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The Benthic Macroinvertebrates of Kentucky Lake, a Mainstem Reservoir on the Tennessee River, U.S.A.

David S. White

Hancock Biological Station; Murray State University; 561 Emma Drive, Murray, KY 42071; USA.
Correspondence: dwhite@murraystate.edu

ABSTRACT

More than 230 species of benthic macroinvertebrates are recorded from Kentucky Lake, a major reservoir on the Tennessee River system, and compiled in an annotated list. Chironomidae (Diptera) and Unionidae (mussels) comprise more than 60% of the total taxa. Most species are restricted to shallow or marginal areas of the lake with only about 12 being common everywhere. The common species were similar to those found in both large and small reservoirs in the eastern United States. High disturbance regimes and sedimentation patterns are thought to control the similarities, limiting the communities to a small suite of adaptable species. This may reduce the usefulness of reservoirs in understanding climate change. A small number of invasive benthic species are well-established but appear to have had little affect on the rest of the benthic community. Invasive zooplankton and fish seem to have had little influence on the benthos, but the recent invasion of silver carp, *Hypophthalmichthys molitrix* (Valenciennes), may be a tipping point.

Keywords: Kentucky Lake, macroinvertebrates, species list, reservoirs, invasive species

INTRODUCTION

Most of our knowledge of aquatic macroinvertebrate communities has come from studies of natural lakes, streams, and rivers (Wetzel 2001; Thorp et al. 2010). Even though much has been published on the physical management of reservoirs, how reservoirs fit into ecological paradigms remains largely unstudied (Thornton 1990; White 1990; Wetzel 2001). The surface area of reservoirs in the United States now exceeds that for natural lakes outside the Laurentian Great Lakes (Thornton 1990). The 2012 Army Corps of Engineers' National Inventory of Dams lists 45,000 with dams that exceed 6 feet (1.8 m) in height or higher. Other estimates put the number at 75,000+ in the United States. The majority of larger reservoirs occur in parts of the US where there are few natural lakes due to geology, hydrology, and/or geography (Thornton 1990, Wetzel 2001). While few new major dams have been constructed in the U.S. since the 1970s, parts of the developing world (e.g., China) continue to build large reservoirs (Rosenberg et al. 2000, Downing et al. 2006).

Reservoirs differ from natural lakes and rivers in a number of significant ways (Rosenberg et al. 2000) including relative drainage basin size (Thornton 1990), stratification regime and dissolved oxygen dynamics (Cole and Hannan 1990), sedimentation processes (Ford 1990; Thornton 1990), and water retention time (Wetzel 2001). Variations in such influential characteristics and resulting disturbances likely affect aquatic community structure from fish to plankton to benthos. Reservoirs are often classified as one of a few major types: millpond, tributary, mainstem, and run-of-the-river (Thornton 1990, Wetzel 2001, Downing et al 2006). Mainstem reservoirs occur on large rivers and can change from lake-like to river-like depending on human manipulations and events in the watersheds. Most natural lakes exist on scales of thousands to millions of years (Wetzel 2001).

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Largely because of sedimentation rates, reservoirs exist on scales of decades to hundreds of years (Thornton 1990). Thus there has been little time for the evolutionary adaptation of the biota, and what is present are those species that can tolerate or even thrive in this new set of conditions.

Because the majority of reservoirs have been constructed by a federal agency (US Army Corps of Engineers, Tennessee Valley Authority, Bureau of Land Management), it has fallen to the agencies themselves to monitor water quantity and quality for regulatory purposes. In most cases, agencies have little funding or even the incentive to support basic ecological research. Monitoring may be done in-house, by consulting firms, and occasionally by universities. Unlike research on natural lakes (Wetzel 2001), reservoir monitoring is not often published in the open literature, winding up instead in non-peer-reviewed reports where data are difficult to find. For organisms such as phytoplankton, zooplankton, and benthos, data are often spotty, at low taxonomic resolution, and/or decades old. Further, the effects of invasive species on water quality and reservoir ecology are largely unknown, as are biotic responses to reservoir aging. On the other hand fisheries and wildlife data are often quite good because of public interest.

Recent droughts and floods have severely affected US reservoir water levels leading to increased interest in the role of global climate change on reservoir management (Christensen et al. 2004, Brekke et al. 2009). Reservoir management and responses to climate change must include understanding the species present, how the ecosystems are structured in relation to physical conditions, and species invasions. The goals of this paper are to 1) document the present status of Kentucky Lake benthic macroinvertebrates using available data, 2) provide a baseline that can be used to assess future impacts on the reservoir, 3) compare these data with what is known about reservoirs throughout the eastern United States, and 4) assess the potential effects of invasive species.

Kentucky Lake Study Site

Kentucky Lake (Figure 1) is a mainstem reservoir completed in 1944 by the Tennessee Valley Authority (TVA) for power generation, flood control, and transportation (White et al. 2005) (Figure 1). It is the ninth and terminal reservoir on the Tennessee River and the largest reservoir east of the Mississippi River. The drainage basin covers 104,117 km^2. The lake is 296 km long with a surface area of 651 km^2. Mean discharge is 1,812 m^3 sec^{-1}, and mean retention time is 16.7 days, but these numbers are highly variable depending on power generation needs and the effects of floods and droughts. Mean water depth at summer pool is approximately 6 m, and maximum depth is 18 m in the main channel, although 7-m fluctuations have been recorded within the past few years. Summer conservation or normal pool (109 m amsl) begins in April and lasts through August. Winter conservation pool (107 m amsl) that allows for flood storage generally is reached by September. The primary focus here is on open lake and embayments of the lower third of Kentucky Lake (Figure 1). Several detailed reports have concentrated on two embayments near the Hancock Biological Station, Anderson and Ledbetter, and their locations are indicated on the map.

