Tips for Salmon Watch Volunteers

You have a fun experience ahead of you! Being a Salmon Watch Volunteer is a challenging and rewarding role. Jump in! Get involved! Above all, have fun! You have much to give and enthusiasm is contagious. Here are a few suggestions to help you:

What is my role as a volunteer?
You will be working with students in the field, sharing your perspective and maximizing their learning experience. Please demonstrate exemplary behavior and attitude in the natural environment. Your curiosity will lead others to follow suit. Encourage your students to:

- Ask questions.
- Investigate their study area, while minimizing disturbance.

How can I help students get the most out of their field trip?
Talk with the teacher about their goals for the trip. Be sure you understand the plan for the day. Review your Salmon Watch Volunteer Resource Packet before your trip. Utilize the "learning moments" during the day; be alert to unique opportunities that may seem like tangents to the activity, yet offer a springboard for further discussion of the original topic.

How do I lead the group?
There are many effective techniques for getting students engaged in the planned activities. Here are a few suggestions:

- Ask students to describe their observations.
- Choose a plant, animal, or other physical object they can touch and examine.
- Offer positive comments for their answers; keep a positive attitude.
- Provide interactive activities to engage the students in learning. **Avoid a lecture format.**

How do I involve everyone in the group?
Be sure to try to connect with all the students in the group. There will always be a few who have all the answers. Encourage the shy or quiet children to share their ideas too. When an answer is given ask the group to offer comments: agree/disagree, elaborate, find relationships.

How do I deal with questions I don't know the answer to?
Don't be embarrassed to admit you don't know the answer to every question. You are not expected to. Also, there often isn't one simple explanation, or any correct answer. There are many ways to deal with this predicament. For example, you can:

- Reason aloud. Go through the process of how you would find out an answer.
- Show students the resources available. Have students look through field guides. or other resources. Knowing where to find an answer is as important as knowing the answer.
- Turn the question back to the group as a whole. Encourage brainstorming.
- Turn the question over to the agency expert.

Techniques for Working with Students

A Note on Lecturing

Many educators rely too much on lecturing. Most individuals, both youth and adults, find they learn better when using a hands-on, discovery approach. By breaking up the lecture with activity, one can appeal to as many senses as possible.

Research suggests that there are different types of learners. We find that a large percentage of the population does not learn easily from lecture. Most adults tolerate lecture better than children do.

Environmental education programs usually emphasize hands-on activities, and the learner is exposed to the subject over many sessions. Interpretive programs often rely more on lecture, because the entire program fits into a short time frame, thus we have included tips for effective public speaking.

Again, the best advice is to resist the urge to lecture and to use a variety of teaching methods. (Note, however, that lecturing and storytelling are different. Almost everyone enjoys a *well-told* story.)

Public Speaking Techniques

1. Be sure to make your presentation age and knowledge level appropriate.

2. Try to NEVER JUST TALK. Hands-on learning can and should be woven into every presentation.

3. You make presentations with your body as well as with your words, and body frequently has greater impact. Be sure to make your body language consistent with your words.

4. Get animated, be dynamic, move, gesture, use vocal variety. Don't stand in one place. Be aware of what your group can see and hear.

5. ALWAYS speak to the whole group (beginners sometimes address only part of a group.) Yet try to have a one-on-one encounter with each person at the same time by using good eye contact.

6. Use a few, gripping, "pungent" facts and use analogies the listener can relate to easily.

7. Information should flow and be logically organized. Use repetition and internal summaries.

8. Use impact words, simple sentences, personal statements and stories. Let them know WHY this information is important, or what it relates to.

9. ENGAGE THEM WITH QUESTIONS. Size up your group, read their body language. Pacing is very important. Make sure you keep it varied and interesting. Get intense and focused with a scattered group. Adjust your pace to their responses.

Group Management

1. The most important thing to remember is to set clear expectations at the beginning of your session.

2. If you anticipate the group may not be focused, mention the expectations set by the teacher.

3. Always set limits. Always focus their attention. Always break into small groups.

4. Sometimes when leading a nature walk, students compete to walk near the leader. There are several techniques for dealing with this. Tell them to keep their attention focused outward from the trail, not forward. Or, let them take turns leading.

5. Dealing with wet and cold:
   - Accept the weather.
   - YOUR ATTITUDE will make a difference.
   - Be prepared, extra hats, sweaters and garbage bags.
   - Get under trees if it is raining hard.
   - Move around to keep warm.
   - Frequently check in with students on their comfort level and intervene when necessary.

6. Dealing with a "special" child, one who really wants your full attention, get them to focus by assigning him or her small tasks and/or enlisting their support in other meaningful ways.

Principles of Teaching

1. Remember that you represent a powerful role model for young people. Model awareness, respect for living things, and curiosity.

2. Enthusiasm is contagious. Feel upbeat, love your topic, and you will help your group to enjoy the field trip experience.

3. As much as possible, the children should be the ones doing the activity. Find ways to involve them even when you are talking and demonstrating. For example, if you cast a track, let one child mix and another pour, rather than you doing any of it.

4. You are responsible for the health and safety of these people when they are engaged in activities led by you. Safety must be a top priority. It's better to be too conservative than to have an injury. Don't let kids climb on logs. If you have a student and/or adult along who is not surefooted, make sure they get assistance. If the group samples wild foods, make sure they show you what they have picked before eating it.

5. This is a multi-cultural world. Check your comments for bias in assumptions of experiences connected to economic class or ethnic background and for possible sexist behavior (e.g. calling on males more than females to answer questions.)

6. It is not our job to convince kids of any one point of view (including environmentalism). It is OK to define the environmental ethic, say what you believe, express your point of view.

7. Understand that developmental stages exist and what they are. Make sure the activity is age and developmentally appropriate for the group.

8. We try to make sure each program has a theme. Students seem to learn best when the lesson fits together. For example, in the ancient forest, we keep coming back to diversity.

9. Always take advantage of the "teachable moment". It is perfectly okay to be upstaged by an earthworm, otter, or eagle during your presentation.

Teaching Tips

Engage with Students

- Be hands on and assist students with their activities
- Crouch down and talk to students at eye level
- Walk around, avoid standing in one place
- Be enthusiastic about your subject and let it show

Make it Catchy

- Start by engaging students with a question
- Give students something to do right away
- Make lessons meaningful by relating to students everyday lives (why is this topic important to them?)

Minimize Jargon

- When introducing new vocabulary, be clear, and use it repeatedly. Have students help you define the new word. Do not overwhelm students with too many new words in one lesson.
- Ask questions rather than making statements
- Answer a question with a question- “that’s a great question, what does everyone think?”
- Ask open ended questions- “what do you think will happen if..? Why do you think that will happen?”

Use Wait Time

- After asking a question wait 8-10 seconds before calling on students
- Reinforce a question/idea by waiting and then repeating it in a different way before calling on students

Think, Pair, Share

- Give students a lot of different ways to participate and respond
    - Can they talk to a partner first?
    - Can they write in a journal first?
    - Can they draw?
- Encourage students who are not participating by figuring out jobs for them that will keep them actively engaged
    - Put them in charge of something (handing out or collecting supplies)

Group Management Tips

1. Get off to a good start and establish your expectations at the start of the day

- Don't talk while I am talking or while your friends are talking.
- Raise your hands to share information.

Let students know that following these basic rules will benefit them as they will get more out of the experience. Have high expectations of the students, they will only rise as high as you ask them to.

2. Wait for student attention, don't talk over them

- If students are not giving their attention, calmly let them know that you will wait for them to give you their attention and then do. Remind students that if they waste time not following directions they may not get to lunch on time. Don't show agitation; just let them know that these are the facts.
- If a specific student continues to interrupt, the chaperone should intervene. If no chaperone is present, talk to the student separately and tell them that they will not be able to participate in the activity and will need to sit out with their teacher if they continue to interrupt. Talk to their teacher if needed and ask them to step in.

3. Proximity

If students are talking amongst themselves while you are having a discussion, stand next to them. Remain close by while continuing on with your lesson. Walking around while you are talking can help eliminate side conversations. If students continue talking ask one of them a question to get them back on track.

4. Give students transition time

- Make sure to give students enough time to finish up what they are doing. Let them know in advance that you will be switching gears and asking for their attention (5 min. warning, 2 min. warning, etc.).
- If groups are having a hard time getting refocused, be creative in getting attention. (Count down from 5 to zero voices. Voices off, eyes on me. If you can hear me clap once, if you can hear me clap twice. Count down and then ask for all hands in the air if they are working with their hands.)

5. Positive reinforcement: focus on positive behavior not the negative

- Give a lot of positive reinforcement and let students know when they are doing what you want them to be doing. "Thank you so much to those of you quietly and patiently waiting for directions".
- When the entire group has done a good job giving you their attention let them know..
- If you notice a student getting off track regularly, give them a task to keep them engaged.

6. Be Interesting

Students are often disruptive because they are not interested in what you are saying. Make sure to not talk at students for very long and to give them plenty of time to participate (see ***Teaching Tips handout***).

Salmon Biology Station

OBJECTIVES:
Students learn:

- Wild salmon are indicator species and keystone species whose survival is connected to the health of the watershed.
    - Riparian – salmon need trees and trees need salmon
    - Aquatic Macroinvertebrates feed on carcasses
    - Water Quality – Salmon can only survive in high quality water (high dissolved oxygen, low turbidity, neutral to slightly alkaline pH, and cool temperatures).
- Salmon life cycle stages
- Significance of salmon to our economy and culture

MATERIALS:

- Polarized sun glasses
- Salmon life cycle diagram
- Adult salmon carcasses
- Knife for dissecting carcasses and removing tail at end of day (only the station leader uses the knife)
- Hand sanitizer

VOCABULARY:

alevins	anadromous
eggs	fry
milt	parr marks
percolation	porous gravel
redd	Salmonids
smolt	smoltification
spawn	vitelline vein
yolk sac	

PREPARATION:

- Arrange to have an adult salmon carcass at the station for dissection.
    - Check with Federal or State salmon hatcheries or your local ODFW fish biologist for carcasses. ODFW salmon hatcheries are often spawning fish at the same time as Salmon Watch.
    - Carcasses also freeze well for future use.
- Arrive early to scope out the river/park. Check out the designated Salmon Biology station then walk around the park and look for other places there may be salmon. For example, at Clemens Park on the Alsea River there is a small tributary called Sealy Creek. When there are high flows and turbidity in the Alsea River, you can sometimes find salmon in Sealy Creek. Knowing the park will also help if you need to take the students for a nature walk or have a disabled student with the school. Even if you are familiar with the location, it is still good to arrive a bit early to scope out the situation and find where the salmon are in the river.

INTRODUCTION: (10 minutes)

- Tell the students that we are upstream from the ocean, where the adult salmon migrated from. Ask them where they live in relation to where they are in the watershed. Are they upstream or downstream?
- Using information from the World Salmon Council information sheets "Where Are the Salmon When?" and "Habitat Requirements for Salmonids in Oregon Coastal Streams" (attached) review the salmon species that might be found at the site.
- Review some basic information about Salmon (you do NOT have to address all of these questions):

    - What conditions are necessary for growing young salmon?
    - What do salmon fry feed upon?
    - What is smoltification?
    - What is the importance of stream flow to salmon migration?
    - How do salmon migrate back to their native streams?
- Review the important roles salmon played in the lives of the native tribes of the PNW.
    - The annual return of the salmon was celebrated as a renewal and continuation of life.
    - The abundance of salmon and subsequent trade made the tribes wealthy.
    - Salmon and the rivers they come from provide native people with a sense of place, and a requirement to take care of the land and water.
- Review the salmon life cycle
    - When available, use the life stages display model to show the students what eggs, sac fry, and fry look like.
    - Be sure to cover the fact that Coho and Chinook salmon die after spawning, but Steelhead can return to the ocean. Ask the students why they think Coho and Chinook die in the spawning streams.
      The streams where the salmon spawn are nutrient poor. The salmon have evolved to die after spawning in order to provide nourishment for the next generation so they can grow large and strong enough to survive in the ocean.
- Talk about why this area of the river might be good for salmon spawning.
  Shade, lack of predators, gravel substrate, clear water, fast-flowing water and/or pools, macroinvertebrates for young salmon to feed upon, good water quality.

NOTE: Adult chaperones don't always control the students so be assertive if necessary. Don't allow the chatty or restless students to dominate the group. For example, if two students won't stop whispering to each other, separate them to either side of the group.

ACTIVITY (25 minutes?)

If spawning salmon are present:

- ***DO NOT allow the students to harass or disturb the fish.***
    - Don't allow running, yelling, or wading in the creek.
    - Explain that salmon are sensitive to disturbances and have limited energy for spawning.
    - Admonish any student that throws rocks or attempts to wade into the creek
- Allow the students to observe the fish.
    - Interject information about the salmon life cycle.
    - Ask about the female salmon behavior and actions. What are they doing? (Building or guarding red?)
    - Ask about the male salmon behavior and actions. What are they doing? (Fighting, chasing other males?)

If fish are not present:

- Take the students on a nature walk to other location where you may find spawning salmon or carcasses
    - Have a garbage bag to collect litter if you walk the students around.

Whether or not salmon are present in the stream:

- Review and have the students complete the Salmon Biology worksheet
- Ask the students lots of "why do you think the salmon do…" questions to get them thinking about behavior. For example, why is there so much variation in salmon behavior (ocean vs stream type Chinook salmon).
- Ask the students why they think salmon don't just live in either the river or the ocean. Why might they migrate between the two?
- Talk in detail about how important salmon are to us (economic, social, and cultural).
- Talk in detail about the relationship between salmon and their ecosystem.
    - Keystone species
    - Indicator species

    - How might a healthy riparian zone benefit salmon? (bank stabilization, flood protection, shade, food for invertebrates, fallen trees slow currents and add structure).
    - How do returning salmon benefit the forest? (forest animals eat salmon & their feces fertilize the forest. More than 20% of the nitrogen in the tissues of riparian trees and shrubs comes from salmon.
    - Salmon carcasses feed macroinvertebrates. Macroinvertebrates, in turn, feed salmon fry.
- DISSECT THE SALMON CARCASS
    - For detailed information, see attached dissection curriculum.
- Cut through and remove the caudal fin of the carcass and put the carcass and the fin into the stream. This insures that the carcass is not counted when fish counts are done on the stream.

