A Healthy Lake Food Chain Base:
Macroinvertebrates & Zooplankton

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Introduction

Freshwater macroinvertebrates (otherwise known as "aquatic bugs") may be found in almost every lake, as even the most impacted lake contains some representatives of this diverse and ecologically important group of organisms. Benthic (bottom-dwelling) macroinvertebrates are key components of lake food webs both in terms of total biomass and in the important ecological role that they play in the processing of energy (lake metabolism). Others are important predators, graze alga on rocks and logs, and are important food sources for fish. The removal of macroinvertebrates has been shown to negatively impact fish populations and total species richness of an entire lake or stream food web (Lenat and Barbour 1994). In the food webs of lakes, benthic macroinvertebrates have an intermediate position between primary producers (such as algae) and higher trophic levels (such as fish) on the other side. Hence, they play an essential role in key ecosystem processes (food chain dynamics, productivity, nutrient cycling and decomposition).

Figure 1 - Water Scorpion

Indicators of Water Quality

Several characteristics of benthic macroinvertebrates make them useful bio-indicators of lake water quality including that many are sensitive to changes in physical, chemical, and biological conditions of a lake, many complete their life cycle in a single year, their life cycles and ecological requirements are generally well known, they are stationary organisms and cannot readily escape pollution or other negative environmental conditions, and they are easily collected. Their ubiquitous nature and varied ecological roles in lakes make them very useful as indicators of water quality. As benthic macroinvertebrates respond sensitively not only to pollution, but also to a number of other human impacts (hydrological, climatological, morphological, navigational, recreational, and others), they could potentially be used for a holistic indication system for lake ecosystem health (Solimini et al., 2006). The midge larvae family Chironomidae can be found in both high and low quality water (Lenat and Barbour 1994). The mayfly, Hexagenia limbata, has been shown to be linked with good water quality. For example, ten different macroinvertebrate taxa were found in Maple Lake (Van Buren County, Michigan) sediments during a 2012-2013 study and ten different macroinvertebrate taxa were found in Crystal Lake (Montcalm County, Michigan) sediments during a 2014 study. Each of the taxa from both lakes may be grouped into good or fair water quality categories and thus are useful but not the only environmental indicators (Restorative Lake Sciences data).

Types and Roles of Aquatic Bugs

Some common lake macroinvertebrates include the Diptera (true flies), Coleoptera (beetles), Odonata (damselflies and dragonflies), Ephemeroptera (mayflies), Hemiptera (true bugs), Megaloptera (hellgrammites), Trichoptera (caddisflies), Plecoptera (stoneflies), Crustacea (freshwater shrimp, crayfish, isopods), Gastropoda (snails), Bivalvia (clams and mussels), Oligochaeta (earthworms), Hirudinea (leeches), Turbellaria (planarians). Predatory insects include the true bugs (order Hemiptera), and the Damsel and Dragonfly larvae (order Odonata). Water scorpions (Figure 1) generally exist in backwater areas of lakes and consume many other macroinvertebrate species by use of a needle-like mouthpart that ingests nutrients from prey. Water striders (Figure 2 on page 23) use the water tension to float on the surface of the water due to their long hydrophobic legs. As adults, dragonflies are known to kill and eat mosquitoes, which make them extra important for controlling biting insects near lakes. Fincke et al., (1997) showed that predation by Odonates

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reduced mosquito infestations of even smaller water bodies including water-filled tree holes. The Damsel and Dragonflies both consume mosquito larvae (Shaalan and Canyon 2009).

Impacts from Invasive Species

Native lake macroinvertebrate communities can and have been impacted by exotic and invasive species. A study by Stewart and Haynes (1994) examined changes in the benthic macroinvertebrate community of southwestern Lake Ontario following the invasion of zebra and quagga mussels (Dreissena spp.). They found that invasive mussels had replaced a species of freshwater shrimp as the dominant species. Additionally, they noted that additional macroinvertebrates actually increased in the ten-year study, although some species were considered more pollution-tolerant than others. This increase was thought to have been due to an increase in invasive mussel colonies increasing additional habitat for other macroinvertebrates.

