 | 2.132 |
| | | Valid N (listwise) | 10 | | | | |
| | OldDummy | Families | 21 | 7 | 17 | 10.33 | 2.576 |
| | | Valid N (listwise) | 21 | | | | |
| | Taiholman | Families | 10 | 8 | 18 | 13.70 | 2.908 |
| | | Valid N (listwise) | 10 | | | | |

## Taxa

**Descriptive Statistics**

| SiteType | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| C | Taxa | 50 | 10 | 26 | 16.84 | 3.334 |
| | Valid N (listwise) | 50 | | | | |
| N | Taxa | 70 | 1 | 19 | 11.40 | 4.095 |
| | Valid N (listwise) | 70 | | | | |
| S | Taxa | 11 | 7 | 15 | 10.36 | 2.942 |
| | Valid N (listwise) | 11 | | | | |

**Descriptive Statistics**

| SiteType | SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| C | BigKald | Taxa | 20 | 10 | 19 | 15.10 | 2.337 |
| | | Valid N (listwise) | 20 | | | | |
| | Kodakina | Taxa | 10 | 14 | 26 | 19.00 | 4.028 |
| | | Valid N (listwise) | 10 | | | | |
| | KodosinM | Taxa | 10 | 13 | 23 | 17.00 | 3.651 |
| | | Valid N (listwise) | 10 | | | | |
| | Unnamed9 | Taxa | 10 | 14 | 21 | 18.00 | 2.449 |
| | | Valid N (listwise) | 10 | | | | |
| N | FishCreek | Taxa | 20 | 1 | 18 | 9.90 | 5.004 |
| | | Valid N (listwise) | 20 | | | | |
| | LittleKald | Taxa | 10 | 10 | 19 | 12.90 | 2.601 |
| | | Valid N (listwise) | 10 | | | | |
| | Mingkoket | Taxa | 20 | 5 | 17 | 11.75 | 3.492 |
| | | Valid N (listwise) | 20 | | | | |
| | Minnkokut | Taxa | 20 | 3 | 18 | 11.80 | 4.073 |
| | | Valid N (listwise) | 20 | | | | |
| S | OldDummy | Taxa | 11 | 7 | 15 | 10.36 | 2.942 |
| | | Valid N (listwise) | 11 | | | | |

## *Appendix 6: Functional Feeding Groups*

| Table 1. Abbreviations for functional group variables. These data are all at the family level, so that the 1999 data could be included. | |
|---|---|
| Pred | Predator-engulfer |
| Shred | Shredder |
| Scrap | Scraper |
| CollGath | Collector-Gatherer |
| CollFF | Collector-Filterfeeder |
| PiercerH | Piercer-Herbivore |
| PiercerA | Piercer-Animal |
| Unknown | Unknown |

### Overall date (over lakes and years)

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Pred% | 181 | .000 | .304 | .05038 | .051932 |
| Shred% | 181 | .000 | .952 | .08409 | .153968 |
| Scrap% | 181 | .000 | .446 | .05380 | .071612 |
| CollGath% | 181 | .008 | 1.000 | .41860 | .266780 |
| CollFF% | 181 | .00 | .96 | .3687 | .24819 |
| PiercerH% | 181 | .000 | .095 | .00352 | .012026 |
| PiercerA% | 181 | .000 | .372 | .01940 | .042505 |
| Unknown% | 181 | .000 | .087 | .00149 | .007957 |
| Valid N (listwise) | 181 | | | | |

### Within Lake

**Descriptive Statistics**

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| BigKald | Pred% | 20 | .004 | .203 | .08430 | .064254 |
| | Shred% | 20 | .000 | .268 | .04828 | .065133 |
| | Scrap% | 20 | .004 | .094 | .03107 | .025737 |
| | CollGath% | 20 | .223 | .878 | .52154 | .189024 |
| | CollFF% | 20 | .07 | .54 | .3042 | .12838 |
| | PiercerH% | 20 | .000 | .009 | .00251 | .002951 |
| | PiercerA% | 20 | .000 | .070 | .00811 | .015975 |
| | Unknown% | 20 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 20 | | | | |

Appendix 6, Within Lake, descriptive statistics, continued.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| FishCreek | Pred% | 20 | .000 | .304 | .03603 | .070390 |
| | Shred% | 20 | .000 | .274 | .06807 | .091198 |
| | Scrap% | 20 | .000 | .056 | .01293 | .016111 |
| | CollGath% | 20 | .008 | 1.000 | .54718 | .359932 |
| | CollFF% | 20 | .00 | .68 | .2729 | .23373 |
| | PiercerH% | 20 | .000 | .000 | .00000 | .000000 |
| | PiercerA% | 20 | .000 | .372 | .06288 | .099035 |
| | Unknown% | 20 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 20 | | | | |
| Kodakina | Pred% | 10 | .002 | .039 | .01520 | .013447 |
| | Shred% | 10 | .002 | .048 | .02580 | .017966 |
| | Scrap% | 10 | .020 | .080 | .04741 | .020120 |
| | CollGath% | 10 | .019 | .639 | .28903 | .199997 |
| | CollFF% | 10 | .27 | .91 | .6061 | .22758 |
| | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | PiercerA% | 10 | .000 | .018 | .00804 | .006414 |
| | Unknown% | 10 | .000 | .036 | .00844 | .011184 |
| | Valid N (listwise) | 10 | | | | |
| KodosinM | Pred% | 10 | .008 | .171 | .04574 | .048696 |
| | Shred% | 10 | .017 | .466 | .21141 | .177102 |
| | Scrap% | 10 | .000 | .237 | .09574 | .077323 |
| | CollGath% | 10 | .047 | .570 | .16570 | .150067 |
| | CollFF% | 10 | .05 | .71 | .4408 | .23053 |
| | PiercerH% | 10 | .000 | .021 | .00517 | .007660 |
| | PiercerA% | 10 | .000 | .062 | .02554 | .019231 |
| | Unknown% | 10 | .000 | .087 | .00987 | .027306 |
| | Valid N (listwise) | 10 | | | | |
| LakeG | Pred% | 10 | .052 | .202 | .10209 | .044582 |
| | Shred% | 10 | .000 | .052 | .01968 | .016981 |
| | Scrap% | 10 | .008 | .206 | .07859 | .069777 |
| | CollGath% | 10 | .242 | .600 | .39991 | .113477 |
| | CollFF% | 10 | .16 | .58 | .3778 | .15602 |
| | PiercerH% | 10 | .000 | .089 | .02157 | .029196 |
| | PiercerA% | 10 | .000 | .002 | .00034 | .000736 |
| | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 10 | | | | |