DISCUSSION (10 minutes)

- Talk about similarities and differences in salmon and human biology.
- Ask the students about where they are in the watershed, the salmon life cycle, the importance of salmon to the ecosystem, and their cultural significance to Native Americans.
- Talk about all the challenges salmon face in a healthy ecosystem, and all the new challenges humans have added. Make the connection between how the students live their lives and how it affects the salmon in a positive or negative way
    - *How humans affect salmon in their daily lives (water use, pollution, habitat degradation)*
    - *How students can help salmon in their daily lives (use less water, protect water quality, restore healthy fish habitat).*
- Being a Good Steward: Lead by Example. Talk to the students about things **you** do to help salmon (conserving water, using minimal pesticides and fertilizers, driving less, using less electricity)
- If time allows, go around the group and ask each student what they have learned. Ask for something specific like something humans have in common with salmon (anatomy/physiology) or what they think is the most awesome thing about the fish
- Relate the lesson from the Salmon Biology station to the station they came from and are going to.
- Ask each student what they can do in their daily lives to make things better for the salmon.

EXTENSION ACTIVITIES:

Take advantage of times when you can share information about your profession.

- Talk to them about what you do as a fish biologist;
- Relate stories about cool or interesting things you have seen or learned on the job;
- Discuss what they need to do if they want to be a fish biologist, what classes are important in high school and college, and what job shadow or internship opportunities there are at your office.

WHERE ARE THE SALMON, WHEN?

GENERALIZED LIFE HISTORY PATTERNS OF SALMON, STEELHEAD, AND TROUT IN THE PACIFIC NORTHWEST*

	Adult Return	Spawning Location	Eggs in Gravel**	Young in Stream	Freshwater Habitat	Young Migrate Downstream	Time in Estuary	Time in Ocean	Adult Weight (Avg.)
COHO	Oct-Jan	coastal streams, shallow tribs.	Oct-May	1+yrs	tributaries, main-stem, slack water	Mar-Jul (2nd yr.)	few days	2 yrs	5-20 lb (8)
CHUM	Sep-Jan	coastal rivers and streams lower reaches	Sep-Mar	days-weeks	little time in freshwater	shortly after leaving gravel	4-14 days	2.5-3 yrs	8-12 lb (10)
CHINOOK		mainstem large and small rivers			mainstem-large and small rivers		days-months	2-5 yrs	
spring	Jan-Jul		Jul-Jan	1+yrs		Mar-Jul (2nd yr.)			10-20 lb (15)
summer	Jun-Aug		Sep-Nov	1+yrs		Spring (2nd yr.)			10-30 lb (14)
fall	Aug-Mar		Sep-Mar	3-7 months		Apr-Jun (2nd yr.)			10-40 lb
CUTTHROAT (Coastal-Sea Run)	Jul-Dec	tiny tributaries of coastal streams	Dec-Jul	1-3 yrs (2 Avg.)	tributaries	Mar-Jun (2nd-4th yr.)	less than one month	0.5-1 yrs	0.5-4 lb (1)
PINK	Jul-Oct	mainstem of large and small streams, tribs, lower reaches	Aug-Jan	days-weeks	little time in freshwater	Dec-May	few days	1.5 yrs	3-10 lb (4)
SOCKEYE	Jul-Aug	streams, usually near lakes	Aug-Apr.	1-3 yrs	lakes	Apr-Jun (2nd-4th yr.)	few days	1-4 yrs	3-8 lb (6)
STEELHEAD* **		tributaries, streams & rivers			tributaries		less than one month	1-4 yrs	
winter	Nov-Jun	Nov-Jun	Feb-Jul	1-3 yrs		Mar-Jun (2nd-5th yr.)			5-28 l b(8)
spring	Feb-Jun	Feb-Jun	Dec-May	1-2 yrs		Spr & Sum (3rd-4th yr.)			5-20 lb
summer(Col. R)	Jun-Oct	Jun-Oct	Feb-Jun	1-3 yrs		Mar-Jun (of 3rd-5th yr.)			5-30 lb (8)
summer(coastal)	Apr-Nov	Apr-Nov	Feb-Jul	1-2 yrs		Mar-Jun (of 2nd-5th yr.)			5-30 lb (8)

* There is much variation in life history patterns--each stream system having fish with their own unique timing and patterns of spawning, growth, and migration. Ask a local biologist about the specific patterns of the fish in your streams and update this chart for your area.

** The eggs of most salmonids take 3-5 months to hatch at the preferred water temperature of 50-55 degrees F; Steelhead eggs can hatch in 2 months.

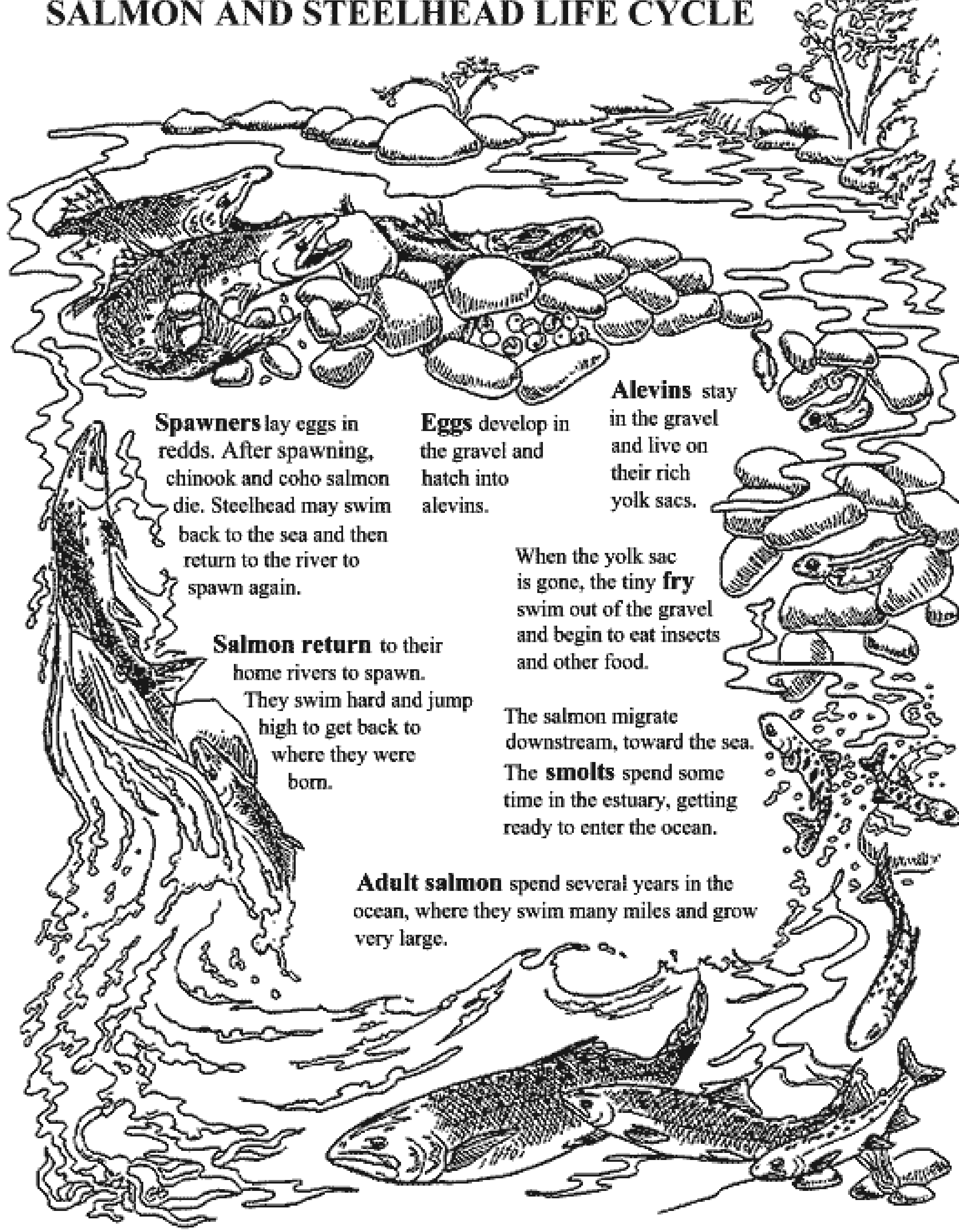
*** Steelhead, unlike salmon and cutthroat trout, may not die after spawning. They can migrate back out to sea and return in later years to spawn again.

Adapted by Pacific States Marine Fisheries Commission. Sources: Ocean Ecology of North Pacific Salmonids, Bill Pearcy, University of Washington Press, 1992 Fisheries Handbook of Engineering Requirements and Biological Criteria, Milo Bell, U.S. Army Corps of Engineers, 1986; Adopting A Stream; A Northwest Handbook, Steve Yates, Adopt-A Stream Foundation, 1988.

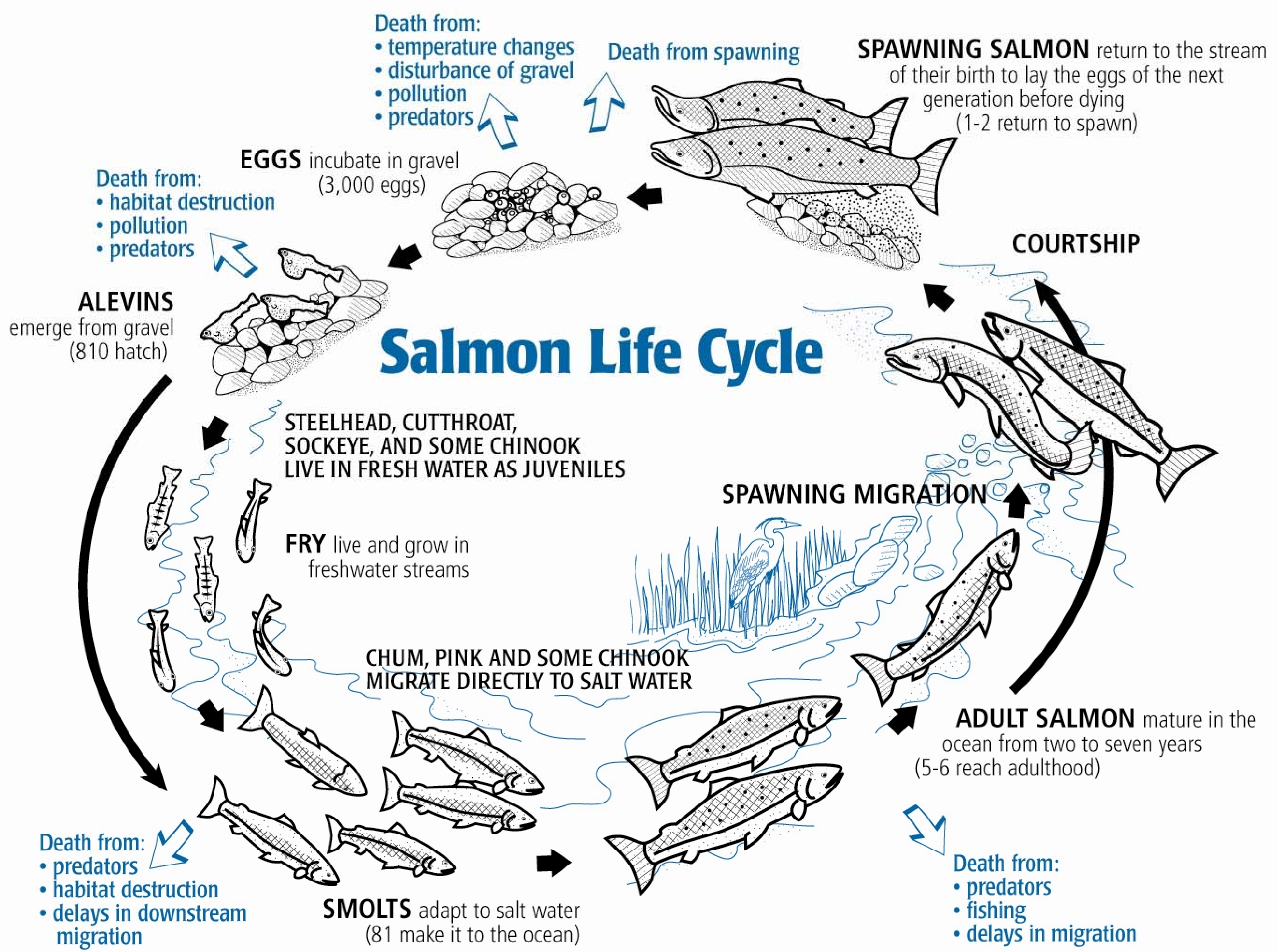
Table 2. Salmonid Habitat Requirements
Oregon Coastal Streams
Spawning (including upstream migration)

