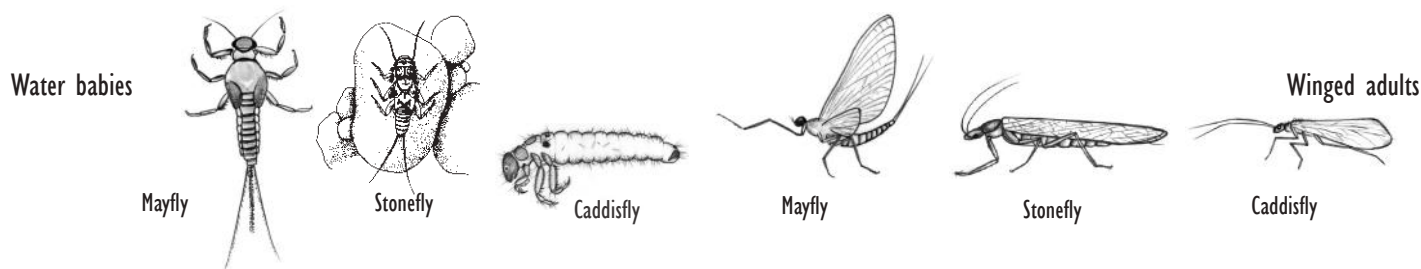


# Healthy Bugs = Healthy Streams

Stream Bugs Tell An Important Story



# How Do We Measure Watershed Health?



The fish, mayflies, stoneflies, snails, clams and other invertebrates that live in a stream are the best indicators of a watershed's health. Healthy streams have an enormous diversity of aquatic species with a variety of survival strategies and adaptations to life in streams. The scientific name for the insects, crustaceans and worms that live in the rocky bottom of a stream is "benthic invertebrates," but for simplicity we often just call them stream bugs.

Like salmon, stream bugs need clear, clean, and cool water; adequate oxygen, stable flows, and a steady source of food to complete their life cycles. Disturbed streams have fewer species of stream bugs. Samples of invertebrates are collected regularly from Kitsap County streams as a check-up to see how the watersheds are doing. We calculate 10 measures from the bug samples (see below) and score them as indicative of good, moderate or poor stream condition. The measures are used to calculate the benthic index of biotic integrity (B-IBI), also referred to as "the bug index."

## 1 **Total species richness.**

Includes all the different stream bugs collected from a stream site: mayflies, caddisflies, stoneflies, true flies, midges, clams, snails, and worms. The biodiversity of a stream declines as patterns of water flow are altered, habitat is lost, chemicals are introduced, energy cycles are disrupted, and alien taxa invade.

## 2 **Number of mayfly species.**

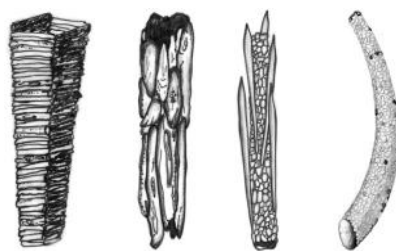
Many mayflies graze on algae and are particularly sensitive to chemical pollution because of their fragile gills. People who fly fish use lures to imitate the winged adults that hatch once a year.

## 3 **Number of stonefly species.**

Many stoneflies eat leaves that fall from trees overhanging the stream. Like salmon, stoneflies need cool water temperatures and high oxygen to live.

## 4 **Number of caddisfly species.**

Some caddisflies spin silk nets to catch food. Other species build unique cases from gravel, leaves or wood to protect them from predators. More unique species of caddisflies indicate healthy stream habitat.



## 5 **Number of intolerant species.**

The most sensitive species are the first to disappear as pollutants increase and natural habitats are lost.

## 6 **Number of clinger species.**

Clingers have special claws or suckers that allow them to cling to smooth rock surfaces as the stream rushes by. Their numbers are reduced as sediment fills the space between the rocks and cobble.

## 7 **Number of long-lived species.**

These species require more than one year to complete their life cycles. They are sensitive to changes in the flow regime that result in longer dry periods or more frequent flooding.

