A Bug's Life in the Columbia Slough:

Handbook of Invertebrates and Macroinvertebrate Monitoring in the Columbia Slough

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(Cover photo: restoration site on Columbia Slough near Interstate 205. The benches had recently been created, but had not yet been planted with native vegetation.)

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INTRODUCTION

The Columbia Slough watershed supports a surprisingly diverse array of fish, birds, mammals, reptiles, amphibians, plants and invertebrates (animals without spines). The Slough provides a rare and valuable biological, recreational, and community resource in a highly urbanized environment, despite many decades of intense human land use. This diversity includes plants and animals that have been transplanted to the Northwest from other parts of the world, but many others are native and require specific conditions for survival.


Colorful male Pacific forktail damselfly (*Ischnura cervula*).

This handbook focuses on the invertebrates that spend part or all of their life in waters of the Columbia Slough watershed. Smaller aquatic invertebrates will receive mention, but the emphasis is on macroinvertebrates – invertebrates which are larger than half the thickness of a dime (0.5 mm; 500µm; or 1/50th inch).

Aquatic macroinvertebrates have cultural, monitoring, aesthetic, and conservation significance. The colorful, acrobatic and ravenously predatory dragonflies and damselflies like the Pacific forktail above are certainly among the more charismatic aquatic predators in the Slough. Though not exactly tasty, freshwater mussels provided portable protein for American Indians across the Northwest. The mussels in the Slough can grow up to 8" long and can live for 30 or 40 years. The crayfish of the Slough, with their large claws and tasty tails, are important scavengers. They may also represent a conservation struggle. A particularly nasty invasive species that has been documented in the Slough (though not yet confirmed) could actually eliminate the native species. Sadly, because of pollution in the sediments, the mussels and crayfish of the Slough today should not be eaten.

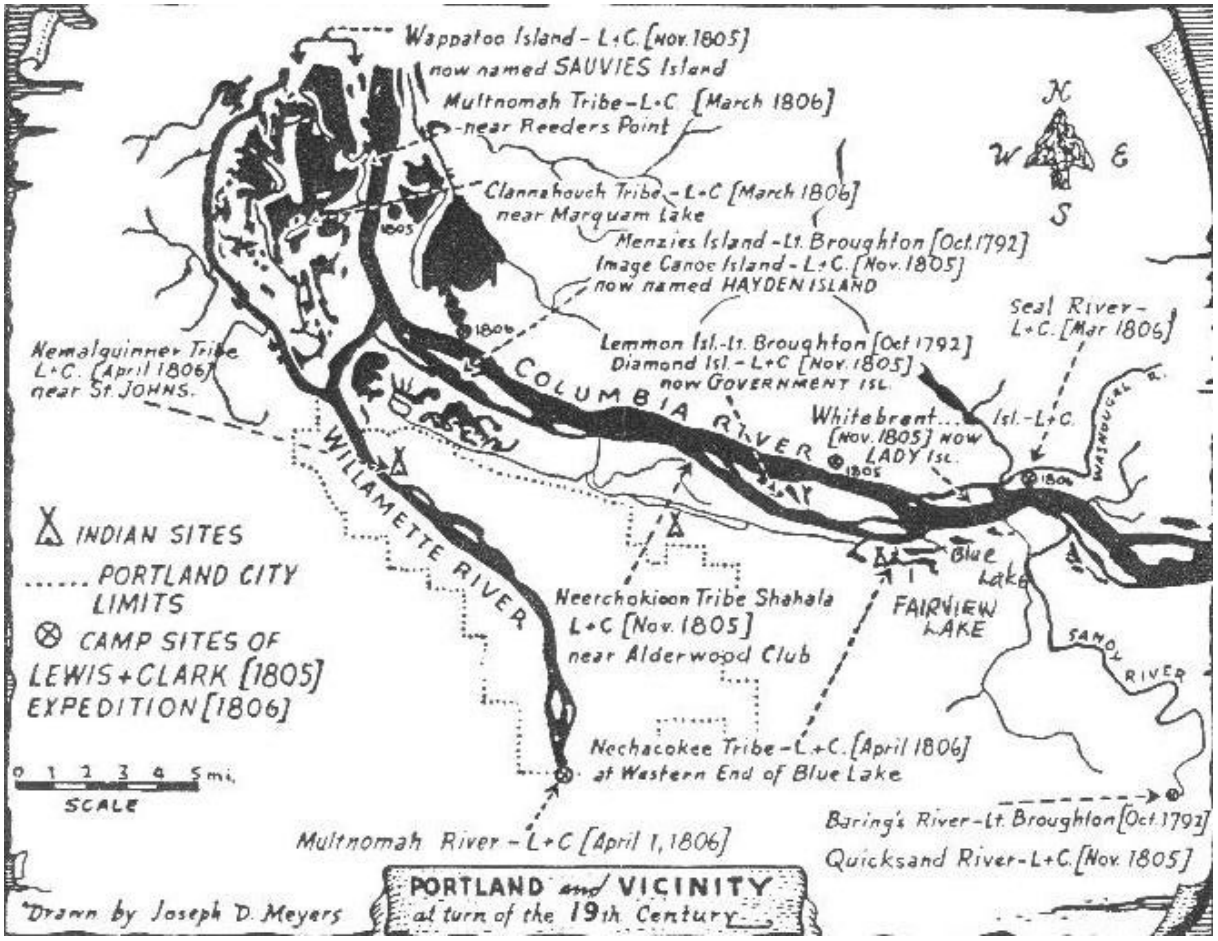
By understanding and appreciating the rich diversity of these organisms and how that diversity can be affected by human activities in the watershed, we can add to our appreciation of the highly urban Columbia Slough and what it contributes to the landscape, economics, and culture of the region. It may also make you wonder what kinds of organisms are supported by other urban environments, what threats are likely to impact their survival, and how we can work together to protect them and their habitat from degradation or loss.

In this handbook you will learn about the Columbia Slough, macroinvertebrate monitoring in the Slough, and invertebrates that are already known to live in the Columbia Slough watershed. You will also learn about the joint project between the Xerces Society for Invertebrate Conservation and the Columbia Slough Watershed Council to collect macroinvertebrate samples in the Slough and in its tributaries, and about how you can contribute to our understanding of invertebrates in the Slough.

THE COLUMBIA SLOUGH

HISTORY

The Columbia Slough is a 60-mile long remnant of interconnected lakes, wetlands and slow-moving channels in the southern floodplain of the Columbia River. The area's wildlife and plants once sustained powerful American Indian tribes who were decimated by diseases brought to the region by European sailors and traders. Lewis and Clark witnessed the biological richness of the watershed during 1805 and 1806, noting plentiful wildlife (particularly geese, brandts, ducks, and otter) in the Slough.



This and other maps are available from the Center for Columbia River History – Columbia Communities: Columbia Slough http://www.ccrh.org/comm/slough/main.htm.

In the early 1920's levees were constructed to prevent seasonal flooding, and the waterway was transformed into a slow-moving drainage canal to manage the water levels in the one of the most economically important watersheds in the state. This canal then became known as the Columbia Slough.

Today, the Slough has two sections that are controlled by very different factors. Flow in the upstream section is created mostly by springs and storm runoff and controlled by levees and

water control structures. The downstream section is tidally influenced with water levels changing as much as 3'/day. As you may imagine, the differences between the two sections of the watershed also influences the plants and animals that live there.

HUMAN INFLUENCE

Agricultural, industrial and residential development flourished once the yearly floods were nearly eliminated. Today the 40,000 acres of watershed contains 24,000 homes, 4,500 businesses, and 1/10 of all the jobs in Oregon. Each year more than 13.7 million people and over 275,000 tons of freight come through the watershed. With development, much of the habitat for fish and wildlife in the watershed has been destroyed or highly modified.

The Port of Portland is one of the myriad of businesses that operate in the Columbia Slough watershed.

The Columbia Slough Watershed Council was formed to address the impacts that 150 years of development have had in the Slough, and despite a long history of environmental decline, the Slough is cleaner today than it has been in over 100 years. Even though the legacy of pollution will long be chronicled in sediments and fish that can both contain PCBs and pesticides, but Combined Sewer Overflows (CSOs) were eliminated in 2000, removing untreated sewage and reducing storm runoff into the Slough. Watershed-wide efforts to revegetate nearby natural areas with native plants and the creation of wetland benches in the Slough have increased the habitat available for fish, birds, invertebrates, and other wildlife. Finally, increasing awareness among businesses and residents has lead to greater appreciation of the Slough as a biological and community resource.

VALUE AND OPPORTUNITIES

As habitats are modified throughout the Portland metropolitan region, the Slough's importance as a component of our regional system of greenspaces grows. The Slough's ribbon of habitat and openspace provides some connectivity for wildlife and can be explored by recreationalists on foot and bicycle or in canoe and kayak. The Slough is one of the largest urban waterways contained wholly within the metropolitan urban growth boundary. Flanked on the west by the 2,000 acre Smith and Bybee lakes, and on the east by the 102 acre Fairview Lake, the Slough's 60 miles of waterways and its watershed represent an irreplaceable resource for the region.