	Migration	Spawn Time	Location	Substrate Size	Water Depth	Water Velocity	Dissolved Oxygen	Spawning Water Temp	Percent Fines Tolerable	Notes
Chinook – Fall	Sept-Dec	Oct- Jan	Mainstem and large tributaries	Pea to Orange (1.3-10.2 cm)	Extremely variable 0.05-7 m	0.1 – 1.5m/s; max is 2.4 m/s	> 5 mg/l	5.6-13.9°C	Fines (<6.4 mm) make up less than 25% of substrate	Large body size limits movement over barriers
Chinook-Spring	Mar-Jun	Late Aug -Oct	Upper mainstem streams	Pea to Orange (1.3-10.2 cm)	Extremely variable 0.05-7m	.21-1.5 m/s; max is 2.4m/s	>5 mg/l	5.6 –13.9°C	Fines (<6.4 mm) make up less than 25% of substrate	Require deep water for travel-pools for summer habitat
Coho	Sept-Jan	Sept - Jan	Small tributaries	Pea to Apple (1.3-9.0 cm)	0.18 – 1 m	0.08 – 0.11 m/sec; max is 2.4 m/s	>8 mg/l	4.4-14°C	Fines (<6.4 mm) make up less than 25% of substrate	Primary target for many sport fisherman
Chum	Oct -Dec	Nov-Dec	Lower mainstem and tributaries	Pea to Orange (0.5-10.2 cm)	13-50 cm; ideal 21cm	0.21-0.83 m/s; max is 2.4 m/s	>5 mg/l; above 80% saturation best	7.2-12.8°C	Fines (<6.4 mm) make up less than 25% of substrate	Strong swimmer but doesn't jump
Steelhead-Winter	Nov-May	Dec -May	Small & mid-size tributaries with moderate gradient	Pea to Apple (0.5-9.0 cm)	> 18 cm	<2.4 m/s	>5 mg/l	3.9-9.4°C	Fines (<6.4 mm) make up less than 25% of substrate	May spawn more than once
Steelhead-Summer	May-Jul	Jan-Jun	Small & mid-size tributaries with moderate gradient	Pea to Apple (0.5-9.0 cm)	>18 cm	<2.4 m/s	>5 mg/l	3.9-9.4°C	Fines (<6.4 mm) make up less than 25% of substrate	May spawn more than once
Sea Run Cutthroat Trout	Jun-Oct	Dec-Feb	Small headwater tributaries 1st & 2nd order streams	Pea to Golf Ball (0.5-7.5 cm)	0.01 –1 m; 10-15 cm best	0.11-0.90 m/s; max is 2.4m/s	>5 mg/l	6-17°C; best is 10°C	Fines (<6.4 mm) make up less than 25% of substrate	May spawn more than once

SALMON AND STEELHEAD LIFE CYCLE



From *Salmon & Trout Go To School* by D. Higgins   Illustration by Gary Bloomfield   CDFG 1996

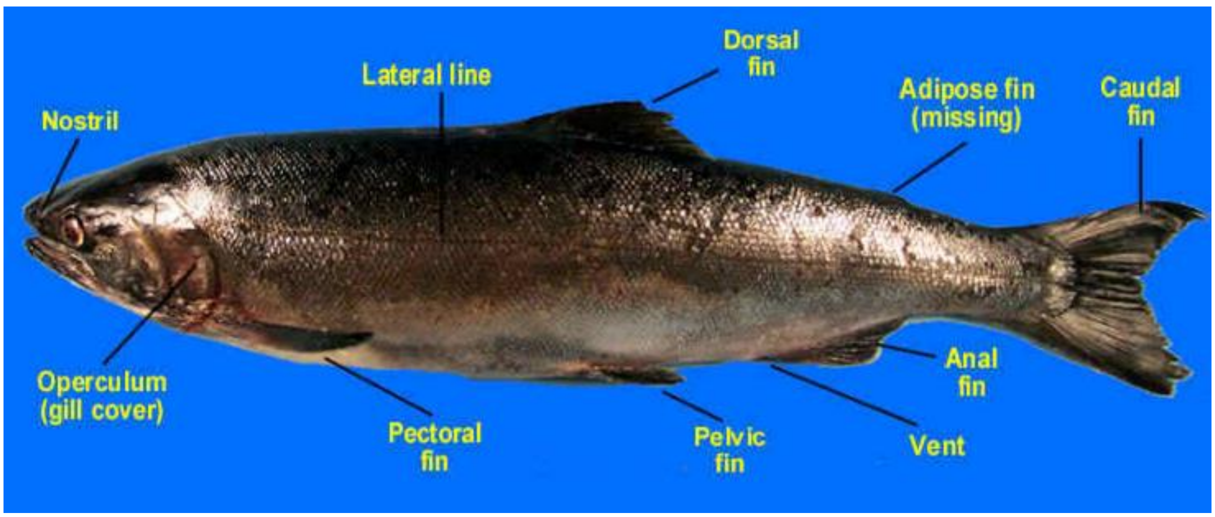

Salmon Life Cycle
SPAWNING SALMON return to the stream of their birth to lay the eggs of the next generation before dying (1-2 return to spawn)
Death from spawning
COURTSHIP
EGGS incubate in gravel (3,000 eggs)
Death from:
• temperature changes
• disturbance of gravel
• pollution
• predators
ALEVINS emerge from gravel (810 hatch)
Death from:
• habitat destruction
• pollution
• predators
STEELHEAD, CUTTHROAT, SOCKEYE, AND SOME CHINOOK LIVE IN FRESH WATER AS JUVENILES
FRY live and grow in freshwater streams
CHUM, PINK AND SOME CHINOOK MIGRATE DIRECTLY TO SALT WATER
SMOLTS adapt to salt water (81 make it to the ocean)
Death from:
• predators
• habitat destruction
• delays in downstream migration
SPAWNING MIGRATION
ADULT SALMON mature in the ocean from two to seven years (5-6 reach adulthood)
Death from:
• predators
• fishing
• delays in migration

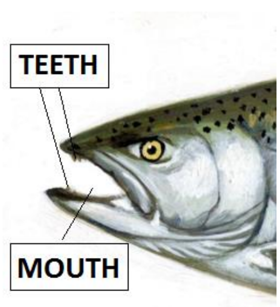
Salmon Dissection

If you are unfamiliar with fish dissection, use this curriculum to guide you through the process.

Using the diagram provided, explain the external/ internal anatomy and physiology of the salmon.

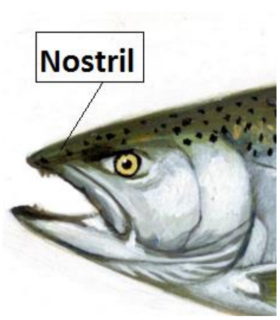
- **EXTERNAL:**
  - Have the students feel the salmon. Why is it slimy?
    - *So the fish can more easily slip away from predators such as bears. The slime also serves as an anti-abrasive so the fish can easily slip over rocks. This slime lubricates the fish and makes it easier for it to swim through the water.It also works to protect the salmon against fungus, parasites, and disease.*
  - Point out and discuss the mouth, eyes, nostril, operculum, lateral line, vent, and fins.



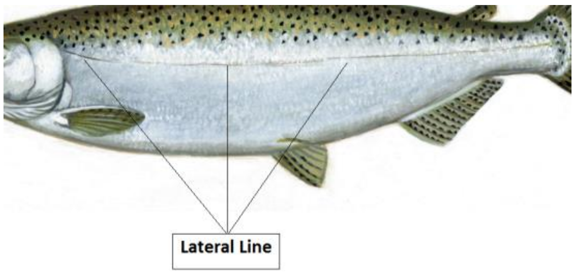


MOUTH
The mouth contains sharp, needle-like teeth which the salmon use to grab their prey. They do not use their teeth for chewing! Salmon have taste buds like humans and are thought to taste salt, sweet, bitter, and acid.

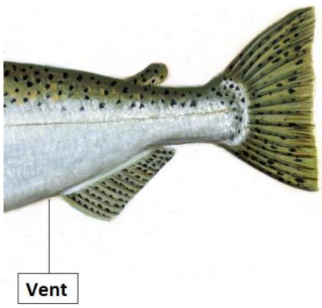
Salmon EYES are different from humans eyes. Salmon can swivel each eye independently to provide a wider field of vision. However, salmon do not have depth perception like humans do.



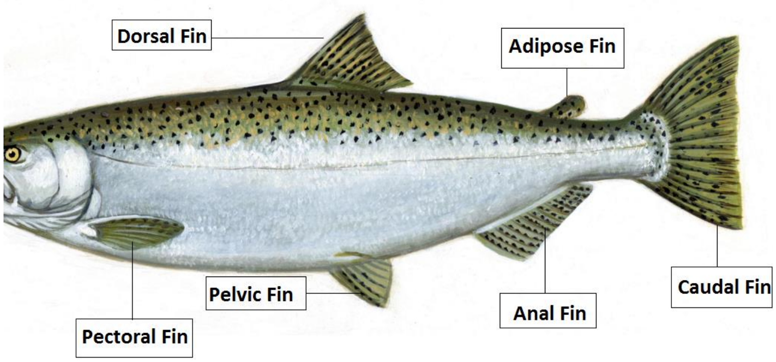
NOSTRIL
Nostril is not attached to the mouth, and is not used for breathing. Salmon can smell small amounts of chemicals in the water and can detect pollution and to avoid potential threats. What else might salmon use their sense of smell for? This sense of smell is likely also used to help the salmon navigate back to their natal stream from the ocean. Salmon may be able to pick up on certain chemical “markings”, such as mineral composition, of their native streams.



LATERAL LINE
The lateral line is a specialize feature of fish that allows them to sense their environment. It functions sort of like the sense of hearing, sort of like the sense of touch, and sort of like the sense of sight. The series of organs along the line emit low level vibrations (kind of like sonar) and can detect changes to the environment, such as disturbances in the water and help the fish navigate through the water when they cannot see very well.



VENT
The vent is a small opening on the underside of the salmon. This is where females lay their eggs from and where males release their milt. Both sexes eliminate waste from their vent.



FINS
Salmon have eight fins, including their caudal fin or tail. They contain spines with a thin layer of skin between them.

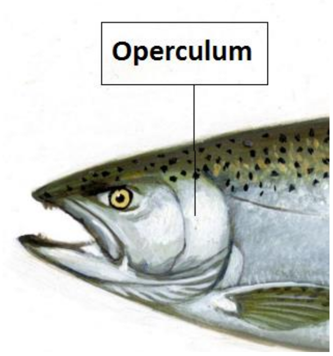
The CAUDAL fin is the largest and most powerful fin. It pushes water to move the salmon forward.

Think of the DORSAL fin like the keel on a ship. What does the keel do? It keeps the ship upright and controls the direction on that ship moves in. The dorsal fin does this for the salmon.

The ANAL fin also helps keep the salmon stable and upright.

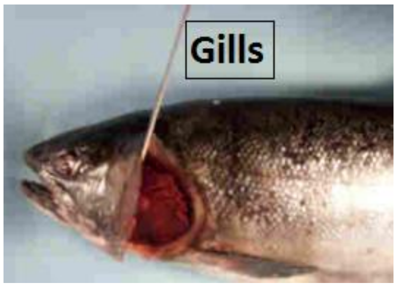
Salmon use their paired fins, PECTORAL and PELVIC, for steering and balance. They also use these fins to move up and down in the water column.

The ADIPOSE fin serves no known function. Sometimes at the hatchery, this fin is cut off to help differentiate these fish from wild salmon when they return or are caught.



OPERCULUM
The operculum, or gill cover protects the gills. Salmon can open and close their operculum to let water pass over the gills. Why do salmon pass water over their gills?

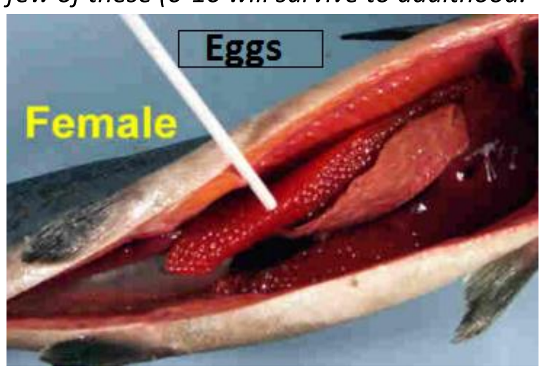
- Pull back the operculum to reveal the gills

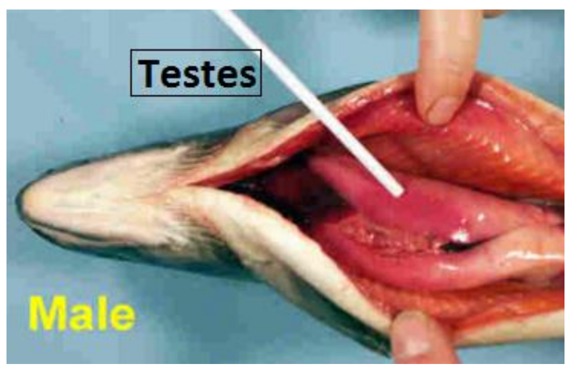


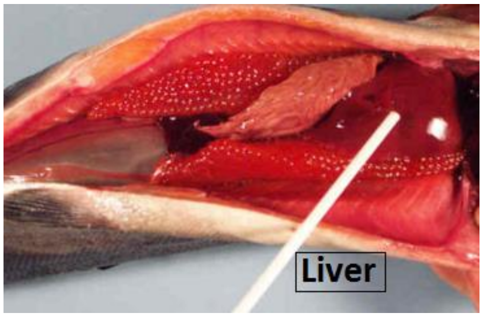
GILLS
The gills are red because they are filled with blood. The gills are where salmon blood is oxygenated. Fish breathe by washing water over their gills, either by opening the operculum or by gulping water into their mouths and letting it run out through the gills. The gills look like think branched structures in order to provide a large surface area for oxygen absorption.

INTERNAL: Point out and discuss the swim bladder, gills, kidney, heart, liver, stomach, and heart.

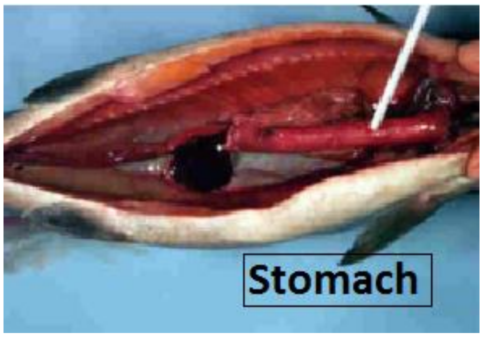
- Cut the salmon open but making an incision at the vent and cutting up towards the throat.
- Point out the eggs or testes present.
- If eggs are present, ask the students why there are so many.
  Female salmon lay between 1,500 – 10,000 eggs, depending on the species. On average, only a few of these (0-10 will survive to adulthood.







