

How beaver pond age affects aquatic invertebrates

Abstract

Beavers are ecological engineers, benefitting the aquatic ecosystems with their dams and ponds. The beaver ponds change over time; beaver ponds of different ages will have different characteristics. These differences will influence what types of aquatic invertebrates will inhabit these ponds. Understanding these different successional stages will help us understand more about the beavers' role in the ecosystem. We surveyed three newer beaver ponds and four older beaver ponds to assess the aquatic invertebrate community composition and taxa richness. The newer beaver ponds had an average of 18 taxa, whereas the older beaver ponds had an average of 28.25 taxa. The community composition between newer and older ponds was significantly different, due to some species that were unique or abundant for each pond age group. The habitat in the newer ponds is a type of middle ground between wetland and stream habitat. This could mean that few wetland and stream invertebrates can colonize there. The presence of trout in the newer ponds could also contribute to the low number of taxa. Learning more about the biodiversity associated with successional stages of beaver ponds can inform evaluation criteria for restoration using beaver and improve our understanding of beavers' role in the ecosystem.

Introduction

Over the last few decades, beavers have begun repopulating North America after being hunted in excess in the past (Baker & Hill, 2003). This has allowed them to recolonize their habitats (Washko et al., 2022). As ecological engineers, they are a beneficial part of river ecosystems. Beavers contribute unique habitats to the area by constructing dams in a stream or river, which slows the waterflow, ultimately causing flooding (Naiman et al., 1988). In addition to benefiting the beavers, this flooded area creates new and unique lentic habitats, called beaver ponds, for aquatic invertebrates (Washko et al., 2022). The habitat is distinct from the adjacent lotic habitats, therefore the aquatic invertebrates living within beaver ponds have been shown to be distinct also (Arndt & Domdei, 2011; Pliūraitė & Kesminas, 2012; S. E. Washko et al., 2020).

Beaver-created habitats are long-lasting, undergoing multiple successional stages. The successional stages of beaver ponds also influence which aquatic invertebrates inhabit the pond. Older beaver ponds accumulate more sediment, which provides habitat for sediment-dwelling species (i.e. burrowing and sprawling taxa) and those dependent on fine particulate organic matter (i.e. gatherers) (Bush et al., 2019; S. Washko et al., 2022). Moreover, shredders prefer newer beaver ponds because of the abundance of decaying vegetation produced from recent flooding (Bush et al., 2019; S. Washko et al., 2022). The beavers' food caches and piles of woody debris they may leave also attract scrapers (Bush et al., 2019; S. Washko et al., 2022). In a study done in Finland, there were 14 species of aquatic beetles found only in newer ponds, and three found only in older beaver ponds (Nummi et al., 2021). Also, old and new beaver ponds had multiple species of beetles, while non-beaver ponds did not have more than one species (Nummi et al., 2021). These examples demonstrate how the different successional stages of beaver ponds can be valuable to biodiversity.

Studying the differences and similarities of various invertebrate communities in the different successional stages of beaver ponds is important for restoration. The information gathered from these studies can be useful to land managers when evaluating beaver dam analogues, which are human-made dams used in restoration because they mimic beaver dams and reshape degraded streams. By comparing invertebrates in habitats related to beaver dam analogues with information from natural beaver ponds, land managers can assess how well beaver dam analogues are repairing streams or making progress towards restoration goals. Overall, studying the aquatic invertebrates that inhabit beaver ponds is crucial for understanding the beavers' important role in the ecosystem (Washko et al., 2022).

Our objective is to compare aquatic invertebrate communities in beaver ponds of different ages in the East River Valley. We expect that older beaver ponds will have different communities than newer beaver ponds due to containing more wetland taxa. Also, we expect that newer beaver ponds will have higher species richness due to more recent flooding creating habitat heterogeneity with both lotic and lentic areas.

Methods

Field Data Collection

We sampled aquatic invertebrates from beaver ponds of different ages (Table 1). Four older ponds (20 years or older) and three newer ponds (7 years or younger) were sampled. Using Google Earth's historical imagery function (also known as 'time slider'), we were able to look back at previous years' imagery for the year the pond first appeared or started to form. Using the year of the imagery where each pond was first seen, we determined the approximate age of each pond.