## 8 **Percent tolerant individuals.**

Tolerant animals are the most hardy and tough species. Although present at most stream sites, they increase as pollutants increase and natural habitats disappear.

## 9 **Percent predators.**

Predators such as dragonfly larvae have large eyes and long legs for hunting other animals. Predators depend on a healthy population of prey and decline with disturbance.

## 10 **Percent dominance.**

As species diversity declines, a few taxa come to dominate the assemblage. Opportunistic species that are less particular about where they live replace species that need special foods or habitats to live.

# TEN INDICATORS OF WATERSHED HEALTH

1

total taxa

2

mayflies

3

stoneflies

4

caddisflies

5

intolerant

6

clingers

7

long lived

8

% tolerant

9

predators

10

dominant species

## Quality of Life Where We Live

Vibrant human communities depend on diversity, that is, grocers, nurses, teachers, farmers, and business owners. A county of people who were all fire fighters would not support a healthy economy! In the same way, stream communities depend on diversity to live and thrive.

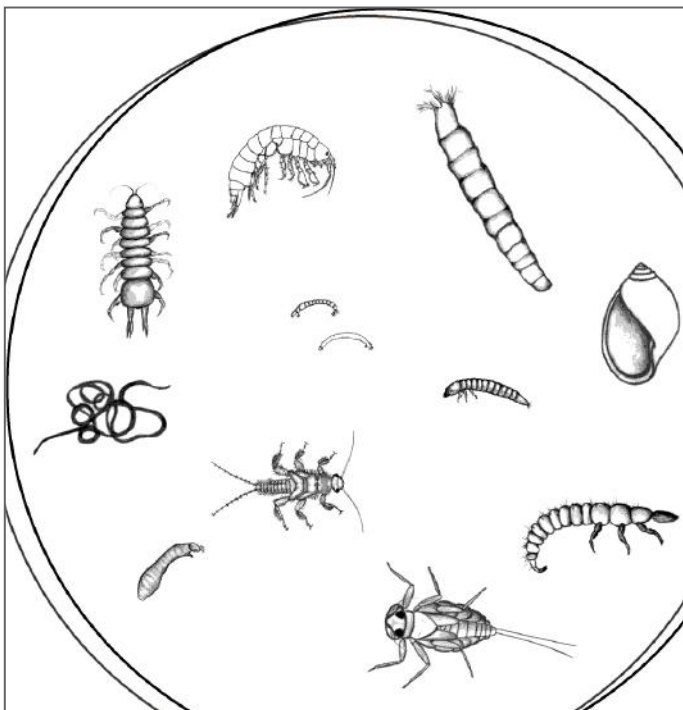
A typical healthy stream in Kitsap County will yield more than 40 unique species of invertebrates from a standard sample net. Many of these creatures will be caddisflies who look like fat caterpillars but who distinguish themselves by creating beautiful houses out of fir needles, pebbles, sand, and twigs. The carefully constructed case surrounds the

young insect like a sleeping bag. The hard case makes them less tasty to predators.

Some caddisflies don't have cases. These are the predators that eat other invertebrates. When predators are present, they indicate a healthy ecosystem because they depend on a mix of other animals who eat algae, catch food in nets, and shred leaves.

We can also learn how healthy a watershed is by who isn't in the sample. The sensitive species are the first to disappear. When only a few hardy species are found, the stream may need to be evaluated for restoration.

## Meet Your Neighbors



Healthy stream communities thrive with a diversity of stream bugs



Healthy human communities thrive with a diversity of people and professions



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## People Meet Bugs

Fly fishers know the connection between bugs and fish. They fish with dry or wet fly imitations that “match the hatch” of insects when they emerge as winged adults. Richard Stoll has fished in Kitsap County for over 50 years. For him, fly fishing is more than hooking and playing a fish, it’s about engaging with the totality of the environments that support fish.