The Columbia Slough Watershed Council is a diverse group of neighbors, property owners, businesses, environmental groups, recreation advocates, and government agencies who work to restore and enhance the 60 miles of waterways, wetlands, and slow moving channels known as the Columbia Slough. Through partnerships and action they work towards their mission: to foster action to protect, enhance, restore and revitalize the Slough and its watershed. Visit the Council on-line at http://www.columbiaslough.org.

BIOLOGICAL MONITORING

As the name suggests, biological monitoring (also known as biomonitoring) involves using the plants or animals that live or should live in a certain environment to evaluate the condition of that environment. This concept can apply to any "habitat" using any organism or group of organisms – from canaries in coal mines, to kings wine tasters, to macroinvertebrate monitoring of streams.

Typically, biomonitoring involves comparing the assemblage of organisms found at a location that has been altered by human activity to a similar location that has minimal human activity present. By using other organisms as indicators, we can learn about the ability of an environment to support a diverse and healthy biological community.

Reducing pollution is important to us because we are concerned about the effect pollution may have on living things, including ourselves. That being the case, it makes sense to look at the organisms living in a particular environment to see what they tell us about the condition in which they live. Collecting water chemistry measurements is like taking snapshots of the ecosystem and has very valuable applicatiosn, but looking at the biology is like looking at a motion picture because the organisms integrate their environmental influences over time.

WHY ARE MACROINVERTEBRATES COMMONLY USED IN BIOMONITORING?

Any biological group can be used for biomonitoring, but in aquatic systems, macroinvertebrates have been the most popular and effective group, giving us a broad base of knowledge to build from. Macroinvertebrates have several advantages over groups of organisms like fish or plants:

1) they are present and abundant nearly everywhere there is water;
2) they are an essential part of the aquatic and terrestrial food web;
3) there are many easily identifiable species;
4) different species respond differently to changes in their environment;
5) they don't move much and are influenced by their surroundings for most of their life;
6) they have diverse life histories, some living for a few days and others a few decades;
7) they integrate the effects of human influence over time.

MACROINVERTEBRATE MONITORING IN THE COLUMBIA SLOUGH

Past biological monitoring or survey projects in the Columbia Slough watershed have involved either plankton tows to collect meiofauna (tiny invertebrates) from the water column, or have used heavy, expensive grab samplers and a boat to collect a certain volume of the soft bottom substrate. The meiofauna collections are outside of the emphasis of this handbook, though a species list and a few images are included in Appendix D.

The sediment grabs primarily sample the worms and midges that live in the often oxygen-poor sediments. The list of Slough invertebrates in Appendix B reflects such sampling because many of the species identified are worms and midges.

In 2003, the Xerces Society and the Columbia Slough began a collaboration to get more information on the full diversity of macroinvertebrates in the Columbia Slough and to use those invertebrates as monitors of water quality and habitat condition. A single, qualitative sample was collected from Alice Springs and formed the basis for Appendix C. Sampling protocols were also practiced and refined in the slow-moving waters of the Columbia Slough in preparation for future monitoring.

YOU CAN HELP MONITOR THE SLOUGH!

If you like to paddle in the Slough while learning about its natural history and its more secretive inhabitants, then you should consider becoming a volunteer in the macroinvertebrate monitoring program. In August and September of 2005, the Xerces Society, the Columbia Slough Watershed Council and volunteers of all ages will collect macroinvertebrate samples in the Columbia Slough watershed. Volunteers can also sort and identify macroinvertebrate samples as time and interest allow. To become a volunteer sampler, contact Jeff Adams at (503) 232-6639 or jadams@xerces.org.

Macroinvertebrate monitoring in the Columbia Slough watershed will provide baseline information on the Slough's biological condition, and should give land managers and decisions makers additional tools to monitoring the effects of restoration ad management changes on the organisms in the Slough. The information gathered from the project will then be interpreted and given to the volunteers, agencies, and organizations involved in the Slough.

This California floater and other mussels in the Columbia Slough may live several decades in the Slough, are relatively sensitive to some types of environmental changes, and can accumulate pollutants in their tissue.

COLLECTING MACROINVERTEBRATE SAMPLES

COLLECTING MACROINVERTEBRATES FROM SLOW OR STILL WATER HABITATS

Since macroinvertebrate monitoring in the Pacific Northwest is most widely conducted in erosional (riffle or fast-moving, shallow water) habitats of streams, we have had to consider alternative protocols for sampling in the slow water habitats of the Slough, including sloughs, wetlands, lakes, and ponds.

Appendix A contains a step-by-step sampling page that outlines a protocol for use in the still waters of the Columbia Slough and can be used from a boat or from the shoreline where access and safety permit. The goal is to collect macroinvertebrates from approximately 8 square feet of shoreline substrate, where the water is only one foot deep (see the first page of Appendix A for more details). Equipment necessary for these protocols is listed in the table below.

Collecting a sample from canoe – notice sample depth is the top of the net hoop and is equal to 12 inches or 1 foot.

EQUIPMENT

Field Sampling

- _ Net - 500 µm mesh D-frame kicknet
- _ field sheets (Appendix A)
- _ sample labels (Appendix A)
- _ 5 gallon bucket
- _ Clipboard
- _ Pencil
- _ Squirt bottle
- _ Tweezers
- _ Thermometer
- _ Camera
- _ Sampling jars and 95% Ethanol (if preserving for future sorting and ID)

Identification

- _ ID sheet (Appendix A)
- _ Clipboard
- _ Pencil
- _ 2 white tubs
- _ 2 ice cube tray
- _ Small square of window screen
- _ Tweezers
- _ Squirt bottle
- _ Vial or other container 3/4 filled with rubbing alcohol or 75% Ethanol

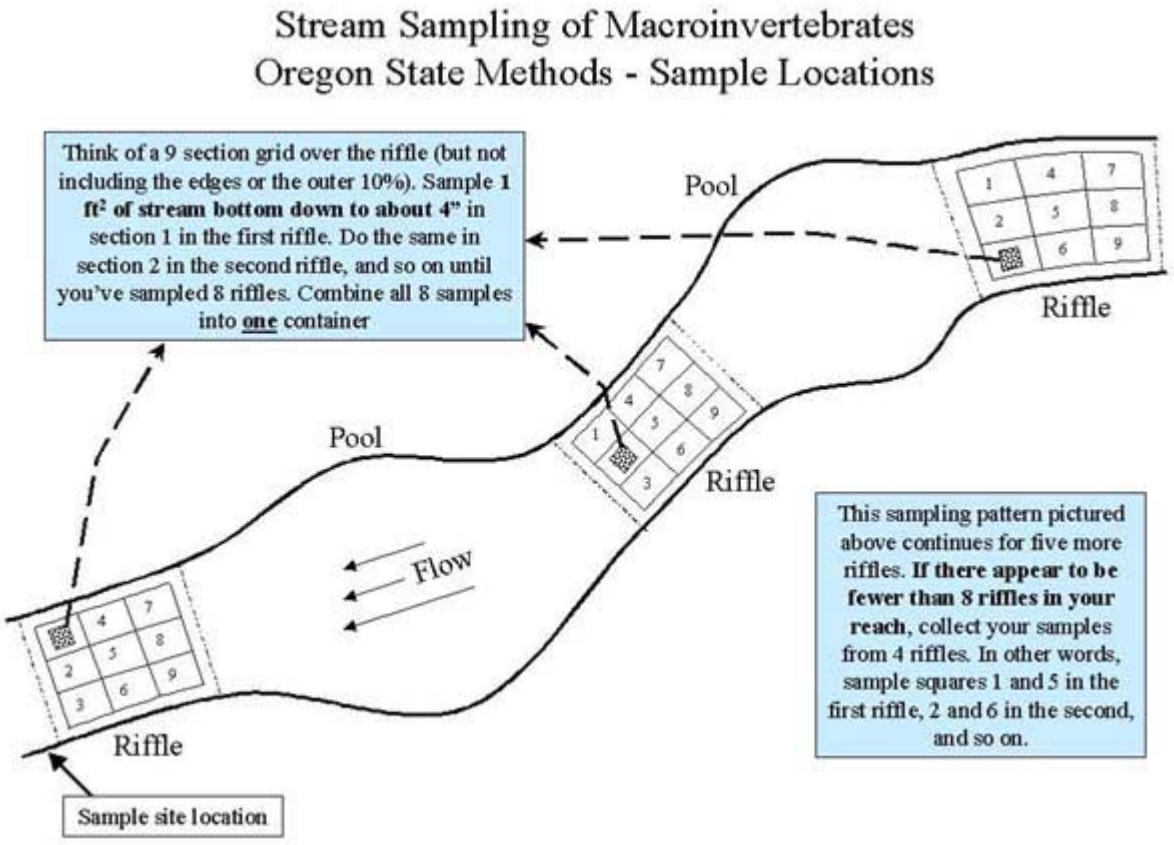
COLLECTING MACROINVERTEBRATES IN FAST-FLOWING WATERS

The equipment is much the same for sampling fast-flowing streams as it is for the slow water sampling in the project. However, protocols are well established for wadeable streams. Samples are typically collected using a D-frame kicknet (same as we are using in the slow waters of the Slough) to collect 8 square feet of stream bottom in riffle habitats. Riffles are parts of the stream where the stream is shallow, the water is rough, and the substrate is larger (gravel and cobble instead of sand and mud).