As is the case with Kentucky Lake, mainstem reservoirs tend to flood the old river channel and its floodplain (Thornton 1990) creating broad, shallow reaches and a narrow but deep area in the old river channel (Figure 2). The mouths of tributary streams are flooded creating embayments, the size of which is determined largely by stream order (Figure 1). The old tributary channels still exist in most places producing secondary channels in the embayments and in the lake itself (Figure 2). Most embayments have clay and gravel “bay mouth bars” (Figure 2) that limit water circulation and exchange with the main channel. Retention times in some of the larger embayments as determined by drogue studies can be up to several months, which promotes sediment deposition from inflowing streams. Some patches of sand and rock, primarily chert, occur in the backs of embayments and along marginal areas of the main lake. Overbank areas boarder the secondary and main channels and remain erosional with hard clay

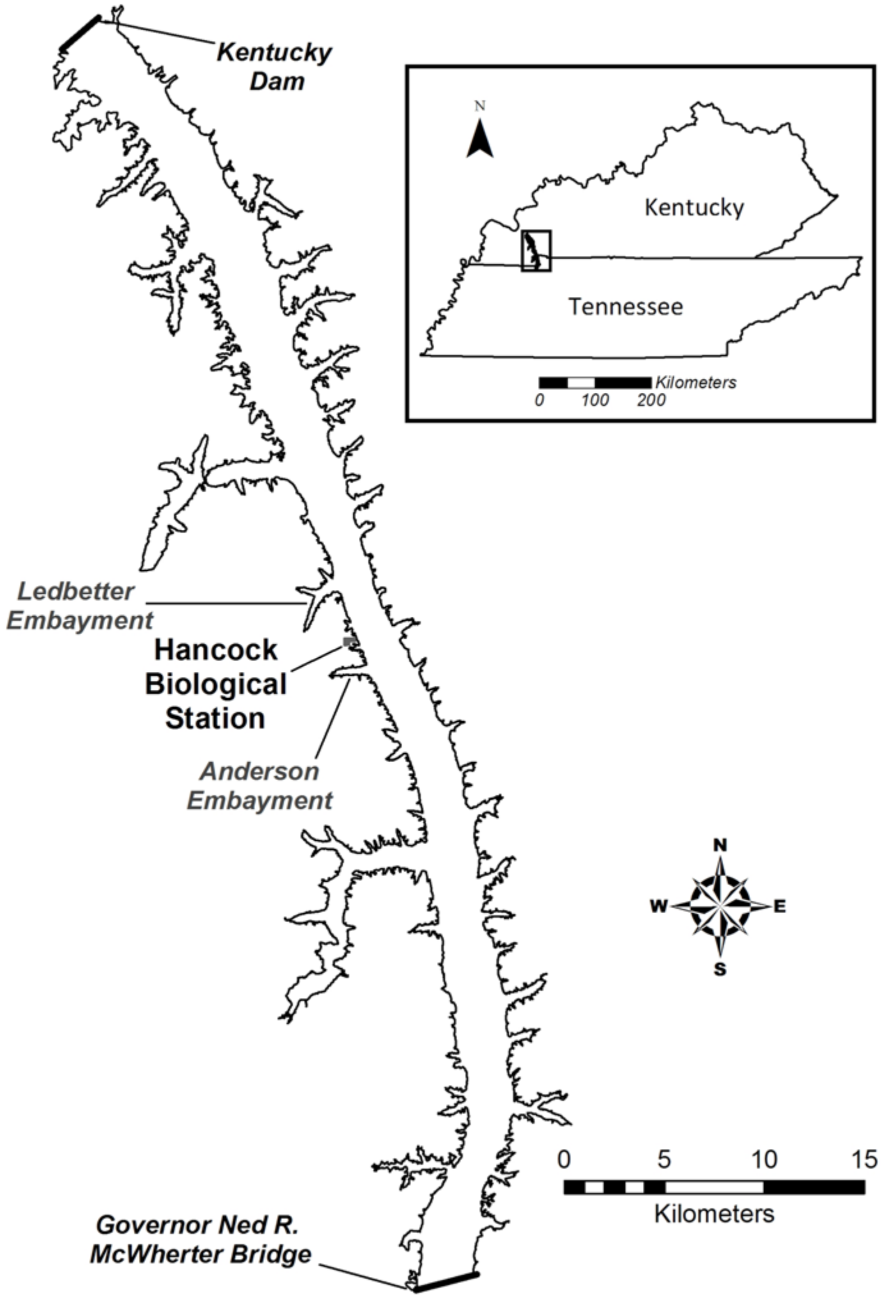

Figure 1. Map of the lower portion of Kentucky Lake, Kentucky and Tennessee, showing major features. Many of the studies cited here have been conducted in Ledbetter and Anderson embayments.

