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Biological resources of the Bear Lake basin, Utah

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BIOLOGICAL RESOURCES

The Bear Lake basin has a range of land types that provide habitat for aquatic, riparian, and terrestrial wildlife and plant species. Near the lake a limited ring of semi aquatic plants grow in association with spring and creek waters. Agriculture lands are used as pasture and to grow feed crops such as hay and alfalfa. Larger stream inflows host riparian and aquatic meadow plants. The low hills of the valley support sagebrush, grasslands, pinion, juniper, maple, and brushy communities. In the higher mountains brushes give way to large tree complexes of aspen, spruce, pine, and their associated undergrowths. The very tops of the mountains contain alpine growth and parkland.

The Bear Lake National Wildlife Refuge at the north end of Bear Lake provides the largest area of wetlands, with nearly 30 square miles of open water and grassland habitat. This protected area provides nesting sites and migratory pathways for many shorebirds, wading birds, and waterfowl. Bear Lake itself is home to 4

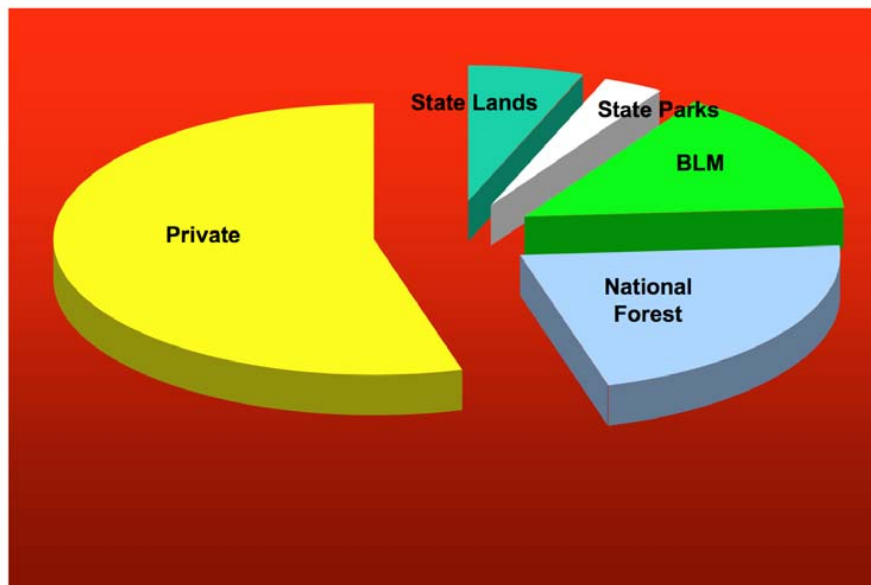


Figure 10. Land Use Management within Bear Lake Basin in FY 2003/2004 Expressed as Percent. (Environmental Management Group, 2004).

species of fish that are found nowhere else in the world: the Bonneville cisco, Bonneville whitefish, Bear Lake whitefish, and Bear Lake sculpin. Bear Lake also supports a strain of the Bonneville cutthroat trout that evolved in Bear Lake.

Stream corridors and bottomlands around Bear Lake are largely privately owned and are used for pasture and hay crop growth. Much of the steeper land surrounding the lake is managed by governmental agencies. Figure 10 present proportions for each organization. The Bear River Basin comprises 7,500 square miles including 2,700 in Idaho, 3,300 in Utah and 1,500 in Wyoming. The Bear River crosses state boundaries 5 times and is the largest stream in the western hemisphere that does not empty into the ocean. It is unique in that it is entirely enclosed by mountains, thus forming a huge basin with no external drainage outlets. Numerically the Bureau of Land Management administers 1,128 square miles or 15% of the basin, United States Forest Service operates 1,649 square miles or 22%. Idaho, Wyoming and Utah State Land Administrations has 424 square miles for 6% control, Idaho and Utah State Parks own 206 square miles for just under 3% of the basin, and 4,093 square miles (55%) are privately owned (Environmental Management Research Group, 2004).