Once you have reached the sample location (predetermined based on your study question, access, etc.), look upstream and downstream to evaluate how many riffles are available for sampling. Ideally, a single $1ft^2$ sample is collected from each of 8 riffles. Where riffles are very long, few in number, or limited because of landowner access, a pair of $1ft^2$ samples can be collected in each of 4 riffles. In extreme cases, four $1ft^2$ samples can be collected in each of 2 riffles. The number of riffles sampled should be noted on sample labels.


Collecting macroinvertebrates from a riffle in a wadeable stream.

Avoid sampling the edges of the riffle (the outer 10% on the sides and top and bottom). Think of the remainder as 3 rows and 3 columns, numbered 1 to 9 from left to right, downstream to upstream (see picture below). **When sampling 8 riffles**, sample the center of section 1 in the most downstream riffle, the center of grid 2 in the next riffle upstream, etc. **When sampling 4 riffles**, sample the centers of sections 1 and 5 in the first riffle, 2 and 6 in the second riffle, etc. Regardless of how many riffles you sample, make sure not to sample the same section number twice. See the third page of Appendix A for a step-by-step sampling procedure.



PROPOSED SAMPLE SITES

Several sample sites have been selected in the Columbia Slough watershed for macroinvertebrate sample collection. These sites were chosen for a variety of reasons including the local and upstream land uses, local restoration, and access. Ten sites are in the slower water bodies of the watershed (sloughs and lakes) and six sites were selected from tributary streams and springs. The sites are listed below for each type of water body, generally in order from the most downstream point of the Slough (where it enters the Willamette) to the headwaters in Gresham.

Sloughs/Lakes

1. Lower Columbia Slough at the St. John's Landfill site
2. North Slough near the water control structure for Smith and Bybee Lakes
3. Downstream of MCDD Facility (1880 NE Elrod)
4. Bridgeton Slough
5. Whitaker Slough at the confluence with the main stem of Columbia Slough
6. Mainstem at NE 92nd Ave near Johnson Lake
7. Prison Pond
8. NE 148th Ave
9. NE 158th Ave
10. Big 4 Corners

Springs/streams

11. Wilkes Creek
12. Alice Springs
13. Osborn Creek
14. Fairview Creek
15. Headwaters Wetlands (near 181st and Powell at base of Kelly Butte)

Additional/Alternative Sites

16. Smith & Bybee Lakes
17. Mouth of the Columbia Slough at Kelley Point Park
18. Lower Columbia Slough at the Wastewater Treatment Plant
19. Lower Columbia Slough at the Ramsey Lake Wetlands
20. Lower Columbia Slough at the Rivergate Slough Trail near confluence upstream from Kelley Point Park
21. Kenton Cove
22. NE 33rd Culvert/ Buffalo Slough
23. Whitaker Ponds
24. NE 185th Ave
25. Fairview Lake

DATA INTERPRETATION

Data collected in the Columbia Slough tributary streams can be evaluated using a well established and effective index called a Benthic Index of Biological Integrity (B-IBI). The B-IBI uses community characteristics (% tolerant macroinvertebrates in the sample, number of different kinds of mayflies, % dominance of the most abundant macroinvertebrate, etc.). New models have also been developed that will allow us to compare what different kinds of

macroinvertebrates were found to what would be expected from nearby reference sites that have very little human activity in the watershed. The models will also allow us to evaluate the effects of fine sediment and water temperature on the macroinvertebrate community.

Unfortunately, none of these evaluation techniques have been developed for slow or still waters of the West. This project will contribute to our understanding of macroinvertebrate monitoring in these habitats. We will examine the data for trends from upstream to downstream and for potential improvements in the macroinvertebrates from unrestored to restored sites.

AQUATIC INVERTEBRATES OF THE COLUMBIA SLOUGH

Nearly 150 different kinds of aquatic invertebrates have already been identified from the Columbia Slough watershed. Aquatic invertebrates are often separated into two groups – those that are visible with the unaided eye (macroinvertebrates) and those that aren't (meiofauna or microinvertebrates). More specifically, macroinvertebrates are larger than 500 micrometer, which is the equivalent of half the thickness of a dime or 1/50th inch or 0.5 millimeter.

The minnow mayfly, *Callibaetis* has very large gills and three tails with a dark band across the middle.

The meiofauna are usually poorly known even though they are very abundant both in the water column and in the substrate. Those that live in the water column are called pelagic and are at the mercy of the water's flow to get around. In the lower Columbia Slough, they move back and forth with the tide, while in the upper Slough, they move downstream with the current. Meiofauna are not the focus of this handbook, but species collected in the lower Columbia Slough watershed are listed in Appendix D. Though small, they are important aquatic invertebrates and an essential link near the bottom of the food chain.

Many macroinvertebrates are benthic (bottom dwelling) and spend at least part of their life living in or on the substrates available in the Slough (wood, mud, sand, plants, shopping carts, soda bottles, etc.). Other macroinvertebrates, like water striders and whirligig beetles, live on the water surface. They all have adaptations for living in particular habitats. For example, some have large gills or hemoglobin to help the acquire oxygen in low-oxygen environments.

The information below includes pictures and text about macroinvertebrates that have been collected in the Columbia Slough watershed. A table and a picture page of the organisms collected from the Slough in the past is included in Appendix B, while Appendix C has a table and images page of macroinvertebrates found in the streams and springs of the Columbia Slough watershed. Sample collections during 2005 will add to the list and incrase our understanding of the Slough's diversity.

Baetis is the most common, abundant, and tolerant of the small minnow mayflies, but is not regularly fond in still waters.

MAYFLIES (EPHEMEROPTERA)

Mayflies usually aren't a major part of the diversity of still or slow waters like the Columbia Slough. However, one type of minnow mayfly called *Callibaetis* (pictured above) can be fairly common in the mainstem of the Slough. It feeds on small bits of plant and other organic matter, and (as with most

mayflies) may be sensitive to heavy metals and other toxic substances, though studies from the Midwest have shown *Callibaetis* to be fairly tolerant to road salts at least.

In the springs and streams of the Columbia Slough watershed, other mayflies can be found. In fact, mayflies tend to be most diverse in faster flows and larger substrates. The common and fairly tolerant small minnow mayfly is called *Baetis* (pictured above) and has been found Alice Springs. It looks much like *Callibaetis*, but is smaller with smaller gills and tails that are all one color.

Other mayflies are likely to be found in the springs and streams of the watershed, including other minnow mayflies (*Ameletus* and *Diphetor*), a few flatheaded mayflies (*Rhithrogena*, *Ironodes*, and *Epeorus*), and the prongill mayflies (*Paraleptophlebia*). These taxa, along with *Baetis*, are probably more sensitive to changes in environmental conditions than the *Callibaetis* that can be found in the mainstem of the Slough, and their habitat (springs in particular) can be very susceptible to degradation or drying due to land use activities.

The common forestfly has been found at Alice Springs and is likely to be in other springs and streams of the Slough. It's a very small stonefly with finger-like gills coming out of the underside of its neck.

STONEFLIES (PLECOPTERA)

Stoneflies are considered one of the most sensitive groups of macroinvertebrates. They generally require a high oxygen levels and larger substrate, so to find them in the Columbia Slough watershed, we're going to have to look in the springs and streams.

The common forestfly *Zapada cintipes* (above) was collected at Alice Springs in 2003. Other stoneflies might be found in these springs and in other small tributaries to the Slough including the small, short-tailed, golden-colored common sallfly *Sweltsa*; the medium-sized, predatory American springfly *Skwala* (also called little yellow stonefly); and the large, dark *Hesperoperla pacifica*, commonly called a golden stone for its color as an adult.

The northern case makers pictured here (*Limnephilus*) are regularly found in moving and still water habitats, and are probably present in the Slough watershed. They are fairly large (~1") and make different kinds of cases out of bits of plants.

CADDISFLIES (TRICHOPTERA)

We know very little about the caddisflies in the Slough, but we do know that there are a lot of caddisflies in the Northwest that live in still and slow waters. Such caddisflies usually make cases out of plant material and are often quite large. Northern case maker caddisflies can be common in still waters, including *Limnephilus* (right) which make grass blade or twig cases. After more searching, we may find several other types of caddisflies in the Slough's slow waters,

including the scraping purse case makers and the net fishing tube-case makers.

In the streams of the Slough. green rock worms (*Rhyacophila grandis* Species Group) and finger-net caddsiflies (*Wormaldia*) have been collected (below). *Rhyacophila grandis* can be bright green when alive (pink when preserved) with clusters of fingerlike gills on its abdomen. It is an important predator in stream systems. The finger-net caddis is usually yellow and wriggly when alive and white when preserved. In the stream it lives inside a delicate silk case attached to a rock, but these cases are rarely collected during standard sampling. Many other caddisflies could be present in these streams, including the tube and purse case makers mentioned above and the uenoid case maker *Neophylax*.

The finger-net caddisfly changes from yellow to white when preserved, and its delicate case is rarely collected. The caseless green rock worm is neon green in life but turns pink when preserved.