Table 1: Pond names, locations, and approximate ages for sites included in this study.

Pond Name	Coordinates	Approximate Age (years)
Copper 1	38.967307, -106.968327	4-5 [new]
Copper 2	38.973665, -106.962079	1-2 [new]
Copper 3	38.974427, -106.961186	6-7 [new]
401	38.974418, -106.991902	20+ [old]
Rustler's Turnoff	38.988462, -107.010925	25+ [old]
Quigley Creek	38.993478, -107.014681	20+ [old]
East River Friends	38.995461, -107.015925	20+ [old]

Using a D-net, we swept along one meter of the benthic substrate for ten seconds to collect aquatic invertebrates, the total sample area about one-third meter squared each. A sample was taken at the inflow, middle edge, and outflow of each pond. After the invertebrates were collected in the net, we put them into a tray for field identification. Once identified, we released the invertebrates back into the same area of the pond from which they were retrieved. Additionally, we sampled all habitats in the pond haphazardly, recording any species not found

in the sweep samples to create a full list for taxa richness calculations. We recorded the data on field datasheets and later transferred them to an online format. After sampling, all equipment was disinfected before moving to new sites.

Habitat Factors

In addition to sampling invertebrates, we made habitat observations to control for any differences between ponds. We calculated pond area in Google Earth by creating a polygon of the surface area. At the inflow, outflow, and middle of the ponds, the average water depth was measured with a meter stick. The width of the inflow and outflow were also taken with the meter stick. As a proxy for water velocity at the inflow, outflow and middle, we placed a ping pong ball in the water. Using a stopwatch, we timed how many seconds the ping pong ball took to travel one meter. We also made visual observations to determine if the pond was being actively maintained by beaver or has been abandoned by noting recently foraged bushes (Figure 1a), sticks that had been chewed or gnawed (Figure 1b), scent mounds or beaver-made mud piles (Figure 1c), or seeing a beaver (Figure 1d). Lastly, we made note of if a pond was inhabited by trout based on if we saw trout swimming or jumping (Figure 1e).



Figure 1 **A)** Willow stump with teeth marks exposing the light wood middle where main branches were chewed off by beaver. The light color of the wood indicates the chewing is recent, since the wood turns darker with time and exposure to the elements. **B)** Pile of light colored, freshly chewed sticks left in a pile by beavers to eat later. **C)** Mound of mud made when beavers scoop out mud or sediment that has accumulated from the pond and banks in order to keep the water deep. **D)** Beaver along the edge of a beaver pond. **E)** Trout swimming in a beaver pond.

Statistical Analysis

All statistical tests were carried out in RStudio (R Core Team, 2023). We analyzed the data to determine if there were differences in the taxa richness and aquatic invertebrate communities of new versus old beaver ponds. We compared communities using non-metric multidimensional scaling and permanova tests via the *vegan* package in R (Oksanen et al., 2022). Additionally, we compared taxa richness (where habitat-level survey data were pooled by site to avoid pseudoreplication) using a t-test. Finally, we ran an indicator species analysis in the *indicspecies* package to determine if certain taxa were indicative of particular pond ages (Cáceres & Legendre, 2009). As a final measure of the uniqueness of beaver pond habitats, we compared taxa lists for nearby streams and ponds to identify taxa only found in beaver ponds, which represent their contribution to regional biodiversity.

Results

Richness

Contrary to our expectations, taxa richness was higher in old beaver ponds than new beaver ponds (t-test, $t = -6.62$, $df = 3.90$, $p = 0.003$; Figure 2). The average (mean) richness for old ponds was 28.25 taxa, while the average richness for new ponds was 18 taxa. Surface area of the pond and richness were not related (ANOVA, $F_{1,5} = 0.12$, $p = 0.743$).