VEGETATION

The vegetation in the Bear Lake watershed is a mixture of sagebrush, rabbitbrush, bitterbrush, arrowleaf balsamroot, and associated grasses and forbs. Mountain mahogany and Utah juniper occurs in scattered clumps around Swan Creek and Meadowville. Other important browse include a combination of mules ear, snowberry, prickly pear, and serviceberry. Perennial grasses are represented by moderate amounts of bluebunch wheatgrass, sandberg bluegrass, and Indian ricegrass, followed by lesser amounts of bottlebrush squirrel tail. The most numerous perennial forbs are Utah milkvetch, thistle, wayside gromwell, and yellow salsify. Vegetation trend studies conducted for big game winter browse by the Utah Division of Wildlife Resources have been in place since the early 1980,s. Domestic sheep and cattle heavily grazed the eastern side of the lake at that time and many

sites were declining due to high erosion, heavy use, poor vigor and drought. Study sites were placed within the Rich county portion of the Cache management unit and include Lower Hodges Canyon, Garden City Canyon, Meadowville, Swan Creek, Laketown Canyon, and North Eden. Key browse species include sagebrush, bitterbrush, mahogany and rabbitbrush. Management practices and favorable climate quickly improved the region. The 2001 trend study found a slight decline in key species density due to maturing plants at recent drought like conditions. Reproduction has been inadequate, it is reported, since 1990 due to poor numbers of seedlings and young plants. This trend is repeated on all sites. Historically, the amount of cheatgrass was up to 66% in Garden City, 63% in Lower Hodges, 60% in Swan Creek, and 34% in Laketown. This has declined over the years to approximately 10% in most locations to a low of 7% in Meadowville (Utah Division of Wildlife Resources, 2004). In the agricultural area, vegetation consists chiefly of the planted winter wheat with some invading forbs (Utah Division of Water Resources, 2000). Table 11 shows the percentage of each vegetation type.

Vegetation Type for Bear Lake Valley		
Land Cover Type	Percent of Total	Area in Square
Shrubland	39%	496
Evergreen Forest	12%	155
Herbaceous and Recreational	10%	124
Pasture / Hay / Row Crops	10%	127
Small Grains	8%	106
Deciduous and Mixed Forest	5%	73
Herbaceous and Woody Wetlands	5%	53
Other	11%	133

Table 11. Vegetative Land Cover of the Bear Lake Watershed (Bear River Watershed Information Systems at <http://www.bearriverinfo.org/>).

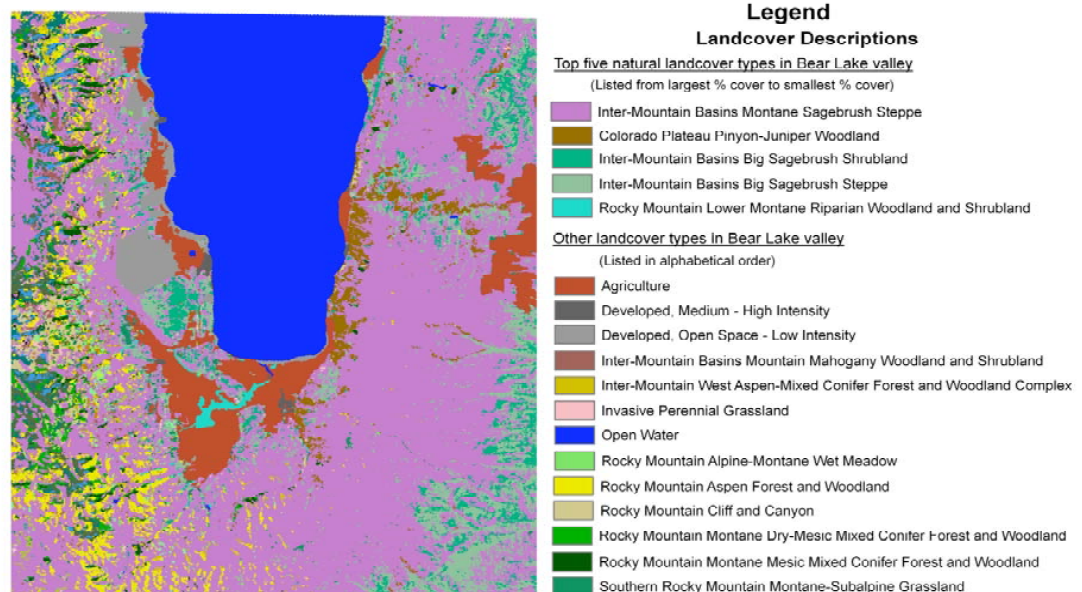


Figure 10. Example of Land Cover Map as Illustrated in SWGAP Database.