Appendix 6, Within Lake, descriptive statistics, continued.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| LakeL | Pred% | 10 | .017 | .140 | .06556 | .037349 |
| | Shred% | 10 | .000 | .160 | .02812 | .049390 |
| | Scrap% | 10 | .000 | .054 | .02288 | .017046 |
| | CollGath% | 10 | .130 | .500 | .31187 | .131661 |
| | CollFF% | 10 | .16 | .76 | .5502 | .18770 |
| | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | PiercerA% | 10 | .006 | .066 | .02136 | .018316 |
| | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 10 | | | | |
| LittleKald | Pred% | 10 | .016 | .117 | .03828 | .030650 |
| | Shred% | 10 | .002 | .022 | .00844 | .007442 |
| | Scrap% | 10 | .000 | .012 | .00495 | .004365 |
| | CollGath% | 10 | .084 | .454 | .24761 | .121702 |
| | CollFF% | 10 | .50 | .89 | .6915 | .13707 |
| | PiercerH% | 10 | .000 | .002 | .00021 | .000662 |
| | PiercerA% | 10 | .000 | .039 | .00878 | .011335 |
| | Unknown% | 10 | .000 | .002 | .00021 | .000662 |
| | Valid N (listwise) | 10 | | | | |
| Mingkoket | Pred% | 20 | .010 | .268 | .06281 | .069730 |
| | Shred% | 20 | .004 | .833 | .16312 | .229654 |
| | Scrap% | 20 | .000 | .107 | .03108 | .033107 |
| | CollGath% | 20 | .067 | .778 | .40444 | .278266 |
| | CollFF% | 20 | .00 | .80 | .3247 | .25985 |
| | PiercerH% | 20 | .000 | .049 | .00244 | .010908 |
| | PiercerA% | 20 | .000 | .079 | .01136 | .020368 |
| | Unknown% | 20 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 20 | | | | |
| Minnkokut | Pred% | 20 | .000 | .169 | .05460 | .042976 |
| | Shred% | 20 | .000 | .017 | .00273 | .005434 |
| | Scrap% | 20 | .000 | .150 | .03061 | .037487 |
| | CollGath% | 20 | .376 | .940 | .70580 | .201841 |
| | CollFF% | 20 | .00 | .50 | .1772 | .17552 |
| | PiercerH% | 20 | .000 | .095 | .01115 | .022608 |
| | PiercerA% | 20 | .000 | .127 | .01423 | .030455 |
| | Unknown% | 20 | .000 | .034 | .00363 | .009987 |
| | Valid N (listwise) | 20 | | | | |
| MudLake | Pred% | 10 | .000 | .095 | .03201 | .029108 |
| | Shred% | 10 | .010 | .171 | .06378 | .059411 |
| | Scrap% | 10 | .016 | .235 | .10293 | .063604 |
| | CollGath% | 10 | .010 | .433 | .16449 | .155410 |
| | CollFF% | 10 | .29 | .96 | .5974 | .21523 |
| | PiercerH% | 10 | .000 | .010 | .00098 | .003100 |
| | PiercerA% | 10 | .000 | .108 | .03841 | .037728 |
| | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 10 | | | | |

Appendix 6, Within Lake, descriptive statistics, continued.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| OldDummy | Pred% | 21 | .000 | .095 | .02334 | .025868 |
| | Shred% | 21 | .000 | .735 | .17800 | .224922 |
| | Scrap% | 21 | .000 | .446 | .14697 | .135141 |
| | CollGath% | 21 | .035 | .985 | .45594 | .260108 |
| | CollFF% | 21 | .00 | .46 | .1832 | .15337 |
| | PiercerH% | 21 | .000 | .000 | .00000 | .000000 |
| | PiercerA% | 21 | .000 | .057 | .01254 | .015206 |
| | Unknown% | 21 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 21 | | | | |
| Taiholman | Pred% | 10 | .000 | .091 | .04545 | .029118 |
| | Shred% | 10 | .014 | .952 | .19513 | .281300 |
| | Scrap% | 10 | .000 | .044 | .02943 | .013264 |
| | CollGath% | 10 | .033 | .701 | .35412 | .227905 |
| | CollFF% | 10 | .01 | .86 | .3484 | .26254 |
| | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | PiercerA% | 10 | .002 | .178 | .02743 | .053878 |
| | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | Valid N (listwise) | 10 | | | | |
| Unnamed9 | Pred% | 10 | .016 | .063 | .04302 | .013711 |
| | Shred% | 10 | .005 | .095 | .03152 | .024507 |
| | Scrap% | 10 | .004 | .142 | .07175 | .037628 |
| | CollGath% | 10 | .168 | .582 | .32853 | .152095 |
| | CollFF% | 10 | .30 | .77 | .5186 | .15271 |
| | PiercerH% | 10 | .000 | .008 | .00353 | .002515 |
| | PiercerA% | 10 | .000 | .006 | .00176 | .002286 |
| | Unknown% | 10 | .000 | .011 | .00125 | .003319 |
| | Valid N (listwise) | 10 | | | | |

