A Bug's Life in the Columbia Slough

Handbook of Aquatic Invertebrates and Macroinvertebrate Monitoring in the Columbia Slough Watershed

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(Cover photos: The author and Ethan Chessin (CSWC Volunteer Coordinator) collecting benthic macroinvertebrates in the Columbia Slough near Whitaker Slough (Photo by Ry Thompson, Portland BES). The inset in the upper left is an adult Pacific forktail damselfly, while the inset on the right is of the aquatic nymph state of either a forktail or bluet damselfly with close-ups of various body parts.

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INTRODUCTION

The Columbia Slough provides a rare and valuable biological, recreational, and community resource in a highly urbanized environment, despite many decades of intense human land use. The Slough watershed supports a diverse array of fish, birds, mammals, reptiles, amphibians, plants and invertebrates. Some of these plants and animals have been transplanted to the Pacific Northwest from other parts of the world, but most are native and require specific conditions for survival.

Male Pacific forktail damselfly (*Ischnura cervula*) with forest green eyes and turquoise blue markings.

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

Aquatic macroinvertebrates in the Columbia Slough have cultural, monitoring, aesthetic and conservation significance.

- 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 signal crayfish, with large claws and a tasty tail, is another large invertebrate that has an important role in the food chain of the Slough. **Note**: Because of legacy of pollution in Columbia Slough sediments, the mussels and crayfish of the Slough today should not be eaten.
- The diverse array of aquatic invertebrates species in the Slough represents a range of dietary preferences, habitat niches, tolerances, and life histories. Having enough species to reflect such diverse characteristics is important for biological monitoring.
- The colorful, acrobatic and ravenously predatory dragonflies and damselflies are certainly among the more charismatic aquatic predators in the Slough.
- Alice Springs supports a very large population of Columbia dusky snails, which were classified as a Survey and Manage species under the Northwest Forest Plan. The Columbia Slough is also home to three species of freshwater mussel – one of the most endangered groups of invertebrates in the world.

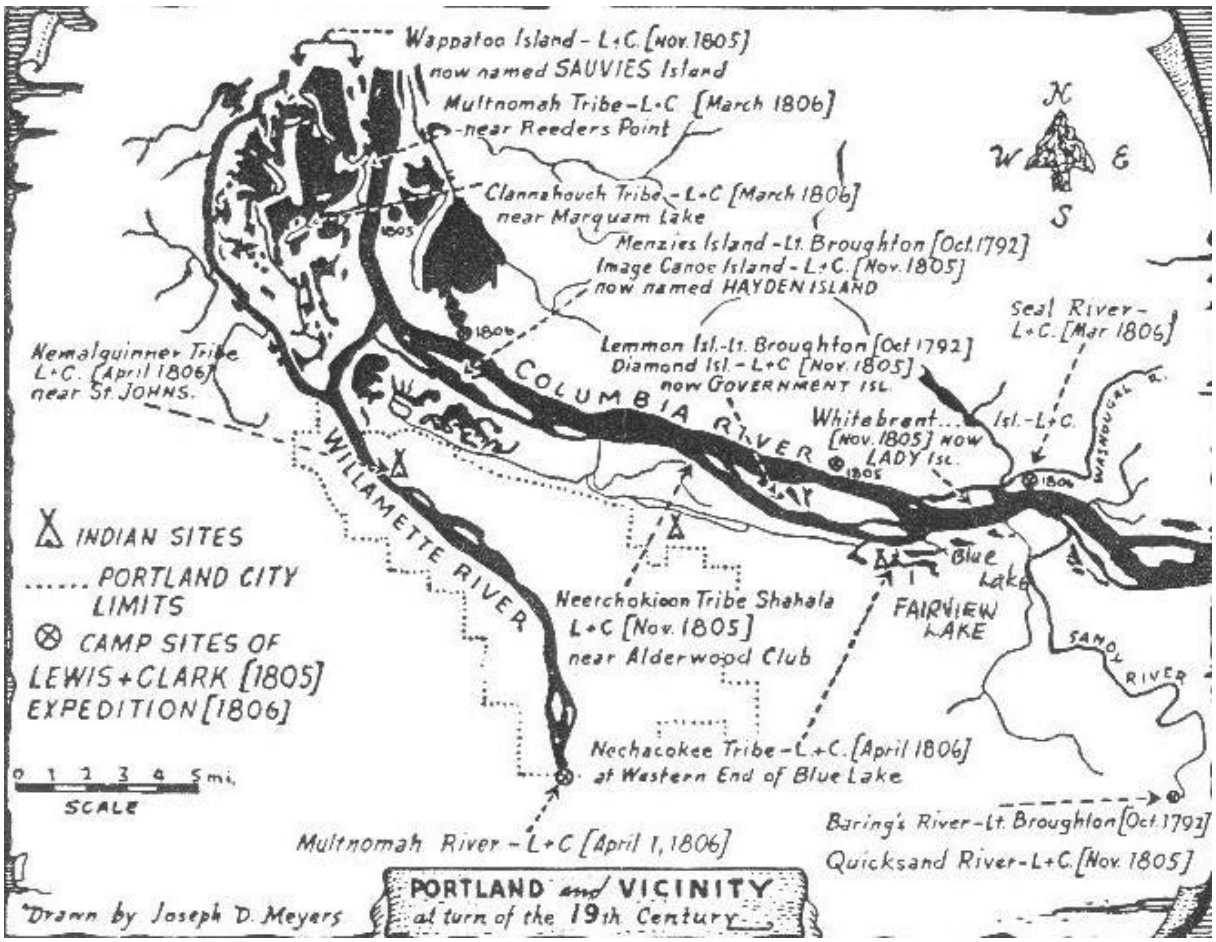
By understanding and appreciating the rich diversity of these organisms and how that diversity can be affected by human activities in the watershed, we can add to our appreciation of the highly urban Columbia Slough and what it contributes to the landscape, economics, and culture of the region. It may also make you wonder what kinds of organisms are supported by terrestrial urban habitats, what threats are likely to impact invertebrate survival, and how can we work together to protect invertebrates 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 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, though only 19 miles long by itself, is part of nearly 60 miles of remnant interconnected lakes, wetlands and slow-moving channels in the southern floodplain of the Columbia River near its confluence with the Willamette 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 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 storm runoff and springs and controlled by levees and water control structures. The downstream section is tidally influenced with water levels changing as much as 3 feet per 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 flooding from the Columbia and Willamette was 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 such activity, it is no surprise that much of the habitat for fish and wildlife in the watershed has been destroyed or highly modified. The Slough has also been subjected to the types of pollutants you might expect with a heavily industrialized watershed – organic waste, PCBs, DDT, heavy metals, plane de-icing chemicals and untreated runoff. The legacy of pollution will long be chronicled in sediments and fish that can both contain PCBs, pesticides and a myriad of other toxic compounds.

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

Despite a long history of environmental decline, the Slough is cleaner today than it has been in over 100 years. 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. Increasing awareness among businesses and residents has also led to greater appreciation of the Slough as a biological and community resource.

IMPORTANCE AND ACTION

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 connectivity for wildlife and can be explored by recreationalists on foot or bicycle and in a canoe or 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 (CSWC) was formed to address the impacts that 150 years of development have had in the Slough. The Council is a diverse group of neighbors, property owners, businesses, environmental groups, recreation advocates, and government agencies who, through partnerships and action, work towards their mission: to foster action to protect, enhance, restore and revitalize the Slough and its watershed. Visit the Council on-line at www.columbiaslough.org.