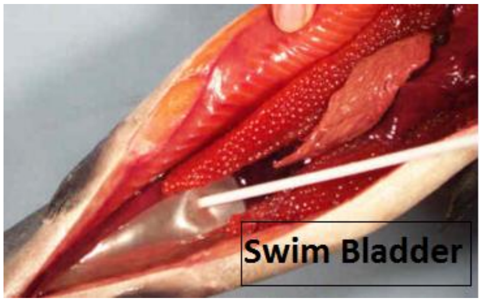
LIVER
The liver is the largest organ in the salmon body. Like in humans, the liver helps maintain the proper level of chemicals and sugars in the blood.



STOMACH
Like our STOMACHS, the salmon stomach breaks down food with digestive juices.

INTESTINES
After leaving the stomach, partially digested food passes into an organ that humans do not have, called the Pyloric ceca. You may be able to observe this organ in your dissection. It is a series of small finger-like pouches. Food is further digested here before it passes into the intestines. Like in humans, the digestion process is completed in the intestines.

HEART
The heart pumps blood through the body. It is close to the gills, where the blood can be recharged with oxygen. In humans, our hearts are close to our lungs for the same reason.



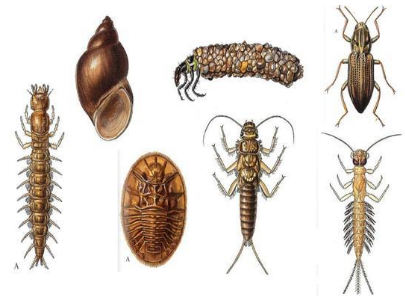
SWIM BLADDER

Salmon fill their swim bladder with air for buoyancy, allowing them to float in the water. The fish fill the swim bladder for the first time as fry. They can adjust the air in the swim bladder so they can move up and down and hover in the water.

“Do fish have lungs?” “Most, including salmon do not, so they use their GILLS to breathe.”

Salmon KIDNEYS are crucial to smoltification. Salmon have two kidneys that are connected. Like our kidneys, the front one produces red blood cells, the back one cleans the blood.

Macroinvertebrate Station



OBJECTIVES:
Students learn:

- The important roles of macroinvertebrates in streams as
  - indictors of water quality, and as
  - an integral part of the stream food web linked to riparian health and salmon rearing.
- How to collect samples and determine the health of a stream using macroinvertebrate assessments.
- Practice scientific method inquiry (question, procedures, data collection, analysis).

INTRODUCTION: (10 minutes)
Macroinvertebrates are animals that lack a backbone ("invertebrate") and can be seen with the unaided eye ("macro"). They include insects such as mayflies, mosquitoes, and beetles, as well as mussels, leeches, sideswimmers, and worms. Aquatic macroinvertebrates spend the majority, if not all of their lives in streams, wetlands, lakes and other aquatic environments.

Aquatic macroinvertebrates are animals, just like we are, and like us they need oxygen to breathe. Aquatic macroinvertebrates can acquire dissolved oxygen across the surface of their bodies, but many types such as mayflies, damselflies, and stoneflies have elaborate branched, tufted or leaf like gills that help them obtain dissolved oxygen from the water. Still others have breathing tubes or siphons that they stick up above the surface of the water to breathe (water scorpions, mosquito larvae), while some water beetles capture bubbles of air at the water's surface and dive down with their own portable "scuba tank".

Sensitivity: Measuring water quality alone (temperature, pH, heavy metals, etc) doesn't give a complete picture of stream health. It isn't possible to test for every different contaminant that might be present in a stream or lake, but invertebrates live in that water all of the time. They are constantly exposed to whatever chemicals, sediments, or changes in the temperature may be occurring, and may respond by dying out, migrating away, or reproducing in even higher numbers, depending on the type of invertebrate.

Aquatic macroinvertebrates are excellent "bioindicators": they are found everywhere, generally in large numbers, and are easy to collect; they are confined to the aquatic environment for most or all of their life cycle; they integrate the effects of many stressors (sediment, temperature, pollution etc) over their life span; different species have different known responses to specific stressors and they are a critical part of the stream food web. Changes in the presence, composition and relative abundances of specific groups of macroinvertebrates can signal pollution or disturbance occurring in a watershed. Government and other groups that monitor water quality are using this method more and more.

Food web: Macroinvertebrates are critically important in the aquatic food web. Some serve directly as food for predators such as fish, amphibians, birds, and other invertebrates; others help make more food available in the aquatic system by breaking down leaves and plant material. Fish populations depend on healthy macroinvertebrate populations to survive. The availability of macroinvertebrates as food is determined by both the physical and biological condition of the stream, riparian areas and the whole watershed. (See Macroinvertebrates and the Aquatic Food Web below)

River continuum is the way in which smaller and smaller particles of sediment and organic debris are expected to be found further downstream in the watershed. For this reason, different functional feeding groups of macroinvertebrates are expected in different parts of the watershed. (See The River Continuum below)

After the introduction, explain that students will be collecting samples from the stream, sorting samples into containers, recording the numbers and types of macroinvertebrates onto data sheets, and assessing the health of the stream based on results. The field guides and cards will help identify the macroinvertebrates.

ACTIVITY: (25 minutes)
Materials:

- D-frame nets
- Small 'fish tank' nets
- Tubs for initial sorting of samples
- Ice cube trays or petri dishes for specific sorting
- Hand lens or 2-way magnifying viewer
- Turkey basters or eye droppers for picking up macroinvertebrates
- Tolerant / Intolerant to pollution ID cards
- Field guides
- Clipboard, data sheets, pencils

Safety is especially important in this station due to proximity to the water. Depending on site specific conditions, students may or may not be allowed to enter the water (be sure to check with your site manager). If students are not to enter the water, samples should be collected by adults prior to the arrival of students. The station leader can then demonstrate how the samples were collected using the D-net.

Safety guidelines:

- Macroinvertebrate sampling should be conducted well away from and downstream of spawning salmon and redds.
- Students may not enter water above the calf, and in some cases, should not go deeper than the ankle.
- Avoid fast-moving water.
- Take care when walking on slippery rocks.
- Never drink the water.
- Place nets safely to the side, when not being used, where they will not be tripped over.

Procedure

1. Be very clear explaining safety precautions and rules.
2. If you have more than 5 students, split them into small teams of about 3 and assign each team a spot along the stream. This is best if adult volunteers are able to assist the teams.
3. Identify the microhabitat (riffle, pool) to be sampled.
4. Collect sample from 1-square foot area immediately upstream from the net opening. To do this, approach site from downstream. Hold net downstream from area to be sampled, perpendicular to flow. Upstream, begin rubbing rocks, or leaf litter to remove any invertebrates. Or shuffle the stream bottom in place using your feet. The invertebrates should flow into the net. Replace the rocks.
5. Repeat up to 3 other locations if necessary.
6. Remove net contents into a large shallow tray for sorting into groups in ice cube trays. Use basters or droppers to move individual macroinvertebrates. Use magnifiers to observe body parts such as different types of gills and mouth parts. After a few minutes of sorting, remind students to use the identification cards and begin filling out the data sheets.
7. Count the different kinds of invertebrates in each sensitivity group and record onto the data sheet. http://www.streamwebs.org/sites/streamwebs/files/files/Macros_OSU.pdf Use the field guides to help with identification. *Identifying species can be difficult and is not a priority – sorting into similar groups and understanding some of the differences is more important.* Macros can also be sorted by habitat type or where found in the stream.
8. At about 10 minutes before the end of the session, discuss the results and ask some discussion questions (see below).
9. At 5 minutes before the end of the session, clean up as and gently return macroinvertebrates to the stream.

DISCUSSION: (5 MINUTES)
Have students use the completed data sheets to determine the general health of the stream. Which group best reflects the insect community found in the stream sampled? Does this make sense based on what they learned during the other stations that day?

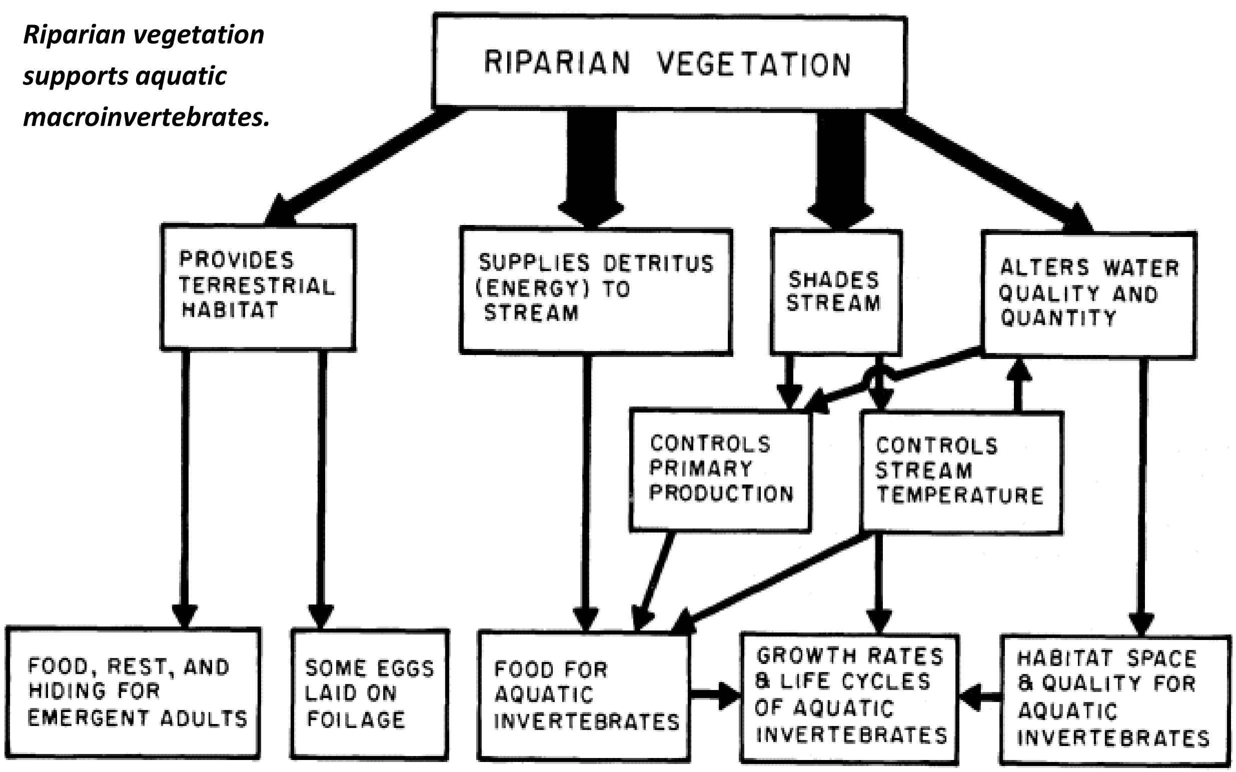
Habitat Requirements Questions
- What species are you more likely to find in moving water? Calmer water?
- Which particular nymph type (immature form) is only found in fast, cold water?
- Why might one insect need less dissolved oxygen than another?
- Why is there more dissolved oxygen in a fast flowing stream than in a pond?

Macroinvertebrates and Water Quality
- Why are macroinvertebrates good indicators of water quality?
- What area of the stream contains the most diverse assemblage of insects?
- What species would be more likely found in stagnant areas with more fine sediments?
- What kinds of links on the food chain are filled by aquatic insects? (herbivores, carnivores, detritivores (insects that eat dead stuff)

What can you do?
- What measures can be taken to protect a stream with healthy macroinvertebrate populations that support salmonids?
- What measures can be taken to help restore a system that has been degraded and has lost the diversity of insects that are part of a healthy watershed for fish?

CLEAN-UP: (5 MINUTES)
1. Put all items back into appropriate tubs, clean off any debris, and set them aside for next group.
2. If using laminated ID sheets erase all writing.
3. At end of day, rinse and dry supplies and place them back into the bin.

Riparian vegetation supports aquatic macroinvertebrates.



Macroinvertebrates and the Aquatic Food Web

Macroinvertebrates are critically important in the aquatic food web. Some serve directly as food for predators such as fish, amphibians, birds, and other invertebrates; others help make more food available in the aquatic system by breaking down leaves and plant material. Fish populations depend on healthy macroinvertebrate populations to survive. The availability of macroinvertebrates as food is determined by both the physical and biological condition of the stream, riparian areas and the whole watershed.

Macroinvertebrates have a wide variety of shapes, sizes, appearances, and mouth parts, and this diversity reflects a diversity of feeding habits as well. Macroinvertebrates may feed on living material (algae, plants, or other invertebrates), as well as on dead or decomposing material and particles of organic detritus, and they are often classified according to the way in which they obtain nutrients. The major different functional feeding groups (FFG) are shredders, collectors, scraper/grazers, and predators. These distinctions are somewhat artificial, as some may fit into more than one category (i.e. scrapers may eat detritus while they graze on algae), but they are still a valuable method of classifying the stream macroinvertebrate community. By looking at the feeding habits of these invertebrates, you can begin to sort out different roles these animals play in the ecology of watersheds.
The main categories of functional feeding groups include:

Shredders
Chew on intact or large pieces (>1 mm) of plant material.
Examples: giant stoneflies, Northern caddisflies
Found in: leaf packs, water-logged wood, headwater streams and areas with a high percentage of canopy cover.