## Year within Lake

**Descriptive Statistics**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| BigKald | 2000 | Pred% | 10 | .004 | .197 | .07183 | .066343 |
| | | Shred% | 10 | .004 | .028 | .01539 | .007392 |
| | | Scrap% | 10 | .004 | .094 | .03526 | .029305 |
| | | CollGath% | 10 | .223 | .878 | .58662 | .209516 |
| | | CollFF% | 10 | .07 | .54 | .2829 | .14978 |
| | | PiercerH% | 10 | .000 | .009 | .00282 | .003063 |
| | | PiercerA% | 10 | .000 | .022 | .00519 | .007712 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Pred% | 10 | .018 | .203 | .09678 | .062998 |
| | | Shred% | 10 | .000 | .268 | .08116 | .080609 |
| | | Scrap% | 10 | .008 | .082 | .02689 | .022378 |
| | | CollGath% | 10 | .227 | .710 | .45647 | .148735 |
| | | CollFF% | 10 | .17 | .53 | .3255 | .10654 |
| | | PiercerH% | 10 | .000 | .007 | .00220 | .002966 |
| | | PiercerA% | 10 | .000 | .070 | .01103 | .021455 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| FishCreek | 2000 | Pred% | 10 | .004 | .108 | .02958 | .030558 |
| | | Shred% | 10 | .011 | .274 | .12337 | .100187 |
| | | Scrap% | 10 | .004 | .056 | .02066 | .018518 |
| | | CollGath% | 10 | .008 | .742 | .26485 | .274156 |
| | | CollFF% | 10 | .13 | .68 | .4394 | .21748 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .022 | .372 | .12218 | .112969 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Pred% | 10 | .000 | .304 | .04247 | .097129 |
| | | Shred% | 10 | .000 | .065 | .01277 | .026933 |
| | | Scrap% | 10 | .000 | .020 | .00520 | .008511 |
| | | CollGath% | 10 | .500 | 1.000 | .82950 | .145632 |
| | | CollFF% | 10 | .00 | .25 | .1065 | .08047 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .000 | .036 | .00357 | .011294 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| Kodakina | 2000 | Pred% | 10 | .002 | .039 | .01520 | .013447 |
| | | Shred% | 10 | .002 | .048 | .02580 | .017966 |
| | | Scrap% | 10 | .020 | .080 | .04741 | .020120 |
| | | CollGath% | 10 | .019 | .639 | .28903 | .199997 |
| | | CollFF% | 10 | .27 | .91 | .6061 | .22758 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |

Appendix 6, Year within Lake, descriptive statistics, continued.

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| | | PiercerA% | 10 | .000 | .018 | .00804 | .006414 |
| | | Unknown% | 10 | .000 | .036 | .00844 | .011184 |
| | | Valid N (listwise) | 10 | | | | |
| KodosinM | 2000 | Pred% | 10 | .008 | .171 | .04574 | .048696 |
| | | Shred% | 10 | .017 | .466 | .21141 | .177102 |
| | | Scrap% | 10 | .000 | .237 | .09574 | .077323 |
| | | CollGath% | 10 | .047 | .570 | .16570 | .150067 |
| | | CollFF% | 10 | .05 | .71 | .4408 | .23053 |
| | | PiercerH% | 10 | .000 | .021 | .00517 | .007660 |
| | | PiercerA% | 10 | .000 | .062 | .02554 | .019231 |
| | | Unknown% | 10 | .000 | .087 | .00987 | .027306 |
| | | Valid N (listwise) | 10 | | | | |
| LakeG | 1999 | Pred% | 10 | .052 | .202 | .10209 | .044582 |
| | | Shred% | 10 | .000 | .052 | .01968 | .016981 |
| | | Scrap% | 10 | .008 | .206 | .07859 | .069777 |
| | | CollGath% | 10 | .242 | .600 | .39991 | .113477 |
| | | CollFF% | 10 | .16 | .58 | .3778 | .15602 |
| | | PiercerH% | 10 | .000 | .089 | .02157 | .029196 |
| | | PiercerA% | 10 | .000 | .002 | .00034 | .000736 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| LakeL | 1999 | Pred% | 10 | .017 | .140 | .06556 | .037349 |
| | | Shred% | 10 | .000 | .160 | .02812 | .049390 |
| | | Scrap% | 10 | .000 | .054 | .02288 | .017046 |
| | | CollGath% | 10 | .130 | .500 | .31187 | .131661 |
| | | CollFF% | 10 | .16 | .76 | .5502 | .18770 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .006 | .066 | .02136 | .018316 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| LittleKald | 2000 | Pred% | 10 | .016 | .117 | .03828 | .030650 |
| | | Shred% | 10 | .002 | .022 | .00844 | .007442 |
| | | Scrap% | 10 | .000 | .012 | .00495 | .004365 |
| | | CollGath% | 10 | .084 | .454 | .24761 | .121702 |
| | | CollFF% | 10 | .50 | .89 | .6915 | .13707 |
| | | PiercerH% | 10 | .000 | .002 | .00021 | .000662 |
| | | PiercerA% | 10 | .000 | .039 | .00878 | .011335 |
| | | Unknown% | 10 | .000 | .002 | .00021 | .000662 |
| | | Valid N (listwise) | 10 | | | | |
| Mingkoket | 2000 | Pred% | 10 | .012 | .043 | .02382 | .009839 |
| | | Shred% | 10 | .004 | .090 | .03061 | .029471 |
| | | Scrap% | 10 | .000 | .051 | .01347 | .015203 |
| | | CollGath% | 10 | .134 | .750 | .46346 | .270949 |
| | | CollFF% | 10 | .20 | .80 | .4556 | .24181 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .000 | .079 | .01307 | .024121 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |

Appendix 6, Year within Lake, descriptive statistics, continued.