BIOLOGICAL MONITORING

As the name suggests, biological monitoring (also known as biomonitoring or bioassessment) involves using the plants or animals that live or should live in a certain ecosystem to evaluate the effects of human activity on that ecosystem. The concept can apply to any "habitat" using any organism or group of organisms – from canaries in coal mines, to wine tasters for kings, to macroinvertebrate monitoring of streams. By using other organisms as indicators, we can learn about the ability of an ecosystem to support a diverse and healthy biological community.

WHY ARE MACROINVERTEBRATES COMMONLY USED IN BIOMONITORING?

Any organism or group of organisms can be used for biomonitoring, but in rivers and streams, macroinvertebrates have been the most widely used and effective. Macroinvertebrates as a community have several characteristics that make them ideal for biomonitoring:

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 varied widely, but typically involved either the tiny invertebrates of the waters column (called zooplankton) or the larger invertebrates living in sediments and on substrates (benthic macroinvertebrates). Zooplankton were collected by dragging a fine mesh net through the water column (DEQ 1974, Clifton 1983, and Fishman 1986), while dipnets or heavy,

expensive grab samplers were used to collect benthic macroinvertebrates (Perente and Smith 1981, Clifton 1983, Fishman 1986, BES 1989, Lev, et al. 1995, Parametrix 1996, and recent efforts by the CSWC and Xerces). One study however, used transplanted freshwater clams to measure contamination levels in the Columbia Slough (Fishman 1993).

Zooplankton collections are not the emphasis of this handbook, but since they are still of aquatic invertebrate interest, the collection sites from two of the above studies are included in the map below, and a species list with a few images is included in Appendix C. The primary finding of the zooplankton studies was that there were two seasonal peaks in abundance of zooplankton, one in July and another in October. In July, water fleas (Cladocera) dominate the zooplankton, while in October rotifers and copepods (Rotifera and Copepoda) appear to be the most abundant groups. These peaks can be significant for fish diets since zooplankton is a very important food source for many fish.

Benthic macroinvertebrate samples collected with an Ekman dredge or grab sampler collected mostly worms and some midges. Since the grab samplers are effectively a large set of clamping metal jaws, there is a high possibility of woody or gravelly material becoming lodged in the jaws and the sample washing out, the samplers are not effective throughout the Columbia Slough and its tributaries. The dipnets are more versatile, but the consistency of results is still not well understood. The studies that collected benthic macroinvertebrates most significant conclusions related to the biological differences between the Lower (tidally influenced) and Upper (runoff and spring driven) halves of the Columbia Slough and to the relationship between invertebrate abundance and the relative amount of silt in the substrate (more silt = higher abundance, though it tended to be lower diversity and mostly worms).

The above studies differed slightly to widely in the protocols, sampling gear, mesh sizes, sorting techniques, and level of identification. Such inconsistencies are probably typical of still water monitoring in the Pacific Northwest. Biological monitoring in slow and still waters has not had the level of research and attention that rivers and streams have received over the last 25 years. Using a consistent set of protocols will be very helpful in developing any long term monitoring programs in the Columbia Slough watershed.

Xerces and CSWC macroinvertebrate monitoring collaboration

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. Volunteer sampling protocols have been practiced and refined in the slow-moving waters of the Columbia Slough as part of the project and in preparation for future monitoring. Stream samples (using standard Oregon DEQ protocols) were also collected in the four streams that drain into the Slough.

Two recent monitoring efforts have supported the past findings of the differences in diversity and types of invertebrates found in the Lower and Upper halves of the Columbia Slough. The sampling has added substantially to our understanding of the full diversity of life in the Slough and has provided a fun learning opportunity for many volunteers.

The samples collected from springs and streams had some very interesting results. When scored against more pristine streams of the region, the streams actually scored quite poorly. However, when looking at the species collected from the sites (particularly Alice Springs and the headwaters of Osborne Creek), it is clear that these water bodies provide a very important refuge for organisms that would otherwise not be able to live in an urban environment. For example, a cold water caddisfly that is typically found in small, cold mountain streams lives in the springs of Osborne Creek. Of greater conservation significance is that a large, dense population of the Columbia dusky snail (*Colligyrus* n. sp. 1 - a Survey and Manage species under the Northwest Forest Plan) calls Alice Springs home. The species is typically found in the Columbia Gorge east of Multnomah County.

Files with consolidated data from current macroinvertebrate sampling and many of the previous invertebrate studies from the Columbia Slough (as well as a color PDF of this handbook) can be found at the Columbia Slough Watershed Council website: www.columbiaslough.org/bugs.

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 with the Columbia Slough Watershed Council. Macroinvertebrate samples will be collected in the Columbia Slough in the late summer of 2006, and if resources allow the macroinvertebrate monitoring program to continue, Columbia Slough Watershed Council staff and volunteers of all ages will collect macroinvertebrate samples for some time to come. Volunteers can also learn to sort and identify macroinvertebrate samples if they have some spare time. To learn more about volunteer opportunities with this program and others, contact the Columbia Slough Watershed Council at 503- 281-1132 or info@columbiaslough.org.

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

Macroinvertebrate monitoring in the Columbia Slough watershed provides an excellent educational opportunity and baseline information on the Slough's biological condition. It may also give land managers and decisions makers additional tools to monitor the effects of restoration and management changes on the organisms in the Slough. The information gathered as part of the program will be interpreted and made freely available to the volunteers, agencies, and organizations involved in the Slough.

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, alternative protocols have been considered for sampling in the slow water habitats of the Slough, including sloughs, wetlands, lakes, and ponds. As mentioned above, past invertebrate sampling efforts in the Slough have included plankton tows, sediment grabs, and dipnet samples. The dipnet samples are the most cost effective and practical for volunteer monitoring and actually sample a more diverse and easily identifiable community than grab samplers or plankton tows.

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

Appendix B 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 12 square feet of shoreline substrate, where the water is only one foot deep (see the first page of Appendix B for more details).

Equipment necessary for these protocols is listed in the table below.