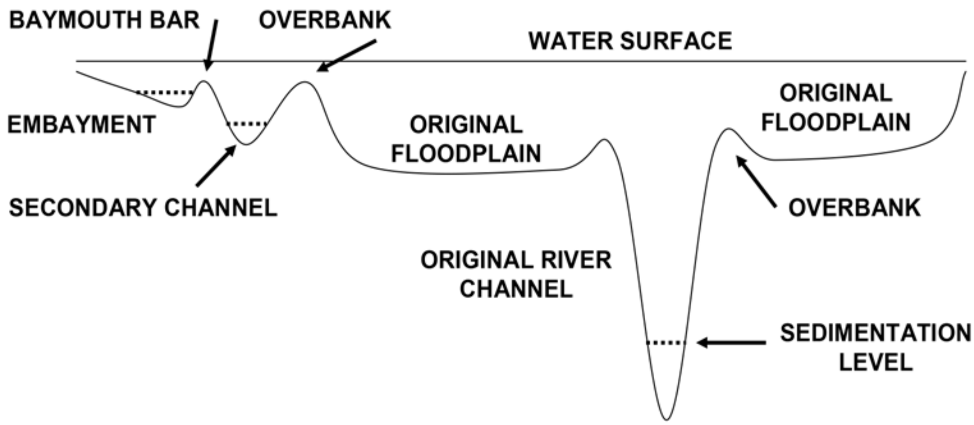

Figure 2. Typical cross section of Kentucky Lake showing bottom features. Depth greatly exaggerated.

and gravel as do the bay mouth bars. Floodplains are patchy ranging from erosional to depositional, but sediment deposition is generally less than 20 cm. These deposits are continually resuspended by boat and barge traffic. About 2 m of sediment have accumulated in the main and 1 m or more in secondary channels (Figure 2). Sediment organic carbon levels are low, ~2% throughout the lake, which is common for southern reservoirs (Yurista et al. 2001a, 2004). Even near the mouths of tributary streams, the organic carbon in the sediments results from autochthonous production as determined by stable isotope studies ($\delta^{13}C$ and $\delta^{15}N$) of both sediments and macroinvertebrates (Martin 2013).

Murray State University's Center for Reservoir Research began a long-term monitoring program on Kentucky Lake in 1988 (White et al. 2007). Fourteen sites are surveyed every 16 days for water column physical, chemical, and biological parameters. Biological measurements include zooplankton, phytoplankton, primary productivity, and chlorophyll. Only occasional benthic surveys have been conducted. Based on nutrient chemistry and plankton populations, Kentucky Lake is considered mesotrophic. No unusual levels of toxic organic compounds have been found or published (B. Loganathan, Murray State University, pers. com.). Summer water temperatures reach 32 ºC in August and rarely go below 4 ºC in winter. Ice seldom accumulates and then only in the backs of embayments. The water column usually is well-mixed due to wind and currents, but oxygen levels in bottom waters can approach 1% in mid-summer if discharge is low.

Because of fluctuating water levels, macrophyte beds are limited. Invasive *Myriophyllum spicatum* L. stands had been extensive in the backs of embayments. Concerted efforts by state agencies eliminated most of the *Myriophyllum* in the late 1990s, but it is now returning along with alligator weed, *Alternanthera philoxeroides* Griseb. The only other widespread aquatic plant in embayments is native water-willow, *Justicia americana* (L.) Vahl., an emergent that appears well-adapted to water level changes. These small plants beds likely harbor macroinvertebrate taxa (e.g., Odonata, Coleoptera, Hemiptera) not included in the list. The lake was cleared of most trees before impoundment, but some old stumps do exist in deeper areas. These sites have not been surveyed and also may harbor additional macroinvertebrate species.

METHODS AND MATERIALS

Benthic macroinvertebrates are defined as organisms that are retained on a 0.5 mm sieve, which excludes rotifers, nematodes, and other very small taxa (Strayer 2009). Data used here are taken from publications (e.g., Heyn and Sickel 1990; Balci et al. 2005; Ramsey et al. 2007), agency reports (e.g., Pennington and Associates 1994; Hubbs 2009), Master's theses (e.g., Miller 1979; Newberry 1984; Boon 1985; McGregor 1991; Moyer 2002), and collections housed at the Hancock Biological Station. Additional data are taken from unpublished surveys. No attempt has been made to verify the reported taxa or distributions. The majority of the samples have been taken using PONAR grabs. Unionids most often were collected by divers. Hyen and Sickel (1990) used both Peterson grabs and D-frame dip nets in their study of Anderson Embayment.

Most reported data were listed at the "lowest practical taxonomic unit". In many cases, this was at the Family (e.g., Chironomidae) or Genus levels except where genera are monotypic or only a single species is known to exist in this part of the country (e.g., *Taphromysis louisianae*). Where taxa may have more than one species but are listed only at the Family or Genus levels, it is recognized that one species may be abundant or common while others may be rare or that only one species in that genus was collected. Densities m^2 were often listed, but only a few reports gave actual locations in the lake or described bottom conditions. Relative density used here is estimated as 1) abundant – appearing in all references and expected to be collected throughout the lake; 2) common – appearing in most references but usually with densities of only 1-2 per m^2; 3) uncommon – occasionally listed but might be common at a specific site; and 4) rare – only one to a few records.

RESULTS AND DISCUSSION

At least 230 benthic macroinvertebrate taxa have been recorded from Kentucky Lake (Table 1), of which more than 100 are in the dipteran family Chironomidae, and 41 are unionid mussels. As a Family, Chironomidae were numerically dominant in all substrates and accounted for the majority of the biomass (exclusive of the unionid mussels). Of the 12 most abundant taxa, seven were insects, two were oligochaetes, and three were mollusks (Table 2). Three Federally Endangered unionid mussel species are present, *Cyprogenia stegaria*, *Lampsilis abrupta*, and *Plethobasus cooperianus,* but all are rare.