DRAGON AND DAMSELFLIES (ODONATA)

Dragonflies and damselflies are among the more ancient, interesting, and obvious predators of still and slow waters. Only a few types live in flowing waters and we're unlikely to collect any in the springs and streams of the Columbia Slough watershed.

The delicate-looking Pacific forktail damselfly and the robust eight-spotted skimmer live in the Slough as larva.

Most everyone is familiar with adult dragonflies, and a lucky few may have gotten a close look while a dragonfly chowed down a mosquito. If you've spend much time relaxing near a wetland or lake, you may have noticed different sizes, shapes, and colors of dragonflies. There are quite a lot of species around and the sexes can often look so different, you might think they were a different species.

Damselflies like the delicate-looking Pacific forktail (left) and the Tule bluet live in the Slough as a larva and can be seen as adults in the summer. Even more damselfly species probably live in the Slough.

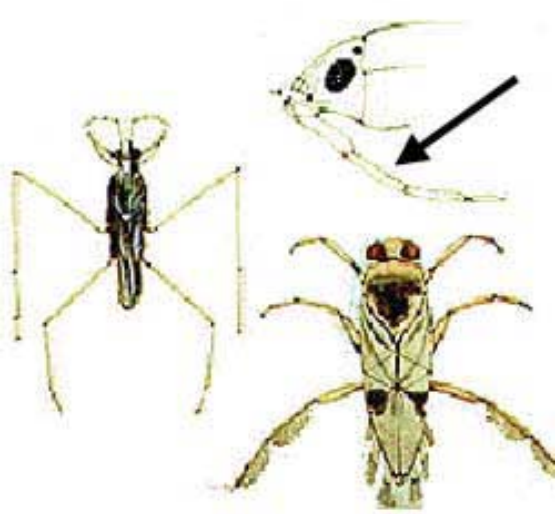
The larvae of dragon and damselflies can look quite different. The skimmer above is short and broad, while the darner is long and thin. The damselfly is very long and thin with 3 tail-like plates on its hind end.

The robust red, green, yellow, or blue dragonflies, like the female eight-spotted skimmer above, can be

seen around the Slough throughout the summer.

Dragonfly and damselfly larvae (sometimes called nymphs or naiads) are equally important as predators in the water as the adults are in the air. They are unique from all other aquatic invertebrates in that they have a modified mouthpart that works as a grabbing arm. That way, they don't have to get quite as close to prey – just close enough for their lightening quick mouthpart. They are also valuable indicators of water body type and probably of habitat and water quality, though some (particularly dragonfly nymphs) can be extremely tolerant of changes in their environmental conditions.

Nymphs of at least three families of dragonflies have been collected in the Columbia Slough (pictured above). The grabbing mouthpart on skimmers (Libellulidae) covers most of their face and has very small teeth. Their bodies are sometimes spider-like in appearance. The darners (Aeshnidae) are some of the largest dragonflies. Their grabbing mouthpart is flat and underneath their head. The pond damsels (Coenagrionidae), like other damselflies, are long and skinny and have three tail-like plates on the end of their abdomen.



Water strider and backswimmer (from the University of Illinois Department of Entomology).

WATER BOATMEN, WATER STRIDERS, TOE BITERS, AND KIN (HEMIPTERA)

Like the dragon and damselflies, the true bugs are unique because of their mouthparts. They basically just have a tube that they use to pierce prey, inject digestive enzymes, and then slurp out the yummy juices.

Most true bugs are not truly benthic and are rarely collected in springs and streams. They're all air breathers, so the have to return to the surface regularly to breathe. Some, like water striders (Gerridae), live on top of the water and never break the surface. Others, like backswimmers (Corixidae) and water boatmen (Notonectidae) rest just below the surface while they breathe, then dive to capture prey or escape threats.

A few bugs, including creeping water bugs (Naucoridae), giant water bugs (Belostomatidae), and water scorpions (Nepidae), spend a significant amount of time hanging on to substrates under water, waiting for prey. Such bugs are generally considered benthic.

The creeping water bug Naucoridae is a voracious predator that grabs prey with its pincer-like front legs.

Water boatmen and water striders are abundant in the Slough. In fact, water boatmen can make up the bulk of the bugs in a sample. Some of the benthic bugs are probably present in the Slough, but haven't been collected and recorded in past studies reviewed for this handbook.

This larval water scavenger beetle is unusual and has long filaments on its abdomen. Larvae of whirligig beetles have similar filaments. A variety of adult and larval predaceous diving beetles can be found in the Slough.

BEETLES (COLEOPTERA)

Aquatic and semi-aquatic beetles are an important and diverse part of slow and still waters. Only two families of beetles are common in moving waters, but many other families can be collected in habitats ranging from pools and shorelines to mossy bogs and tree holes.

The diversity can make aquatic beetles difficult to identify at times. To add to the challenge, you can find both adults and larvae in the same sample. Still some have colorful patterns; others have long appendage; and still others have different antennae. Some are streamlined, while others are blocky, and some are smooth shinny while others are rough and dull.

Riffle beetle adults and larvae are regularly found together in streams.

Some of the most common beetles in the Columbia Slough are predaceous diving beetles (Dytiscidae) and water scavenger beetles (Hydrophilidae) pictured above, crawling water beetles (Haliplidae), and riffle beetles (Elmidae) image to the left. The larvae for most of these beetles are benthic and found on or in the substrate, while many of the adults swim in the water column or on the surface. The adults can also fly, if they need to or to disperse.

Only the riffle beetles (Elmidae) are likely to be in the springs and streams of the Columbia Slough watershed. They are fairly diverse and are good indicators of water quality and temperature.

TRUE FLIES (DIPTERA)

The larvae of true flies are what we affectionately call maggots. There are lots of different kinds of fly larvae in aquatic environments, most of which don't look anything like the maggots you find cleaning up road kill. Aquatic fly larvae, particularly midges, are an extremely important part of the diets of fish.

The most common flies in still water and in strong currents are the midges (Chronomidae). Some midges are commonly known as blood worms (below) because of their bright red color.

In their dried form, these bright red bloodworms are well known to most folks who have an aquaria.

Blood worms are more commonly found in still waters because the hemoglobin which makes their blood red (just as it does ours) helps them efficiently use oxygen when there is not a lot around.

A variety of other fly larvae can be found in both the still and moving waters. In the Columbia Slough long, skinny (Ceratopogoninae) and short, broad (Forcypomyiinae) biting midges have been collected. Craneflies have also been found, but because they are very diverse in soft sediments and stream margins, it seems likely more will be found.

Few people can get excited about biting midges or no-see-um. Fortunately, the larvae only bite aquatic prey.

In the springs and streams of the Slough watershed dixid midges (Dixidae) have also been collected. Dixids typically live and feed on substrates near the water surface so they can breathe air. They can wriggle quickly away from the surface if disturbed.

Flies are a well known indicator of macroinvertebrate monitoring and are diverse, both in flowing waters and still.

ALDERFLIES (MEGALOPTERA)

There are several different kinds of Megloptera in the Northwest, but most live in cool mountain streams. Such Megaloptera are called fishflies, but the fairly unique alderfly (*Sialis* sp.) can be found in many aquatic habitats. The alderflies (above) can be common in slow and still waters and have been easily collected in the Columbia Slough.

Alderfly larvae are important predators in still and slow waters as you might guess from the large sharp teeth!

Alderflies look a bit like a centipede, having a pair of “legs” on each segment of their body. Like other insects, only 6 of these are actually legs. Looking closely, they have a long jointed gill filament on either side of each abdominal segment. By looking at the mandibles in the picture above you can get a

sense of the predatory feeding habits of the alderfly. They live in a variety of habitats, which may mean they are fairly tolerant of a range of temperature and dissolved oxygen.

SPRINGTAILS (COLLEMBOLA)

Springtails are tiny, unusual insects that are regularly collected in aquatic invertebrate samples. Most live on land but regularly flick themselves into the water. The "flicking" is the most unique thing about them and what gives them the name springtails. Many springtails have a tail-like furcula that can be pulled against their body, then quickly released when they sense danger, thus flinging them out of harms way. Without sometimes poor direction and distance control, they can find themselves springing out of the frying pan and into the fire.

Collembolan – arrow points to furcula.

They come in a lovely array of colors (blue, purple, red, yellow), but aren't much use in biological monitoring since they are more terrestrial than aquatic.

CRUSTACEANS (CRUSTACEA)

Because the lower Columbia Slough is an estuary with saltwater mixing in from the ocean, and because the watershed is part of a major center for transportation and commerce, it contains several crustaceans that are unusual in inland waterways or are introduced from other parts of the world. It also contains some very familiar native crustaceans including crayfish, scuds, and sowbugs.

Large signal crayfish from the Columbia River.

Crayfish are one of the more endangered groups of organisms in the world, yet the group also contains some of the most destructive aquatic invasive species. The signal crayfish (*Pacifasticus leniusculus leniusculus*) is a Northwest native that has been introduced throughout the Southwestern US and Europe. It has been collected in the Columbia Slough and is probably an important scavenger of dead animals and organic debris. The signal crayfish can be fairly large and has a relatively smooth, gray-green body with orange to gray green claws.