“Stream insects are not just important as adults for feeding fish, they are an important part of the whole food chain in a stream,” says Richard. Stream bugs are also food for the young juvenile fish as they grow before they move out into marine waters.

“The return of the salmon to streams turns out to be more important than previously thought,” notes Richard. The carcasses of the adult salmon are full of nutrients from the ocean. The bugs step in again at this part of the food chain, breaking down the carcasses to make nutrients available for the juvenile fish, other insects, even the trees around the streams.



Richard Stoll fishes in Kitsap County and is the author of ***Fly Fishing Inshore Saltwaters for Pacific Salmon***.



*Mayflies and imitations*



*Caddisfly imitation*



*Caddisfly*

Photos: Rick Hafele

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## Watching the salmon return



Watching salmon return at Grovers Creek

Every fall our salmon return and make their way up local streams to spawn. Many people make it a tradition to hike down to their local creek and watch for them. These fish are intent on getting upstream to find a mate and build a cobble nest for their eggs.

Returning salmon bring a bonanza of minerals and nutrients from the ocean back to the stream. Invertebrates living in streams fertilized by adult salmon carcasses are bigger, and so are the growing salmon. Streams with some of the best index scores for invertebrates also support healthy salmon returns.

As the young fish grow, they will be hungry. They depend on midges, mayflies and caddisflies that they find in the rocks of the stream bed as larvae and also as adults flying near the surface of the stream. The cumulative fats of long-lived invertebrates make a good meal for young fish.

## People Meet Fish Who Eat Bugs

### Where and when to see returning salmon:

<http://web.kitsapsun.com/1newsroom/flash/salmon/salmon2.swf>



Salmon kayak tour watching for fish returning in Miller Bay



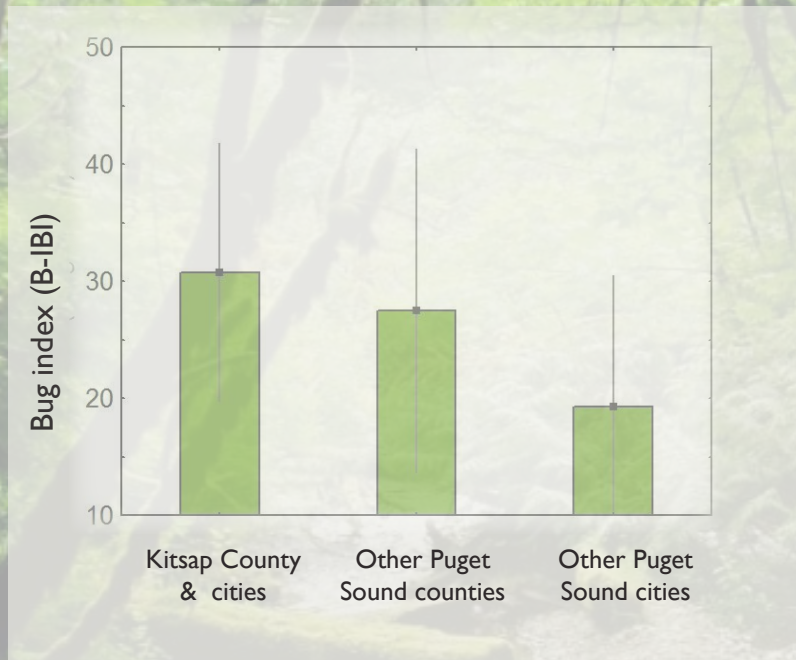
Coho leaping into a culvert at Otto Jarstad Park in Gorst.