Overall, the benthic macroinvertebrate composition of Kentucky Lake is similar to that of both large and small reservoirs in the eastern United States, e.g., Arbuckle Lake (Parrish and Wilhm 1978), Ham's Lake (Ferraris and Wilhm 1977), Lake Carl Blackwell (Howick and Wilhm 1984), Arcadia Lake (Bass 1992), Keystone Reservoir (Ransom and Dorris 1972), Dardanelle Reservoir (Rickett and Watson 1994), a South Dakota power plant cooling reservoir (Sloane and Benda 1981), and Lake Texoma (Sublette 1957; Vaughn 1982). In many cases, the reservoirs mentioned above were sampled only once or twice. Most of the publications were in the 1970s and 1980s, and newer surveys are not as common.

The benthic macroinvertebrate communities of the majority of eastern U.S. reservoirs are surprisingly similar. The communities are not diverse with generally only a few dozen common taxa being recorded in most. Tubificidae (*Limnodrilus*), *Hexagenia*, *Sialis*, *Chaoborus*, *Coelotanypus*, and *Sphaerium*, generally associated with soft sediment deposits, are the dominant benthic taxa in most of the reservoirs. The Kentucky Lake community follows this pattern with some notable additions, particularly *Chironomus major* and the rich freshwater mussel fauna. The overall higher diversity can be attributed to a number of intensive surveys and additional sampling in marginal areas.

Reservoirs are geologically ephemeral in the landscape with lifespans of only decades or centuries. It could be justifiably said that most species in reservoirs are successful invaders because the majority of the species now present did not exist in the unimpounded river. Studies of macroinvertebrate colonization immediately after impoundment are rare. In a study of Lake Anna, a mainstem reservoir of the North Anna River, Virginia, Voshell and Simmons (1984) observed that benthic macroinvertebrate populations changed rapidly after impoundment, stabilizing in just a few years as primary organic matter sources changed from allochthonous to autochthonous. There were no available post-impoundment surveys of Kentucky Lake, but it can be assumed that similar events occurred and that the benthic community is essentially the same today as it was in the late 1940s with the addition of some more recent invasive species.

Diversity and densities may slowly decrease with reservoir age as bottom sediments become more uniform (Popp and Hoagland 2005), but once the community is established, there are few reported major changes over time even when new benthic species invasions have occurred (Rickett and Watson 1994). Unfortunately there are exceedingly few other studies that have followed reservoir community structure long enough or in enough detail to determine if changes actually have occurred or if there are any consistent long-term patterns among reservoirs.

While the primary Kentucky Lake species resemble those of other reservoirs, diversity appears higher most likely because of the varied bottom topography that retains both depositional and erosional features. The bottom of the Kentucky Lake main and secondary channels consists of fine particles (Figure 2) and has the lowest benthos density and diversity, similar to other reservoirs, while the backs of embayments and overbank areas have remained comparatively diverse.

Natural lakes have a different and often much more abundant benthic fauna than do reservoirs (Wetzel 2001). The differences are reflected in the oligochaete, chironomid, fingernail clam, and amphipod species present (Brinkhurst 1974; Karatayev et al. 2013). Further, natural lake benthos tend to be more reflecttive of trophic status (Wetzel 2001). While some eastern reservoirs may stratify and range from oligotrophic to eutrophic, assessment of the water quality requirements based on the benthos places most in a mesotrophic-like category. High disturbance regimes through physical manipulations have been shown to alter benthos density and diversity in reservoirs (Furey et al. 2006; Kaster and Jacobi 1978), particularly in shallower areas (McEwen and Butler 2010), but the effects of floods, droughts, and sedimentation actually may make reservoirs more biologically stable over time by limiting plankton and benthos to a small suite of adaptable species (e.g., Townsend and Scarsbrook 1997).

Species introductions and invasions are capable of dramatically altering natural lake benthic communities (Spencer et al. 1999; Karatayev et al. 2013). Similar introductions in reservoirs seem to have had less effect on overall community structure, and few studies have demonstrated linkages between the benthos, fish, zooplankton, or algae invasions. The invasion and subsequent removal of *Myriophyllum* and *Alternanthera* in Kentucky Lake appeared to have had no demonstrable effect on either main lake or embayment benthic communities. Other notable benthic invasives in Kentucky Lake include *Corbicula*, *Plectomerus*, and *Chironomus major*. *Corbicula* has been in this and most other U.S. reservoirs for decades, and its effect on community structure is largely unknown. *C. major* and the more native mayfly *Hexagenia bilineata* do appear to be interacting with each other but not with the other benthic taxa (Balci et al. 2005; Ramsey et al. 2007). The invasive cladoceran, *Daphnia lumholtzi*, has become one of the primary components of the zooplankton but has not had much affect on the rest of the very stable zooplankton community (Yurista et al. 2001b, but see Havel et al. 2005). Zebra mussels have not become well-established throughout Kentucky Lake and have had limited, if any, long term effects on the benthic community, particularly the unionid mussels