This blood red crayfish has been introduced into slow and still waters of the Northwest.

Unfortunately, the highly destructive red swamp crayfish (*Procambarus clarkii*) has been introduced to the Northwest from the Southeast. Though its distribution in the Northwest is not fully known, it may be present in the Columbia Slough, and can be identified by the large bumps or spines on its claws and by its red color.

The Asian or Siberian shrimp (*Exopalaemon modestus*) has also been introduced into the lower Columbia and is present in the Columbia Slough.

Probably the most commonly collected macroinvertebrate crustaceans in the Slough are the scuds (Amphipoda, also called sideswimmers) and the sowbugs (Isopoda). At least three different kinds of scuds live in the Slough and its tributaries. A fourth, very strange scud is a likely visitor at least in the lower Slough.

The first two are different scuds known in the Columbia Slough. *Gammarus* has very long first antennae (highest on the head) and shorter second antennae. The first antennae of *Hyalella* are very short, much shorter than the second pair. Corophium is an estuarine scud that may be present in the lower Columbia Slough and has greatly enlarged, almost leg-like first antennae.

Only one type of sowbug, *Caecidotea*, is found regularly in the Slough, and it can be quite common. Sowbugs look much like scuds but are flattened from top to bottom instead of side to side.

Other crustaceans are found in the Slough but are either small, rare, or in unusual habitats. Seed shrimp are tiny crustaceans whose body expands into a bivalve shell like a clam. The spiny-tail fairy shrimp *Streptocephalus sealii* can be found in the wetlands of the Colubmia Slough watershed.

These images are extreme close-ups of very small invertebrates. Aquatic mites are among the smallest animals in the sample that are visible with the naked eye.

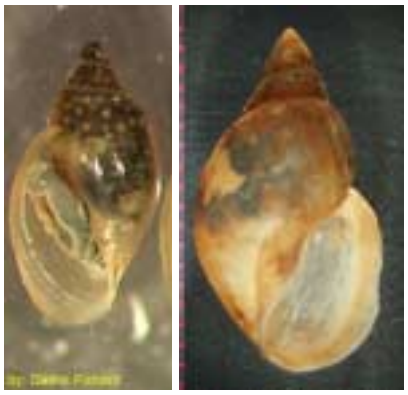
WATER MITES (ACARI)

Water mites can be collected from almost any aquatic habitat, and can sometimes be incredibly abundant and

diverse. With only very rare exception, they start out life as super tiny, 6-legged larvae that parasitize a terrestrial or aquatic host. They grow on their host, then become a free-living nymph that either returns to the water from its terrestrial host or remains in the water and matures into an adult, which is what we mostly encounter in standard wadeable stream samples. The adults are mostly carnivorous (live or dead macroinvertebrates) but some feed on detritus as well.


The common but cryptic freshwater limpet *Ferrissia*.

Hydracarina come in a wide variety of colors (most often red and green, but sometimes yellow, orange, or blue) and have a hard or soft, (often rounded) unsegmented body with eight segmented legs. Their palps (finger-like mouthparts) may also be prominent on their head end. Several examples of aquatic mites are shown below.


The left-handed Physa and the right-handed Stagnicola are both common in the Slough.

SNAILS AND LIMPETS (GASTROPODA)

Quite a few different kinds of snails call the Columbia Slough home. The most unusual among them are the freshwater limpets. They are essentially snails whose shell doesn't coil. Probably only one kind of limpet, *Ferrissia*, lives in the Slough and its tributaries. It's easily separtated from other snails, by its large soft foot and cap for a shell. Ferrissia is also often small, dark, and looks more like a bump on the substrate than a macroinvertebrate.


Juga is a common snail in a wide range of rivers and streams.

Several snails with conically coiled shells live in the Slough. The most typical of which are the left-handed snail *Physa* and a very similar looking snail called *Stagnicola*, which is a right-handed. You can tell which direction the shell opens by sticking the point of the shell upward and the opening toward you. If the opening is on your left, it's the left-handed snail. If it's on the right, it could be one of several other snails.

Another odd group of snails are the orb or planorbid snails (Planorbidae) which have a flattened coil. At least two different types of these snails can be commonly collected in the Columbia Slough, but are not common in the streams and springs of the watershed.

The most common stream snail in the Columbia Slough is *Juga* (right). *Juga* is a right-handed snail with an operculum or plate that covers the opening of the shell when it retracts inside. *Juga* is usually reddish brown and may have ridges near the end of the shell.

MUSSELS/CLAMS (BIVALVIA)

Three species of floater (freshwater mussels in the genus *Anodonta*) have been found in the Columbia Slough – the Oregon floater, the California floater and the winged floater. The common name for the floaters is derived from their appearance in death. When they die, their shell forms a tight seal and as the gasses of decomposition build up inside, the shell floats up to the surface.

Three species of freshwater mussels of the genus *Anodonta* live in the Columbia Slough.

Their complex life history involves a stage called glochidia which is parasitic on the gills or fins of fish. A pilot project is currently underway to try to determine what fish hosts are being used by the floaters and what time of year the glochidia are present. Eventually, the glochidia drop off the gills, and a lucky few will grow and mature in the sediments.

Fingernail clams (right) can be abundant in a variety of habitats. They are never much larger than your pinky nail and are more typically the size of a pin head. They can be found the Slough and in the springs and streams. The introduced Asian clam looks much like a very large fingernail clam but has ridges on the shell that you can feel if you pass your finger over it.

Tiny fingernail clams can be found in most water bodies of the Columbia Slough watershed.

WORMS, LEECHES, AND CRAYFISH WORMS (ANNELIDA)

A lot of different worms inhabit the soft sediments of the Columbia Slough. Worms in general are little more than tubes of muscle that process dirt, but some of them have gills, noses, crusty skin, or eyes, that suggest that several different species are present. Some worms can be very good indicators of pollution.

Most leeches live in slow water habitats. Leeches have 34 body segments, most of which are subdivided, so they look wrinkly as much as segmented. *Helobdella stagnalis* is a common and highly tolerant leech that can be found in the Slough. It has a distinctive shape and eye spot

Front end of the leech *Helobdella* found in the Columbia Slough.

pattern, but it also has a small hard plate in the middle of the body just behind the eyes.

The crayfish worms (Branchiobdellida) look much like a leech, but they have fewer segments an use crayfish as their substrate. If you find a crayfish in the slough, look for little grayish-white blobs wiggling around on its claws and exoskeleton. These are the crayfish worms. They don't actually harm the crayfish, but they probably consume organic debris the crayfish stirs up when it's feeding.

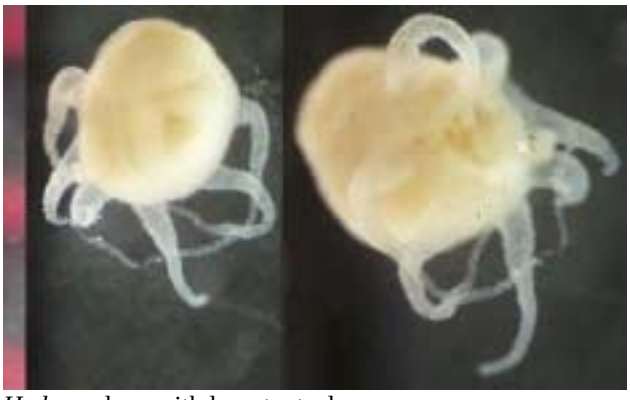

Crayfish worms, Branchiobdellida, live only on crayfish exoskeletons.

FLATWORMS OR PLANARIANS (TURBELLARIA)

Flatworms are a common part of many water bodies from cold mountain streams to mucky urban drainage ditches and are found in the streams and springs as well as the mainstem of the Slough. Many biology students past and present can recall learning about planarians and their ability to regenerate. Turbellaria are quite delicate and will tear easily if you try to pick them up with tweezers when they're alive. When preserved in alcohol, they tend to self-destruct, and their spongy remains are sometimes difficult to recognize as an animal. The alcohol tends to make the white feeding tube (called a pharynx) pop out of or completely separate from the body.

HYDRAS (CNIDARIA)

Hydroids are one of those groups that blur the boundaries between plant and animal when you're looking through a sample. If not for their tentacles, they would simply be bits of soft, white tissue. For the most part, they are sessile (attached to the substrate) in the shallows of all sorts of water bodies. They can move very slowly at their base or even detach and drift if necessary. Innocent as they may look, these little creatures are poisonous (not to humans) predators that will sting and eat just about anything they can fit into the space between their tentacles. Hydroids are probably present throughout the Columbia Slough and its tributaries.


Hydra polyps with long tentacles.

ROUNDWORMS (NEMATODA)

Roundworms (or nematodes) live everywhere on land and water. Freshwater nematodes have adaptations for eating everything from plants and detritus to other animals. The freeliving (not parasitic) aquatic species are largely ignored by scientists because they tend to be very small, though they are sometimes abundant. I've included great visual


Nematodes can be extremely abundant.

quote regarding nematodes below.