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

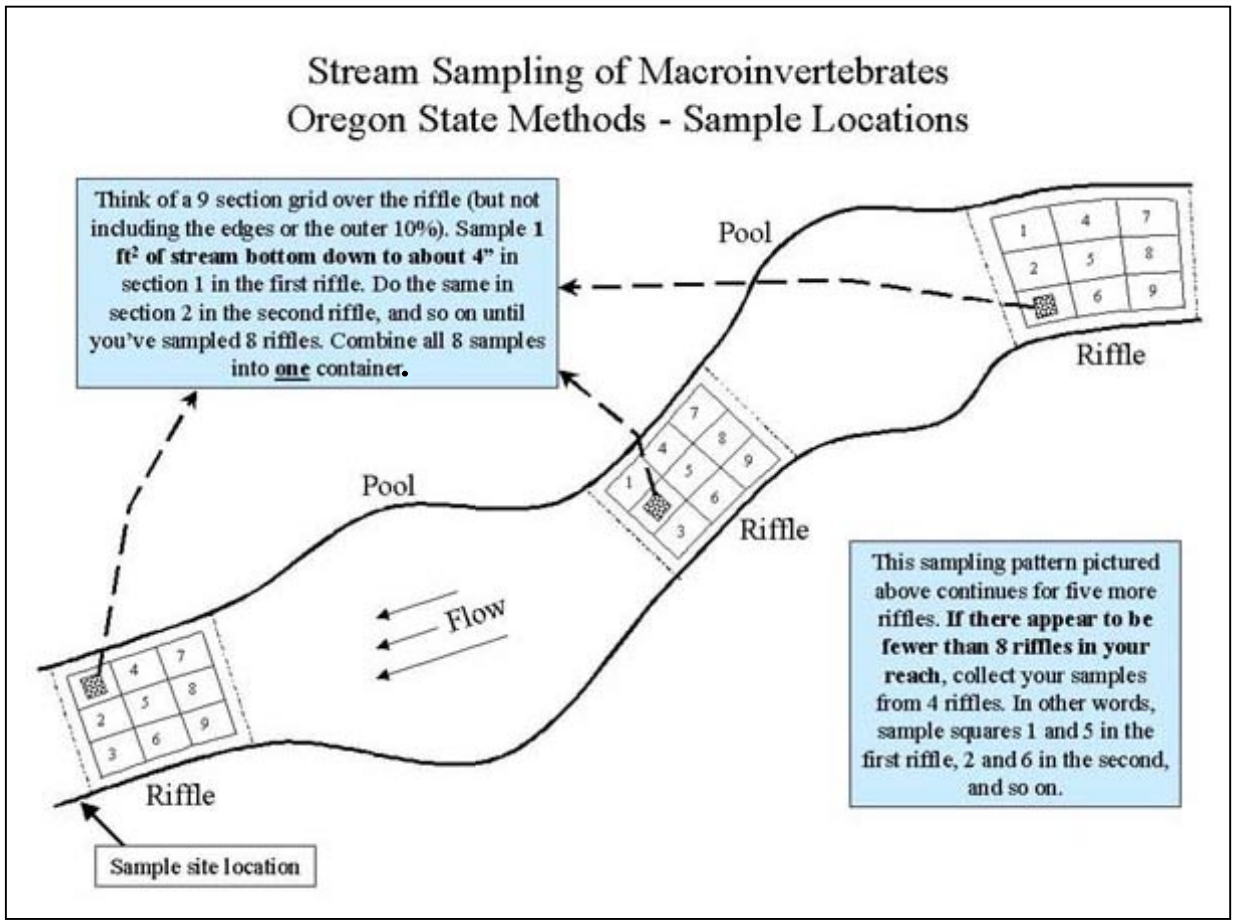
_ ID sheet (Appendix A)
_ Clipboard
_ Pencil
_ 2 white tubs
_ 2 ice cube trays
_ Small square of window screen
_ Tweezers
_ Squirt bottle
_ Vial or other container 3/4 filled with rubbing alcohol or 75% Ethanol

COLLECTING MACROINVERTEBRATES IN FAST-FLOWING WATERS

Fortunately, protocols are well established for Northwest wadeable streams. Samples are typically collected using a D-frame kicknet (the same net that is used in the slow water sampling above). The goal is 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).

Collecting macroinvertebrates from a riffle in a wadeable stream.

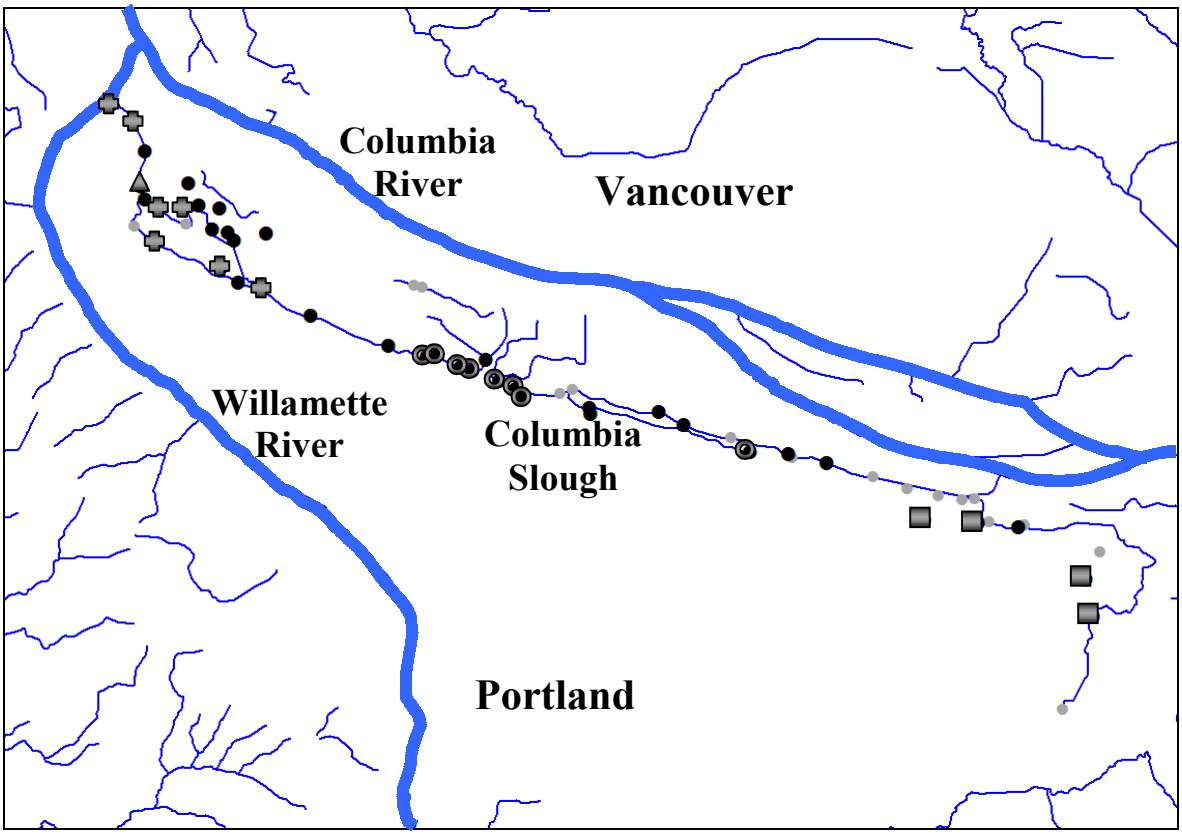
Once you have reached the sample location, look upstream and downstream to evaluate how many riffles are available for sampling. Ideally, a single $1ft^2$ sample is collected from each of 8 riffles. Where riffles are very long, few in number (typical of the tributaries to the Columbia Slough), or limited 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.



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 above). 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 B for a step-by-step sampling procedure.

MACROINVERTEBRATE SAMPLE SITES

A large number of 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. The map below shows sites from past and recent sampling efforts as well as several proposed sites for future monitoring. Latitude, longitude, waterbody name and site description for the sample sites below are in Appendix A.



Invertebrate sample site locations on the Columbia Slough and its tributaries.
▲ = sites with only zooplankton sample; ✚ = sites with both zooplankton and benthic macroinvertebrates; ● = past macroinvertebrate sample sites (using either dipnet or Ekman dredge); ◉ = slow water macroinvertebrate sample sites associated with the CSWC/Xerces collaborative project (dipnet - 2004/2005) while the small, light gray spots (•) are potential future sample sites; and ■ = stream macroinvertebrates collected in 2005.