Although the plankton-feeding silver carp, *Hypophthalmichthys molitrix* (Valenciennes), and bighead carp, *Hypophthalmichthys nobilis* (Richardson), have been present in Kentucky Lake since 1987, only in the past 2-3 years have they become abundant. The Kentucky Department of Fish and Wildlife now estimates there are “millions of pounds” of silver carp in Kentucky Lake and its sister reservoir, Lake Barkley. These species are expected to dramatically affect zooplankton and phytoplankton populations that potentially could be a tipping point for the benthic macroinvertebrate community (Radke and Kahl 2002; Ma et al. 2010). However, as of 2013, we had not detected any changes to the plankton community based on the long-term monitoring program. The black carp, *Mylopharyngodon piceus* (Richardson), is present in the Ohio River and most likely now in Kentucky Lake. It feeds on snails and mussels and over time may greatly affect mollusk populations (Nico 2005). With the exception of the zebra mussel, we do not know what species have attempted but failed to colonize.

Havel et al. (2005) speculated that invasive species could more readily colonize reservoirs because of higher disturbance levels. This may be true for water column species of zooplankton and fish but has yet to be demonstrated for benthic macroinvertebrates. Ricciardi (2001) argues, however, that diverse natural lake ecosystems (the Laurentian Great Lakes) become more easily invaded as the number of existing species increases (also see Spencer et al. 1999). It can be speculated that an invasive species might be successful in Kentucky Lake simply because it is a disturbed habitat or unsuccessful because it is disturbed with low species diversity.

In summary, the published and unpublished literature on Kentucky Lake produced a list of more than 230 benthic macroinvertebrates, perhaps the most comprehensive for any eastern United States reservoir. Only a few taxa were actually common throughout the lake and were the same as in most other eastern U.S. reservoirs. Similarities in benthos could be due to similarities in the types of disturbances in reservoirs that govern the physical regimes: fluctuating water levels, sedimentation patterns, currents. In general, reservoirs may not be good indicators of climate change because perturbations most likely will overwhelm any climate change signals, and the species present are adaptable to harsher environments. Similarly, invasive species appear to have had little effect on community structure to date. Only severe pollution, drastic changes in the watershed, or a dramatic species invasion that alters the trophic status is expected to change the benthic macroinvertebrate community. Silver carp may be that dramatic invasive. The annotated list provides a baseline upon which to measure both short and long-term changes in the benthic macroinvertebrate community.

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Table 1. Annotated list of macroinvertebrate benthos in Kentucky Lake.

CNIDARIA
Olindiidae

The medusas are presumed uncommon but occasionally seen in the water column around boat docks in summer, and a few have been collected in grab samples.

Craspedacusta sowerbyi Lankester

BRYOZOA

Both taxa are common and found on every hard substrate in the lake (rocks, wood, metal, boats) and are particularly noticeable in summer and fall. *Pectinatella* colonies in Kentucky Lake occasionally reach 0.5 m in diameter. Statoblasts often number in the 1000s m^2 in the surface sediments beneath structures such as boathouses. Wood (2010) reported that *Pectinatella*'s range has expanded from east of the Mississippi River to reservoirs in every part of the country.

Plumatellidae
Plumatella repens (Linnaeus)

Lophopodidae
Pectinatella magnifica (Leidy)

ENTOGNATHA
COLLEMBOLA

Springtails are abundant in midsummer along the margins of embayments.
Podura aquatica (L.)

INSECTA
EPHEMEROPTERA

Caenis is common in shallower waters of embayments. More has been published on Kentucky Lake *Hexagenia* than any other aquatic insect including life histories, secondary production, and distribution. *Hexagenia* is abundant and widely distributed throughout the lake but uncommon in waters greater than 6 m deep. The distribution appears to have become limited to waters 2 m deep or shallower in the past few years because of possible competition with *Chironomus major*. There are two mass emergences, one in late June and one near the end of August. *Stenomena* is common on rocky substrates and overbank areas.

Caenidae
Caenis sp.
Ephemeridae
Hexagenia bilineata (Say)
Heptageniidae
Stenonema sp.

ODONATA

A number of other odonates occur along the shoreline in shallow water but rarely have been found in open water. Most taxa listed below are uncommon in benthic samples except where substrates are firm. *Progomphus* and *Macromia* are occasionally found in shallow, soft sediments.

Zygoptera
Lestidae
Lestes sp.
Coenagrionidae
Enellagma sp.
Anisoptera
Corduliidae
Epitheca sp.
Gomphidae
Progomphus sp.
Macromiidae
Macromia sp.

HEMIPTERA

Hemiptera are generally uncommon in the open lake. Occasional *Notonecta* have been collected in bottom samples along with unidentified Corixidae. *Aquarius* is abundant on the surface and often occurs in large numbers offshore. *Rhagovelia* is often abundant near shore in the backs of embayments.

Gerridae

Aquarius sp.

Corixidae

Unidentified spp.

Notonectidae

Notonecta sp.

Veliidae

Rhagovelia sp.

MEGALOPTERA

Sialis is common to abundant everywhere throughout the lake with densities up to 300 m^2. It is one of the few predatory benthic macroinvertebrates in Kentucky Lake.

Sialidae

Sialis velata (Ross)

TRICHOPTERA

Oecetis is the only caddisfly common throughout the lake in soft sediments. Other Trichoptera are rare but occur on firm substrates.

Hydroptilidae

Oxyethira sp.

Leptoceridae

Oecetis sp.