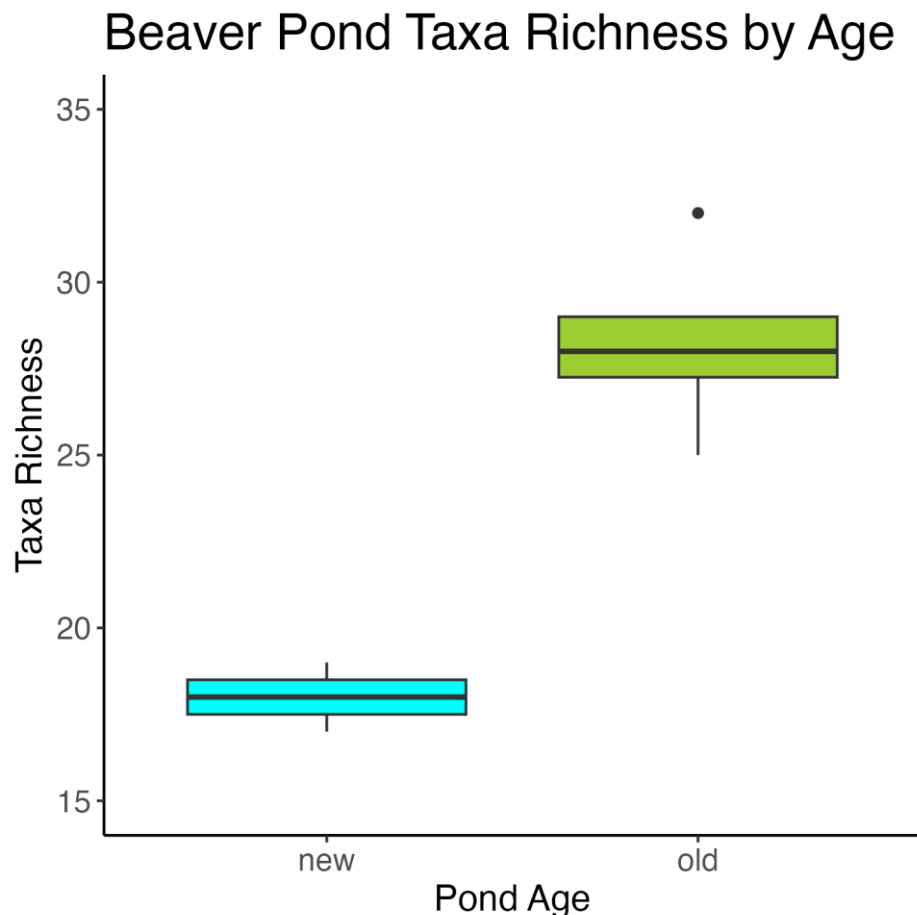


Figure 2 Beaver pond taxa richness differed by pond age. Old ponds (n = 4) had higher richness than younger ponds (n = 3).

Community Composition

The beaver pond communities from our samples were significantly different by pond age (PERMANOVA, $F_{1,19} = 5.388$, $R^2 = 0.221$, $p < 0.001$; Figure 3), but the communities did not differ based on their habitat (PERMANOVA, $F_{2,18} = 0.820$, $R^2 = 0.084$, $p = 0.637$). The Indicator Species Analysis highlighted taxa that contribute strongly to the differentiation of these communities; the new and old beaver ponds have species that are either unique or more common in their samples. In new ponds, Limnephilidae caddisflies (stat = 0.986, $p = 0.001$) (genera not found in older ponds, *Hesperophylax* and *Psychoglypha*) were indicator taxa, as well as Muscidae larvae (stat = 0.745, $p = 0.008$). In the old ponds, indicator taxa included *Pisidium* (stat = 0.904, $p = 0.005$), Platyhelminthes (stat = 0.866, $p = 0.002$), Amphipod (stat = 0.816, $p = 0.004$), *Limnephilus externus* (stat = 0.764, $p = 0.012$), Cladocera (stat = 0.764, $p = 0.023$), *Limnephilus picturatus* (stat = 0.707, $p = 0.036$), and Aeshnidae (stat = 0.645, $p = 0.047$).