Spawning chum from Chico Creek



# Kitsap Streams Among

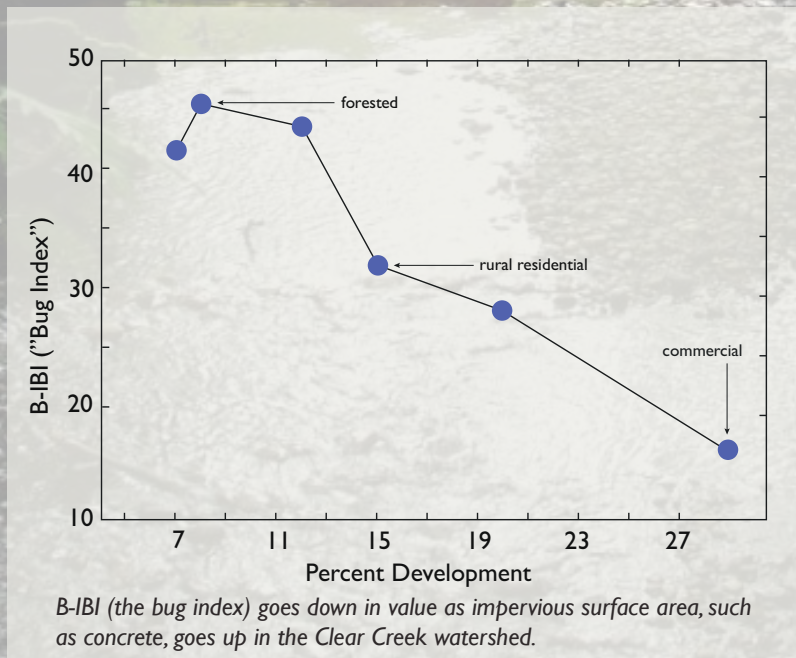


## What We Know

Kitsap streams, though not pristine, are some of the healthiest in the region with salmon returning every year. Compared to other counties, Kitsap streams look a bit healthier. Compared to streams flowing through Puget Sound cities, Kitsap streams are much healthier.

The healthiest communities of aquatic bugs are found in streams that are surrounded by forests. Areas with urban development and agricultural use have lower values for the bug index, partly because paved areas and rooftops increase surface run-off directly into streams. The most important place for trees and other native vegetation to be located is in the area closest to the streams, the riparian area.

## Clear Creek near Silverdale



**“Water is a resource, NOT a waste stream”**



# Healthiest in Region

## What We Are Doing

Water quality specialists from Kitsap County visit over 50 stream sites during a two-year period to collect invertebrates and calculate a bug index for each site. The streams visited represent the largest watersheds in Kitsap County. We want to know which streams are healthy and which are not. We also want to know if streams are changing through time. That is, are current protective measures, such as building regulations and stormwater management, doing the job to maintain stream health as land development increases?

When bug index values are lower than expected, we wonder what is happening in the watershed that might

degrade stream health. The same changes in watershed health also affect the life cycle of salmon. We can look at how people are using the land to identify ways to restore damaged sites. Streams may be rehabilitated by planting native vegetation, stabilizing banks that create sediment, or reducing pesticide use in the watershed.

We know now that restoring a stream site after it has been damaged is not easy. How do you remove sediment from between rocks? Keeping the sediment and toxics out of streams is a better approach than trying to fix it later.



Macroinvertebrate Sampling Sites

Learn more at *SSWM WQ Bug page*  
[http://www.kitsapgov.com/sswm/wq\\_bugs.htm](http://www.kitsapgov.com/sswm/wq_bugs.htm)