DATA INTERPRETATION

Macroinvertebrate identification and count data from the samples collected as part of this project will be made available at the Columbia Slough Watershed Council website (www.columbiaslough.org/bugs). The four stream samples were sorted and identified by Aquatic Biology Associates, Inc., while the Columbia Slough, Buffalo Slough and Johnson Lake samples were sorted by volunteers or Xerces staff, and identified by Xerces staff.

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. Additional models can allow us to evaluate the effects of fine sediment and water temperature on the macroinvertebrate community.

The streams all scored poorly because they have relatively low diversity of species. However, we look beyond these tests to see another important story about these spring fed streams. They provide unique refugia to species (particularly snails) that would otherwise not be able to live in the area, as discussed above.

Unfortunately, none of these evaluation techniques have been developed for slow or still waters of the West. As more consistent data is available, we can get a better understanding of macroinvertebrate monitoring in these habitats and how to interpret that data. When looking at currently available data, we can see some trends.

The tidally influenced portion of the Slough has a lower diversity than the upstream sections. Also, a number of common taxa were found in more than half of the 11 samples collected in the Columbia Slough in 2004 and 2005 (below). If many or most of these taxa were absent from a sample, then it would probably be reason for concern, particularly in the Upper Columbia Slough where the tidal influence does not affect the substrate and biota.

Common taxa expected in samples from slow waters of the Columbia Slough

Caecidotea (sowbugs)
Callibaetis (mayflies)
Ceratopogoninae (biting midges)
Chironomidae (midges)
Coenagrionidae (damselflies)
Corixidae (water boatmen)
Dubiraphia (riffle beetles)
Helobdella stagnalis (leech)
Hyallela (scud)
Lymnaea (snails)
Oligochaeta (worms)
Pectinatella magnifica (resting statoblasts)
Physidae (snails)
Pisidium (clams)
Vorticifex effusa (snail)
Trombidiformes (mites)

We have learned a lot from the samples collected as part of the current work, but as slow and still water macroinvertebrate monitoring expands in the Northwest, our ability to effectively interpret the data will improve as well.

AQUATIC INVERTEBRATES OF THE COLUMBIA SLOUGH

More than 200 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 are not (meiofauna or microinvertebrates – including zooplankton). More specifically, macroinvertebrates are larger than 500 micrometers, 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 very abundant both in the water column and in the substrate. Those that live in the water column are called zooplankton and are at the mercy of the water's movement 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 slow current or hold their position in backwaters or eddies. Meiofauna are not the focus of this handbook, but species collected in the Lower Columbia Slough and Smith and Bybee Lakes are listed in Appendix C. 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, 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 them acquire oxygen in low-oxygen environments.

The information below includes pictures and text about macroinvertebrates that have been collected in the Columbia Slough watershed. Tables of the species of macroinvertebrates currently known from the Columbia Slough watershed are included in Appendix C, and color reference sheets with images of many of the organisms are included in Appendix D.

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

MAYFLIES (EPHEMEROPTERA)

Mayflies usually are not 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.

Other mayflies can be found in the springs and streams of the Columbia Slough watershed. In fact, mayflies tend to be most diverse in faster flows and larger substrates. The common and fairly tolerant small minnow mayfly called *Baetis* (pictured above) has been found in all four streams in the watershed, and the prong gill mayfly (*Paraleptophlebia*) has been found in Osborn and Wilkes Creeks.

Other mayflies that may be found in the watershed include other minnow mayflies (*Ameletus* and *Diphetor*) and a few flatheaded mayflies (*Rhithrogena*, *Ironodes*, and *Epeorus*). These taxa, along with *Baetis* and *Paraleptophlebia* 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 in the springs of the Columbia Slough watershed. It is 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 high oxygen levels and larger substrate, so in the Columbia Slough watershed, they are most likely to be found in the springs and streams.

The common forestfly *Zapada cintipes* (above) and a little green stonefly (*Sweltsa*) were collected in both Alice Springs and Osborn Creek. Osborne Creek is also home to a different forestfly species (*Malenka*).

Other stoneflies might be found in these springs and in other small tributaries to the Slough including 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)

Recent sampling revealed a large number of caddisfly species in the watershed, particularly in the springs and streams.

The tube making caddisfly (*Polycentropus*) and a long-horned caddis (*Mystacides*) were found in the slow waters of the Slough. The long-horned caddis seems to be pretty common in the

upper half of the Slough. A number of others may be present. In particular, northern case maker caddisflies can be common in still waters, including *Limnephilus* (above), which make grass blade or twig cases.

In the streams of the Slough, green rock worms (*Rhyacophila grandis* Species Group), finger-net caddsiflies (*Wormaldia*), two different tortoise case makers (*Glossosoma* and *Anagapetus*), humpless case makers, and purse case makers (*Ochrotrichia*) have all been found in the springs and streams. *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. *Anagapetus* is a very sensitive cold water taxa that is typically found in small, cold mountain streams.

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

DRAGON AND DAMSELFLIES (ODONATA)

Dragonflies and damselflies are among the more ancient, interesting, and visible predators of still and slow waters. A few types live in flowing waters and a dancer damselfly (*Argia*) was found in a couple of the Columbia Slough watershed streams.

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 spent much time relaxing near a wetland or lake, you may have noticed different sizes, shapes, and colors of dragonflies.

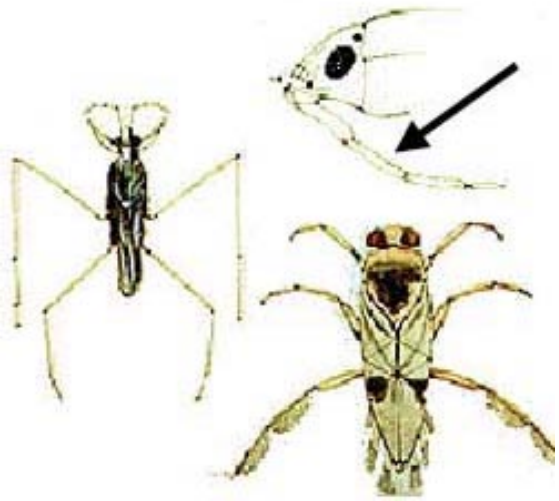
The delicate-looking Pacific forktail damselfly (top) and the robust eight-spotted skimmer (bottom) live in the Slough.

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

There are quite a lot of species and the sexes can often look so different, you might think they were a different species.

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

The robust red, green, yellow, or blue dragonflies, like the female eight-spotted skimmer (above left bottom), can be also seen around the Slough throughout the summer.



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

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. 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.

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

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 are all air breathers, so they 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.

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 have not been collected and recorded in past studies reviewed for this handbook.

This larval water scavenger beetle (left) 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 (right) 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 and shiny 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 escape less than desirable water conditions or to disperse to new habitats.

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 do not 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. Flies are also well known indicators in macroinvertebrate monitoring and are diverse, both in flowing waters and still.

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

The most common flies in still water and in strong currents are the midges (Chironomidae). Some midges are commonly known as bloodworms (above) because of their bright red color. 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.

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

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. Crane flies have also been found, but because they are very diverse in soft sediments and stream margins, it seems likely that more will be found.

In the springs and streams of the Slough watershed dixid midges (Dixidae) and black flies (Simuliidae) 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. Black fly larvae have fans on their heads that they use to grab organic debris from the water.

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

ALDERFLIES (MEGALOPTERA)

There are several different kinds of Megaloptera 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.


Collembolan – arrow points to furcula.