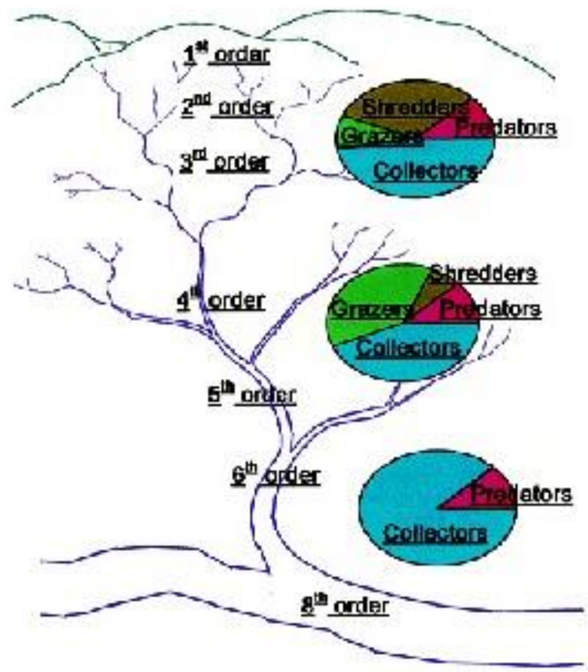
Scrapers/grazers
Scrape off and consume thin layer of algae growing on solid substrates in shallower waters
Examples: snails, flatheaded mayflies, water pennies
Found in: more open areas with enough sunlight to support algal growth; rocks in open- canopied areas, mid-stream reaches

Collectors (collector/filterers and collector/gatherers)
Consume very small pieces of detritus (<1 mm)
Examples: common netspinner caddisflies, back flies, brush-legged mayflies, mussels
Found in: rocks and mud; common in all reaches, but make up larger proportion in lower reaches where sediment collects

Predators
Feed on living animals; may swallow smaller prey whole, tear pieces out of larger prey, or suck out body fluids
Examples: predaceous diving beetles, dragonfly larvae, common stoneflies
Found in: all habitat types, in smaller proportion relative to other feeding groups

The River Continuum

The river continuum concept (RCC) is a model that describes running water systems using elements such as stream width, depth, velocity, channel shape, and associated biological communities. Because stream morphology, vegetation, and energy inputs change from headwaters to mouth, biological communities in a stream also change in a somewhat predictable pattern. This pattern is influenced by channel structure, gradient, bank stability, sediment loads, riparian vegetation, light penetration, and temperature.



A stream is a continuum that transports progressively smaller food materials from the headwaters to the lower reaches. Each year, large amounts of organic material fall into the headwaters of forested streams. Only 20-35% of this material is flushed downstream; the remaining organic input is retained and used by stream organisms. It can be processed by bacteria and fungi, physically abraded, or consumed by insects. As it is processed, organic debris is broken into smaller pieces, which increases their surface area and subjects them to further degradation by microbial action.

In this way, small 1st- and 2nd-order streams send partially prepared food into larger, higher order streams. Processing continues as small debris moves downstream through the system. Because different invertebrate functional feeding groups process different-sized food particles, different FFG communities are expected in different stream reaches.

Forests at the headwaters (1st- to 3rd-order streams) have less influence as a stream gets larger. With less input from the riparian habitat, the energy base relies more on algae that is produced as additional sunlight penetrates through the open canopy, and on processed material carried in from intermediate or midreach (3rd- to 5th-order) streams. As the kind of organic material changes, the proportion of shredders decreases and the proportion of collectors and scrapers increases.

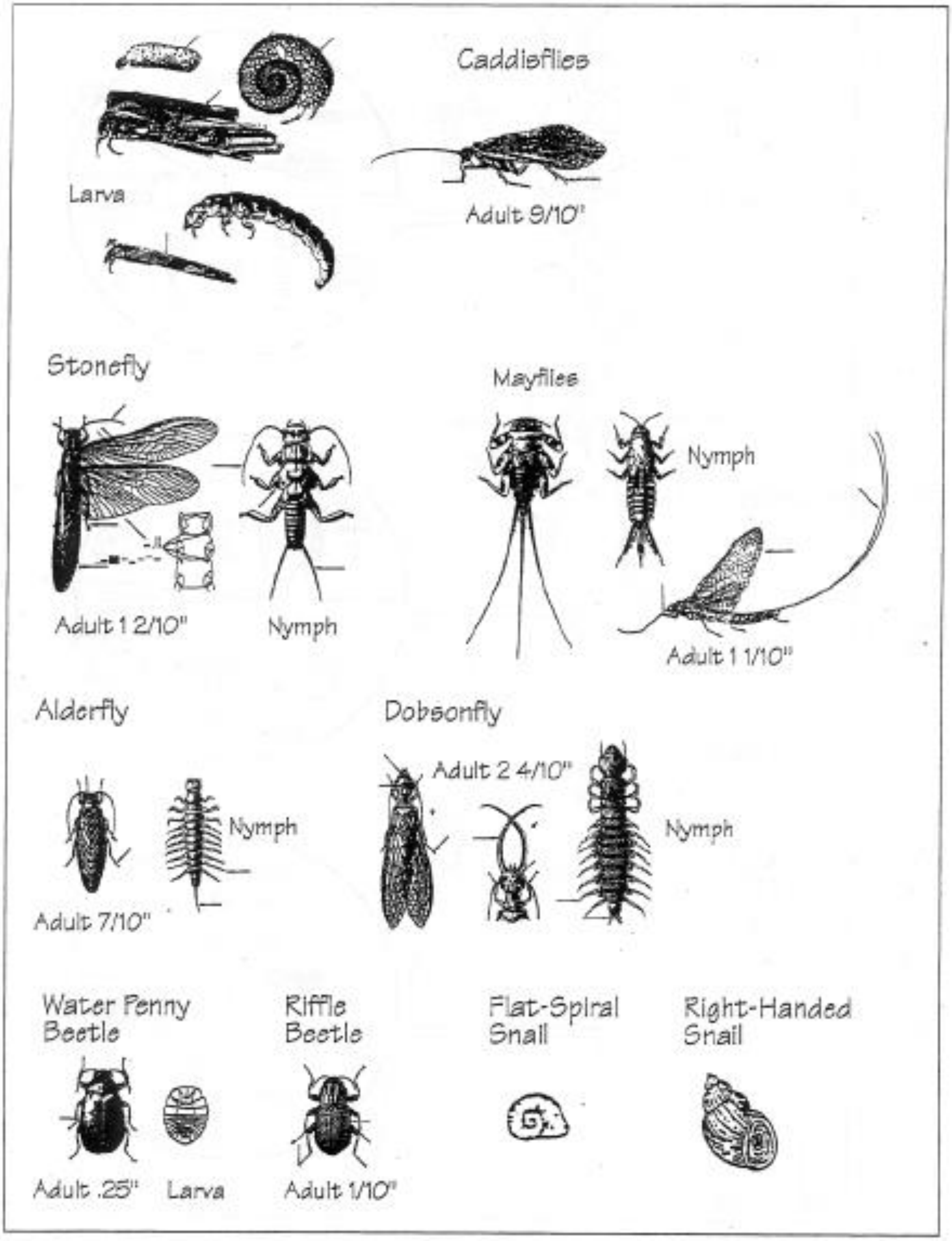
The midreaches of a stream system have a greater diversity of species than is found either upstream or downstream. The reason is not completely understood, but may be due to the fact that midreach water temperatures can change more than those of headwaters or larger rivers. The variety of organic substrates and physical components found in midreach streams may also have an effect.

Turbidity increases in the lower reaches (6th- and higher-order streams) due to greater loads of fine sediments from tributaries and downstream movement of processed particulate matter. Collectors dominate these reaches, and the diversity of other organisms decreases. Increased turbidity reduces light penetration and thereby reduces the efficiency and photosynthetic production of algae in larger streams. Large plankton communities are important in these areas.

There are exceptions to the pattern outlined in The River Continuum, but the concept shows what might be expected in a stream system. If a community is "out of place" or missing, it can be a red flag, encouraging further investigation.

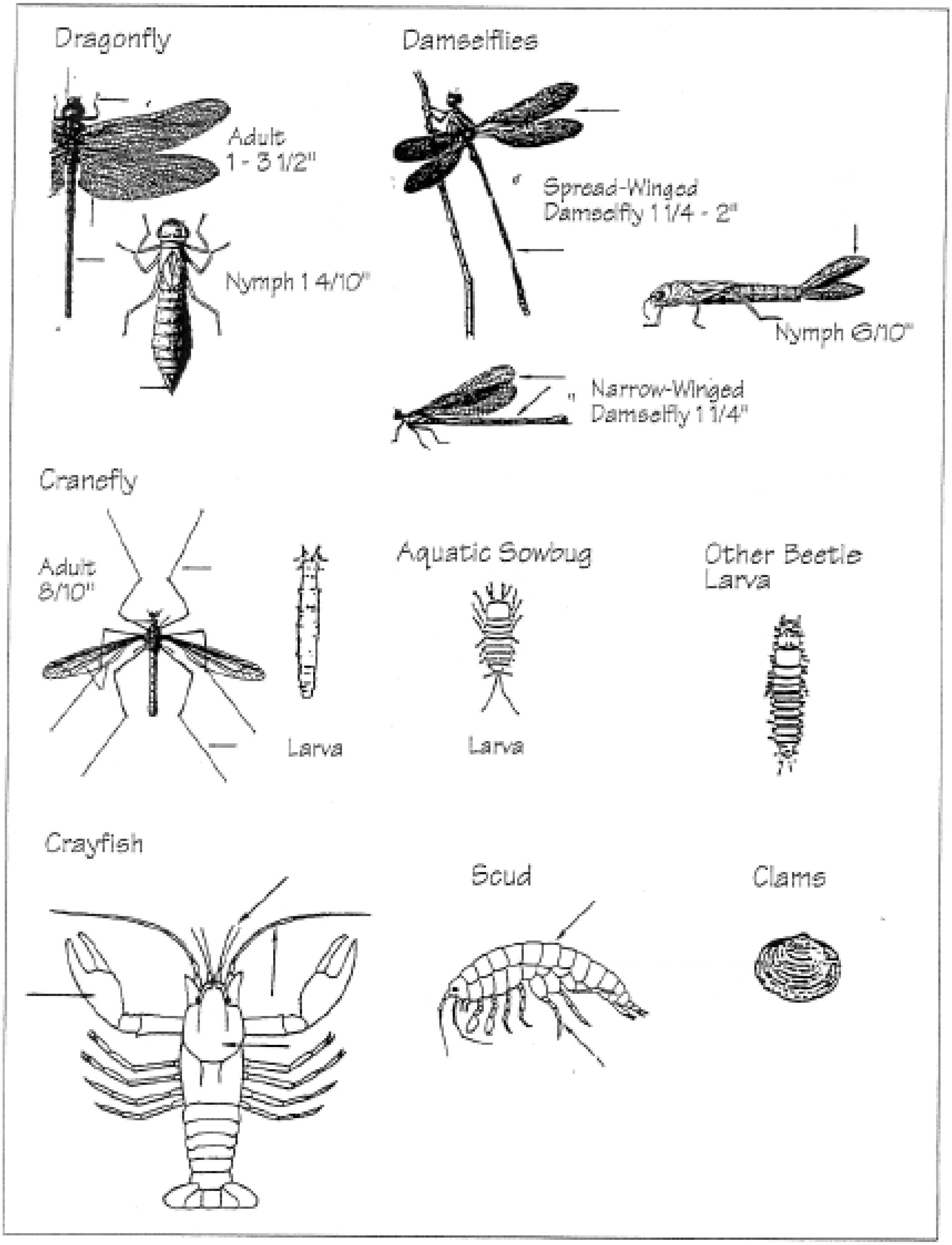
INSECT GROUPS ARRANGED BY TOLERANCE TO POLLUTION

Group 1: Intolerant
These organisms are sensitive to pollution.
Their dominance generally suggests good water quality.



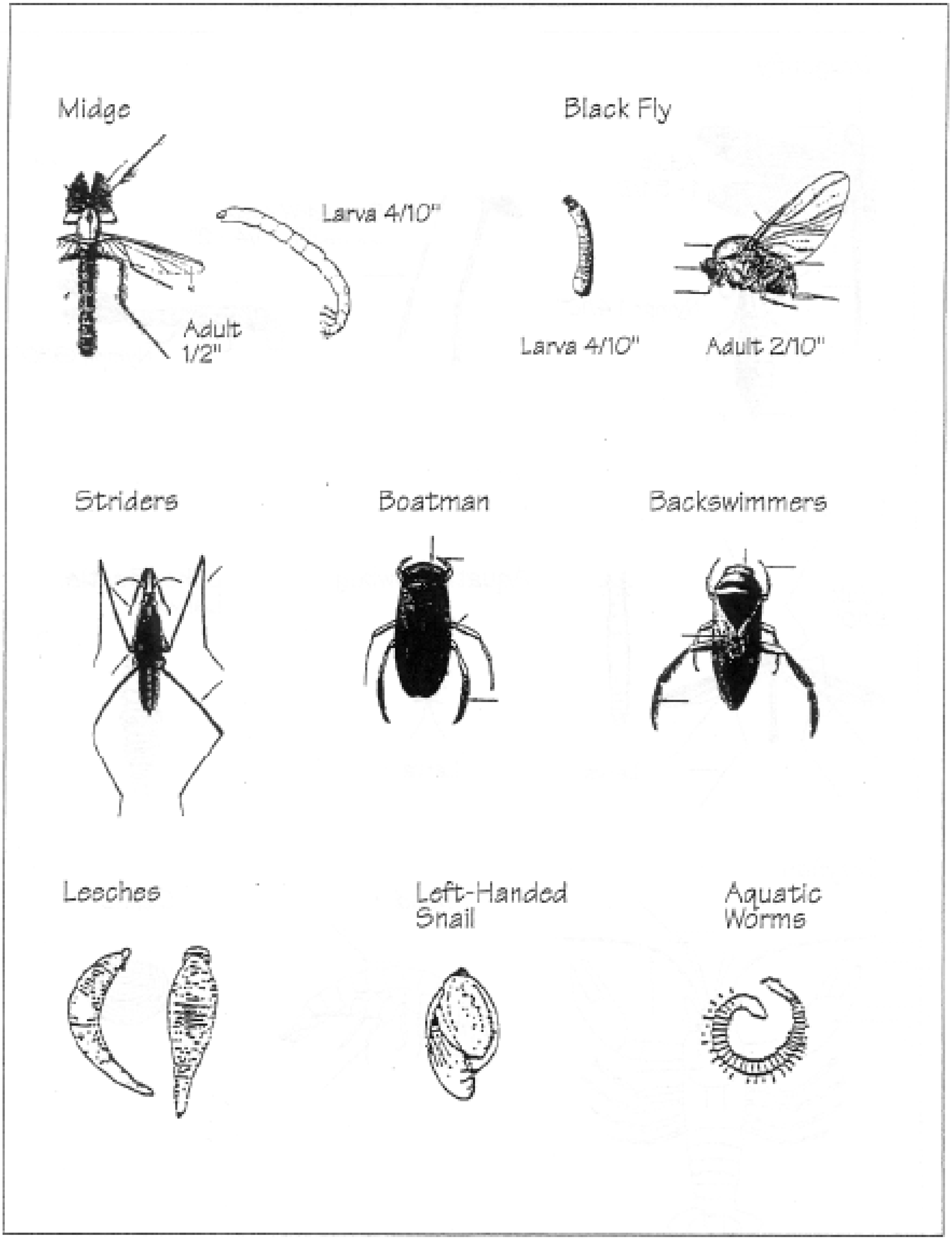
Group 2: Somewhat Tolerant

These organisms can tolerate a wider range of water quality conditions.