Polycentropodidae

Cyrnellus fraternus (Banks)

COLEOPTERA

Shoreline and wave zone areas contain a wide variety of aquatic beetles, e.g., Hydrophilidae, Dytiscidae, Heteroceridae, Carabidae, but few appear to have been collected in the open lake. The gyrinids are included because colonies of up to several thousand are common on the lake surface throughout the lake in mid-summer, and their larvae presumably inhabit near shore sediments. A single *Dubiraphia* was recorded.

Elmidae

Dubiraphia sp. (larva only)

Gyrinidae

Gyrinus sp.
Dineutus sp.

DIPTERA

Culicidae
(rare, pupae only)

Ceratopogonidae

Ceratopogonids are wide spread and probably more common in shallower waters than reported. Because of their small size, they can pass through most sieves and are easy to overlook in benthic samples. Other genera should be present.

Bezzia sp.
Culicoides sp.

Chaoboridae

Chaoborus is planktonic at night but abundant everywhere in soft bottom sediments during daylight hours. Mass emergences occur in mid summer.

Chaoborus punctipennis (Say)

Chirononomidae

More than 100 chironomid species probably occur in Kentucky Lake. The list below is primarily from Heyn and Sickel (1990) and reflects an intensive study of the Anderson Embayment (Figure 1). The majority (~90%) of the Heyn and Sickel taxa were collected in the littoral zone and are not present or common in deeper waters. Species collected only as adults from blacklight samples are not included here. Most other sources recorded chironomids only at the genus level, and they are listed below without "sp". Chironomid systematics and nomenclature are continually changing, thus those species reported by Heyn and Sickel (1990) are listed as they appeared in the publication.

Only a few genera and species are abundant or common in the open lake sediments, but they numerically dominate the macroinvertebrates.

These include, in order of relative abundance, *Coelotanypus* (*C. scapularis* and *C. tricolor)*, *Chironomus* (*C. major* and *C. crassicaudatus*), *Tanypus*, *Procladius*, *Natarsia*, and *Cryptochironomus*. *Coelotanypus* and *Chironomus* are widespread and abundant and account for most of the insect larvae taken in grab samples. Other taxa are either rare or occur only in shallow littoral zones, usually on firm substrates.

The up to 60 mm long, bright red *C. major* is the most conspicuous species. It is abundant and comprises the bulk of the insect biomass in most areas of the lake (Balci et al. 2005). It has been found only in impoundments in the southern U.S. and nowhere else is abundant except in Kentucky Lake. Heyn and Sickel (1990) recorded the species from Anderson Embayment in the late 1980s, but apparently it was uncommon at that time. While most chironomids live at the sediment-water interface or construct burrows in the upper cm or so, *C. major* burrows are often 20+ cm deep and may be mechanically interfering with *Hexagenia bilineata* burrows, forcing them into shallower waters. *C. major* was originally described based solely on larvae collected in a small reservoir near Atlanta, GA. Because *C. major* is a junior synonym, it will have to be renamed. Adults emerge in large numbers in late October through early November.

Diamesinae

Potthastia longimanus Kieffer

Tanypodinae

Ablabesmyia
A. annulata (Say)
A. mallochi (Walley)
A. peleensis (Walley)
A. ramphe (Sublette)
Clinotanypus pinguis (Loew)
Coelotanypus
C. concinnus (Coquillett)
C. scapularis (Loew)
C. tricolor (Loew)
Conchapelopia sp.
Chaetocladius sp.
Larsia decolorata (Malloch)
Natarsia sp.
Procladius
P. sublettei Roback
P. bellus (Loew)
Tanypus
T. stellatus (Coquillett)
Zavrelimyia sp.

Chironominae

Chironomus
C. crassicaudatus (Malloch)
Chironomus decorus Johannsen
C. major (Wülker and Butler)
Cladopelma amachaerus (Townes)
*Cryptochironomu*s
C. blarina (Townes)
C. fluvus (Johannsen) Townes
*Cryptotendipe*s
C. pseudotener (Geotghebuer)
Dicrotendipes
D. fumidus (Johannsen)
D. modestus (Say)
D. neomodestus (Malloch)
D. lucifer (Johannsen)
Endochironomus nigricans (Johannsen)
Glyptotendipes
G. amplus Townes
G. meridionalis Dendy and Sublette
Harnichia curtilamellata (Malloch)
Kiefferulus sp.
Lauterborniella sp.
Microchironomus nigrovittatus (Malloch)
Microtendipes pedullus (DeGreer)
Parachironomus
P. carinatus (Townes)
P. frequens (Johannsen)
P. monochromus (van der Wulp)
Paracladopelma
P. nereis (Townes)
P. undine (Townes)
Paralauterborniella nigrohalteralis (Malloch)
Paratendipes albimanus (Meigen)
Phanopsectra obediens (Johannsen)
Polypedilum
P. aviceps Townes
P. halterale Coquillett
P. illinoense Malloch
P. scalaenum (Schrank)HS
Stenochironomus palliatus (Coquillett)
Tribelos jucundum (Walker)

Pseudochironomini

Pseudochironomus sp.