The closely-related Chinese mystery snail (Bellamya chinensis) is a large invasive gastropod that achieves high densities in waters across North America and the Great Lakes Region. Solomon et al., (2010) surveyed many lakes in Wisconsin to describe the patterns and determinants of Chinese mystery snail distributions to assess the likelihood of effects on native snail communities in the invaded systems. The Chinese mystery snail was widespread among surveyed lakes and its occurrence was correlated with indicators of lake productivity and anthropogenic dispersal vectors (boat landings, distance to population centers, shoreline housing density). Some native snail species tended not to occur at sites where the Chinese mystery snail was abundant; however, the study found that this exotic snail did not appear to have strong impacts on native snail assemblages.

Many aquatic macroinvertebrates can be directly affected by changes in aquatic plant density and quality (Carpenter and Lodge 1986). While the majority of these are native species, numerous invasive species have been impacting lakes in the Great Lakes Region. Eurasian Watermilfoil (Myriophyllum spicatum) has also been shown to negatively influence both fish and macroinvertebrate communities (Lilliea and Buddb 1992). Keast (1984) showed that the colonization of Eurasian Watermilfoil in an Ontario Lake decreased not only fish usage of the area, but also decreased usage of isopods, chironomids, trichopteran larvae, and ephemeropteran nymphs. Chilton (1990) studied three different aquatic plant species; Wild Celery (Vallisneria americana), Eurasian Watermilfoil (Myriophyllum spicatum), and Coontail (Ceratophyllum demersum) and their relationships to macroinvertebrate populations in Lake

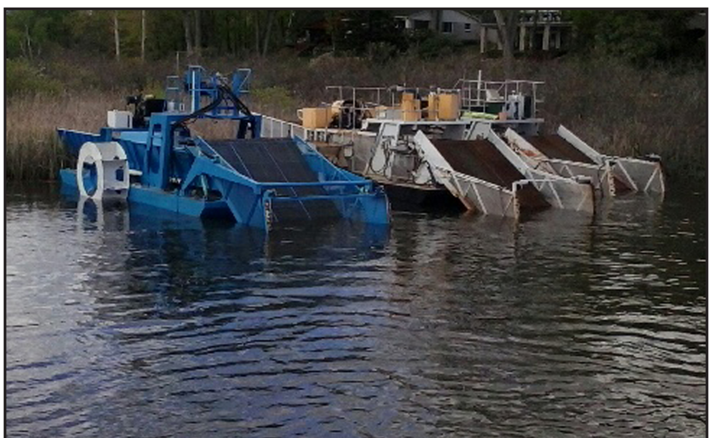


Figure 2 - Water Strider

Onalaska, Wisconsin. He found that the distribution of several taxa was significantly affected by plant species present. Hyalella azteca (overall the most abundant species) and Enallagma spp. (the most abundant predator) were consistently most numerous in Coontail samples and least abundant in Wild Celery samples. Generally, macroinvertebrate community composition differed significantly among plant species throughout the summer and between native and exotic species. Exotic and invasive species can have an effect on aquatic macroinvertebrates as well as vertebrates.

Aquatic Bugs and Nutrient Loading

In addition to exotic and invasive macroinvertebrate species, macroinvertebrate assemblages can be affected by land-use. Stewart et al., (2000) showed that macroinvertebrates were negatively affected by surrounding land-use. They also noted these land-use practices are important to restoration and management of lakes. Schreiber et al., (2003) stated that disturbance and anthropogenic land use changes are usually considered to be key factors facilitating biological invasions. In addition, lake ecological health has been measured by many states by eutrophication status and total maximum daily load indices. While this is considered sufficient by many, the need to supplement with biotic indexes is paramount, including surveys of the aquatic macroinvertebrates (Beck and Hatch 2009). Lake health should include measurements regarding eutrophication and nutrient status, but also include biotic measurements involving macroinvertebrates and vertebrates to acquire a complete status of a lake's health.

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