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. With sometimes poor direction and distance control, they can find themselves springing out of the frying pan and into the fire.


Large signal crayfish from the Columbia River.

They come in a lovely array of colors (blue, purple, red, yellow), but are not 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.


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

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.

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.

Above are three of the 5 or more different scuds known in the Columbia Slough. *Gammarus* (left) has very long first antennae (highest on the head) and shorter second antennae. The first antennae of *Hyalella* (middle) are very short, much shorter than the second pair. *Corophium* (right) is an estuarine scud that is present in the Lower Columbia Slough and has greatly enlarged, almost leg-like first antennae.

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 five different kinds of scuds live in the Slough and its tributaries.

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.

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

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 Columbia Slough watershed.

The common but cryptic freshwater limpet *Ferrissia parallelus*.

WATER MITES (TROMBIDIFORMES)

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 and 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.

Trombidiformes 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. An example of an aquatic mite is shown on the previous page.

The left-handed *Physa* (left) and the right-handed *Lymnaea* (right) 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. Two species of *Ferrissia* live in the Slough and its tributaries, and are essentially snails whose shell does not coil. *Ferrissia* is also often small and dark and looks more like a bump on the substrate than a macroinvertebrate.

Several snails with conically coiled shells live in the Slough. The most typical of which are the left-handed snail *Physa* and two species of the very similar but right-handed snail called *Lymnaea*. 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 is the left-handed snail. If it is on the right, it could be one of several other snails.

Juga is a common and diverse right-handed snail in rivers and streams.

An 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 and its tributaries.

The most common stream snail in the Columbia Slough is *Juga* (above), 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. Two species are found in the streams of the Columbia Slough watershed. A small, unusual and uncommon snail called the Columbia dusky snail is actually found in abundance at Alice Springs.

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

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.

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 fish, and a lucky few will grow and mature in the sediments.

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

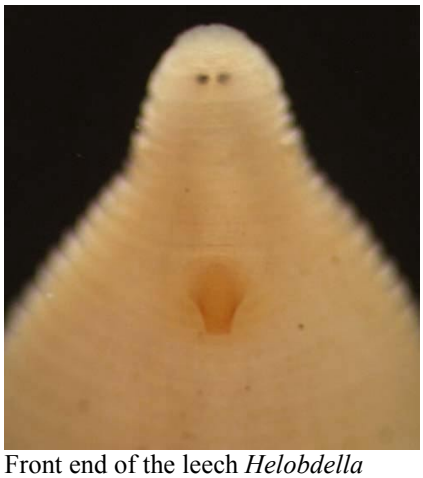
Fingernail clams (right) can be abundant in a variety of habitats. They are never much larger than your pinky nail and are more typically the size of a pinhead. They can be found in the Slough and in the springs and streams. The introduced Asian clam looks much like a very large fingernail clam but has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

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


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

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 do not actually harm the crayfish, but they probably consume organic debris the crayfish stirs up when it's feeding or clean material off its exoskeleton.

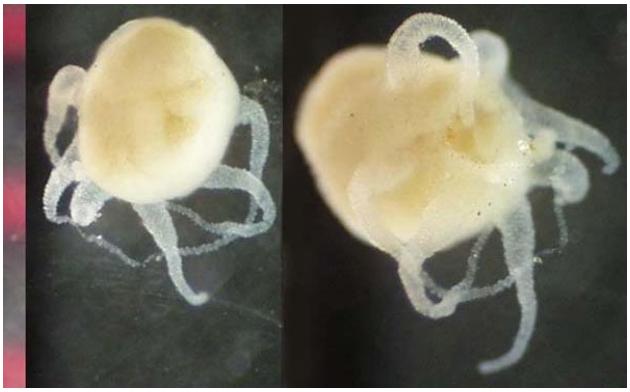
FLATWORMS OR PLANARIANS (TURBELLARIA)

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.


Crayfish worms, Branchiobdellida, live only on crayfish exoskeletons.

HYDRA (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 free living (not parasitic) aquatic species are largely ignored by scientists because they tend to be very small, though they are sometimes abundant. Below is a wonderfully visual quote regarding nematodes:

> "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)

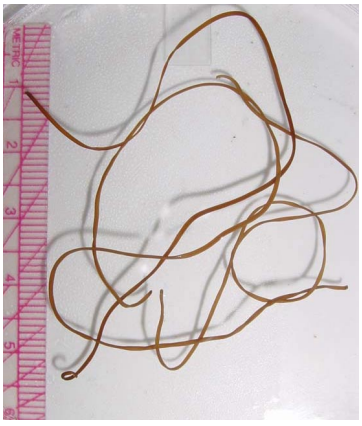
Nematodes can be extremely abundant.

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 be 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 feet long!), 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.

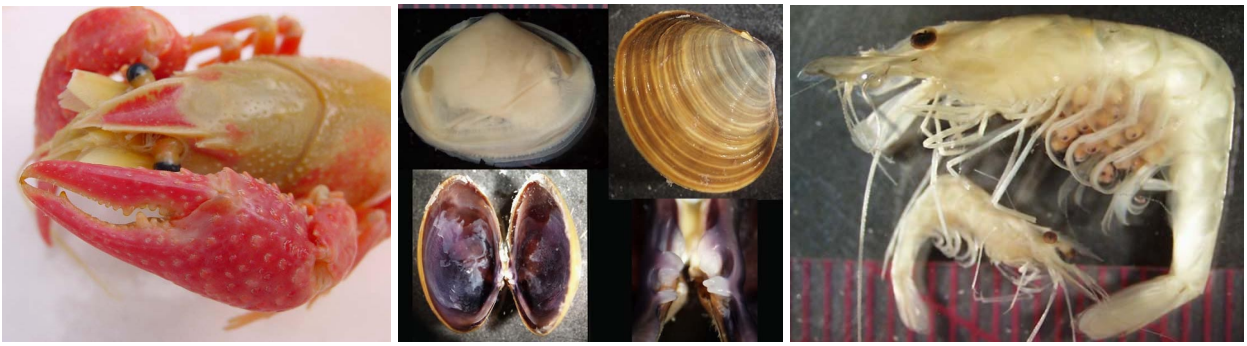
Their bodies are incredibly simple, having no organs or tissues. As with a sponge you might find in your kitchen or bath (though most of those are synthetic) freshwater sponges are covered with numerous microscopic holes by which water passes into the sponge, and a few large holes by which water leaves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

Freshwater sponge – photo by Daniel Pickard, California Department of 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 above, 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 survive transportation from one place to another. There are likely 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 for your interest in the aquatic invertebrates of the Columbia Slough, and please consider volunteering with the Columbia Slough Watershed Council at 503-281-1132 or info@columbiaslough.org.

If have any questions about this handbook, please contact Jeff Adams at jadams@xerces.org or 503-232-6639. Please also consider joining the Xerces Society to support this and other efforts in invertebrate conservation at 503-232-6639 or www.xerces.org/Membership/index.htm.

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

ACKNOWLEDGMENTS

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. Special thanks to Ethan Chessin, former volunteer coordinator with the Watershed Council and to Ry Thompson with the Portland Bureau of Environmental Services for being an integral part of this project. 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 Sprit Mountain Community Fund, the Oregon Watershed Enhancement Board, members of the Xerces Society for Invertebrate Conservation, Northwest Service Academy, and City of Portland Bureau of Environmental Services' Community Watershed Stewardship Program.