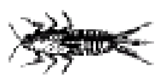
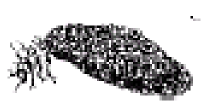
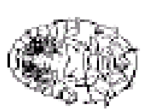


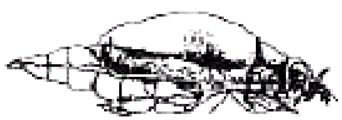
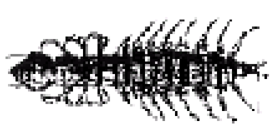
Group 3: Tolerant

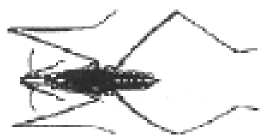
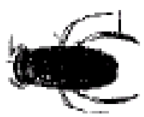
These organisms are generally tolerant of pollution. Their dominance suggests poor water quality.

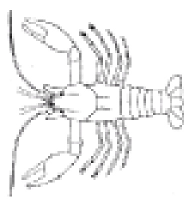
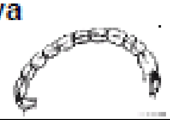


QUICK REFERENCE GUIDE TO AQUATIC INVERTEBRATES

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Stonefly Nymph 	2 tails, 2 sets wing pads, (wing pads not always noticeable)	Cold running water	Through body surface; some small gills; does "pushups to increase oxygen flow	Predator or herbivore	Streamlined body for crawling on rocks; requires high oxygen levels
Mayfly Nymph 	3 tails (sometimes 2); 1 set wing pads.	Cool or cold running water	Through gills along abdomen; may wave gills in water to increase oxygen flow	Herbivore or scavenger	Requires high to medium oxygen levels
Caddisfly Larva 	Most species build cases or nets soft body, some free living	Cool or cold running water; ponds	Through body surface; some finger-like gills	Filter feeder, herbivore, predator	Builds cases of heavy material (rocks) to avoid being swept away by fast-flowing streams; uses grass and plants to make cases as well
Water Penny Larva 	Round, flat, segmented, disk-like body	Cold running water	Usually through gills on underside	Herbivore—grazes on algae	Flattened body resists pull of current
Predaceous Diving Beetle Larva 	Up to 6 cm long; robust jaws	Most still and moving water habitats	Through body surface	Voracious predator	Special channels in jaws to suck body fluids of prey

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Whirligig Beetle 	Black; congregates in schools	Surface of quiet water	From atmosphere	Predator or scavenger	Has two pairs of eyes to see above and below water's surface; has type of "radar" to locate object in water; secretes white odorous substance to deter predators
Black Fly Larva 	Small body; small hooks at end of abdomen attach to rocks	Cold running water	Through body surface; small gills	Filter feeder	Anchors to rocks with silk; only needs medium to high oxygen levels
Dragonfly Nymph 	Stout body; arm-like grabbing mouthpart	Cool still water	Dissolved oxygen, through gills in internal body chamber	Active predator	Clings to vegetation or hides in clumps of dead leaves or sediment
Damselfly Nymph 	3 leaf-like gills at end; arm-like grabbing mouthpart	Cool still water	Through gills at end of abdomen	Active predator	Clings to vegetation or hides in clumps of dead leaves or sediment
Hellgrammite (Dobsonfly, Alderfly or fishfly Larva 	Up to 9 cm. Long	Cool or cold, slow to fast moving water	Through gills along side of abdomen; some fish flies have breathing tubes	Active predator	Can swallow prey without chewing

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things to Look For
Water Strider Adult 	Skates on water's surface	Ponds or still pools of stream	From atmosphere	Active predator	Can stay on water's surface because feet have small surface area and are water repellant
Water Boatman Adult 	Long swimming hairs on legs	Ponds or still pools of stream	From atmosphere, by carrying air bubble from water's surface on body	Omnivore, herbivore, or scavenger	Has swimming hairs on legs that act as oars
Backswimmer Adult 	Light-colored underside; swims on back	Ponds or still pools of streams	From atmosphere, by carrying air bubble from water's surface on body	Predator	Swim on back, sleek body shape
Cranefly Larva 	Cylindrical body; often has lobes at hind end, may have small soft legs	Bottoms of streams and ponds in sediment and algae	From atmosphere through spiracles (openings) at hind end	Active predator, herbivore, or omnivore	Species that eat woody decaying matter have gut bacteria to digest cellulose
Mosquito Larva 	Small body; floats at surface	Cool to warm still water	From atmosphere through breathing tube, on hind end as a larva and front end as pupa	Scavenger —feeds on micro-organisms	Swims or dives when disturbed

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things to Look For
Aquatic Sowbug 	Flattened body, top to bottom; 7 pairs legs	Shallow freshwater, among rocks and dead leaves	Through body surface on legs	Scavenger —eats decaying matter---or omnivore	Male clasps female under it during mating; female then sheds half of exoskeleton, which becomes case into which fertilized eggs are placed
Crayfish 	5 pairs of legs, first pair often robust; looks like small lobster	Under rocks or in burrows in shallow freshwater	Through gills under body	Scavenger or omnivore	Crawls backwards when disturbed; males display some courtship behavior to reduce female aggressiveness
Scud 	Flattened body, side to side swims on side	Bottom of lakes, streams or ponds, or streams	Through gills under body	Scavenger or omnivore	Male carries female on its back during mating; female then sheds half of exoskeleton, which becomes case into which fertilized eggs are placed
Midge Larva 	Small thin body with a hard head and small legs on the hind end	Most still and moving water habitats	Through body surface, small gills	Predator, herbivore, or omnivore	Extremely common; sometimes red because they have hemoglobin in their blood to help transport oxygen; wiggle actively
Rat-Tailed Maggot Larva 	Cylindrical body; tail-like breathing tube	Cool to warm water with low oxygen levels	From atmosphere through breathing tube	Scavenger —eats decaying matter and sewage	Can survive low oxygen levels fatal to most invertebrates

OSU Oregon State University Extension Service

StreamWebs™
Student Stewardship Network

MACROINVERTEBRATE SAMPLING

Share your field data quickly and easily using StreamWebs. Find out what the macroinvertebrates you found say about your stream, keep track of your photopoints, graph water quality data, upload a video, and much more.

www.streamwebs.org

Name:______________________________

School: ______________________ Teacher: ______________________

Date: ____________ Time: __________ Weather: ______________________

Stream/Site Name: ______________ Time spent sorting/identifying: ______________

# of people sorting/identifying: ________ ☐ Riffle ☐ Pool

Directions:
1. Record the number of each type of organism found in the # found column of each section.
2. Then circle the number in the score column (3, 2, or 1) if any of that organism was found.
3. Complete the equation at the bottom by adding up the circled numbers from each score column.

SENSITIVITY TO POLLUTION

Sensitive / Intolerant

	# found	score
caddisfly		3
mayfly		3
riffle beetle		3
stonefly		3
water penny		3
dobsonfly		3
Sensitive TOTAL =		

Somewhat Sensitive

	# found	score
clam/mussel		2
crane fly		2
crayfish		2
damselfly		2
dragonfly		2
scud		2
fishfly		2
alderfly		2
mite		2
Somewhat Sensitive TOTAL =		

Tolerant

	# found	score
aquatic worm		1
blackfly		1
leech		1
midge		1
snail		1
mosquito larva		1
Tolerant TOTAL =		

☐ Sensitive total
\+ ☐ Somewhat sensitive total
\+ ☐ Tolerant total
= ☐ **Water Quality Rating**

☐ Excellent (>22) ☐ Good (17-22)
☐ Fair (11-16) ☐ Poor (<11)

Adapted from: Environmental Services City of Portland

OSU Oregon State University Extension Service

StreamWebs™ Student Stewardship Network

MACROINVERTEBRATE SAMPLING

Share your field data quickly and easily using StreamWebs. Find out what the macroinvertebrates you found say about your stream, keep track of your photopoints, graph water quality data, upload a video, and much more.

www.streamwebs.org

Name: ____________________________________

School: ____________________________ Teacher: ____________________________

Date: __________________ Time: ____________ Weather: ____________________________

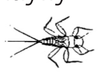
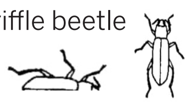
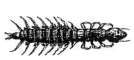
Stream/Site Name: ____________________ Time spent sorting/identifying: ____________________

# of people sorting/identifying: __________ ☐ Riffle ☐ Pool

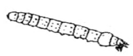
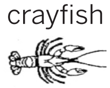
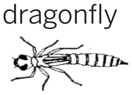
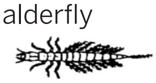
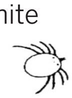
Directions:
1. Record the number of each type of organism found in the # found column of each section.
2. Then circle the number in the score column (3, 2, or 1) if any of that organism was found.
3. Complete the equation at the bottom by adding up the circled numbers from each score column.

SENSITIVITY TO POLLUTION

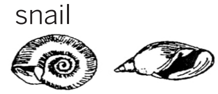
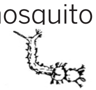
Sensitive / Intolerant

	# found	score
caddisfly 		3
mayfly 		3
riffle beetle 		3
stonefly 		3
water penny 		3
dobsonfly 		3
Sensitive TOTAL =		

Somewhat Sensitive

	# found	score
clam/mussel 		2
crane fly 		2
crayfish 		2
damselfly 		2
dragonfly 		2
scud 		2
fishfly 		2
alderfly 		2
mite 		2
Somewhat Sensitive TOTAL =		

Tolerant

	# found	score
aquatic worm 		1
blackfly 		1
leech 		1
midge 		1
snail 		1
mosquito larva 		1
Tolerant TOTAL =		

☐ Sensitive total
\+ ☐ Somewhat sensitive total
\+ ☐ Tolerant total
= ☐ **Water Quality Rating**

☐ Excellent (>22) ☐ Good (17-22)
☐ Fair (11-16) ☐ Poor (<11)

Adapted from: Environmental Services City of Portland

Water Quality Station

OBJECTIVES:

Students will:

- Perform stream water quality tests measuring pH, dissolved oxygen, temperature and turbidity
- Practice detailed data recording methods
- Analyze and make judgments on the quality of water based on collected data
- Discuss the connections between water quality and other station topics

MATERIALS

- LaMotte pH kit
- LaMotte DO test kit
- Air/water thermometer
- Turbidity tube
- Waste container
- Gloves
- Goggles
- Thermometer with string attached
- Laminated sheets: Optimum Temperature Limits; Optimal Dissolved Oxygen Limits; Lethal pH Limits
- StreamWebs data collection sheets

VOCABULARY

- Water quality
- pH
- Dissolved oxygen
- Turbidity
- Temperature

SITE PREPARATION

1. Set up your table on a flat area close to the water.
2. Set out all of the water quality test equipment.
3. Review instructions for each of the 4 tests the students will conduct (pH, Dissolved oxygen, Turbidity, and Air/Water Temperature)

Note: Caution should be taken when handling and disposing of chemicals. Waste chemicals should be poured into the waste container provided in the equipment tub. Always wash your hands if you come into contact with testing chemicals

INTRODUCTION (10 minutes)

Explain to students that **water quality** is a measurement of how clean or polluted the water is for the people or wildlife that need to use it. For example cold-water fish, such as salmon and trout, need water to be cooler than and dissolved oxygen levels above 11 mg/l for some life stages.

A good way to describe water quality is to use one of the following metaphors:

- The students are doctors performing a checkup and the water source is their patient. More than one test must be conducted to find the true health of the river just like a doctor conducts multiple tests before making a diagnosis.
- The students are auto mechanics looking under the hood of a car, the water source being the car. They must run certain tests on the car to determine what kind of work the vehicle needs.

Tell students that they will be investigating four different aspects of water quality:

- **pH**, a measure of how acidic the water is. A lemon, which is very acidic, has a pH of 3, and milk, which is not acidic, has a pH of 8. Salmon need water with a pH between 6.5 and 7.
- **Dissolved oxygen**. Like us, fish need oxygen to live. Unlike us, fish are able to use the oxygen that is dissolved in the water. The dissolved oxygen is a gas just like the carbon dioxide that is dissolved in water to make fizzy drinks like sodas. We need to make sure there is enough dissolved oxygen for the fish to breathe.
- **Turbidity**, a measure of how much clear or cloudy the water is. When a lot of sand or sediment is stirred up, the water is murky and the fish have a hard time breathing, just as we have a hard time breathing when the air is dusty.
- **Temperature**. Salmon and trout need water to be cooler than 64° F or they find it hard to survive and thrive.