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| Mingkoket, cont'd | 2001 | Pred% | 10 | .010 | .268 | .10180 | .082402 |
| | | Shred% | 10 | .022 | .833 | .29563 | .267309 |
| | | Scrap% | 10 | .000 | .107 | .04869 | .037333 |
| | | CollGath% | 10 | .067 | .778 | .34542 | .286903 |
| | | CollFF% | 10 | .00 | .71 | .1939 | .21459 |
| | | PiercerH% | 10 | .000 | .049 | .00488 | .015426 |
| | | PiercerA% | 10 | .000 | .044 | .00966 | .016955 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| Minnkokut | 2000 | Pred% | 10 | .011 | .085 | .03557 | .023328 |
| | | Shred% | 10 | .000 | .004 | .00105 | .001510 |
| | | Scrap% | 10 | .002 | .150 | .04529 | .047048 |
| | | CollGath% | 10 | .376 | .902 | .58758 | .185812 |
| | | CollFF% | 10 | .04 | .50 | .3021 | .16488 |
| | | PiercerH% | 10 | .002 | .095 | .02230 | .028331 |
| | | PiercerA% | 10 | .000 | .029 | .00586 | .010131 |
| | | Unknown% | 10 | .000 | .002 | .00022 | .000686 |
| | | Valid N (listwise) | 10 | | | | |
| | 2001 | Pred% | 10 | .000 | .169 | .07363 | .050499 |
| | | Shred% | 10 | .000 | .017 | .00441 | .007335 |
| | | Scrap% | 10 | .000 | .042 | .01593 | .016562 |
| | | CollGath% | 10 | .441 | .940 | .82402 | .142903 |
| | | CollFF% | 10 | .00 | .20 | .0524 | .05654 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .000 | .127 | .02259 | .041231 |
| | | Unknown% | 10 | .000 | .034 | .00705 | .013570 |
| | | Valid N (listwise) | 10 | | | | |
| MudLake | 1999 | Pred% | 10 | .000 | .095 | .03201 | .029108 |
| | | Shred% | 10 | .010 | .171 | .06378 | .059411 |
| | | Scrap% | 10 | .016 | .235 | .10293 | .063604 |
| | | CollGath% | 10 | .010 | .433 | .16449 | .155410 |
| | | CollFF% | 10 | .29 | .96 | .5974 | .21523 |
| | | PiercerH% | 10 | .000 | .010 | .00098 | .003100 |
| | | PiercerA% | 10 | .000 | .108 | .03841 | .037728 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |

Appendix 6, Year within Lake, descriptive statistics, continued.

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| OldDummy | 2001 | Pred% | 11 | .000 | .044 | .01252 | .017576 |
| | | Shred% | 11 | .000 | .735 | .32354 | .227759 |
| | | Scrap% | 11 | .000 | .178 | .06923 | .063184 |
| | | CollGath% | 11 | .035 | .985 | .47578 | .297210 |
| | | CollFF% | 11 | .00 | .30 | .1085 | .08352 |
| | | PiercerH% | 11 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 11 | .000 | .029 | .01040 | .012173 |
| | | Unknown% | 11 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 11 | | | | |
| | 1999 | Pred% | 10 | .013 | .095 | .03525 | .029034 |
| | | Shred% | 10 | .000 | .058 | .01790 | .020417 |
| | | Scrap% | 10 | .038 | .446 | .23249 | .143649 |
| | | CollGath% | 10 | .057 | .844 | .43411 | .226246 |
| | | CollFF% | 10 | .03 | .46 | .2653 | .17381 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .000 | .057 | .01490 | .018367 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| Taiholman | 1999 | Pred% | 10 | .000 | .091 | .04545 | .029118 |
| | | Shred% | 10 | .014 | .952 | .19513 | .281300 |
| | | Scrap% | 10 | .000 | .044 | .02943 | .013264 |
| | | CollGath% | 10 | .033 | .701 | .35412 | .227905 |
| | | CollFF% | 10 | .01 | .86 | .3484 | .26254 |
| | | PiercerH% | 10 | .000 | .000 | .00000 | .000000 |
| | | PiercerA% | 10 | .002 | .178 | .02743 | .053878 |
| | | Unknown% | 10 | .000 | .000 | .00000 | .000000 |
| | | Valid N (listwise) | 10 | | | | |
| Unnamed9 | 2000 | Pred% | 10 | .016 | .063 | .04302 | .013711 |
| | | Shred% | 10 | .005 | .095 | .03152 | .024507 |
| | | Scrap% | 10 | .004 | .142 | .07175 | .037628 |
| | | CollGath% | 10 | .168 | .582 | .32853 | .152095 |
| | | CollFF% | 10 | .30 | .77 | .5186 | .15271 |
| | | PiercerH% | 10 | .000 | .008 | .00353 | .002515 |
| | | PiercerA% | 10 | .000 | .006 | .00176 | .002286 |
| | | Unknown% | 10 | .000 | .011 | .00125 | .003319 |
| | | Valid N (listwise) | 10 | | | | |

## Appendix 7: Water Quality Summary Data

**Descriptive Statistics: overall statistics.**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Temp | 52 | 6.9 | 19.2 | 12.681 | 3.4408 |
| pH | 39 | 6.0 | 9.0 | 7.009 | .7512 |
| Color | 51 | 5 | 100 | 57.65 | 37.763 |
| Cond | 52 | 12.07 | 154.10 | 41.0100 | 27.78438 |
| Secchi | 23 | .5 | 1.7 | 1.226 | .3720 |
| Valid N (listwise) | 23 | | | | |