# TEN INDICATORS OF WATERSHED HEALTH

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total taxa

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## When Water Moves Dirt

### The Problem with Sediment

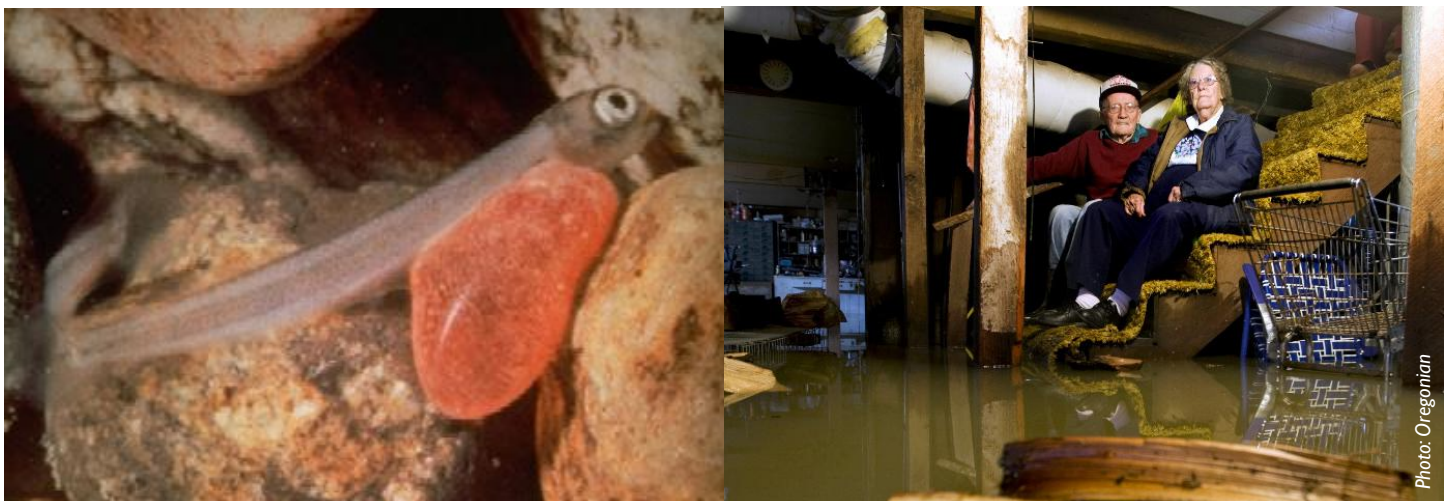
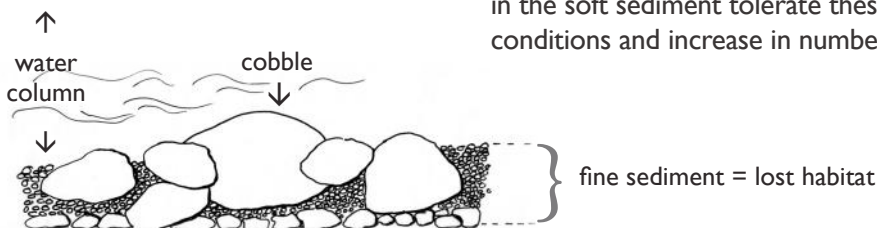
Streams naturally ebb and flow with the rains. Heavy rain can bring unexpected flooding, and the mud and sediment moved by water is often more damaging than the water itself, especially when the flood moves inside people's homes.

Sediment causes similar problems for the animals living in streams. Fine sand and sediment can become trapped and fill the open space between rocks and cobble. Many invertebrates and young fish depend on the spaces in between cobble to live and grow. Invertebrate clingers cannot hold onto sand, they need smooth rock surfaces. Hardy invertebrates that can survive in the water column without rock cover or in the soft sediment tolerate these conditions and increase in number.

Predators with no place to hunt or hide are lost as sediment increases.

When the land near streams is developed, the soil is loosened and can move more easily when it rains. In contrast, native trees and plants hold the soil and creek banks in place and keep sediment out of the stream.

Local building regulations are designed to protect streams, wetlands, and other water resource areas. Throughout the state, streams are classified based on their size and importance to wildlife and people. The level of protection of the vegetated riparian area is greater for fish bearing streams and less for smaller streams that do not support fish.



Sediment can fill spaces where baby salmon (alevin) hide

Sediment and water from flooding



## Agricultural and Urban Effects

Agricultural and urban land use affect streams differently. Changes in water flow, channel structure, sediment, and toxics are reflected in the stream bugs we find in the streams.

Stream bugs can help diagnose problems in streams and focus our efforts for restoration.