ACTIVITY (30 minutes)

1. Divide the students into teams for each activity; temperature/turbidity, dissolved oxygen and pH. You can also have two sub-groups complete their own sets of tests in two different sampling spots and then compare results. *Be sure to assign one student as the role of data collector!
2. Pass out equipment for each test with accompanying directions. Have each group decide who will read the directions.
3. Facilitate the activity by floating between groups, providing assistance when necessary.
4. When 5 minutes are left for the lesson, bring students back together to discuss their findings.

LESSON CLOSURE/DISCUSSION (5 minutes)

- When all tests are complete, bring the group together to clean up and organize equipment.
- Review the laminated charts and graphs for students to interpret their results.
- Let each team report their own results.
- Ask students: Based on the results of these water quality tests, is this stream a suitable habitat for salmon? Why/why not?
- What kinds of activities and events will affect the future conditions of salmon bearing streams?
- What are some of the things we can do to help reduce our impact on streams?
- Fill out the StreamWebs data collection sheet

CLEAN-UP

1. Pour waste chemicals in the waste container provided in the kit.
2. Rinse off testing equipment.
3. Have students rinse their hands.

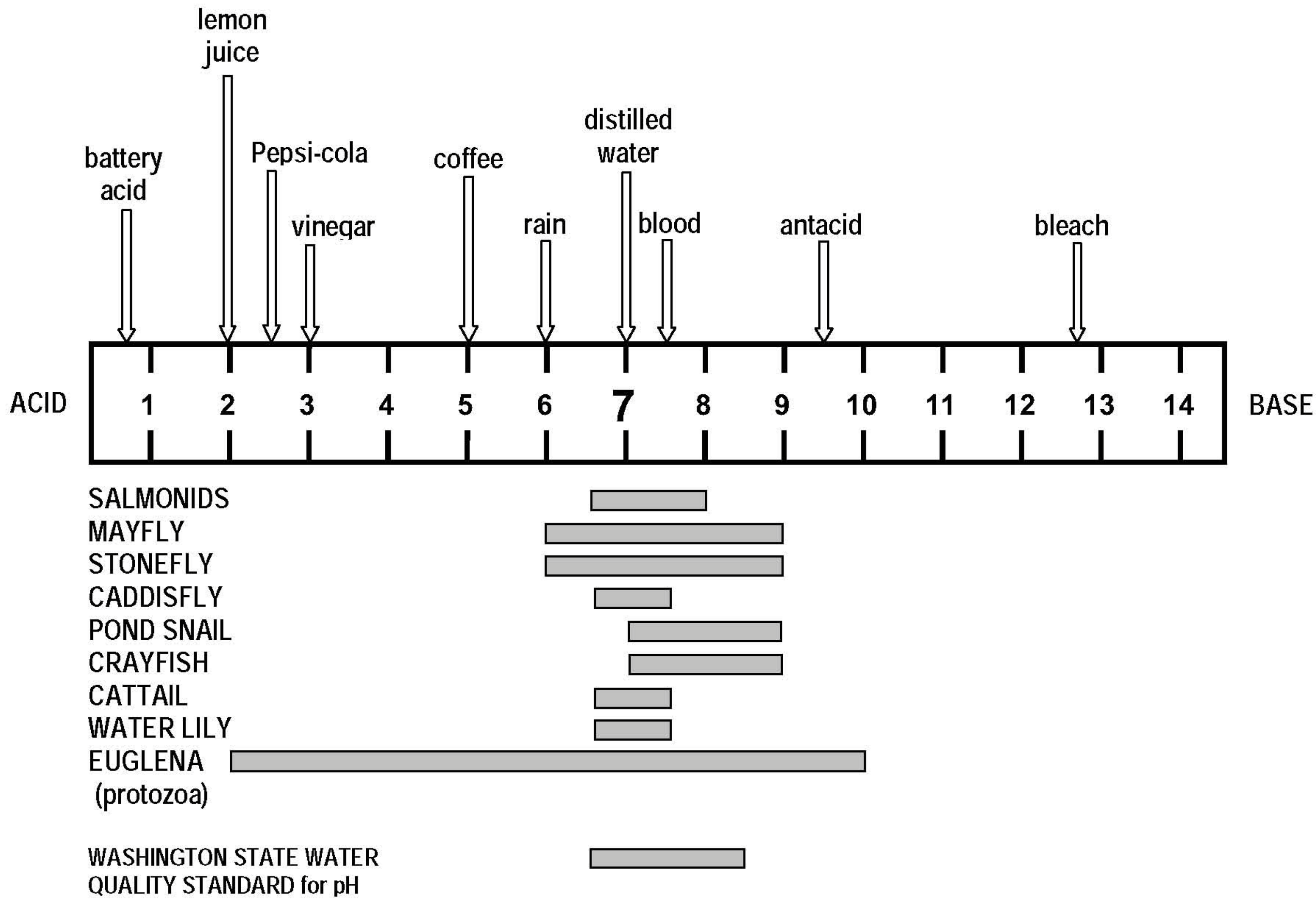
pH TEST

Materials
LaMotte Precision pH Test Kit

Procedure
1. Fill a test tube to the 10 mL line with sample water.
2. Add 10 drops of *Wide Range pH Indicator.
3. Cap and mix.
4. Insert Wide Range pH Octa-Slide 2Bar into the Octa-Slide 2 Viewer.
5. Insert test tube into Octa-Slide 2 Viewer.
6. Match sample color to a color standard. Record as pH.

WARNING! This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Discussion Questions
- Does the pH of the water that you tested fall within the lethal limits for aquatic organisms?
- What other liquids have a pH that is similar to the water you tested?
- What are we measuring when we test pH?
- Why does pH matter?
- How does water get more acidic/alkaline?
- How can we make sure that water doesn’t get too acidic/alkaline?



LETHAL pH LIMITS FOR AQUATIC ORGANISMS

Compiled from Stream scene, Investigating Our Ecosystem, Aquatic Project Wild, Streamkeeper's Field Guide

D.O. (Dissolved Oxygen) TEST

Materials
LaMotte D.O. titration kit

Procedure
1. Participants don gloves and goggles.
2. Rinse and fill Water Sampling Bottle. Turn filled bottle upside down to make sure there are no air bubbles.
3. Uncap and add 8 drops of Manganous Sulfate Solution.
4. Immediately add 8 drops of Alkaline Potassium Iodide Azide.
5. Recap and mix thoroughly.
6. Allow precipitate to settle below bottle shoulder.
7. Uncap and add 8 drops of Sulfuric Acid (red cap).
8. Cap and mix until reagent and precipitate dissolve.
9. Fill test tube to the 20 mL line with test solution.
10. Add 8 drops of Starch Indicator. Solution turns black/purple.
11. Fill titrator (syringe) with Sodium Thiosulfate.
12. Continue titration by adding one drop at a time and swirling until blue color disappears and solution is colorless. This happens suddenly so be careful not to overshoot the endpoint.
13. Read the number at the bottom of the titration plunger. This number equals the ppm of Dissolved Oxygen in the water sample.
14. Read result in ppm Dissolved Oxygen.

Note: Biological activity may cause rapid oxygen depletion. Dipping and pouring operations should be performed with as little agitation as possible.

D.O. ALTERNATE TEST (not preferred - for when you are short on time.)

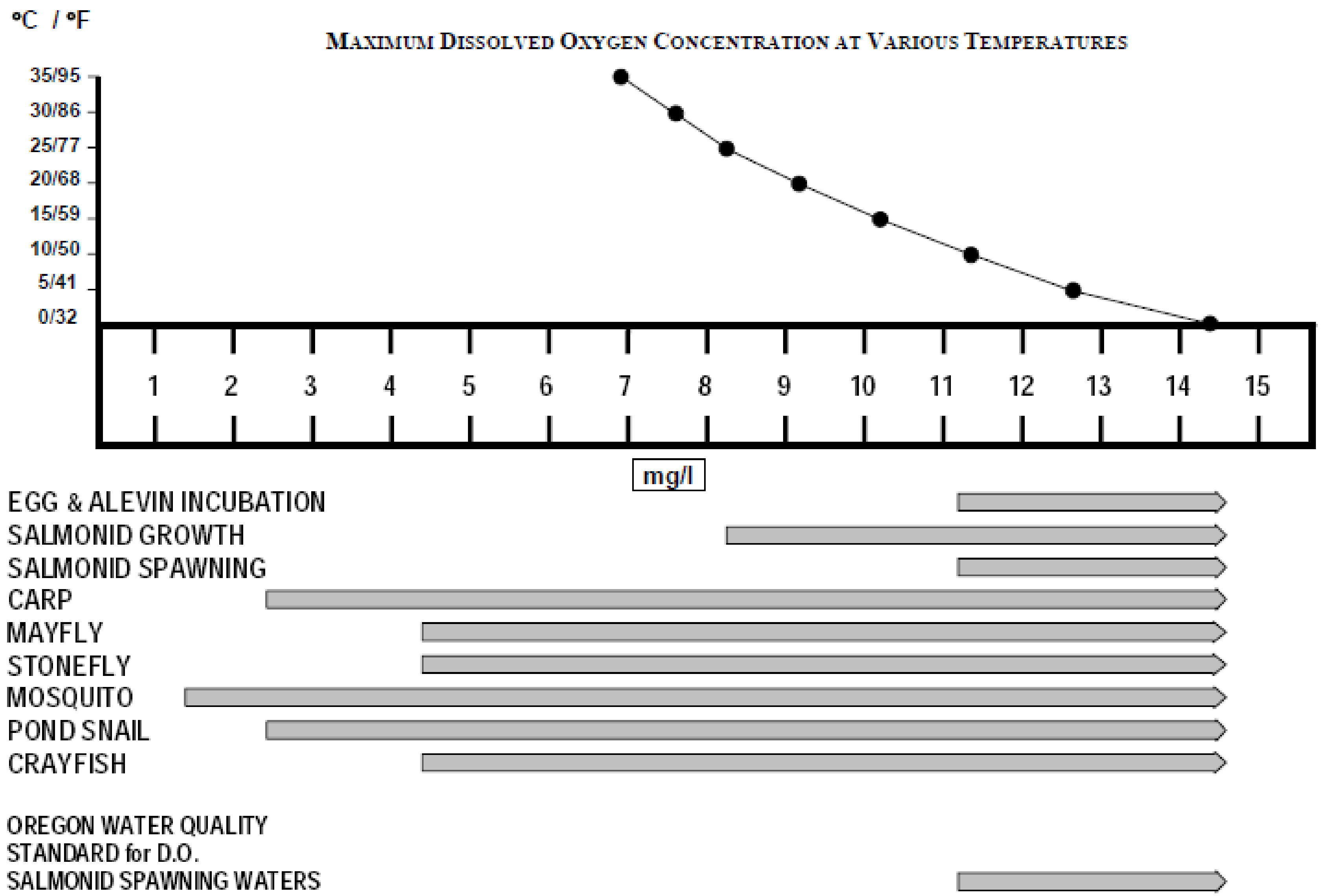
Materials: Oxygen CHEMets Kit

Procedure

Fill the sample cup to the 25 mL mark with the sample to be tested.
2. Place the ampoule, tip first, into the sample cup. Snap the tip. The ampoule will fill, leaving a bubble for mixing.
3. To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
4. Dry the ampoule and wait 2 minutes for color development.
5. Obtain a test result by placing the ampoule between the color standards until the best color match is found.

Discussion Questions

- How is the amount of dissolved oxygen in the water that you tested compare to the optimum amounts of dissolved oxygen for different aquatic organisms?
- What can affect levels of dissolved oxygen? *(Temperature, time of year, time of day, depth, plant growth)*
- How do animals breathe in the water?
- What are some anthropogenic (human-made) activities that can affect DO levels?
- How does oxygen get in the water?



OPTIMUM DISSOLVED OXYGEN LIMITS FOR AQUATIC ORGANISMS

Compiled from Streamkeepers Field Guide, DEQ Adminstrative Rules, Aquatic Project WILD, Stream Scene, Investigating Our Ecosystem.

TURBIDITY TEST

Materials
Turbidity Tube, 60 cm

Procedure
1. Make sure drain hose is crimped, then fill clean turbidity tube to top with stream water.
2. Stand with your back to the light (e.g. sunlight).
3. Hold tube vertically in front of you, not at your side. Extend arm down (arm's length) so you are looking down into the bottom of the tube.
4. While student holding the tube observes the disk at the bottom of the turbidity tube, another student SLOWLY releases water from the tube by uncrimping the drain hose.
5. When the black and white secchi pattern is visible, record the cm reading.
6. Use the Centimeters to NTU Conversion Chart to determine the NTUs, then compare to the Optimum Turbidity for Aquatic Organisms Chart to interpret the results.
7. If time allows, check turbidity in more than one area and compare.