**Descriptive Statistics: by SiteName.**

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| BigKald | Temp | 6 | 6.9 | 12.2 | 9.600 | 2.2601 |
| | pH | 6 | 6.2 | 6.5 | 6.385 | .1512 |
| | Color | 6 | 10 | 72 | 41.33 | 32.873 |
| | Cond | 6 | 20.20 | 21.70 | 21.0333 | .63770 |
| | Secchi | 4 | 1.1 | 1.7 | 1.475 | .2630 |
| | Valid N (listwise) | 4 | | | | |
| FishCreek | Temp | 6 | 9.5 | 11.8 | 10.567 | .9852 |
| | pH | 6 | 7.0 | 7.2 | 7.063 | .0802 |
| | Color | 6 | 95 | 100 | 98.17 | 2.229 |
| | Cond | 6 | 23.60 | 31.20 | 27.7833 | 3.58910 |
| | Secchi | 4 | .5 | 1.4 | .725 | .4500 |
| | Valid N (listwise) | 4 | | | | |
| Kodakina | Temp | 3 | 9.1 | 9.6 | 9.400 | .2646 |
| | pH | 3 | 9.0 | 9.0 | 9.000 | .0000 |
| | Color | 3 | 13 | 15 | 13.67 | 1.155 |
| | Cond | 3 | 51.60 | 51.80 | 51.7000 | .10000 |
| | Secchi | 1 | 1.5 | 1.5 | 1.500 | . |
| | Valid N (listwise) | 1 | | | | |
| KodosinM | Temp | 3 | 11.5 | 12.2 | 11.833 | .3512 |
| | pH | 3 | 7.5 | 7.5 | 7.500 | .0000 |
| | Color | 3 | 5 | 6 | 5.67 | .577 |
| | Cond | 3 | 55.70 | 56.20 | 55.9667 | .25166 |
| | Secchi | 1 | 1.7 | 1.7 | 1.700 | . |
| | Valid N (listwise) | 1 | | | | |
| LakeG | Temp | 1 | 19.0 | 19.0 | 19.000 | . |
| | pH | 0 | | | | |
| | Color | 1 | 27 | 27 | 27.00 | . |
| | Cond | 1 | 154.10 | 154.10 | 154.1000 | . |
| | Secchi | 0 | | | | |
| | Valid N (listwise) | 0 | | | | |

Appendix 7, Descriptive statistics: Water Quality By SiteName, continued.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| LakeL | Temp | 3 | 17.4 | 19.2 | 18.500 | .9644 |
| | pH | 0 | | | | |
| | Color | 2 | 98 | 100 | 99.00 | 1.414 |
| | Cond | 3 | 101.10 | 103.90 | 102.5667 | 1.40475 |
| | Secchi | 0 | | | | |
| | Valid N (listwise) | 0 | | | | |
| LittleKald | Temp | 3 | 9.6 | 9.7 | 9.667 | .0577 |
| | pH | 3 | 6.0 | 6.0 | 6.000 | .0000 |
| | Color | 3 | 18 | 20 | 19.33 | 1.155 |
| | Cond | 3 | 12.07 | 13.02 | 12.4100 | .52943 |
| | Secchi | 1 | 1.2 | 1.2 | 1.200 | . |
| | Valid N (listwise) | 1 | | | | |
| Mingkoket | Temp | 6 | 10.4 | 15.3 | 12.533 | 2.3432 |
| | pH | 6 | 6.5 | 7.2 | 6.843 | .3761 |
| | Color | 6 | 53 | 79 | 66.17 | 13.717 |
| | Cond | 6 | 18.07 | 19.71 | 18.9150 | .84994 |
| | Secchi | 4 | 1.2 | 1.3 | 1.250 | .0577 |
| | Valid N (listwise) | 4 | | | | |
| Minnkokut | Temp | 6 | 10.8 | 13.2 | 11.917 | 1.1600 |
| | pH | 6 | 6.5 | 6.9 | 6.632 | .1670 |
| | Color | 6 | 11 | 80 | 45.33 | 36.887 |
| | Cond | 6 | 20.40 | 24.50 | 22.7667 | 1.91485 |
| | Secchi | 4 | 1.5 | 1.6 | 1.525 | .0500 |
| | Valid N (listwise) | 4 | | | | |
| MudLake | Temp | 3 | 16.6 | 17.0 | 16.800 | .2000 |
| | pH | 0 | | | | |
| | Color | 3 | 98 | 100 | 99.33 | 1.155 |
| | Cond | 3 | 59.20 | 59.90 | 59.6000 | .36056 |
| | Secchi | 0 | | | | |
| | Valid N (listwise) | 0 | | | | |
| OldDummy | Temp | 6 | 12.3 | 18.9 | 15.667 | 3.4760 |
| | pH | 3 | 7.4 | 7.8 | 7.607 | .2183 |
| | Color | 6 | 56 | 100 | 79.67 | 22.358 |
| | Cond | 6 | 32.20 | 50.70 | 40.9833 | 8.89256 |
| | Secchi | 3 | .8 | 1.0 | .933 | .1155 |
| | Valid N (listwise) | 3 | | | | |
| Taiholman | Temp | 3 | 16.2 | 17.6 | 16.933 | .7024 |
| | pH | 0 | | | | |
| | Color | 3 | 95 | 100 | 97.33 | 2.517 |
| | Cond | 3 | 62.30 | 66.50 | 63.9667 | 2.23010 |
| | Secchi | 0 | | | | |
| | Valid N (listwise) | 0 | | | | |

Appendix 7, Descriptive statistics:  Water Quality By SiteName, continued.

| SiteName | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| Unnamed9 | Temp | 3 | 9.1 | 10.3 | 9.767 | .6110 |
| | pH | 3 | 7.0 | 7.5 | 7.167 | .2887 |
| | Color | 3 | 8 | 9 | 8.33 | .577 |
| | Cond | 3 | 50.00 | 50.70 | 50.3000 | .36056 |
| | Secchi | 1 | 1.1 | 1.1 | 1.100 | . |
| | Valid N (listwise) | 1 | | | | |