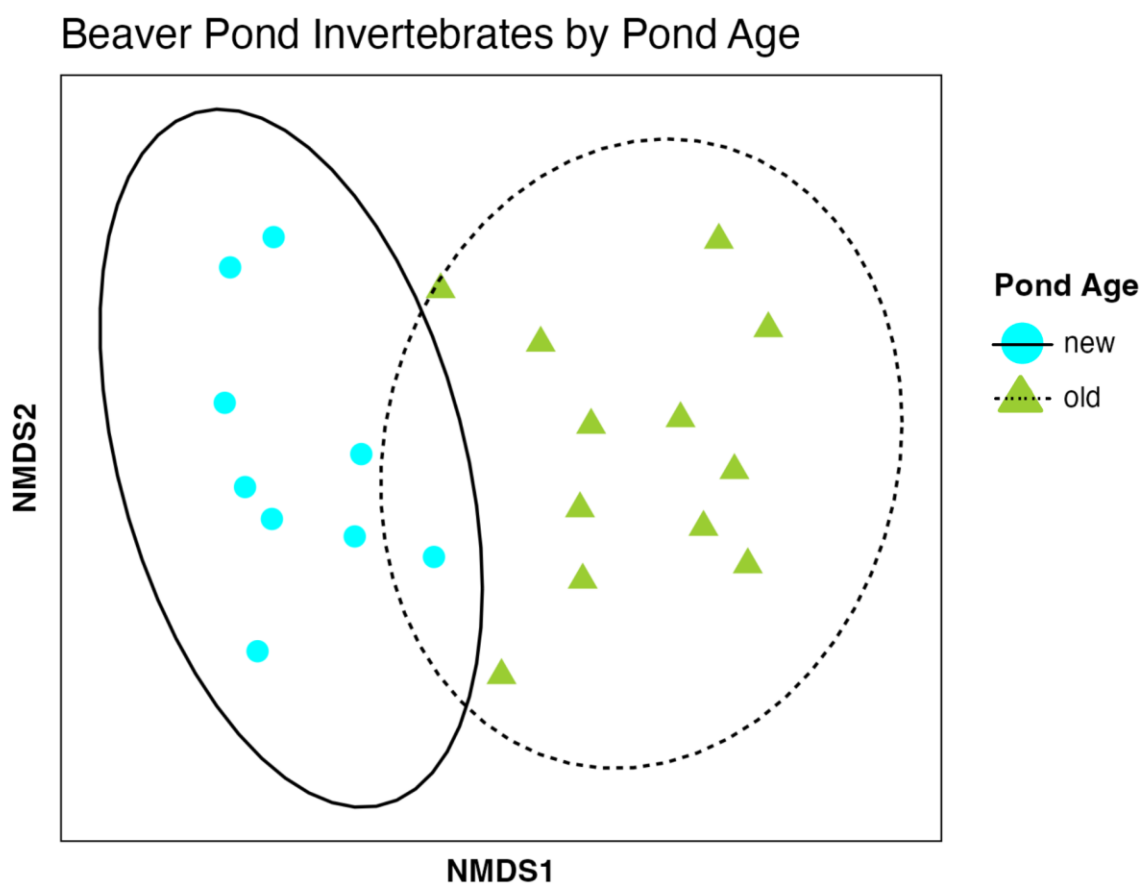


Figure 3 Non-metric multidimensional scaling plot of aquatic invertebrate communities in old versus new beaver ponds (stress < 0.2). Ellipses represent 95% confidence intervals of where each age group falls in community space.

Discussion

Richness & Community Composition

The structure of new ponds may not meet the needs of many of the stream or wetland invertebrates, resulting in lower taxa richness in newer ponds than in older ponds and different communities in newer versus older ponds. The slowing of the water likely does not suit the obligate stream invertebrates, which are often adapted for clinging in lotic conditions (S. E. Washko et al., 2020). The slow velocity also causes fine sediment to collect at the bottom of the pond, which is not ideal for the stream invertebrates who rely on and live in interstitial spaces (S. E. Washko et al., 2020). Furthermore, because some velocity still remains in new ponds (the tributary is larger than those filling the old ponds), there is likely too much flow for obligately lentic taxa to colonize. The indicator species for the both newer and older ponds were lentic-adapted species, including large bodied, case-building, species. Older ponds offer more lentic habitat for these taxa due to slower water and lots of fine sediment, which may be why there were more indicator taxa for older ponds than newer ponds. Lastly, higher taxa richness might be expected in larger ponds, because a larger pond would offer more habitat (Angermeier & Schlosser, 1989; Spencer et al., 1999), allowing more species. In our case, the surface area did not have an effect on the taxa richness.