Tanytarsini

Cladotanytarsus (4 spp.) common
Rheotanytarsus nr. *exiguus* (Roback)
Stempellinella nr. *pentatoma* (Roback)
Stempellina nr. *bausei* (Kieffer)
Tanytarsus (13+ species, some potentially common)

Orthocladiinae

Chaetocladius sp.
Corynoneura taris Roback
Cricotopus bicinctus (Meigen)
C. remus Sublette
C. sylvestris (Fabricius)
C. trifasciatus (Meigen)
Epoicoladius flavens (Malloch)
Eukiefferiella coerulescens gr.
Heterotrissocladius marcidus gr.
Hydrobaenus nr. *spinnatus* (Saether)
Krenosmittia sp.
Limnophyes sp.
Lopescladius sp.
Nanocladius
N. distinctus (Malloch)
N. mallochi (Sublette)
Orthocladius nr. *obumbratus* (Johannsen)
Parakiefferiella spp.
Parametriocnemus lundbecki (Johannsen)
Psectrocladius sp.
Psilometriocnemus cristatus Saether
Rheocricotopus nr. *robacki* (Beck and Beck) HS
Smittia sp.
Thienemanniella nr. *fusca* (Kieffer)
T. xena Roback
Tvetenia claipennis gr.

MOLLUSCA

Margaritiferidae

Cumberlandia monodonta (Say) - Spectaclecase

Unionidae

The freshwater mussels are the best-known benthic invertebrates in Kentucky Lake because of their commercial history (button industry, seed pearls) and the number of rare or endangered species present in the Tennessee and Cumberland river basins (Schuster 1988). Both state and federal agencies have conducted numerous surveys and keep extensive databases. The list here was compiled from a number of sources, particularly Sickel and Burnett (2002) and Hubbs (2009). Of the species recorded, only a few are at all common in the lake. Common species include *Amblema plicata*, *Potamilus alatu*s, *Anodonta suborbiculata, Quadrula quadrula*, *Pyganodon grandis, Megalonaias nervosa,* and *Obliquaria reflexa* (T. Levine, Murray State University, pers. com.). *Plectomerus dombeyanus* is abundant everywhere. This is a southern species that appears to have worked its way up the Mississippi River invading the Tennessee River and Kentucky Lake in the 1980s. Three species are Federally Endangered: *Cyprogenia stegaria*, *Lampsilis abrupta*, and *Plethobasus cooperianus*. Ten additional species have been recorded from just below the dam that might occur in the lake (Sickel and Burnett 2002). A large mussel die-off at the upper end of Kentucky Lake below Pickwick Dam occurred in 2007 (Hubbs 2009) concurrent with a zebra mussel die-off. Mussel abundance most often is recorded as number per unit area based on diver made collections; therefore, density and biomass comparisons between mussels and other macroinvertebrate benthos are difficult to make.

Commercial mussel harvesting was a multi-million dollar industry on Kentucky Lake through the late 1990s. Shells were collected using brailing boats in the Kentucky portion and both brailing and diving in the Tennessee portion. The shells were sent to Japan, China, and other Asian countries where they cut and polished into beads that were inserted into oysters to create cultured pearls (Hubbs 2009). Due to problems with the oyster populations, mussel harvests were greatly reduced in the late 1990s but continue today at a much reduced level. The most sought-after commercial species are *Potamilus alatus*, *Megalonaias nervosa, Pleurobema cordatum*, *Fusconaia flava*, *Quadrula quadrula*, *Quadrula apiculata*, *Amblema plicata*, *Elliptio crassidens*, *Quadrula metanevra*, and *Fusconaia ebena* (Hubbs 2009).

Species recorded from Kentucky Lake

Amblema plicata (Say) - Threeridge
Anodonta suborbiculata Say - Flat Floater
Arcidens confragosus (Say) - Rock Pocketbook
Cyclonaias tuberculata (Rafinesque) - Purple Wartyback
Cyprogenia stegaria (Rafinesque) – Fanshell
Ellipsaria lineolata (Rafinesque) - Butterfly
Elliptio crassidens (Lamarck) – Elephantear
Fusconaia ebena (Lea) - Ebonyshell
Fusconaia flava (Rafinesque) - Wabash Pigtoe
Lampsilis abrupta (Say) - Pink Mucket
Lampsilis cardium Rafinesque - Plain Pocketbook
Lampsilis ovata (Say) - Pocketbook
Lampsilis teres (Rafinesque) - Yellow Sandshell
Lasmigona complanata (Barnes) - White Heelsplitter
Leptodea fragilis (Rafinesque) - Fragile Papershell
Ligumia recta (Lamarck) - Black Sandshell
Megalonaias nervosa (Rafinesque) - Washboard
Obliquaria reflexa Rafinesque - Threehorn Wartyback
Plectromerus dombeyanus (Valenciennes) - Bankclimber
Plethobasus cooperianus (Lea) - Orangefoot Pimpleback
Plethobasus cyphyus (Rafinesque) - Sheepnose
Pleurobema cordatum (Rafinesque) - Ohio Pigtoe
Pleurobema rubrum (Rafinesque) - Pyramid Pigtoe
Pleurobema sintoxia (Rafinesque) - Round Pigtoe
Potamilus alatus (Say) - Pink Heelsplitter
Potamilus ohiensis (Rafinesque) - Pink Papershell
Pyganodon grandis (Say) - Giant Floater
Ptychobranchus fasciolaris (Rafinesque) - Kidneyshell
Quadrula apiculata (Conrad) - Southern Mapleleaf
Quadrula cylindrica (Say) - Rabbitsfoot
Quadrula metanevra (Rafinesque) - Monkeyface
Quadrula nodulata (Rafinesque) - Wartyback
Quadrula pustulosa (Lea) - Pimpleback
Quadrula quadrula (Rafinesque) - Mapleleaf
Toxolasma lividis (Rafinesque) - Purple Lilliput
Toxolasma parvus (Barnes) - Lilliput
Tritogonia verrucosa (Rafinesque) - Pistolgrip
Truncilla donaciformis (Lea) - Fawnsfoot
Truncilla truncata Rafinesque - Deertoe
Utterbackia imbecillis (Say) - Paper Pondshell