**Descriptive Statistics: Water Quality by Year within SiteName**

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| BigKald | 2000 | Temp | 3 | 11.2 | 12.2 | 11.600 | .5292 |
| | | pH | 3 | 6.5 | 6.5 | 6.500 | .0000 |
| | | Color | 3 | 10 | 12 | 11.33 | 1.155 |
| | | Cond | 3 | 21.40 | 21.70 | 21.5333 | .15275 |
| | | Secchi | 1 | 1.1 | 1.1 | 1.100 | . |
| | | Valid N (listwise) | 1 | | | | |
| | 2001 | Temp | 3 | 6.9 | 8.3 | 7.600 | .7000 |
| | | pH | 3 | 6.2 | 6.4 | 6.270 | .1323 |
| | | Color | 3 | 71 | 72 | 71.33 | .577 |
| | | Cond | 3 | 20.20 | 21.10 | 20.5333 | .49329 |
| | | Secchi | 3 | 1.5 | 1.7 | 1.600 | .1000 |
| | | Valid N (listwise) | 3 | | | | |
| FishCreek | 2000 | Temp | 3 | 11.2 | 11.8 | 11.433 | .3215 |
| | | pH | 3 | 7.0 | 7.0 | 7.000 | .0000 |
| | | Color | 3 | 95 | 98 | 96.33 | 1.528 |
| | | Cond | 3 | 30.80 | 31.20 | 31.0000 | .20000 |
| | | Secchi | 1 | 1.4 | 1.4 | 1.400 | . |
| | | Valid N (listwise) | 1 | | | | |
| | 2001 | Temp | 3 | 9.5 | 10.0 | 9.700 | .2646 |
| | | pH | 3 | 7.1 | 7.2 | 7.127 | .0635 |
| | | Color | 3 | 100 | 100 | 100.00 | .000 |
| | | Cond | 3 | 23.60 | 25.70 | 24.5667 | 1.05987 |
| | | Secchi | 3 | .5 | .5 | .500 | .0000 |
| | | Valid N (listwise) | 3 | | | | |
| Kodakina | 2000 | Temp | 3 | 9.1 | 9.6 | 9.400 | .2646 |
| | | pH | 3 | 9.0 | 9.0 | 9.000 | .0000 |
| | | Color | 3 | 13 | 15 | 13.67 | 1.155 |
| | | Cond | 3 | 51.60 | 51.80 | 51.7000 | .10000 |
| | | Secchi | 1 | 1.5 | 1.5 | 1.500 | . |
| | | Valid N (listwise) | 1 | | | | |
| KodosinM | 2000 | Temp | 3 | 11.5 | 12.2 | 11.833 | .3512 |
| | | pH | 3 | 7.5 | 7.5 | 7.500 | .0000 |
| | | Color | 3 | 5 | 6 | 5.67 | .577 |
| | | Cond | 3 | 55.70 | 56.20 | 55.9667 | .25166 |
| | | Secchi | 1 | 1.7 | 1.7 | 1.700 | . |
| | | Valid N (listwise) | 1 | | | | |

Appendix 7, Descriptive Statistics: Water Quality by Year within SiteName, continued

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| LakeG | 1999 | Temp | 1 | 19.0 | 19.0 | 19.000 | . |
| | | pH | 0 | | | | |
| | | Color | 1 | 27 | 27 | 27.00 | . |
| | | Cond | 1 | 154.10 | 154.10 | 154.1000 | . |
| | | Secchi | 0 | | | | |
| | | Valid N (listwise) | 0 | | | | |
| LakeL | 1999 | Temp | 3 | 17.4 | 19.2 | 18.500 | .9644 |
| | | pH | 0 | | | | |
| | | Color | 2 | 98 | 100 | 99.00 | 1.414 |
| | | Cond | 3 | 101.10 | 103.90 | 102.5667 | 1.40475 |
| | | Secchi | 0 | | | | |
| | | Valid N (listwise) | 0 | | | | |
| LittleKald | 2000 | Temp | 3 | 9.6 | 9.7 | 9.667 | .0577 |
| | | pH | 3 | 6.0 | 6.0 | 6.000 | .0000 |
| | | Color | 3 | 18 | 20 | 19.33 | 1.155 |
| | | Cond | 3 | 12.07 | 13.02 | 12.4100 | .52943 |
| | | Secchi | 1 | 1.2 | 1.2 | 1.200 | . |
| | | Valid N (listwise) | 1 | | | | |
| Mingkoket | 2000 | Temp | 3 | 10.4 | 10.5 | 10.433 | .0577 |
| | | pH | 3 | 6.5 | 6.5 | 6.500 | .0000 |
| | | Color | 3 | 53 | 55 | 53.67 | 1.155 |
| | | Cond | 3 | 19.67 | 19.71 | 19.6900 | .02000 |
| | | Secchi | 1 | 1.3 | 1.3 | 1.300 | . |
| | | Valid N (listwise) | 1 | | | | |
| | 2001 | Temp | 3 | 13.9 | 15.3 | 14.633 | .7024 |
| | | pH | 3 | 7.2 | 7.2 | 7.187 | .0058 |
| | | Color | 3 | 78 | 79 | 78.67 | .577 |
| | | Cond | 3 | 18.07 | 18.18 | 18.1400 | .06083 |
| | | Secchi | 3 | 1.2 | 1.3 | 1.233 | .0577 |
| | | Valid N (listwise) | 3 | | | | |
| Minnkokut | 2000 | Temp | 3 | 10.8 | 11.0 | 10.867 | .1155 |
| | | pH | 3 | 6.5 | 6.5 | 6.500 | .0000 |
| | | Color | 3 | 11 | 12 | 11.67 | .577 |
| | | Cond | 3 | 24.40 | 24.50 | 24.4667 | .05774 |
| | | Secchi | 1 | 1.5 | 1.5 | 1.500 | . |
| | | Valid N (listwise) | 1 | | | | |
| | 2001 | Temp | 3 | 12.8 | 13.2 | 12.967 | .2082 |
| | | pH | 3 | 6.6 | 6.9 | 6.763 | .1332 |
| | | Color | 3 | 78 | 80 | 79.00 | 1.000 |
| | | Cond | 3 | 20.40 | 21.80 | 21.0667 | .70238 |
| | | Secchi | 3 | 1.5 | 1.6 | 1.533 | .0577 |
| | | Valid N (listwise) | 3 | | | | |
| MudLake | 1999 | Temp | 3 | 16.6 | 17.0 | 16.800 | .2000 |
| | | pH | 0 | | | | |
| | | Color | 3 | 98 | 100 | 99.33 | 1.155 |
| | | Cond | 3 | 59.20 | 59.90 | 59.6000 | .36056 |
| | | Secchi | 0 | | | | |
| | | Valid N (listwise) | 0 | | | | |