An extensive GIS project was conducted to map vegetative land covers of southwestern states (USGS, 2004). The example above is from the extensive database of vegetative types as digitized by the Southwestern Gap Analysis project. The SWGAP database can be found at <http://earth.gis.usu.edu/swgap/>.

PLANT SPECIES OF CONCERN

The Utah Natural Heritage Program conducts on-going biological surveys of rare or declining species and plant communities. This database lists Rich County as having seven plants identified as regionally endemic but without range wide viability concerns. These plants will be monitored at the state level to detect declines in habitat, distribution or abundance. The seven plant species are: Wasatch rock-cress (*Arabis lasiocarpa*), starveling milk-vetch (*Astragalus jejunus*), Garrett's milk-vetch (*Astragalus miser*), tufted cryptantha (*Cryptantha caespitosa*), Wasatch goldenbush (*Ericameria obovata*), Cache bladderpod (*Lequerella mutliceps*) and Cache owl's-clover (*Orthocarpus tolmiei*) (UDWR, 1998). The starveling milkvetch

is also listed on the Wasatch-Cache National Forest and the Bureau of Land Management sensitive plant list for Rich County.

NOXIOUS WEEDS

The state of Utah has designated 18 plant species as noxious weeds (Table 12).

The Utah Noxious Weed Act defines "Noxious weed" as:

“any plant the commissioner determines to be especially injurious to public health, crops, livestock, land, or other property” (Utah Division of Administrative Rules, 2006).

In addition to the state designation for noxious weeds, the Utah Noxious Weed Act requires each county to list weed candidates that are especially troublesome in that particular county. The list is then declared by the county legislative body to be a noxious weed within its county. Rich County designated the three following weeds as county noxious weeds in 2003 (Utah Department of Food and Agriculture, 2003): 1) Black Henbane (*Hyoscyamus niger*); 2) Dalmation toadflax (*Linaria dalmatica*); and 3) Poison Hemlock (*Conium maculatum*).

State of Utah Noxious Weeds list. Bold indicates verified distributions within Rich County			
Common Name	Scientific Name	Common Name	Scientific Name
Bermuda grass	<i>Cynodon dactylon</i>	Musk Thistle	<i>Carduus nutans</i>
Bindweed	<i>Convolvulus spp.</i>	Purple Loosestrife	<i>Lythrum salicarial</i>
Broad-leaved Peppergrass	<i>Lepidium latifolium</i>	Quackgrass	<i>Agropyron repens</i>
Canada Thistle	<i>Cirsium arvense</i>	Russian Knapweed	<i>Centaurea repens</i>
Diffuse Knapweed	<i>Centaurea diffusa</i>	Scotch Thistle	<i>Onopordium acanthium</i>
Dyers Woad	<i>Isatis tinctoria</i>	Spotted Knapweed	<i>Centaurea maculosa</i>
Perennial Sorghum spp (Johnsongrass)	<i>Sorghum halepense</i> , <i>Sorghum Alnum</i>	Squarrose Knapweed	<i>Centaurea squarrosa</i>
Leafy Spurge	<i>Euphorbia esula</i>	Whitetop	<i>Cardaria spp</i>
Medusahead	<i>Taeniatherum caput-medusa</i>	Yellow Starthistle	<i>Centaurea solstitialis</i>

Table 12. State of Utah Noxious Weeds List. Bold indicates verified distributions within Rich County (UDOT, 2005).