Species recorded only from the Tennessee River just below the Kentucky Lake Dam

Actinonaias ligamentina Lamarck – Mucket
Dromus dromas (Lea) - Dromedary Pearlymussel
Elliptio dilatata (Rafinesque) – Ladyfinger
Fusconaia subrotunda (Lea) - Long Solid Mussel
Lamsilis fasciola Rafinesque - Wavy-rayed Lampmussel
Lexingtonia dolabelloides (Lea) - Slabside Pearlymussel
Obovaria retusa (Lamarck) - Ring Pink
Pleurobema clava (Lamarck) – Clubshell
Pleurobema plenum (Lea) Rough Pigtoe
Quadrula fragosa (Conrad) - Winged Mapleleaf

Corbuculidae

The Asiatic clam has been abundant in Kentucky Lake since the late 1950s. It is one of the most common bivalves occurring on soft sediments and abundant on hard clays of the overbank areas. Densities of more than 100 m^2 are not unusual. The only bivalve more abundant is *Sphaerium striatum*.

Corbicula fluminea (Müller)

Pisidiidae

P. compressum is common in embayments. *P. casertanum* is uncommon but widely distributed.

Pisidium spp.
Pisidium casertanum (Poli)
Pisidium compressum Prime

Sphaeriidae

S. striatinum is abundant with densities up to 300 m^2 and comprises about 99% of all the fingernail clams in Kentucky Lake. *Musculium* is rare.

Musculium spp.
Sphaerium spp.
Sphaerium striatinum (Lamarck)

Dreissenidae

The zebra mussel is present in Kentucky Lake but only as adults attached to hard, loose substrates, particularly small pieces of wood. The adults most likely are carried in by commercial traffic or on fishing boats. *Dreissena* apparently cannot reproduce in Kentucky Lake because of low calcium levels (Whittier et al. 2008). Reproducing populations were reported in the upper end of Kentucky Lake from the late 1990's through 2001 that have since declined (Hubbs 2009). Beach collections have been made along several km of shoreline in the lower portions of both Kentucky and Barkley lakes. To date, only a few adult shells have been found.

Dreissena polymorpha Pallas

GASTROPODA

Only *Ferrissia*, *Amnicola*, *Menetus*, and *Viviparus* are common and widely distributed, although *Amnicola* and *Campeloma* can be locally common in embayments. Other taxa are rare.

Pleuroceridae

Pleurocera canaliculatum (Say)
Lithasia geniculata Haldeman

Hygrobiidae

Somatogyrus depressus (Tyron)
Probythinella emarginata (Küster)

Ancyclidae
Ferrissia sp.

Hydrobiidae
Amnicola limosa (Say)

Planorbiidae

Helisoma sp.
Menetus sp.

Viviparidae
Campeloma sp.
Viviparus sp.

OLIGOCHEATA

Tubificidae
Surprisingly few oligochaete species are present in Kentucky Lake. *Limnodrilus* is abundant and densities may reach 500+ m^2 in depositional areas but is far less abundant than in many natural lakes (Brinkhurst 1974). *Branchiura* is common and widely distributed throughout the lake but in low numbers. The low organic carbon content of Kentucky Lake sediments (<2%) may in part be responsible for low tubificid densities and diversity.

Limnodrilus sp.
Limnodrilus hoffmiesteri Claparède
Limnodrilus udekemianus Claparède
Branchiura sowerbyi Beddard

HIRUDINEA

All three genera are widely distributed but uncommon.

Golssiphoniidae
Actinobdella sp.
Helobdella sp.
Placobdella sp.

CRUSTACEA
AMPHIPODA

Hyalella and *Lirceus* are rare. *Taphromysis*, usually associated with southern swampy areas, remains somewhat of a mystery. Only one has been collected in a benthic grab, but they are a component of young bass stomach contents and are attracted to light sticks. It is assumed that they are part of the benthos during daylight hours (Brooks et al. 1998).

Dogielinotidae

Hyalella azteca (Saussure)

ISOPODA

Asellidae

Lirceus sp.

MYSIDA

Mysidae

Taphromysis louisianae (Banner)

DECAPODA

Blue crabs obviously are not native to Kentucky Lake and the Tennessee River, but several live and seemingly healthy individuals have been taking by fishermen (White et al. 2006). We suspect that these were let go by picnickers or escaped somehow. No native crayfish (Cambaridae) have been reported from the lake.

Portunidae

Callinectes sapidus Rathbun

Table 2. List of the 12 most abundant benthic taxa in Kentucky Lake as of 2013 (after Moyer 2002; Balci et al. 2005; Ramsey et al 2007; in part).

Chironomus major
Coelotanypus spp.
Procladius spp.
Chaoborus punctipennis
Hexagenia bilineata
Sialis infumata
Oecetis sp.
Branchyura sowerbyi
Limnodrulus hoffmeisteri
Viviparus sp.
Corbicula fluminea
Sphaerium striatinum