Appendix 7, Descriptive Statistics: Water Quality by Year within SiteName, continued

| SiteName | Year | | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| OldDummy | 2001 | Temp | 3 | 12.3 | 12.9 | 12.500 | .3464 |
| | | pH | 3 | 7.4 | 7.8 | 7.607 | .2183 |
| | | Color | 3 | 100 | 100 | 100.00 | .000 |
| | | Cond | 3 | 32.20 | 34.10 | 32.9333 | 1.02144 |
| | | Secchi | 3 | .8 | 1.0 | .933 | .1155 |
| | | Valid N (listwise) | 3 | | | | |
| | 1999 | Temp | 3 | 18.8 | 18.9 | 18.833 | .0577 |
| | | pH | 0 | | | | |
| | | Color | 3 | 56 | 62 | 59.33 | 3.055 |
| | | Cond | 3 | 47.80 | 50.70 | 49.0333 | 1.49778 |
| | | Secchi | 0 | | | | |
| | | Valid N (listwise) | 0 | | | | |
| Taiholman | 1999 | Temp | 3 | 16.2 | 17.6 | 16.933 | .7024 |
| | | pH | 0 | | | | |
| | | Color | 3 | 95 | 100 | 97.33 | 2.517 |
| | | Cond | 3 | 62.30 | 66.50 | 63.9667 | 2.23010 |
| | | Secchi | 0 | | | | |
| | | Valid N (listwise) | 0 | | | | |
| Unnamed9 | 2000 | Temp | 3 | 9.1 | 10.3 | 9.767 | .6110 |
| | | pH | 3 | 7.0 | 7.5 | 7.167 | .2887 |
| | | Color | 3 | 8 | 9 | 8.33 | .577 |
| | | Cond | 3 | 50.00 | 50.70 | 50.3000 | .36056 |
| | | Secchi | 1 | 1.1 | 1.1 | 1.100 | . |
| | | Valid N (listwise) | 1 | | | | |

**Appendix 14. Presence/absence tables for macroinvertebrates of Kanuti NWR lakes.**

Table 1. Genus level (for most insect taxa). Non-insects were usually identified to class or order. Includes 2000 and 2001 data (1999 data were only identified to family). These taxa were identified by Alaska Biological Research (ABR), Oregon office.

| SiteName | BigKald | FishCreek | Kodakina | KodosinM | LittleKald | Mingkoket | Minnkokut | OldDummy | Unnamed9 |
|---|---|---|---|---|---|---|---|---|---|
| Acari | P | P | P | P | P | P | P | | P |
| Acerpenna | | P | | | P | | | | |
| Aeshna | P | | | P | P | P | P | | P |
| Atrichopogon | P | | | | | | P | | |
| Brachycera | | | P | P | P | | P | | P |
| Caenis | P | | | | | P | P | | P |
| Callibaetis | P | | | | | P | | | P |
| Centroptilum | | P | P | P | | P | | | |
| Ceraclea | | | | | | | | | |
| Chironomidae | P | P | P | P | P | P | P | P | P |
| Cladocera | P | P | P | P | P | P | P | P | P |
| Ceonagrion | P | P | P | P | P | P | P | P | P |
| Copepoda | P | P | P | P | P | P | P | P | P |
| Corixidae | P | P | P | P | P | P | P | P | P |
| Culicidae | | | | | | | P | P | |
| Dasyhelea | P | | P | P | | | P | P | P |
| DipteraA | | | P | | | | P | | |
| DipteraB | P | | | | | | | | |
| DipteraC | | | P | | | | | | |
| DipteraD | | | P | | | | | | |
| DipteraE | | | | | | | | | |
| Dixella | | | P | P | | | P | | P |
| Dytiscidae | P | P | P | P | P | P | P | P | |
| Gerridae | P | P | P | P | | | | | P |
| Grammotaulius | | | | | | | | P | |
| Gyrinus | | | | P | | P | P | P | |
| Haliplus | P | P | P | P | P | P | | | |
| Helodidae | | | P | | P | | | | |
| Hirudinea | P | P | P | P | P | P | P | | P |