Managing and controlling weeds in the Bear Lake Valley Cooperative Weed Management Area (CWMA) is a collaborative effort. Partnerships include: Utah and Idaho State Agencies, Rich County, UT and Bear Lake County, ID local governments, Utah State and Idaho State University Extension Services, specific interest organizations, and private parties. Highlands CWMA includes Rich County and portions of southern Idaho and western Wyoming. In 2004 the program treated 87 acres in the Bear Lake / Garden City area. The target species included dalmation toadflax, dyers woad, pepperweed, and yellow toadflax. Efforts included digging of plants, chemical spraying and the introduction of bio-agents (Highlands CWMA, 2004).

Other noxious weeds have been seen around Bear Lake or are expected in the very near future. Tamarisk is known to be growing around the shores of Bear Lake (J. Robinson personal observation). Species expected to soon be present in the Bear Lake valley include Leafy spurge *Euphorbia esula* (Rosenbaum, 2004) and Canada thistle *Cirsium arvense*.



Dyer's Woad (Isatis tinctoria) Dyer's woad was introduced from Europe and thrives in waste areas, gravel pits, road sides, pastures, field edges, and disturbed soils. Infestations of dyer's woad increase more than 14% annually in the northern Utah. <http://www.cwma.org>

Dyer's Woad

Photo from: Noxious Weeds of Utah at http://utahreach.org/cache/govt/weeddept/pg3_weedwisdom.html

AQUATIC VEGETATION

Aquatic plants increase total system production, provide food and cover for both invertebrates and fishes. Few vascular plants exist in the confines of Bear Lake. The most common is stonewort of the genus *Chara* which grows in beds of shallow water 15-30 feet deep (Scott Tolentino personal communication). Water milfoil in the genus *Myriophyllum* is often seen around the lake in areas with less than 3 feet of water (McConnell, 1957,). Vascular aquatic plants belonging to the genera *Utricularia* and *Potamogeton* have been found throughout the lake with limited distribution (McConnell, 1957).

The level of production of aquatic plant material is one characteristic used to evaluate lakes. This is called the trophic state. Unproductive lakes are oligotrophic, while those water bodies that produce much organic material are called eutrophic. Intermediate productivity is called mesotrophic. The desirability of a particular trophic state is dependent upon the intended use of the lake. Oligotrophic lakes are valued for their high transparency, good swimming, and because they support fishes that require high oxygen levels. These lakes are managed to reduce nutrients levels. Eutrophic lakes managers increase nutrients to stimulate plant growth and fish production.

Water level fluctuations diminish the possibility of in lake emergent plant survival. Emergent plants such as rushes, cattails, sedges, and grasses can be found where surface springs and streams enter the lake. Smaller rooted or poorly established plants are often removed by wave action when lake waters reclaim the spring zones.

When water levels are down vegetation such as willow, bulrush and common terrestrial weeds are often seen growing in dense patches along the silt and sandy beaches. Growth along the beaches is seen as “weedy” by both homeowners and recreationists. Section 404 of the Clean Water Act restricts mechanical actions that

cause discharge of dredged material into the lake. The U.S. Army Corp of Engineers has provided guidelines for the removal of this woody material that would have less adverse impact on the aquatic ecosystem (USEPA, 2006).

Phytoplanktons, microscopic photosynthetic plants that occupy the water column, are the dominant primary producers in Bear Lake. Members of the family of green algae are dominant with diatoms and blue-green algae sometimes present. The maximum abundance of species is in June-July coinciding with the highest temperatures.

The input of nutrients, more specifically phosphorus, in a water body typically leads to an overabundance of phytoplankton, resulting in low transparency and reduced oxygen. In Bear Lake, however, excess phosphorus adheres to the abundant calcium carbonate in the water making it unavailable for the phytoplankton to use, leaving the lake with very low plant productivity (Environmental Management Research Group, 2006).

Moreno (1989), by measuring chlorophyll a concentrations, also concluded that Bear Lake has low plant productivity, with mean summer surface water chlorophyll a levels of only 0.5 ppm (Chlorophyll a concentrations below 0.95 ppm place the lake into the oligotrophic category). During lake water mixing events in spring and fall more nutrients are available and chlorophyll a levels increase to 1-1.5 ppm. During summer stratification in the deep cooler layer, chlorophyll a is often present and primary producers reach densities of 1.8 ppm (Wurtsbaugh and Hawkins, 1990).