# A Tale of Two Watersheds

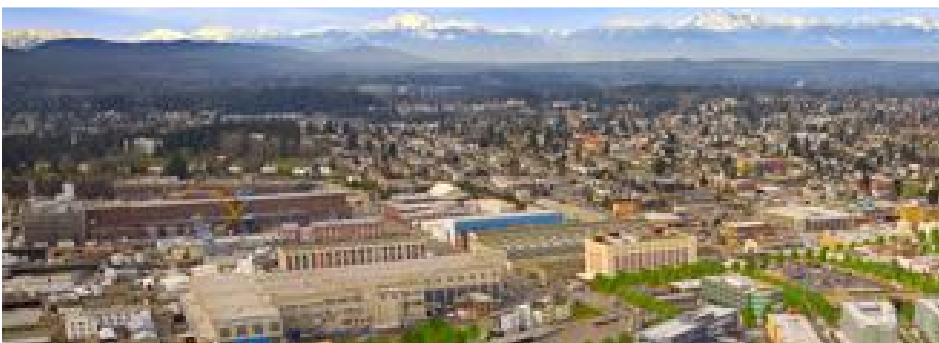
## Agriculture



Grovers Creek has a high percentage of land used for agriculture near the sampling site. As agricultural area increases, mayfly species decline, possibly due to nutrients which feed bacterial growth that can damage their fragile gills. Mayflies are also particularly sensitive to pesticides. Clinger species are sensitive to sediment and decline as agricultural land use increases near the stream site.