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- Toxicology study – collected *Corbicula* clams from the Columbia River and transplanted them to both the Upper and Lower Columbia Sloughs where they were suspended one meter above the bottom for five months. Tissue was then analyzed for pollutants. Floater mussels and crayfish were used for comparison.

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Websites

Columbia Slough Watershed Council
www.columbiaslough.org/
(macroinvertebrate monitoring page)
www.columbiaslough.org/bugs

Columbia Slough Bibliography – searchable database of Columbia Slough related documents
www.fishmanenvironmental.com/CSWdbase/

The Columbia Slough Watershed newsletter put out by the City of Portland
www.cleanrivers-pdx.org/clean_rivers/ws_columbia_slough.htm

City of Portland's Columbia Slough website
www.cleanrivers-pdx.org/clean_rivers/big_pipe.htm

Center for Columbia River History's Columbia Slough website
www.ccrh.org/comm/slough/main.htm

The Xerces Society for Invertebrate Conservation
www.xerces.org

Appendix A: Known invertebrate (zooplankton and benthic macroinvertebrate) sample site locations in the Columbia Slough watershed.

SITE ID	SITE DESCRIPTION	LATITUDE	LONGITUDE
11006	Alice Springs - about 170th – 1/8 mile north of Sandy	45.54981	-122.48649
11018	Buffalo Slough - NE 33rd	45.57665	-122.63441
11046	Bybee Lake - southeast	45.61873	-122.74613
11044	Bybee Lake - northwest	45.62496	-122.74461
11058	Bybee Lake - mid-Bybee Lake	45.61986	-122.74104
11045	Bybee Lake - northeast	45.61919	-122.73435
11035	Columbia Slough - at North Lombard bridge	45.63919	-122.76315
11024	Columbia Slough - below North Slough	45.62390	-122.75994
11033	Columbia Slough - upstream North Lombard Bridge	45.63228	-122.75919
11036	Columbia Slough - at landfill bridge	45.61063	-122.75472
11037	Columbia Slough - downstream of railroad bridge	45.60191	-122.72775
11038	Columbia Slough - at North Portland Road	45.60042	-122.71991
11057	Columbia Slough - upstream end of island west of I-5	45.59471	-122.70403
11047	Columbia Slough - upstream of I-5 bridge	45.58797	-122.67844
11023	Columbia Slough - MLK downstream	45.58560	-122.66595
11022	Columbia Slough - MLK upstream	45.58594	-122.66265
11048	Columbia Slough - downstream of NE 13th outfall	45.58354	-122.65501
11021	Columbia Slough - upstream of NE 13th outfall	45.58261	-122.65120
11019	Columbia Slough - NE 21st Ave	45.58055	-122.64249
11017	Columbia Slough - above Buffalo Slough	45.57861	-122.63695
11049	Columbia Slough - downstream of Colwood Golf Course	45.57423	-122.59065
11050	Columbia Slough - upstream of Colwood Golf Course	45.57115	-122.58251
11012	Columbia Slough - Prison Pond	45.56500	-122.54844
11051	Columbia Slough - NE 122nd	45.56299	-122.53570
11054	Columbia Slough - NE 185th west	45.54907	-122.47333
11003	Fairview Creek - Salish Ponds Fairview Community Park	45.52846	-122.44853
11014	Johnson Lake - north east	45.56517	-122.56085
11002	North Slough - confluence	45.62102	-122.75861
11032	North Slough - power lines	45.61891	-122.75441
11031	Osborne Creek - 205th headwater spring	45.53734	-122.45117
11055	Peninsula Drainage Canal - at MCDD	45.58541	-122.64706
11041	Smith Canal - midway between Smith and Bybee	45.61436	-122.73657
11042	Smith Canal - at outflow of Smith	45.61367	-122.73141
11039	Smith Lake - south edge	45.60530	-122.73301
11043	Smith Lake - near outflow to Smith Canal	45.61179	-122.72949
11040	Smith Lake - northeast edge	45.61367	-122.71921
11056	Whitaker Ponds - settling pond	45.57322	-122.61268
11020	Whitaker Slough - boat launch	45.57460	-122.61307
11005	Wilkes Creek - 154th and 2 blocks south of Sandy	45.55015	-122.50385
11034	Willamette River - upstream of Columbia Slough confluence	45.64305	-122.77037

Appendix A (cont'd): Potential macroinvertebrate sample site locations in the Columbia Slough watershed.

SITE ID	SITE DESCRIPTION	LATITUDE	LONGITUDE
Potential sites for future invertebrate sampling			
11029	Bridgeton Slough - west	45.60244	-122.67054
11030	Bridgeton Slough - east	45.60189	-122.66807
11025	Columbia Slough - above North Slough	45.61461	-122.76166
11016	Columbia Slough - below Whitaker Slough	45.57780	-122.62235
11015	Columbia Slough - above Whitaker Slough	45.57879	-122.61866
11013	Columbia Slough - NE 92nd	45.56854	-122.56673
11028	Columbia Slough - above Prison Pond	45.56409	-122.54682
11011	Columbia Slough - NE 138th	45.56002	-122.52069
11010	Columbia Slough - NE 148th	45.55755	-122.50950
11009	Columbia Slough - NE 158th	45.55599	-122.49948
11052	Columbia Slough - NE Airport Way west bridge	45.55505	-122.49154
11008	Columbia Slough - Big Four-Corners	45.55548	-122.48751
11027	Columbia Slough - above Alice Springs	45.55008	-122.48281
11053	Columbia Slough - NE 185th east	45.54954	-122.47130
11007	Fairview Creek - 200th and Division	45.50660	-122.45758
11026	North Slough - below Bybee	45.61519	-122.74496
11004	Osborne Creek - 207th and Sandy - behind gas station	45.54368	-122.44658

Appendix B: 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 downstream of either side of the Slough;
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 bucket;
8. Repeat steps 4-7 a couple boat lengths upstream of the first sample, and put it into the same bucket;
9. Then, repeat the process on the other side of the Slough for a total of 4 samples in a single bucket;
10. 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 if necessary to leave as little water in the sample as possible; use multiple sample jars if the sample fills 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 critters 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 stick them in vials of alcohol; 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;

3. 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);
4. 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;
5. after all 8 samples are collected and deposited in the same bucket, use tweezers to remove clinging macros from the net;
6. 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);
7. label the sample jar inside and out (don't use ink for the labels, use a pencil);
8. 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);
9. 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 is 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

Sample Name & ID #: _____ 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 visibly 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/brush 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_____

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, car tires, or golf balls

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)

These sample labels are best if printed on waterproof paper and must be written on with a pencil since ink from a pen will be leached out by the alcohol of a sample and you'll be left once again with a blank piece of paper.

Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______	Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______
Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______	Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______
Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______	Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______
Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______	Is this sample a field duplicate? Yes_______ No_______ Sample Name/#: _______________ _____________Site ID # ________ Organization __________________ Team Leader __________________ Date ________/________/_______ Jar ________ of _______

Appendix C: List of known slow or still water invertebrates in the Columbia Slough watershed. Question marks denote uncertainty in the identification. The notation "cf." means it is very similar to a known taxon but not the same.