> "If all the matter in the universe except the nematodes were swept away, our world would still be dimly recognizable, and if, as disembodied spirits, we could then investigate it, we should find its mountains, hills, vales, rivers, lakes and oceans represented by a thin film of nematodes." N.A. Cobb (1914)

Separating nematodes from other aquatic macroinvertebrates is relatively easy. They are long, tubular, unsegmented worms that are usually white, gray, or clear and pointed on one end and somewhat blunt on the other. Identifying parasitism may be of interest in other types of studies, but it is not typically a goal of standard macroinvertebrate monitoring, nematodes that are emerging from or are still inside a host are not counted.

HORSEHAIR WORMS (NEMATOMORPHA)

Adult horsehair worms are typically found in still waters, including stream margins and pools, and the males may even swim clumsily. They sometimes show up in cisterns, often upsetting the owners or users, but there is no need to concerned. All their presence indicates is the presence of other insects around your cistern.

As many as 20 adult horsehair worms may intertwine themselves into a mass, which is where they get their other common name "gordian worms". Their length ranges from 4" to 27" (more than 2'!), with the males on the smaller end and the females on the larger. The specimens pictured here are all male.

Three intertwined horsehair worms.

MOSS ANIMALS (ECTOPROCTA)

The moss animals most commonly seen in the Slough look like a big, gelatinous blob that is purplish when alive in the midsummer and clear or brownish when dead in the fall. These blobs can be as big as a football and are usually glommed onto a stick or plant. When they die off in the late summer, they usually break off their substrate and start drifting down the Slough. The blob is actually a mass of hundreds or thousands of tiny animals. The individuals are similar to corals or hydra, only in that in that they have delicate tentacles (sometimes dozens) that they expose to the water and capture fine, drifting organic material (the hydra are after tiny animals). They can also pull those tentacles into the protective, non-living body of the colony when disturbed.

When moss animals are encountered in preserved samples, you're likely to see the sturdy statoblasts, which will look similar to small seeds (right). The statoblasts are an adaptation for surviving harsh environmental conditions (summer drying or heat, winter cold) and for surviving dispersal to new habitats.

Pectinatella magnifica colony, colony rosettes, and seed-like statoblasts.

SPONGES (PORIFERA)

There are about 30 species of freshwater sponges in North America and all of them belong to the same family, Spongillidae. Sponges typically live in still waters, showing up regularly in larger rivers, lakes, wetlands, and in streams near lake outlets. Sponges are not well known in the Slough but are likely to occur, and may be collected. Sponges serve as food sources for a variety of other macroinvertebrates, including caddisflies, midges, and spongillaflies.

Their bodies are incredibly simple, having no organs or tissues. As with a sponge you might find in your kitchen or bath (though most of those are synthetic) freshwater sponges are covered with numerous microscopic holes by which water passes into the sponge, and a few large holes by which water leaves the sponge.

Sponge – photo by Daniel Pickard, California Fish and Game.

Sponges can reproduce sexually but are highly variable in what sex they choose to be. One may even produce only male gametes one year and only female gametes the next year. They can also multiply by starting a number of new colonies after fracturing from disturbance. Similarly, they have a strong ability for regeneration. Sometimes in urban streams and eutrophic (high nutrient/high plant production) lakes, sponge nodules, like those pictured below, are encountered. These nodules are resting stages called gemmules and are comparable to having an egg in a sample.

INTRODUCED SPECIES

The two groups of macroinvertebrates that are most commonly introduced from one water body into another are crustaceans (crayfish, sowbugs, and scuds) and mollusks (snails and clams). These groups have life history stages and tolerances that allow them to be transported from one place to another. There may be introduced worms as well, but the identification and world distribution of most are so poorly known that it is difficult to tell what was introduced and what was present before countless ships, boats, and people started moving goods and bilge water from other places to the Columbia and Willamette.

The red swamp crayfish *Procambarus clarkii* may have been introduced into the Columbia Slough and the Asian clam *Corbicula fluminea* is very abundant in the Willamette and Columbia. The glass or ghost shrimp *Palaemonetes paluosa* is a close relative to the Siberian prawn *Exopalaemon modestus* which has been introduced into the lower Columbia River.

Other introduced species to watch for in the Columbia Slough watershed are the zebra mussel (Dreissena polymorpha) and the New Zealand mudsnail *Potamopyrgus antipodarum*. The Chinese mitten crab *Eriocher sinensis* may be working its way up the Oregon Coast. The very large Chinese mystery snail Cipangopaludina chinensis has been collected across the river in Vancouver, Washington.

IN CLOSING

Thanks once again for your interest in the macroinvertebrates of the Columbia Slough and please consider volunteering to collect samples in August and September. If you're interested, or have any questions or ideas about this handbook, contact Jeff Adams at jadams@xerces.org or 503-232-6639.

The tiny New Zealand mudsnail can reach densities of 750,000 in a square meter (square yard). The much larger zebra mussels will pile on top of each other until they reach densities of tens of thousands per square meter.

ACKNOWLEDGMENTS

Our heartfelt thanks go out to all the volunteers and professionals who devote time and energy to understanding, restoring, protecting, and teaching people about the Columbia Slough watershed. Thanks to Daniel Pickard of the California Department of Fish and Game, the Center for Columbia River History, and the University of Illinois Department of Entomology for contributing additional images. A special thanks to the funders of the efforts associated with this project, including: Metropolitan Greenspaces Program – a partnership between Metro and the U.S. Fish & Wildlife Service, The Xerces Society for Invertebrate Conservation member contributions, Northwest Service Academy, Oregon Watershed Enhancement Board, and City of Portland Bureau of Environmental Services' Community Watershed Stewardship Program.

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Websites

Columbia Slough Watershed Council Website – http://www.columbiaslough.org/
The Xerces Society – http://www.xerces.org
Columbia Slough Bibliography – searchable database of Columbia Slough related documents – http://www.fishmanenvironmental.com/CSWdbase/
Maps, oral history, written history of the Columbia Slough – http://www.ccrh.org/comm/slough/main.htm

Appendix A: Volunteer macroinvertebrate monitoring protocols, forms and labels for slow and still waters of the Columbia Slough.

Step-by-Step Slow or Still Water Macroinvertebrate Collection from Shore (where safe) or Boat

1. First identify a reach that is approximately half a football field long
    - Try to choose a reach that has consistent habitat - e.g. sample either upstream or downstream of a bridge or tributary; don't put the bridge in the middle;
2. Choose a total of **four areas** of shoreline to sample – **two areas** typical of the reach **on each side** of the Slough;
3. Fill your bucket or tub with 2" or 3" of relatively clean surface water;
4. Start at the most downstream of the four areas;
5. Where the water is about 12" deep (top of the net hoop), put the net in all the way to the bottom and move the net forward, **gently jabbing** the substrate every couple inches, for approximately 2 feet
    - The jabbing motion dislodges the macroinvertebrates, while the slow forward motion captures them in the net;
6. Once the 2 foot sample has been collected, keep the mouth of the net above the water, but move the net bag up and down in the water to allow fine sediment to be rinsed out;
7. Carefully empty the net contents into the tub;
8. Repeat steps 4-7 at the other two areas of shoreline that you intend to sample and combine all three in the same tub;
9. Now you have your sample and it's time to look at the bugs!

(for sorting the macroinvertebrates live, go to the next page; to preserve the invertebrates for examination in the future, see below)

Preservation of Whole Sample

1. Pour the excess water from the bucket through a sieve or back through the side of the net – be careful not to lose any macros off the side of the net or over the top of the sieve;
2. Use your fingers to place or scrape as much of the sample as possible from the bucket and sieve or net into a sampling jar;
3. Use a squirt bottle to rinse the rest of the sample into the jar, or add a bit of water, and use tweezers to pick out any remaining invertebrates;
4. Use tweezers to pick any remaining invertebrates from the sieve or net;
5. Repeat this process if necessary to get as little water in the sample as possible, and use multiple sample jars if the sample fill more than 2/3 of the jar;
6. Finally, add 95% alcohol to the sample for preservation.

Sorting the Macroinvertebrates from Slow or Still waters

1. Half-fill the pockets of an ice cube tray with clean water; put ~2" of water in a white tub
2. Take a small amount of the sample and place it in a tub. Let any sediment settle, then use tweezers or window screen to pick 100 organisms out of the sample. Place things that look the same into the same ice cube pockets
    - Don't forget to think small; look carefully for less obvious (small or slow) macros
    - If there is a lot of material in the sample, you may want to use a second tub and split the sample so it will be easier to see the macroinvertebrates

Identification

1. Count and record the number of pockets that have macroinvertebrates in them
2. Give the macros a name if you can, but either way, count the # of individuals for each different pocket
3. Finally, pick the macros from the ice cube tray and preserve them in vials; put a completed label that includes Sample Site, Date Sampled, Macro # and Type/Description of Macro

Macro #	Type of macro (if known) or description	# of individuals
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
Totals	**# of types of macros = _____**	

Macros to be looking for: clams, snails, worms, scuds, sowbugs, seed shrimp, crayfish, mayflies, caddisflies in cases, midges, dragonflies, damselflies, back swimmers, water boatman, water striders, toe biters, water scorpions, any of a large variety of beetle adults and larvae.

Step-by-Step Fast-flowing Water Macroinvertebrate Collection

Note: Focus on how to avoid losing macros during the collection process - i.e. avoid drift under the net, drift around the net, pick off macros stuck in the net, etc.