## Urbanization

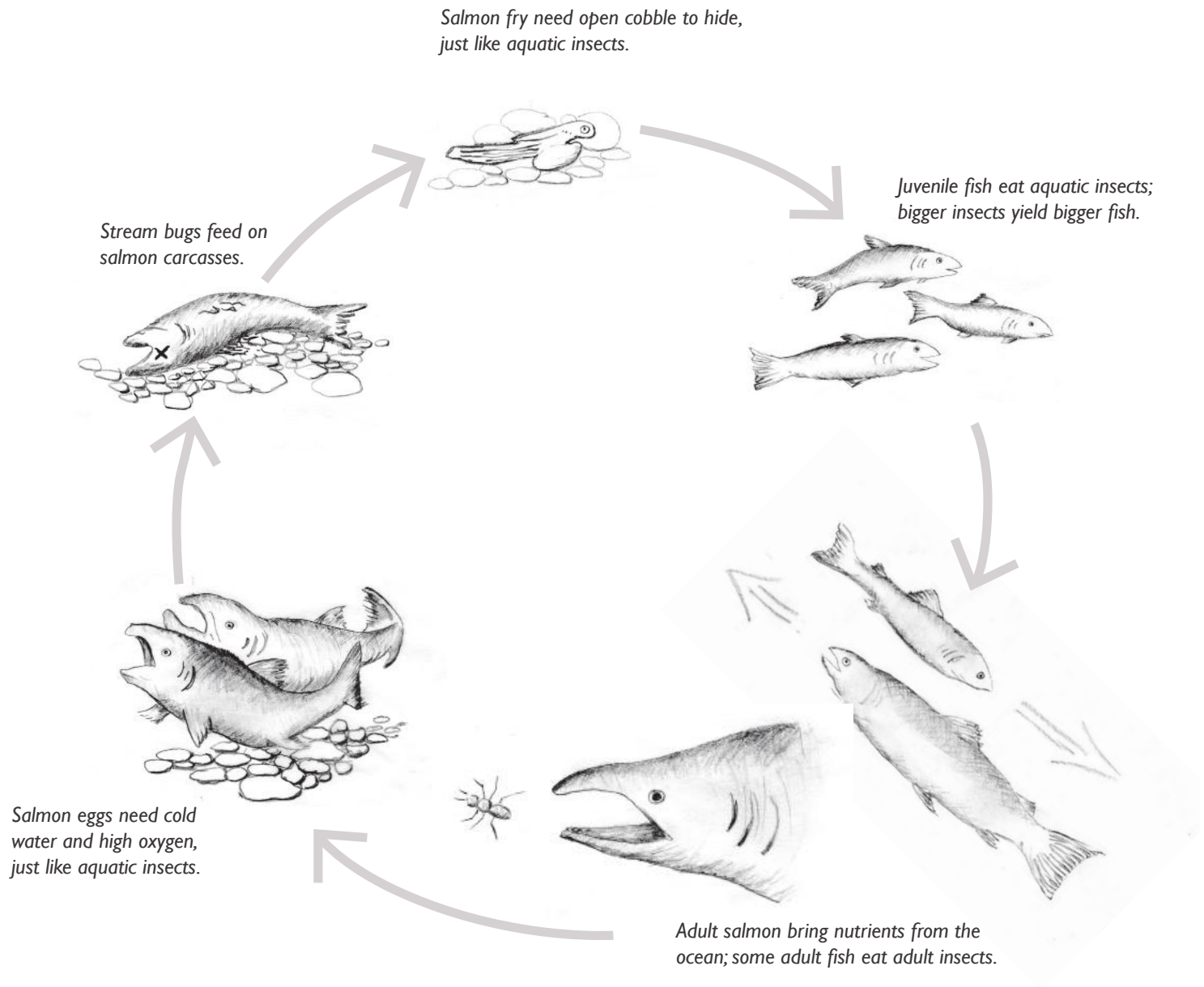


Barker Creek, at one location, has a higher percentage of land near the sampling sites with roads, houses and buildings. As urban development increases, predators and other sensitive species are lost as small habitats between cobble are filled with sediment. The tough, tolerant species increase and tend to dominate the sample.



# Why Are Healthy Watersheds Important?

Healthy watersheds support healthy stream bugs, fish and people



“...restore and maintain the chemical, physical, and biological integrity of our Nation’s water.”

-Clean Water Act, 1972



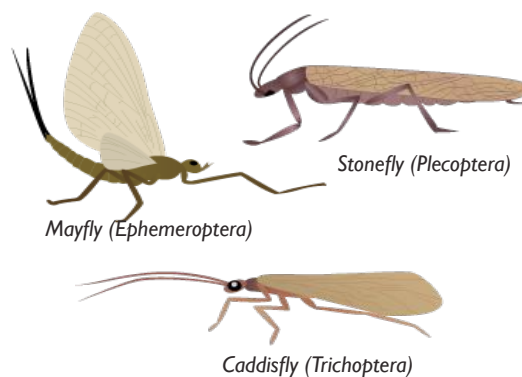
# Connection to Other Programs in the Puget Sound Region

Over 20 cities, counties, and tribes measure stream health using invertebrate samples. Local jurisdictions share a regional database called the Puget Sound Stream Benthos (PSSB) and use the bug index to test low impact development, evaluate restoration projects, and diagnose problems in streams. The PSSB can be found at <http://pugetsoundstreambenthos.org> and get Kitsap Bug data at <http://goo.gl/RifVwc>.

At the state level, the Department of Ecology tracks the status and trends and sets regional expectations for stream health based on invertebrate samples.

At the regional level, the Puget Sound Partnership has set targets for the restoration of 30 small watersheds in the Puget Sound Region by 2020. To measure the program's success, streams will be evaluated using the stream bug index (B-IBI).

At the federal level, EPA uses information about stream condition to allocate federal resources to protect and restore streams under the authority of the Clean Water Act.



bug images courtesy of IAN Image Library

Funded in part by a grant from Washington State Department of Ecology.



# Kitsap County Surface and Stormwater Management

Promoting Clean Runoff Through Knowledge and Assistance

For More Information:

Kitsap County Public Works

614 Division St. MS-26A

Port Orchard, WA 98366

360.337.5777

<http://www.kitsapgov.com/sswm/>



Photos: Richard Bartz

*Perlodid stonefly emerging from its larval case to become a winged adult.*

Stream insects are most vulnerable as they emerge from the waters of their natal stream and transition to their adult life on the wing. Streams are fragile too, as they transform water falling on the land into living communities of insects, fish and people.