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**		
	Nemertea		
Flukes	**Trematoda**		
Leeches, Worms, and kin	**Annelida**		
Leeches	Hirudinea	Glossiphoniidae	*Helobdella stagnalis*
Leeches	Hirudinea	Glossiphoniidae	*Placobdella sp. (?)*
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	*Haemonais waldvogeli*
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 hoffmeisteri*
Aquatic worms	Oligochaeta	Tubificidae	*Limnodrilus udekemanus*
Aquatic worms	Oligochaeta	Tubificidae	*Quistadrilus multisetosus*
Aquatic worms	Oligochaeta	Tubificidae	*Varichaetadrilus (cf.) pacificus*
Scuds, Sowbugs, Crayfish, etc.	**Crustacea**		
Water fleas	Cladocera		
Copepods	Copepoda		
Seed shrimp	Ostracoda		
Scuds or sideswimmers	Amphipoda	Corophiidae	*Corophium sp.*
Scuds or sideswimmers	Amphipoda	Crangonyctidae	*Crangonyx sp.*
Scuds or sideswimmers	Amphipoda	Gammaridae	*Gammarus sp.*
Scuds or sideswimmers	Amphipoda	Gammaridae	*Ramellogamarus sp.*
Scuds or sideswimmers	Amphipoda	Hyalellidae	*Hyalella sp.*
Sowbugs, pillbugs, rolly pollies	Isopoda	Asellidae	*Caecidotea sp.*
Opossum shrimp	Mysida	Mysidae	*Neomysis mercedis*
Siberian prawn	Decapoda	Palaemonidae	*Exopalaemon modestus*
Crayfish	Decapoda	Astacidae	*Pacifastacus leniusculus*
Spiny-tail fairy shrimp	Anostraca	Streptocephalidae	*Streptocephalus sealii*

List of known slow or still water invertebrates in the Columbia Slough watershed (cont'd).

COMMON NAMES	ORDER (or HIGHER)	FAMILY	GENUS SPECIES
Snails, Mussels, Limpets, and Clams	**Mollusca**		
Fragile ancylid	Gastropoda	Ancylidae	*Ferrissia fragilis*
Oblong ancylid	Gastropoda	Ancylidae	*Ferrissia parallelus*
Woodland pondsnail	Gastropoda	Lymnaeidae	*Lymnaea catascopium*
Mimic Lymnaea	Gastropoda	Lymnaeidae	*Pseudosuccinea columella*
Tadpole physa	Gastropoda	Physidae	*Physa gyrina*
Snails	Gastropoda	Planorbidae	*Gyraulus sp.*
Marsh rams-horn	Gastropoda	Planorbidae	*Helisoma trivolvis*
Button sprite	Gastropoda	Planorbidae	*Menetus callioglyptus*
Artemesian rams-horn	Gastropoda	Planorbidae	*Vorticifex effusa*
California floater	Unionoida	Unionidae	*Anodonta californiensis*
Winged floater	Unionoida	Unionidae	*Anodonta nuttalliana*
Oregon floater	Unionoida	Unionidae	*Anodonta oregonensis*
Fingernail or pea clams	Veneroida	Pisidiidae	*Pisidium sp.*
Aquatic mites and spiders	**Arachnida**		
Mites	Trombidiformes		
Springtails	**Collembola**		
Mayflies	**Ephemeroptera**		
Minnow mayflies	Ephemeroptera	Baetidae	*Callibaetis sp.*
Dragonflies	**Odonata**		
Common green darner	Odonata	Aeshnidae	*Anax junius*
Whiteface dragonflies	Odonata	Libellulidae	*Leucorrhinia sp.*
Eight-spotted skimmer	Odonata	Libellulidae	*Libellula forensis*
Common whitetail	Odonata	Libellulidae	*Libellula lydia*
Blue dasher dragonfly	Odonata	Libellulidae	*Pachydiplax longipennis*
Meadowhawk dragonflies	Odonata	Libellulidae	*Sympetrum sp.*
Black saddlebags dragonfly	Odonata	Libellulidae	*Tramea lacerata*
Tule bluet damselfly	Odonata	Coenagrionidae	*Enallagma carunculatum*
Pacific forktail damselfly	Odonata	Coenagrionidae	*Ischnura cervula*
Aquatic true bugs	**Hemiptera**		
Water boatmen	Hemiptera	Corixidae	*Palmocorixa buenoi*
Water boatmen	Hemiptera	Corixidae	*Palmocorixa sp.*
Water boatmen	Hemiptera	Corixidae	*Callicorixa sp.*
Water boatmen	Hemiptera	Corixidae	*Sigara sp. (?)*
Water boatmen	Hemiptera	Corixidae	*Trichocorixa sp.*
Water striders	Hemiptera	Gerridae	*Gerris sp.*
Water treaders	Hemiptera	Mesoveliidae	*Mesovelia mulsanti*
Water treaders	Hemiptera	Mesoveliidae	*Mesovelia (cf.) californiensis*
Backswimmers	Hemiptera	Notonectidae	
Riffle bugs	Hemiptera	Veliidae	*Microvelia*
Caddisflies	**Trichoptera**		
Tube-making caddisfly	Trichoptera	Polycentropodidae	*Polycentropus sp.*
Purse case maker caddislies	Trichoptera	Hydroptilidae	*Hydroptila sp.*
Long-horned case maker caddis	Trichoptera	Leptoceridae	*Mystacides sp.*
Fishflies, alderflies	**Megaloptera**		
Alderflies	Megaloptera	Sialidae	*Sialis sp.*

List of known slow or still water invertebrates in the Columbia Slough watershed (cont'd).

COMMON NAMES	ORDER (or HIGHER)	FAMILY	GENUS SPECIES
Aquatic beetles	**Coleoptera**		
Weevils	Coleoptera	Curculionidae	
Predaceous diving beetles	Coleoptera	Dytiscidae	
Riffle beetles	Coleoptera	Elmidae	*Dubiraphia sp.*
Crawling water beetles	Coleoptera	Haliplidae	*Haliplus sp.*
Crawling water beetles	Coleoptera	Haliplidae	*Peltodytes callosus*
Water scavenger beetles	Coleoptera	Hydrophilidae	*Berosus sp.*
Water scavenger beetles	Coleoptera	Hydrophilidae	(second genus)
Aquatic moths	**Lepidoptera**		
Aquatic moth	Lepidoptera	Nepticulidae	*Nepticula sp.*
Aquatic flies	**Diptera**		
Biting midges	Diptera	Ceratopogonidae	*Bezzia/Palpomyia sp.*
Biting midges	Diptera	Ceratopogonidae	*Culicoides sp.*
Biting midges	Diptera	Ceratopogonidae	*Mallochohelea sp. (?)*
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.*
Dixid midges	Diptera	Dixidae	*Dixa sp.*
Shore flies	Diptera	Ephydridae	
Moth flies	Diptera	Psychodidae	*Psychoda alternata*
Marsh flies	Diptera	Sciomyzidae	
Soldier flies	Diptera	Stratiomyidae	
Craneflies	Diptera	Tipulidae	*Erioptera sp.*
Craneflies	Diptera	Tipulidae	*Limonia sp.*
Craneflies	Diptera	Tipulidae	*Tipula sp.*