Another factor to consider is the presence of fish. In all the newer ponds we sampled, and one older pond, there were trout present. Being a part of a larger tributary, fish were able to easily come into these new ponds compared to the older ponds on much smaller streams. Trout may have been eating the larger, moving invertebrates (Morin, 1984), causing the taxa richness to be lower for these ponds. There is also the possibility that the aquatic invertebrates have sensed the trouts' presence, and therefore avoided ovipositing there (Why, 2012). Indeed, in the one older pond containing trout, we did not record the old pond indicator taxa *Limnephilus externus*, a large-bodied shredding caddisfly, and the taxa richness was slightly lower than in the other older ponds (25 taxa; Figure 2). However, previous work suggests some taxa are resilient to the presence of fish (i.e. *Callibaetis*; Caudill, 2002), so not all taxa may be excluded due to fish predation, though fish may still shape the community.

Relevance to Stream Ecology & Restoration

We noticed that new beaver ponds were not found on the same tributaries as the older beaver ponds. As beavers repopulated the Gothic Valley, they began building on small tributaries (seen via Google Earth imagery time series). These small tributaries provided stable conditions that allowed the ponds to mature into wetlands. However, if flow conditions in a river are too high or the risk of a high-water event is high, beavers often create dams and ponds in the floodplain instead of damming the channel (Bush & Wissinger, 2016). We also noticed floodplain ponds in the Gothic Valley but did not sample them. Instead, we focused on new beaver ponds that dammed entire channels, which only occurred on a larger tributary, Copper Creek. The other new ponds, which had been built on a smaller upstream section of the East River, blew out during the spring snowmelt flood. This mosaic of new and blown out dams may be interesting for further study, and suggests that while the old ponds are stable on the small tributaries, the new ponds may not reach older successional stages (20+ years old) due to flood risks. Monitoring these ponds long-term and incorporating 'blown-out' as a successional stage to study would benefit our understanding of beavers' impacts as ecosystem engineers.

By building both floodplain beaver ponds and channel-damming beaver ponds, beavers are creating multiple types of aquatic habitat that should be examined to better understand their contribution to aquatic biodiversity in the valley (Westbrook et al., 2020). We compiled a species list of all the aquatic invertebrates that are found at stream, wetland, and beaver pond habitats

in the Gothic Valley (Appendix 1). We noticed certain taxa that were only associated with beaver-created habitats (Bush & Wissinger, 2016; Caudill, 2002; B. Peckarsky, personal communication, June 21, 2023; Wissinger et al., 2016). Taxa exclusive of beaver ponds includes numerous Diptera species, some Crustaceans, a couple Hemipterans and Trichopterans, and one Plecopteran (highlighted in Appendix 1). Further work is necessary to continue the list of taxa at more specific taxonomic levels. Generally, this work is useful for informing stream restoration and management in the Gunnison National Forest; by understanding which species are associated and at what stages, evaluation criteria can be created for post-work monitoring of restoration sites. Overall, this research will add to our understanding of how beavers contribute to aquatic biodiversity conservation in the face of the freshwater biodiversity crisis (Washko et al., 2022).

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Appendix

Appendix 1: Complete aquatic invertebrate species list for habitats of the Gothic Valley in the East River watershed. We sorted species by habitats where they were collected, based on previous publications from the area (Bush & Wissinger, 2016; Caudill, 2002; B. Peckarsky, personal communication, June 21, 2023; Wissinger et al., 2016).