1. start at the most downstream sample locations, place the net on the riffle bottom such that the current is flowing directly into the net
2. collect the sample (goal = get all bugs in 1 square foot (~4" deep) of stream bottom into the net)

    A. squat to the side of the net (not upstream)
    B. make sure the bottom of the net is flush against the stream bottom (shift rocks as necessary)
    C. measure 1 foot upstream of the net (hint: the net is 1 foot wide)
    D. pick up all large rocks and debris within that area and scrub thoroughly in the net
    E. once only small rocks remain, stir the substrate to about 4" depth
    F. once thoroughly disturbed, use your boot to give the area a last kick
    G. tilt the net back and lift it off the riffle bottom
    H. use the current to wash the material to the bottom of the net

7. grab the net above where the material has collected in the bottom and invert into a tray or bucket (don't worry about picking every macro out of the net at this point)
8. move to the next section to be sampled, repeat steps above, put the newly collected material in the same bucket, then continue to the next section to be sampled
9. after all 8 samples are collected and deposited in the same bucket, use tweezers to remove clinging macros from the net
10. if your bucket does not have a mesh bottom, pour it into a sieve or back through the net to remove water; then put the material (macros, debris, and all) in to the sample jar (again be sure to use tweezers to pick up any macros that may have poured out with the water)
11. label the sample jar inside and out (don't use ink for the labels, use a pencil)
12. filter water out of the sample jar one more time, then fill jar with 95-100% alcohol (concentration after mixing with residual water needs to be more than 70% - there's a lot of water in organic matter and trapped between inorganic particles)
13. now that the bugs are safely collected, gather the additional habitat information

Note: Field data is not required, but an accurate GPS reading or dot on a map is essential, and it's valuable to note the kind of in-stream and riparian habitat within the reach you are sampling.

Each situation is different depending on substrates, access, and a variety of other reasons. Remember that the goal is to get all the macros from the eight $1ft^2$ areas into the net, then into the sample jar. Take whatever care is necessary to make that possible. Sample collection usually takes between 1.5 and 3 hours.

Columbia Slough Macro-Monitoring Field Data Form

Site Information

Site Name _____ Site ID # _____

Team leader _____ Members: _____

Access OK ☐ yes Landowner _____ Call first ☐ _____ - _____

☐ location NOT sampled - Reason: _____

Date Sampled: _____/_____/_____ Time: _____ (AM or PM [circle one])

Air Temp _____(C or F); Water Temp _____(C or F)

Latitude/Longitude from map or GPS (decimal degrees):
Lat. _____ Long. _____

Location verified by (✔) ☐ GPS ☐ Signs ☐ Roads ☐ Topo map ☐ other _____

Human Use & Influence in Reach

	NOT PRESENT	LEFT ONLY	RIGHT ONLY	BOTH BANKS	ON BANK	WITHIN 30 ft	> 30 ft	Notes
Riprap/wall/dike/revetment	☐	☐	☐	☐	☐	☐	☐	_____
Industrial	☐	☐	☐	☐	☐	☐	☐	_____
Pavement/cleared lot	☐	☐	☐	☐	☐	☐	☐	_____
Roads/railroads	☐	☐	☐	☐	☐	☐	☐	_____
Rural residential	☐	☐	☐	☐	☐	☐	☐	_____
Urban residential	☐	☐	☐	☐	☐	☐	☐	_____
Park/lawn/informal recreation	☐	☐	☐	☐	☐	☐	☐	_____
Row crops	☐	☐	☐	☐	☐	☐	☐	_____
Pasture/range/Hay field	☐	☐	☐	☐	☐	☐	☐	_____
Mining/sand & gravel	☐	☐	☐	☐	☐	☐	☐	_____
Timber harvest	☐	☐	☐	☐	☐	☐	☐	_____
Forest/woodland	☐	☐	☐	☐	☐	☐	☐	_____
Other_____	☐	☐	☐	☐	☐	☐	☐	_____

Biological Observations

Fish observations		Aquatic wildlife		Other wildlife	
species	quantity & size	species	comment	species	comment

Aquatic Habitat Estimates

(discuss these among your sampling group)

Macrophyte cover (area of water or substrate covered by plants):

☐ low under 40%
☐ medium 40–70%
☐ high over 70%

Vegetation description:

Riparian cover (percent of the Slough width shaded by overhanging tree limbs):

☐ low under 40%
☐ medium 40–70%
☐ high over 70%

Vegetation description:

Macroinvertebrate Sample Information

of jabs composited

☐ 4 @ 3 ft² each (2 on each side of Slough)

☐ other_____

Collected by _____

Field duplicate collected: ☐ yes ☐ no

Typical substrate (see below):

Dominant size _____

Secondary size _____

Jars _____ # Field duplicate jars _____

Substrate sizes/types

hard clay
fine silt
sand
gravel
cobble
riprap
live plants
dead plants or plant pieces
wood
shopping carts or car tires

Other Notes and Comments:

(be liberal with your notes; draw pictures if you like; and record any problems or challenges you faced or any techniques that you found particularly useful)

Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____
Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No_____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____
Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____
Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____	Is this sample a field duplicate? Yes_____ No _____ Site ID # _____ Stream _____ Organization _____ Collectors _____ Date _____/_____/_____ Jar _____ of _____

Appendix B: List of known slow or still water invertebrates in the Columbia Slough watershed with an image page of selected taxa. Question marks denote uncertainty in the identification.

COMMON NAMES	ORDER (or HIGHER)	FAMILY	GENUS SPECIES
Sponges	**Porifera**		
Hydras, Jellyfish, and kin	**Cnidaria**	Hydridae	*Hydra sp.*
Moss animals	**Ectoprocta**	Pectinatellidae	*Pectinatella magnifica*
Flatworms	**Turbellaria**		
Roundworms	**Nematoda**		
Leeches, Worms, and kin	**Annelida**		
Leeches	Hirudinea	Glossiphoniidae	*Helobdella stagnalis*
Crayfish worms	Branchiobdellida		
Aquatic worms	Oligochaeta	Lumbriculidae	
Aquatic worms	Oligochaeta	Naididae	*Chaetogaster diaphanus*
Aquatic worms	Oligochaeta	Naididae	*Dero digitata*
Aquatic worms	Oligochaeta	Naididae	*Dero vaga*
Aquatic worms	Oligochaeta	Naididae	*Dero sp.*
Aquatic worms	Oligochaeta	Naididae	*Nais simplex*
Aquatic worms	Oligochaeta	Naididae	*Nais variabilis*
Aquatic worms	Oligochaeta	Naididae	*Ophidonais serpentina*
Aquatic worms	Oligochaeta	Naididae	*Pristina leidyi*
Aquatic worms	Oligochaeta	Naididae	*Slavina appendiculata*
Aquatic worms	Oligochaeta	Naididae	*Stylaria lacustris*
Aquatic worms	Oligochaeta	Tubificidae	*Aulodrilus limnobius*
Aquatic worms	Oligochaeta	Tubificidae	*Aulodrilus piqueti*
Aquatic worms	Oligochaeta	Tubificidae	*Bothrioneurium vejdovskyanum*
Aquatic worms	Oligochaeta	Tubificidae	*Branchiura sowerbyi*
Aquatic worms	Oligochaeta	Tubificidae	*Ilyodrilus frantzi*
Aquatic worms	Oligochaeta	Tubificidae	*Ilyodrilus templetoni*
Aquatic worms	Oligochaeta	Tubificidae	*Limnodrilus udekemanus*
Aquatic worms	Oligochaeta	Tubificidae	*Quistadrilus multisetosus*
Aquatic worms	Oligochaeta	Tubificidae	*Varichaetadrilus ?pacificus*
Scuds, Sowbugs, Crayfish, etc.	**Crustacea**		
Water fleas	Cladocera		
Copepods	Copepoda		
Seed shrimp	Ostracoda		
Scuds or sideswimmers	Amphipoda	Crangonyctidae	*Crangonyx sp.*
Scuds or sideswimmers	Amphipoda	Gammaridae	*Gammarus sp.*
Scuds or sideswimmers	Amphipoda	Hyalellidae	*Hyalella sp.*
Sowbugs, pillbugs, rolly pollies	Isopoda	Asellidae	*Caecidotea sp.*
Siberian prawn	Decapoda	Palaemonidae	*Exopalaemon modestus*
Crayfish	Decapoda	Astacidae	*Pacifastacus leniusculus*
Spiny-tail fairy shrimp	Anostraca	Streptocephalidae	*Streptocephalus sealii*
Snails, Mussels, Limpets, Clams	**Mollusca**		
Limpet	Gastropoda	Ancylidae	*Ferrissia sp.*
Snails	Gastropoda	Hydrobiidae	*Fluminicola columbiana*
Snails	Gastropoda	Lymnaeidae	*Stagnicola sp.*
Snails	Gastropoda	Lymnaeidae	*Pseudosuccinea sp. (?)*
Snails	Gastropoda	Physidae	*Physa sp.*
Snails	Gastropoda	Planorbidae	*Menetus callioglyptus*
Snails	Gastropoda	Planorbidae	*Helisoma sp. (?)*
Snails	Gastropoda	Planorbidae	*Vorticifex sp. (?)*
California floater	Unionoida	Unionidae	*Anodonta californiensis*
Winged floater	Unionoida	Unionidae	*Anodonta nuttalliana*
Oregon floater	Unionoida	Unionidae	*Anodonta oregonensis*
Fingernail or pea clams	Veneroida	Pisiidae	