Wurtsbaugh (1998) analyzed existing research in order to infer the productive potential of the lake. His findings conclude that because of a nearly doubling of nutrients in the lake since the time of the diversions there is a consequent increase in plankton production. Despite the increased production, however, the lake has stabilized and is expected to remain in an oligotrophic state over time (Wurtsbaugh, 1998).

Numerous studies have been conducted in the Bear Lake that includes the sampling of phytoplankton to assess their abundance. Clark and Sigler, in 1961, sampled the lake during September, March, and July. The dominant species found in this study were: green algae, *Ankistrodesmus* (52%) and *Oocystis* (23%), blue-green algae *Lyngbya* (22%), and *Diatoms* (3%).

The Division of Water Quality, more than 30 years later, recognized four taxa as dominant in the Bear Lake. The species, all green algae, are *Ankistrodesmus* (64%), *Lagerheimia* (32%), and *Chlamydomonas* and *Oocystis* (2% each) (Judd, 1997).



Lagerheimia ciliata



Ankistrodesmus falcatus

Photos from: <http://protist.i.hosei.ac.jp>

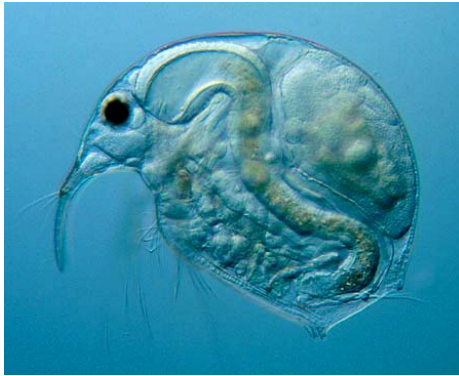
ZOOPLANKTON

Zooplankton are any small animals with limited mobility that reside in the water column. Their distribution within Bear Lake are controlled by temperature and food availability. Larger zooplanktons are important food for forage fish species and larval stages of all fish. The majority of the zooplankton community in Bear Lake is composed of primary consumers, which eat phytoplankton. Copepods, however, become carnivorous and consume other zooplankton during the adult life phase.

Zooplankton, like phytoplankton, indicate the trophic conditions within the Lake. Looking at zooplankton biomass, abundance and species diversity can assess

environmental quality and ecological change. Shifts in zooplankton communities can be correlated to eutrophication in freshwater lakes (Gannon, 1978).

Zooplankton samples have been collected in various studies and during several time periods. Early studies by Kemmerer (1923) and McConnell (1957) found the calanoid copepod, *Epischura*, to be the dominant zooplankton. Lentz (1986) described a community comprised primarily of *Epischura* and the rotifer, *Conochilus*. Lentz's findings concurred with earlier work by Nyquist (1967). Moreno (1989) documented the dominant species as *Epischura* and the cladoceran, *Bosmina*. Taxonomic identification, size, food source and abundance are given in Table 13.