			Habitat		
Taxa			Streams	Ponds	Beaver Ponds
Ephemeroptera					
Ameletidae					x

	<i>Ameletus</i>	<i>velox</i>	x		
Baetidae					
	<i>Acentrella</i>	<i>turbida</i>	x		
	<i>Baetis</i>				x
	<i>Baetis</i>	<i>bicaudatus</i>	x		
	<i>Baetis</i>	<i>billybarrii</i>	x		
	<i>Baetis</i>	<i>tricaudatus</i>	x		
	<i>Callibaetis</i>				x
	<i>Callibaetis</i>	<i>ferrugineus</i>		x	
	<i>Dipheter</i>	<i>hageni</i>	x		
Caenidae					x
Ephemerellidae					x
	<i>Drunella</i>	<i>coloradensis</i>	x		
	<i>Drunella</i>	<i>dodsii</i>	x		
	<i>Drunella</i>	<i>grandis</i>	x		
	<i>Ephemerella</i>	<i>dorothea</i>	x		

Heptageniidae					x
	<i>Cinygmula</i>	<i>spp.</i>	x		x
	<i>Epeorus</i>	<i>deceptivus</i>	x		
	<i>Epeorus</i>	<i>longimanus</i>	x		
	<i>Rhithrogena</i>				x
	<i>Rhithrogena</i>	<i>hageni</i>	x		
	<i>Rhithrogena</i>	<i>robusta</i>	x		
Leptophlebiidae	<i>Paraleptophlebia</i>		x		x
Siphonuridae					x
	<i>Siphonurus</i>				x
Plecoptera					
Chloroperlidae			x		x
Leuctridae	<i>Paraleuctra</i>	<i>vershina</i>	x		
Nemouridae					x
	<i>Amphinemura</i>				x
	<i>Malenka</i>	<i>flexura</i>	x		

	<i>Podmosta</i>				x
	<i>Podmosta</i>	<i>deliculata</i>	x		
	<i>Zapada</i>	<i>cinctipes</i>	x		
	<i>Zapada</i>	<i>haysi</i>	x		
Perlidae					x
	<i>Hesperoperla</i>	<i>pacifica</i>	x		
Perlodidae	<i>Isoperla</i>				x
	<i>Kogotus</i>	<i>modestus</i>	x		
	<i>Megarcys</i>	<i>signata</i>	x		
	<i>Pictetiella</i>	<i>expansa</i>	x		
Pteronarcyidae	<i>Pteronarcella</i>	<i>badia</i>	x		
Trichoptera					
Apataniidae	<i>Allomyia</i>	<i>gnathos</i>	x		
Brachycentridae					x
	<i>Brachycentrus</i>	<i>americanus</i>	x		
Glossostomatidae	<i>Agapetus</i>		x		

Hydropsychidae	<i>Arctopsyche</i>	<i>grandis</i>	x		
Hydroptilidae					x
Lepidostomatidae	<i>Lepidostoma</i>		x		
Limnephilidae					x
	<i>Asynarchus</i>				x
	<i>Asynarchus</i>	<i>nigriculus</i>		x	
	<i>Chyranda</i>				x
	<i>Ecclisomyia</i>				x
	<i>Grammotaulius</i>				x
	<i>Grammotaulius</i>	<i>lorretae</i>		x	x
	<i>Hesperophylax</i>				x
	<i>Hesperophylax</i>	<i>occidentalis</i>	x		x
	<i>Limnephilus</i>				x
	<i>Limnephilus</i>	<i>externus</i>		x	x
	<i>Limnephilus</i>	<i>picturatus</i>		x	x
	<i>Nemotaulius</i>	<i>hostilis</i>		x	

	<i>Psychoglypha</i>		x		x
Phryganeidae	<i>Agrypnia</i>	<i>deflata</i>		x	
Polycentropodidae					x
Rhyacophilidae	<i>Rhyacophila</i>	<i>alberta</i>	x		
	<i>Rhyacophila</i>	<i>brunnea</i>	x		
	<i>Rhyacophila</i>	<i>coloradensis</i>	x		
	<i>Rhyacophila</i>	<i>hyalinata</i>	x		
	<i>Rhyacophila</i>	<i>valuma</i>	x		
	<i>Rhyacophila</i>	<i>verrula</i>	x		
Uenoidae	<i>Neothremma</i>	<i>alicia</i>	x		
Coleoptera					
Chrysomelidae	<i>Plateumaris</i>	<i>pusilla</i>			
Dytiscidae					x
	<i>Acilius</i>				x
	<i>Acilius</i>	<i>semisulcatus</i>		x	x
	<i>Agabus</i>			x	x