Aquatic mites and spiders	**Arachnida**		
Mites	Acarina		
Springtails	**Collembola**		
Mayflies	**Ephemeroptera**		
Minnow mayflies	Ephemeroptera	Baetidae	*Callibaetis sp.*
Dragonflies	**Odonata**		
Common green darner dragonfly	Odonata	Aeshnidae	*Anax junius*
Whiteface dragonflies	Odonata	Libellulidae	*Leucorrhinia sp.*
Eight-spotted skimmer dragonfly	Odonata	Libellulidae	*Libellula forensic*
Blue dasher dragonfly	Odonata	Libellulidae	*Pachydiplax longipennis*
Meadowhawk dragonflies	Odonata	Libellulidae	*Sympetrum sp.*
Black saddlebags dragonfly	Odonata	Libellulidae	*Tramea lacerata*
Bluet damselflies	Odonata	Coenagrionidae	*Enallagma sp.*
Narrowwinged damselflies	Odonata	Coenagrionidae	*Ischnura cervula*
Aquatic true bugs	**Hemiptera**		
Water boatmen	Hemiptera	Corixidae	*Palmocorixa buenoi*
Water boatmen	Hemiptera	Corixidae	*Palmocorixa sp.*
Water striders	Hemiptera	Gerridae	*Gerris sp.*
Water treaders	Hemiptera	Mesoveliidae	*Mesovelia mulsanti*
Backswimmers	Hemiptera	Notonectidae	
Riffle bugs	Hemiptera	Veliidae	*Microvelia*
Fishflies, alderflies	**Megaloptera**		
Alderflies	Megaloptera	Sialidae	*Sialis sp.*
Aquatic beetles	**Coleoptera**		
Weevils	Coleoptera	Curculionidae	
Predaceous diving beetles	Coleoptera	Dytiscidae	
Riffle beetles	Coleoptera	Elmidae	*Dubiraphia sp.*
Crawling water beetles	Coleoptera	Haliplidae	*Peltodytes sp.*
Water scavenger beetles	Coleoptera	Hydrophilidae	*Berosus sp.*
Water scavenger beetles	Coleoptera	Hydrophilidae	*(second genus)*
Aquatic flies	**Diptera**		
Biting midges	Diptera	Ceratopogonidae	Ceratopogoninae
Biting midges	Diptera	Ceratopogonidae	Forcipomyiinae
Phantom midges	Diptera	Chaoboridae	*Chaoborus sp.*
Midges	Diptera	Chironomidae	*Chironomus sp.*
Midges	Diptera	Chironomidae	*Cryptochironomus sp.*
Midges	Diptera	Chironomidae	*Einfeldia sp.*
Midges	Diptera	Chironomidae	*Endochironomus sp.*
Midges	Diptera	Chironomidae	*Glyptotendipes sp.*
Midges	Diptera	Chironomidae	*Parachironomus sp.*
Midges	Diptera	Chironomidae	*Paratanytarsus sp.*
Midges	Diptera	Chironomidae	*Cricotopus sp.*
Midges	Diptera	Chironomidae	*Orthocladius sp.*
Midges	Diptera	Chironomidae	*Nanocladius sp.*
Midges	Diptera	Chironomidae	*Corynoneura sp.*
Midges	Diptera	Chironomidae	*Procladius sp.*
Midges	Diptera	Chironomidae	*Alabesmyia sp.*
Midges	Diptera	Chironomidae	*Larsia sp.*
Mosquitoes	Diptera	Culicidae	*Anopheles sp.*
Shore flies	Diptera	Ephydridae	
Soldier flies	Diptera	Stratiomyidae	
Craneflies	Diptera	Tipulidae	*Limonia sp.*

Selected slow and still water invertebrates of the Columbia Slough watershed (some have not yet been found in the watershed but are expected to be found in future surveys.


Minnow mayflies


Dragonflies, damselflies


Water boatmen


Alderflies


Northern case maker caddisfly


Predaceous diving beetles


Crawling water beetles


Midge larvae


Mites


Scuds


Sowbugs


Crayfish


Snails, limpets


Mussels


Aquatic worms


Moss animals

Appendix C: List of known stream or spring invertebrates in the Columbia Slough watershed with an image page of selected taxa. Question marks denote uncertainty in the identification.

COMMON NAMES	ORDER (or HIGHER)	FAMILY	GENUS SPECIES
Flatworms or Planarians	**Turbellaria**		
Leeches, Worms, and kin	**Annelida**		
Aquatic worms	Oligochaeta	Lumbriculidae	
Scuds, Sowbugs, Crayfish, and kin	**Crustacea**		
Scuds or sideswimmers	Amphipoda	Crangonyctidae	*Crangonyx*
Scuds or sideswimmers	Amphipoda	Gammaridae	*Gammarus*
Mayflies	**Ephemeroptera**		
Small minnow mayflies	Ephemeroptera	Baetidae	*Baetis tricaudatus*
Stoneflies	**Plecoptera**		
Forestfly stoneflies	Plecoptera	Nemouridae	*Zapada cinctipes*
Caddisflies	**Trichoptera**		
Green rock worms	Trichoptera	Rhyacophilidae	*Rhyacophila grandis Gr.*
Fingernet case makers	Trichoptera	Philopotamidae	*Wormaldia*
Aquatic beetles	**Coleoptera**		
Riffle beetles	Coleoptera	Elmidae	*adult – Optioservus (?)*
Riffle beetles	Coleoptera	Elmidae	*larva - Optioservus (?)*
Aquatic flies	**Diptera**		
Midges	Diptera	Chironomidae	
Black flies	Diptera	Simuliidae	*Simulium*
Dixid midges	Diptera	Dixidae	*Dixa*

Selected stream and spring invertebrates of the Columbia Slough watershed (some have not yet been found in the watershed but are expected to be found in future surveys.


Small minnow mayflies


Prong-gill mayflies


Flat headed mayflies


Riffle beetles


Little brown stoneflies


Golden stoneflies


Little green stroneflies


Midges, black flies, dixids


Green rock worm caddisflies


Finger-net caddisflies

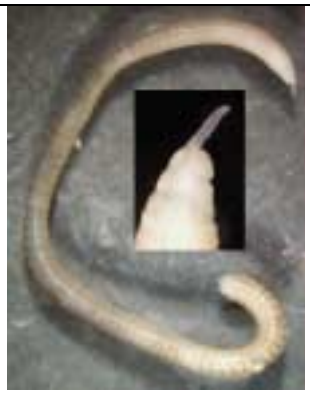

Purse case maker caddisflies


Saddle case maker caddisflies


Mites


Scuds, sowbugs, crayfish


Snails, clams, limpets


Aquatic worms

Appendix D: List of "microinvertebrates" of Smith and Bybee Lakes and the lower Columbia Slough. This list was pulled from X and X reports for the Portland Bureau of Environmental Servcies. Question marks denote species for which the consultants were unsure of the identification.

Copepods (Calanoida)
Diaptomus franciscanus
Diaptomus copepodites
Diaptomus novamexicanus
Diaptomus reighardi

Copepods (Cyclopoida)
Cyclops spp.
Cyclops bicuspidatus thomasi
Cyclops copepodites
Eucyclops agilis

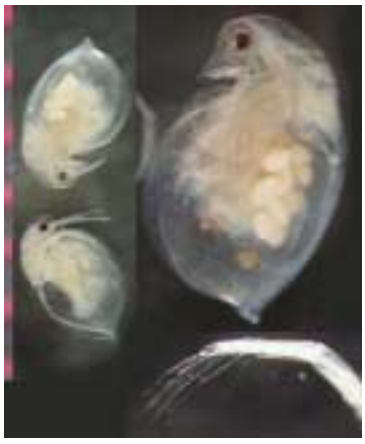
Copepods (Harpacticoida)
Bryocamptus washingtonensis
(either - Canthocampus or Mesochra sp.)

Rotifers (Rotifera)
Asplanchna priodonta
Brachionus calyciflorus
Brachionus rubens (?)
Euchlanis dilatata (?)
Kellicottia bostoniensis
Keratella cochlearis
Polyarthra vulgaris
Rotifera neptunia (?)
Synchaeta oblonga

Water fleas (Cladocera)
Alona costata (?)
Bosmina longirostris
Ceriodaphnia pulchella
Ceriodaphnia reticulata
Chydorus sphaericus
Daphnia parvula
Daphnia retrocurva
Diaphanosoma brachyurum
Diaphanosoma leuchtenbergianum
Eurycercus lamellatus
Eubosmina hagmanni
Leptodora kindti
Leydigia quadrangularis
Macrothrix laticornis
Moina brachiata
Moina micrura
Pleuroxis aduncus
Sida crystallina


Cyclopoid copepod


Harpacticoid copepod


Cladoceran


Rotifer