Photos from: <http://www.microscopy-uk.org.uk/>

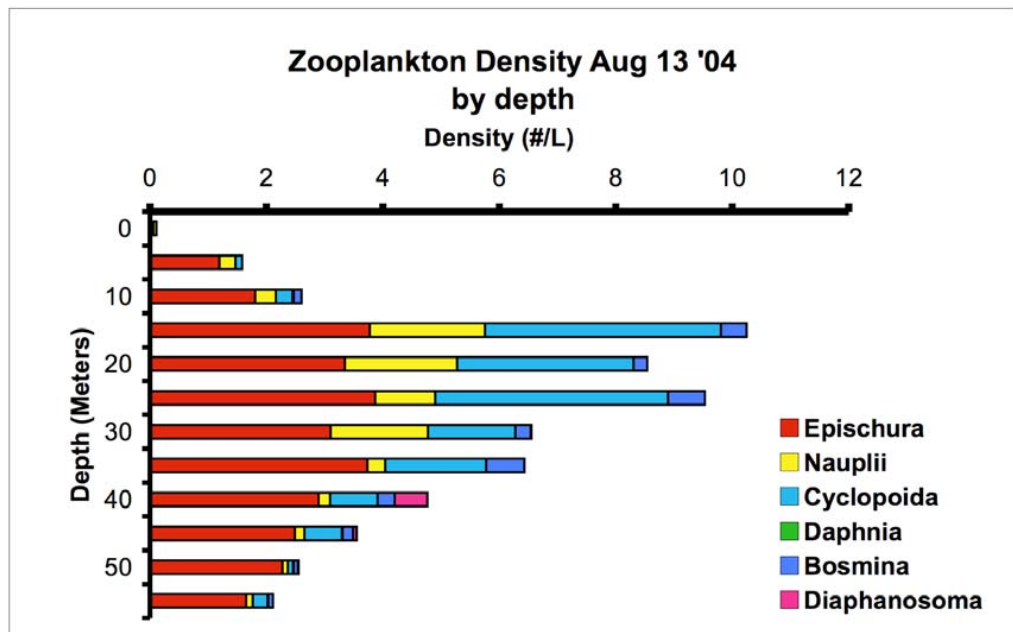
Increased presence of *Daphnia* is hypothesized to be a result of increased nutrient content in the lake as water levels increased after an extended period of drought (see graph 1). *Daphnids* are one of the most efficient water column grazers and would likely be the most rapid responder to increased productivity.

Moreno (1989) found that there is little variation in zooplankton density as one moves laterally

Currently the calanoid copepods still dominate zooplankton biomass, but 2 small cladocerans can be numerically dominant during summer. During the mid 1990s studies by Mazur and Beauchamp (2000) and Wurtsbaugh and Luecke (1998) found *Daphnia* in high numbers (~6.5/pint).



around the lake. Estimates of shallow water zooplankton density (number of individuals/liter of lake water) were not significantly different than those of deep water. Variation in zooplankton biomass (weight of individuals/volume of lake water) changes extensively with water depth (Wurtsbaugh and Luecke, 1993). Zooplankton densities are highest (Graph 8) near the thermocline in summer and were associated with high concentrations of phytoplankton. Chlorophyll concentrations were highest in the 35-50 foot depth interval where larger cladocers became more abundant. Many of the invertebrates seen in the water column are also found at water-sediment interfaces (Wurtsbaugh and Hawkins, 1990).



Graph 8. Vertical Profile of Zooplankton Density for August 2004. Calanoids (*Epischnura*, *Cyclopoids* and their juvenile life stages (*nauplii*)) dominated the assemblage. Samples were taken at 5-meter intervals from 0-55m. Water depth was 57m (Wurtsbaugh and Luecke, 1993).

<i>Genus and species</i>	Max Abundance	Length Range	Mean Length	Trophic Group
Crustacea				
Cladoceran				
Bosmina longirostis	5,200	0.20-0.50	0.35	Grazer
Daphnia pulex	500	0.36-1.98	0.91	Grazer
Ceriodaphnia reticulata	2,500	0.20-0.99	0.58	Grazer
Diaphnosoma brachyurum	250	0.36-1.32	0.74	Grazer
Chydorus sphaericus	30	0.20-0.79	0.46	Grazer
Alona costata				
Alona afinis	65	0.42-0.42	0.42	Grazer
Aslona quadrangularis				
Copepoda				
Copepoda nauplii (all infant copepods)	6,000	0.07-0.36	0.20	Grazer/ Predator
Calanoid				
Epischura nevadensis (Adult)	1,150	0.99-1.48	1.12	Grazer/ Predator
Epischura nevadensis (juvenile)	2,400	0.30-0.99	0.64	Grazer
Cyclopoid				
Paracyclops fimbriatus	120	0.46-0.85	0.64	Grazer/ Predator
Eucyclops agilis	130	0.50-1.00	0.62	Grazer/ Predator
Acanthocyclops vernalis	60	0.82-1.20	0.84	Grazer/ Predator
Cyclopoida juveniles	200	0.30-0.63	0.38	Grazer
Harpacticoida				
Canthocamptus robertcockeri	15	0.53-0.59	0.53	?
Mesochra rapiens	12	0.40-0.59	0.45	?
Huntemania lacustris	35	0.46-0.59	0.49	?
Rotifera				
Keratella quadrata	106,000	0.10-0.17	0.13	Grazer
Keratella cochlearis	9,600	0.07-0.13	0.10	Grazer
Branchionus sp.	6,300	0.07-0.26	0.11	Grazer
Conochilus unicornis	2,000,000	0.07-0.10	0.10	Grazer
Polyarthra sp.	1,000	0.07-0.13	0.10	Grazer