	<i>Agabus</i>	<i>kootenai</i>		x	
	<i>Agabus</i>	<i>strigulosis</i>		x	
	<i>Agabus</i>	<i>tristus</i>		x	
	<i>Colymbetes</i>				x
	<i>Dytiscus</i>			x	x
	<i>Dytiscus</i>	<i>alaskanas</i>		x	
	<i>Dytiscus</i>	<i>duricus</i>		x	
	<i>Hydroporus</i>			x	x
	<i>Hygrotus</i>	<i>patruelis</i>		x	
	<i>Hygrotus</i>	<i>suturalis</i>		x	
	<i>Ilybius</i>	<i>fraterculus</i>		x	
	<i>Liodessus</i>	<i>obscurellus</i>		x	
	<i>Rhantus</i>	<i>binotatus</i>		x	
	<i>Rhantus</i>	<i>gutticolis</i>		x	
	<i>Sanfilippodytes</i>			x	x
	<i>Stictotarus</i>				x

	<i>Stictotarus</i>	<i>grieostriatus</i>		x	
Elmidae	<i>Heterlimnius</i>		x		x
Gyrinidae	<i>Gyrinus</i>				x
	<i>Gyrinus</i>	<i>affinis</i>		x	x
Halplidae	<i>Halplus</i>				x
	<i>Halplus</i>	<i>leechi</i>		x	x
	<i>Halplus</i>	<i>immaculicollis</i>		x	
Hydrophilidae	<i>Helophorus</i>				x
	<i>Helophorus</i>	<i>eclectus</i>		x	
	<i>Helophorus</i>	<i>parasplendidus</i>		x	
	<i>Hydrobius</i>	<i>fuschipes</i>		x	
Staphylinidae					x
	<i>Stenus</i>			x	
Odonata					
Anisoptera					
Aeshnidae				x	x

	<i>Aeshna</i>				x
	<i>Aeshna</i>	<i>juncea</i>		x	
	<i>Aeshna</i>	<i>interrupta</i>		x	
	<i>Aeshna</i>	<i>palmata</i>		x	
Corduliidae	<i>Cordulia</i>	<i>shurtleffi</i>		x	
	<i>Somatochlora</i>	<i>semicirculatus</i>		x	
Gomphidae					x
Libellulidae					x
	<i>Leucorrhinia</i>	<i>hudsonica</i>		x	
	<i>Libellula</i>				x
	<i>Libellula</i>	<i>quadrimaculata</i>		x	
	<i>Sympetrum</i>	<i>costiferum</i>		x	
	<i>Sympetrum</i>	<i>danae</i>		x	
Zygoptera				x	x
Coenagrionidae					x
	<i>Amphiagrion</i>	<i>abbreviatum</i>		x	

	<i>Coenagrion</i>				x
	<i>Coenagrion</i>	<i>resolutum</i>		x	
	<i>Enallagma</i>	<i>annexum</i>		x	
	<i>Enallagma</i>	<i>boreale</i>		x	
	<i>Enallagma</i>	<i>cyathigerum</i>		x	
	<i>Ishnura</i>	<i>damula</i>		x	
Lestidae					x
	<i>Lestes</i>	<i>disjunctus</i>		x	
	<i>Lestes</i>	<i>dryas</i>		x	
Diptera					
Blephariceridae			x		
Ceratopogonidae			x	x	x
	<i>Bezzia</i>			x	
	<i>Culicoides</i>			x	
	<i>Probezzia</i>		x		x
Chaoboridae				x	x