Appendix 14, Table 1, continued.  Genus level

| SiteName | BigKald | FishCreek | Kodakina | KodosinM | LittleKald | Mingkoket | Minnkokut | OldDummy | Unnamed9 |
|---|---|---|---|---|---|---|---|---|---|
| Hyalella | P | P | P | P | | P | | P | P |
| Hydra | P | | | P | | | | | P |
| Hydrobius | | | P | | | | | | |
| Hydrophilidae | P | | P | | P | | | | |
| Hydroptila | | | | P | | | | | |
| Leucorrhinia | P | | | P | P | P | P | | P |
| Libellulidae | | | | | | P | | | P |
| Limnephilidae | P | | | P | P | P | P | P | |
| Limnephilus | P | | P | | | P | P | | |
| Limonia | | | P | | | | | | |
| Mesovelia | P | | P | P | P | | | | P |
| Microvelia | P | | P | | P | | P | | |
| Mystacides | P | P | | P | | P | | P | P |
| Nematoda | P | P | P | P | P | P | P | P | P |
| Nematomorpha | | P | | P | | | | P | |
| Nemotaulius | P | P | P | P | P | P | P | P | P |
| Oecetis | | P | | P | | P | | P | P |
| Oligochaeta | P | P | P | P | P | P | P | P | P |
| Oligotricha | P | P | P | P | P | P | P | P | P |
| Ostracoda | P | P | P | | P | P | P | P | P |
| Oxyethira | P | | | P | P | P | P | | P |
| Palpomyia | P | P | P | P | P | P | P | P | P |
| Pericoma | P | | P | | | | | | |
| Phalacrocera | | | P | | | | | | |
| Phoridae | | | P | | | | | | |
| Physidae | P | P | P | P | P | P | P | P | P |
| Planorbidae | P | P | P | P | P | P | P | P | P |
| Polycentropus | P | | | P | P | P | P | | P |
| Psychoda | P | | P | | | | | P | |
| Saldidae | P | P | P | P | P | | P | | |
| Sciomyzidae | P | | P | | | | P | | P |
| Somatochlora | P | P | | | | P | | | |
| Sphaeriidae | P | P | P | P | P | P | P | P | P |
| Stratiomyidae | | | P | P | | | | P | |

Appendix 14, Table 1, continued.  Genus level

| SiteName | BigKald | FishCreek | Kodakina | KodosinM | LittleKald | Mingkoket | Minnkokut | OldDummy | Unnamed9 |
|---|---|---|---|---|---|---|---|---|---|
| Tabanidae | P | | P | | P | | P | | P |
| Tipula | P | | P | | | | | | |
| Tipulidae | | | P | | | | | | |
| Triaenodes | | | | P | | | | | |
| Turbellaria | | | | P | | | | | |
| Ulomorpha | | | P | | | | | | |

**Table 2: Family level. Includes 1999-2001 data. Invertebrates were identified both by ABR and River Run.**

| SiteName | Big Kald | Fish Creek | Koda-kina | KodosinM | Lake G | LakeL | Little Kald | Mingkoket | Minnkokut | Mud Lake | Old Dummy | Taiholman | Unnamed 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aeshnidae | P | | | P | P | | P | P | P | P | P | P | P |
| Ameletidae | | | | | P | | | | | | | P | |
| Baetidae | P | P | P | P | P | | P | P | | | | P | P |
| Brachycera | | | P | P | | | P | | P | | | | P |
| Caenidae | P | | | | P | P | | P | P | | P | | P |
| Ceratopogonidae | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Chironomidae | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Cladocera | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Coenagrionidae | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Conchostraca | | | | | P | P | | | | P | P | P | |
| Copepoda | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Corduliidae | P | P | | | | | | P | | | | | |
| Corixidae | P | P | P | P | | P | P | P | P | P | P | P | P |
| Culicidae | | | | | | | | | P | | P | | |
| Dixidae | | | P | P | P | P | | | P | | P | | P |
| Dytiscidae | P | P | P | P | P | P | P | P | P | P | P | P | |
| Empididae | | | | | P | P | | | | | | | |
| Ephemerellidae | | | | | P | | | | | | | | |
| Gastropod | | | | | P | P | | | | P | P | P | |
| Gyrinidae | | | | P | | | | P | P | P | P | P | |
| Gerridae | P | P | P | P | P | | P | | P | | | | P |
| Haliplidae | P | P | P | P | P | P | P | P | | P | | P | |
| Helodidae | | | P | | | | P | | | | | | |
| Hirudinea | P | P | P | P | P | P | P | P | P | | P | P | P |
| Hyallelidae | P | P | P | P | P | P | | P | | P | P | P | P |
| Hydracarina | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Hydridae | P | | | P | | | | | | | | | P |
| Hydrophilidae | P | | P | | | | P | | | | | | |
| Hydroptilidae | P | | | P | P | | P | P | P | P | | | P |
| Leptoceridae | P | P | | P | | | | P | | | P | | P |
| Libellulidae | P | | | P | P | P | P | P | P | | | | P |
| Limnephilidae | P | P | P | P | | P | P | P | P | | P | | P |
| Nematoda | P | P | P | P | P | P | P | P | P | P | P | P | P |

Appendix 14, Table 2, continued. Family level

| SiteName | Big Kald | Fish Creek | Koda-kina | KodosinM | Lake G | LakeL | Little Kald | Mingkoket | Minnkokut | Mud Lake | Old Dummy | Taiholman | Unnamed 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nematomorpha | | P | | P | | | | | | | P | | |
| Oligochaeta | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Ostracoda | P | P | P | | P | P | P | P | P | P | P | P | P |
| Phoridae | | | P | | | | | | | | | | |
| Phryganeidae | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Physidae | P | P | P | P | | | P | P | P | | P | | P |
| Planorbidae | P | P | P | P | | | P | P | P | | P | | P |
| Polycentropidae | P | | | P | | | P | P | P | | | | P |
| Psychodidae | P | | P | | | | | | | | P | | |
| Saldidae | P | P | P | P | | | P | | P | | | | |
| Sciomyzidae | P | | P | | | | | | P | | | | P |
| Stratiomyidae | | | P | P | | | | | | | P | | |
| Sphaeriidae | P | P | P | P | P | P | P | P | P | P | P | P | P |
| Tabanidae | P | | P | | | | P | | P | | | | P |
| Tipulidae | P | | P | | | | | | | | P | P | |
| Turbellaria | | | | P | | | | | | | | | |
| Veliidae | | | | | P | P | | | | | P | | |