Appendix C (cont'd): 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
Hydras, Jellyfish, and kin	**Cnidaria**	**Hydridae**	***Hydra sp.***
Flatworms or Planarians	**Turbellaria**		
Leeches, Worms, and kin	**Annelida**		
Leech	Hyrudinea	Erpobdellidae	
Aquatic worms	Oligochaeta	Lumbriculidae	
Snails, Mussels, Limpets, Clams	**Mollusca**		
Columbia dusky snail	Gastropoda	Hydrobiidae	*Colligyrus* n. sp. 1
Pristine springsnail	Gastropoda	Hydrobiidae	*Pristinicola hemphilli*
Snails	Gastropoda	Physidae	*Physa sp.*
Ash gyro	Gastropoda	Planorbidae	*Gyraulus parvus*
Button Sprite	Gastropoda	Planorbidae	*Menetus opercularis*
Marsh rams-horn	Gastropoda	Planorbidae	*Helisoma trivolvis*
Artemesian rams-horn	Gastropoda	Planorbidae	*Vorticifex effusa*
Pleated juga	Gastropoda	Pleuroceridae	*Juga plicifera*
Glassy juga	Gastropoda	Pleuroceridae	*Juga silicula*
Ubiquitous peaclam	Veneroida	Pisidiidae	*Pisidium casertanum*
Scuds, Sowbugs, Crayfish, and kin	**Crustacea**		
Scuds or sideswimmers	Amphipoda	Crangonyctidae	*Crangonyx sp.*
Scuds or sideswimmers	Amphipoda	Gammaridae	*Gammarus sp.*
Scuds or sideswimmers	Amphipoda	Anisogammaridae	*Ramellogammarus sp.*
Crayfish, crawdads	Decapoda	Astacidae	*Pacifastacus sp.*
Sowbugs, pillbugs, rolly pollies	Isopoda	Asellidae	*Caecidotea sp.*
Seed shrimp	Ostracoda		
Aquatic mites and spiders	**Arachnida**		
Mites	Acarina		
Mayflies	**Ephemeroptera**		
Small minnow mayflies	Ephemeroptera	Baetidae	*Baetis tricaudatus*
Prong-gill mayflies	Ephemeroptera	Leptophlebiidae	*Paraleptophlebia sp.*
Dragonflies and Damselflies	**Odonata**		
Dancer damselflies	Odonata	Coenagrionidae	*Argia sp.*
Stoneflies	**Plecoptera**		
Forestfly stoneflies	Plecoptera	Nemouridae	*Malenka sp.*
Forestfly stoneflies	Plecoptera	Nemouridae	*Zapada cinctipes*
Little green stoneflies	Plecoptera	Chloroperlidae	*Sweltsa sp.*
Caddisflies	**Trichoptera**		
Humpless case makers	Trichoptera	Brachycentridae	*Micrasema sp.*
Tortoise case makers	Trichoptera	Glossosomatidae	*Anagapetus sp.*
Tortoise case makers	Trichoptera	Glossosomatidae	*Glossosoma sp.*
Common netspinners	Trichoptera	Hydropsychidae	*Cheumatopsyche sp.*
Common netspinners	Trichoptera	Hydropsychidae	*Parapsyche almota*
Purse case makers	Trichoptera	Hydroptilidae	*Ochrotrichia sp. (?)*
Northern case makers	Trichoptera	Limnephilidae	
Finger-net case makers	Trichoptera	Philopotamidae	*Wormaldia sp.*
Green rock worms	Trichoptera	Rhyacophilidae	*Rhyacophila grandis Gr.*
Uenoid case makers	Trichoptera	Uenoidae	*Neophylax sp.*
Aquatic beetles	**Coleoptera**		
Riffle beetles	Coleoptera	Elmidae	*Heterlimnius sp.*
Riffle beetles	Coleoptera	Elmidae	*Lara sp.*
Riffle beetles	Coleoptera	Elmidae	*Optioservus sp.*

List of known stream or spring invertebrates in the Columbia Slough watershed with an image page of selected taxa (cont'd).

COMMON NAMES	ORDER (or HIGHER)	FAMILY	GENUS SPECIES
Aquatic flies	**Diptera**		
Midges	Diptera	Chironomidae	*Brillia sp.*
Midges	Diptera	Chironomidae	*Corynoneura sp.*
Midges	Diptera	Chironomidae	*Cricotopus Bicinctus Gr.*
Midges	Diptera	Chironomidae	*Dicrotendipes sp.*
Midges	Diptera	Chironomidae	*Lymnophys sp.*
Midges	Diptera	Chironomidae	*Microspectra sp.*
Midges	Diptera	Chironomidae	*Nanocladius sp.*
Midges	Diptera	Chironomidae	*Polypedilum sp.*
Midges	Diptera	Chironomidae	*Psectrocladius sp.*
Midges	Diptera	Chironomidae	*Psilometriocnemus sp.*
Midges	Diptera	Chironomidae	*Rheotanytarsus sp.*
Midges	Diptera	Chironomidae	*Tanytarsus sp.*
Midges	Diptera	Chironomidae	*Thienemanniella sp.*
Midges	Diptera	Chironomidae	*Thienemannimyia Gr.*
Dixid midges	Diptera	Dixidae	*Dixa sp.*
Longlegged flies	Diptera	Dolichopodidae	
Dance flies	Diptera	Empididae	*Chelifera/Metachela sp.*
Fungus gnats	Diptera	Mycetophilidae	
Moth flies	Diptera	Psychodidae	*Pericoma sp.*
Black flies	Diptera	Simuliidae	*Simulium sp.*
Crane flies	Diptera	Tipulidae	*Dicranota sp.*
Crane flies	Diptera	Tipulidae	*Limnophila sp.*

Appendix C (cont'd): List of "microinvertebrates" or meiofauna of Smith and Bybee Lakes and the lower Columbia Slough. This list is was taken from those provided in reports by DEQ (1974) and Fishman Environmental Associates (1986). 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

NOTES:

Appendix D: Selected aquatic macroinvertebrates of the Columbia Slough watershed.

Page 1 – Slow and still water macroinvertebrates.


Minnow mayflies


Dragonflies, damselflies


Water boatmen


Alderflies


Tube-making and Long-horned case maker caddisflies


Predaceous diving beetles


Crawling water beetles

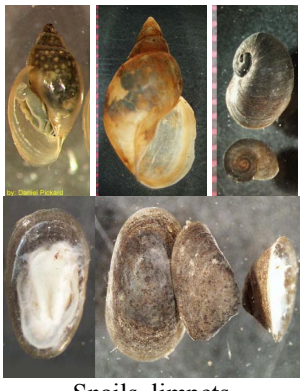

Midge larvae


Mites


Scuds


Sowbugs


Crayfish


Snails, limpets


Mussels


Aquatic worms


Moss animals

Appendix D (cont'd): Selected aquatic macroinvertebrates of the Columbia Slough watershed.

Page 2 – Spring and stream macroinvertebrates.

 Small minnow mayflies	 Prong-gill mayflies	 Little brown stoneflies	 Little green stoneflies
 Green rock worm caddisflies	 Finger-net caddisflies	 Purse case maker caddisflies	 Saddle case maker caddisflies
 Common net spinner caddisflies	 Damselflies	 Riffle beetles	 Midges, black flies, dixids
 Mites	 Scuds, sowbugs, crayfish	 Snails and clams	 Aquatic worms

Thanks again for your interest in the macroinvertebrates of the Columbia Slough and please consider volunteering with the Columbia Slough Watershed Council at 503-281-1132 or info@columbiaslough.org.

If have any questions about this handbook, contact Jeff Adams at jadams@xerces.org or 503-232-6639.

Please also consider joining the Xerces Society to support this and other efforts in invertebrate conservation at 503-232-6639 or www.xerces.org/Membership/index.htm.