	<i>Chaoborus</i>				x
	<i>Chaoborus</i>	<i>americanus</i>		x	
	<i>Eucorethra</i>	<i>underwoodi</i>		x	
Chironomidae			x	x	x
Culicidae				x	x
	<i>Aedes</i>				x
	<i>Aedes</i>	<i>communus</i>		x	
	<i>Aedes</i>	<i>pullatus</i>		x	
	<i>Culex</i>			x	
Dixidae	<i>Dixa</i>		x	x	x
	<i>Dixella</i>				x
	<i>Meringodixa</i>				x
Empididae			x		
	<i>Clinocera</i>				x
Muscidae					x
Pediciidae	<i>Dicronata</i>		x		

Psychodidae	<i>Pericoma</i>				x
Ptychopteridae	<i>Ptychoptera</i>				x
Simuliidae	<i>Simulium</i>		x		x
	<i>Prosimulium</i>		x		x
Tabanidae					x
	<i>Tabanus</i>				x
Tipulidae	<i>Dicranota</i>		x	x	x
	<i>Hexatoma</i>		x	x	x
	<i>Limnophila</i>			x	
Sciomyzidae					x
Stratiomyidae	<i>Stratiomyia</i>			x	
Syrphidae					x
Hemiptera					
Corixidae				x	x
	<i>Arctocorixa</i>	<i>lawsonii</i>		x	
	<i>Coenocorixa</i>	<i>bifida</i>		x	

	<i>Callicorixa</i>	<i>audeni</i>		x	
	<i>Hesperocorixa</i>				x
Gerridae				x	x
	<i>Aquarius</i>			x	x
	<i>Gerris</i>	<i>gillettei</i>		x	
Notonectidae				x	x
	<i>Notonecta</i>			x	
Veliidae	<i>Rhagovelia</i>			x	
Saldidae					x
Crustacea					
Amphipoda				x	x
	<i>Crangonyctidae</i>				x
	<i>Dogielinotidae</i>				
	<i>Gammarus</i>			x	x
	<i>Hyaella</i>			x	x
Anostraca	<i>Branchinecta</i>	<i>coloradensis</i>		x	

Cladocera				x	x
	<i>Bosminidae</i>				x
	<i>Ceriodaphnia</i>	<i>quadrangula</i>		x	
	<i>Chydorus</i>	<i>sphaericus</i>		x	
	<i>Daphnia</i>	<i>middendorffiana</i>		x	
	<i>Daphnia</i>	<i>pulex</i>		x	
	<i>Daphnia</i>	<i>rosea</i>		x	
	<i>Scaphaloberis</i>	<i>mucronata</i>		x	
	<i>Simocephalus</i>	<i>vetulus</i>		x	
Copepoda				x	x
	<i>Acanthocyclops</i>	<i>vernalis</i>		x	
	<i>Calanoida</i>				x
	<i>Hesperodiaptomus</i>	<i>shoshone</i>		x	
	<i>Leptodiaptomus</i>	<i>coloradensis</i>		x	
Ostracoda			x	x	x

	<i>Cypris</i>	<i>palustera</i>		x	
Rotifera					
	<i>Conochilus</i>	<i>hippocrepis</i>		x	
	<i>Euchlanis</i>			x	
	<i>Keratella</i>	<i>cochlearis</i>		x	
Mollusca					
Lymnaeidae			x		x
Physidae	<i>Physa</i>	<i>gyrina</i>		x	x
Planorbidae			x	x	x
	<i>Gyraulus</i>	<i>parvus</i>		x	
Sphaeriidae					x
	<i>Pisidium</i>			x	x
Turbellaria					
Platyhelminthes			x	x	x
	<i>Mesostoma</i>	<i>ehrenbergii</i>		x	

Oligochaeta			x	x	x
	<i>Limnodrilus</i>			x	
	<i>Lumbriculus</i>	<i>variegatus</i>		x	
Hirudinea					x
	<i>Glossiphonia</i>	<i>complanata</i>		x	
	<i>Helobdella</i>	<i>stagnalis</i>		x	
	<i>Nepheleopsis</i>	<i>obscura</i>		x	x
Acari			x	x	x
Hydracarina				x	
	<i>Arrenurus</i>			x	
	<i>Hydrozetes</i>			x	
	<i>Lebertia</i>			x	
	<i>Limnesia</i>			x	
	<i>Piona</i>			x	