Table 13. Crustacea Found in the Water Column, With Associated Maximum Abundance, Max and Min Lengths and Trophic Group. Data represents samples collected October 1986-December 1987 (Recreated from Moreno, 1989).

BENTHIC MACRO INVERTEBRATES

Wurtsbaugh and Hawkins (1990) reported at least 70 taxa of invertebrates associated with the bottom of Bear Lake. The authors note that this is a conservative estimate of species richness due to the difficulty associated with identification to species levels. The numerical majority of the invertebrates were associated with 5 taxonomic groups: worms (nematodes or round worms and Annelids or segmented worms)(6+ species), mites (2+ species), crustacean (other than ostracods)(12 species), ostracods (5+ species) and chironomids (31+ species). Other taxa included representative species of Coelenterata (hydra), Insecta (Ephemeroptera, Plecoptera, Tricoptera, Odonata) and Diptera (Empididae) Table 14 on the following page lists the genus, species and family of samples collected in 1987.

Benthic invertebrate production was very low during 1987 (Wurtsbaugh and Hawkins, 1990) and whole-lake estimates of mean annual biomass were 0.34 grams dry weight per meter squared. Chironomids were the dominant organisms followed by worms and ostracods and then crustaceans. These comprised 40%, 20%, 20% and 15% of the benthic invertebrate biomass respectively. Benthic invertebrate biomass was highest in shallow waters and declined with increasing depth. Oligochoete worms dominated upper sections of the lake, mid-reaches held the most chironomids and deep water was associated with ostracods. Crustaceans were found throughout the benthic-water column interface with highest densities found near the deep chlorophyll layer in summer months. Mites made up little of the biomass of the lake and were only found in high numbers near rock and plant structures. Benthic invertebrates feed on algae, macrophytes, detritus and each other.

Genus and Species	Family	Genus and Species
Ceolenterata	Diptera	
Hydra	Empididae	
nematoda	Chironomidae	
Annelida	Tanyodinae	
Oligocheata	Alabesmyia	
Hirudinea	Natarasia	
Crustacea	Psectrotanypus	
Cladoceran	Placladius	
Alona costata	Diamesinae	
Alona afinis	Potthastia	
Alona quadrangularis	Monodiamesa	
Chydorus sphaericus	Orthoclaudiinae	
Copepoda	Corynoneura	
Huntemania lacustris	Cricotopus	
Mesochra rapiens	Eukiefferiella	
Cyclops vernalis	Orthocladus	
Eucyclops	Paraphaenocladus	
Paracyclops	Psectocladus	
Ostracoda	Tretenia	
Amphipoda	Unknown	
Gammerus lacustris	Chironominae	
Arachnoidea	Chironomus	
Hydrocararia	Cladotanytarus	
Hygrobates	Cryptochironomus	
Lebertia	Cryptotendipes	
Insecta	Dicrotendipes	
Ephemeroptera	Microchironomus	
Caenis	Micropsectra	
Batis	Microtendipes	
Drunella	Nilothauma	
Heptagenia	Paracladopelma	
Odanata	Polypedilum	
Plecoptera	P. pentapedilum	
Trichoptera	P. tripodrus	
Hydroptila	Strictochironomus	
Oecetis	Unknown #1	
Polycentropus	Unknown #2	

Table 14. Benthic Invertebrates Collected in Bear Lake from February to October 1987 (Recreated from Wurtsbaugh and Hawkins, 1990).