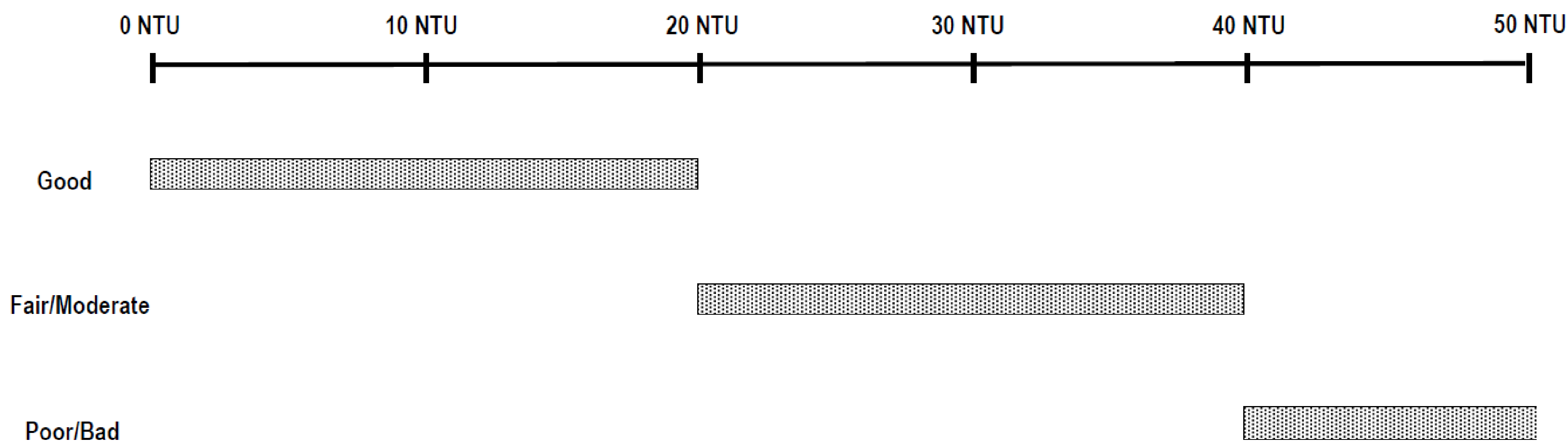
Discussion Questions
- Turbidity relates to how clear the water is. If you are getting a high turbidity reading, i.e. exceeding the limits for a healthy salmon stream (see chart), what do you think might be the source of the turbidity?
- Is this a natural occurrence?
- Describe the impact/activity (i.e. natural or human) that might be contributing to your high reading.
- What, if anything, could be done to try to decrease the turbidity at this site?

Length to Turbidity Conversion Chart

cm	NTU
< 6	> 240
6 to 7	240
7 to 8	185
8 to 9	150
9 to 10	120
10 to 12	100
12 to 14	84
14 to 16	60
16 to 19	48
19 to 21	40
21 to 24	35
24 to 26	30
26 to 29	27
29 to 31	24

cm	NTU
31 to 34	21
34 to 36	19
36 to 39	17
39 to 41	15
41 to 44	14
44 to 46	13
46 to 49	12
49 to 51	11
51 to 54	10
54 to 57	9
57 to 60	8
60 to 70	7
70 to 85	6
> 85	< 5

OPTIMUM TURBIDITY LEVELS FOR AQUATIC ORGANISMS



NTU = nephalometric turbidity unit

10 NTU: Level not to be exceeded for coldwater fisheries per state/federal water quality standards.

50 NTU: Turbidity level which interferes with site feeding; level not to be exceeded in any type of river/stream per State/Federal water quality standards.

Compiled from information regarding water quality from the Oregon Department of Environmental Quality and the U.S. Environmental Protection Agency.

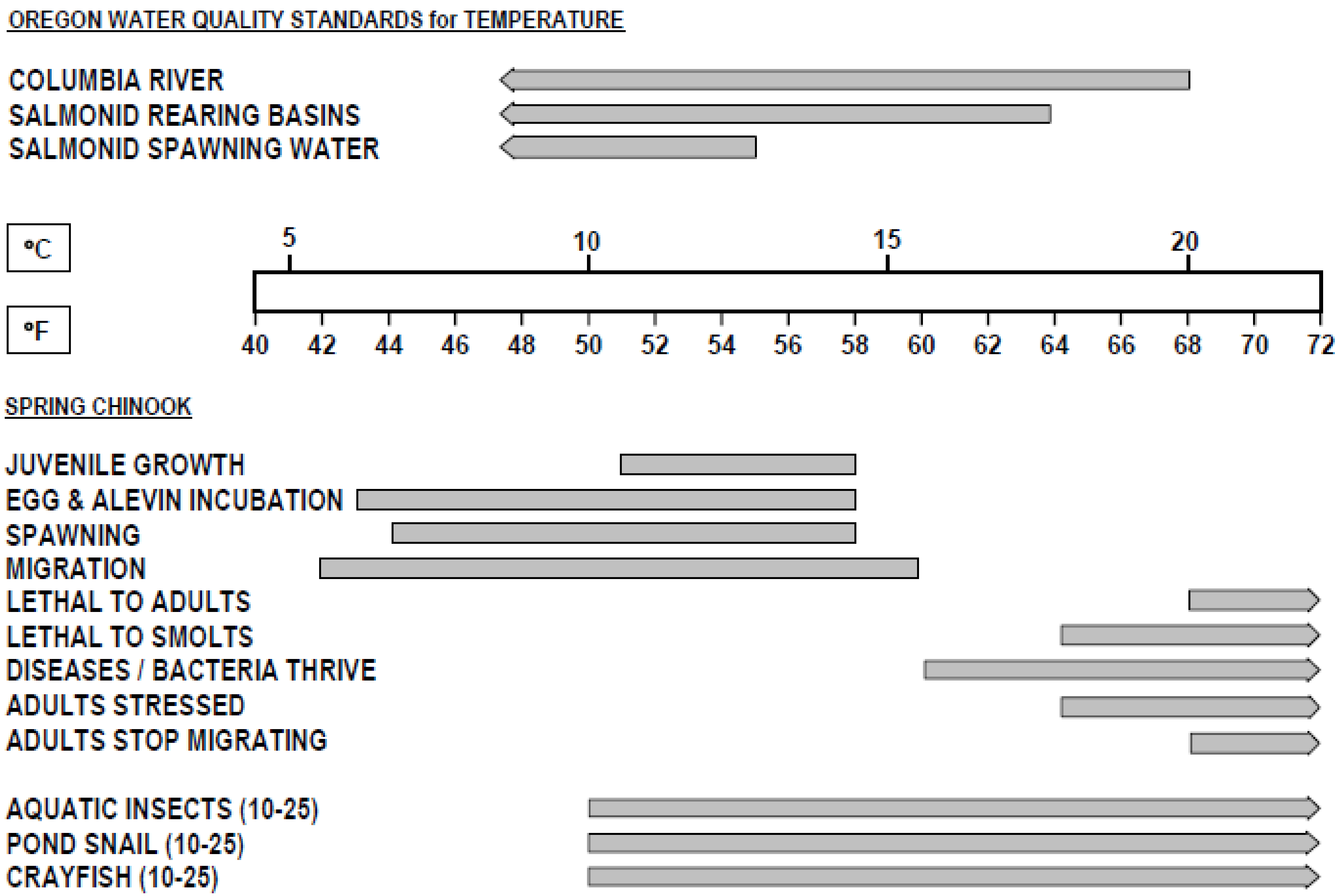
SALMON WATCH

TEMPERATURE TEST

Materials
Armored thermometer with string or plastic ribbon (flagging tape) attached (Hopefully this tether will prevent loss of the thermometer in the current.)

Procedure with manual thermometer
1. Air Temperature: Allow thermometer to reach equilibrium before recording. Make sure the air temperature is taken in the shade, not in direct sunlight. Take air temperature first.
2. Water Temperature: Submerge the thermometer for at least 5 minutes in the water. Read the value while thermometer is still in water, if possible.
3. Record results. lf time allows check temperature in more than one area of the stream and compare results.

Discussion Questions
- Why should we care about water temperature?
- What would happen to animals if the water was too cold or too warm? To plants? To nutrients?
- How does the water in this stream get to be this temperature?
- How does the water stay cool? How does the water get too warm for fish to survive?
- How are temperature and dissolved oxygen related?



Optimum Temperature Limits for Aquatic Organisms

Compiled from Stream Scene, Streamkeepers Field Guide, DEQ Administrative Rules, Aquatic Project Wild, Investigating our Ecosystem

pH BACKGROUND INFORMATION

The concentration of hydrogen ions in a solution is called pH and determines whether a solution is acid or alkaline. A pH value shows the intensity of acid or alkaline conditions. In general, acidity is a measure of substance's ability to neutralize bases, and alkalinity is a measure of a substance's ability to neutralize acids.

The pH scale ranges from 1 (acid) to 14 (alkaline or basic) with 7 as neutral. The scale is logarithmic so a change of one pH unit means a tenfold change in acid or alkaline concentration. A change from 7 to 6 represents 10 times the concentration, 7 to 5, 100 times, and so most organisms have a narrow pH range in which they can live. While some fish can tolerate a range of 5 to 9,mothers cannot tolerate a change of even one pH unit. Because of this narrow range of tolerance, pH limits where many organisms can live and them composition of a community.

While pure distilled water has a pH of about 7, any minerals dissolved in water can change the pH. These minerals can be dissolved from a streambed, the soil in a watershed, sediments washed into a stream, or the atmosphere.

In eastern Oregon, where many soils have a high alkaline content, pH levels of some water bodies can rise above 10. Forest soils tend to be slightly acid and many lakes or streams in forested regions of Oregon can approach a pH of 6.

The age of a lake can also influence pH. Young lakes are often basic. As organic materials build up decomposition forms organic acids and releases carbon dioxide. Carbon dioxide mixed with water forms carbonic acid, making the lake more acidic.

When rain falls through the atmosphere, the gases it comes in contact with come into solution. As rain absorbs carbon dioxide it becomes slightly acidic, but reaches a natural lower limit of pH 5.6. Air pollution, primarily from automobile exhaust and fossil fuel burning, has increased concentrations of sulfur and nitrogen oxides in the air. These fall with rain as weak sulfuric and nitric acids causing an "acid rain." Currently in portions of the eastern United States, the mean pH for rainfall is 4.3, approximately ten times more acidic than normal. Rainfall measuring just under pH 2.0 fell on Wheeling, West Virginia, in 1978. This was approximately 5,000mtimes the acidity of normal rainfall and is the most acidic rainfall on record.

Increased acidity has caused pH to exceed lethal levels for fish in many lakes. A U.S. government study estimated that 55 percent of the lakes and 42 percent of stream miles in the eastern United States are currently being subjected to acidic deposition, which will eventually lead to their deterioration. In addition, acid build-up in soils can have detrimental effects on forests and crops, and hinders natural nutrient recycling processes.

Because rain can fall a considerable distance from a pollution source, acid rain is a regional and global problem. Factors that determine the pH of a body of water can be far removed from a particular site, making it difficult to directly manage the pH. Because pH is a limiting factor, it is important to have a measurement to determine which organisms can survive and prosper. This measurement also serves as a baseline measurement and can assist in the monitoring of future changes.

Testing pH

Water contains both H+ (hydrogen) ions and OH- (hydroxyl) ions. The pH test measures the H+ ion concentration of liquids and substances. Each measured liquid or substance is given a pH value on a scale that ranges from 0 to 14. Pure, de-ionized water contains equal numbers of H+ and OH- ions and is considered neutral (pH 7), neither acidic or basic. lf the sample being measured has more H+ than OH- ions, it is considered acidic and has a pH less than 7. lf the sample contains more OH- ions than H+ ions, it is considered basic, with a pH greater than 7.

It is important to remember that for every one unit change on the pH scale, there is approximately a ten-fold change in how acidic or basic the sample is. For example, lakes of pH 4 (acidic) are roughly 100 times more acidic than lakes of pH 6.

DISSOLVED OXYGEN BACKGROUND INFORMATION

Oxygen is as essential to life in water as it is to life on land. Oxygen availability determines whether an aquatic organism will survive and affects its growth and development. The amount of oxygen found in water is called the dissolved oxygen concentration (DO) and is measured in milligrams per liter of water (mg/L) or an equivalent unit, (parts per million of oxygen to water (ppm).

DO levels are affected by:

- Altitude
- Water agitation
- Water temperature
- Types and numbers of plants
- Light penetration
- Amounts of dissolved or suspended solids

As water low in oxygen comes into contact with air, it absorbs oxygen from the atmosphere. The turbulence of running water and the mixing of air and water in waterfalls and rapids add significant amounts of oxygen to water.

Effects of temperature on DO

Temperature directly affects the amount of oxygen in water-the colder the water, the more oxygen it can hold. Bodies of water with little shade can experience a drop in DO during periods of warm weather.

Thermal pollution, the discharge of warm water used to cool power plants or industrial processes, can reduce DO levels. The area immediately downstream from the entry of warm water can be altered drastically. Thermal pollution generally occurs in larger streams. However, dilution will temper these effects as warm water mixes with colder water downstream.

At higher altitude (elevation), the dissolved oxygen saturation point is lower than under the same conditions at lower altitude. Shown below are maximum amounts, or saturation levels, of dissolved oxygen (in ppm) in fresh water at sea level for different temperatures:

DO ppm	5	6	7	8	9	10	11	12	13	14	15
Temp °F	117	92	90	77	68	59	50	45	39	36	32

When aeration is high, DO levels can temporarily be higher than the saturation level. This extra oxygen is not stored in the water.

Photosynthesis, oxidation, and decomposition
Oxygen can also be added to water as a result of plant photosynthesis. During the day, plants can produce oxygen faster than aquatic animals can use it- This surplus is temporarily available throughout the night for plant and animal respiration. Depending on individual stream conditions, high daytime DO levels and low nighttime DO levels can occur.

Sediments can inhibit photosynthesis. Suspended sediments make water look murky or cloudy and block or reflect much of the sunlight that would otherwise be available for photosynthesis. Sediments can also settle onto the leaves of plants, further blocking their efficiency as oxygen producers.

The chemical oxidation and decomposition of dissolved, suspended and deposited sediments remove oxygen from the water. The amount of oxygen needed for these processes is called biochemical oxygen demand (BOD) and is oxygen that is unavailable for aquatic life. lf the quantity of these sediments is large, remaining oxygen can be insufficient to support many forms of aquatic life.

Most DO problems in Oregon streams occur when temperatures are at their highest and streamflows at their lowest. Salmon and trout are especially at risk during this time. Fry are often limited to small spawning streams during these "pinch periods" and DO is critical to their development. While a juvenile Salmonid can withstand 1-2 ppm of DO for short periods, its growth rate drops sharply below 5 ppm, especially if the temperature is high.

Fish die-off in shallow, warm ponds is a fairly common occurrence during the Summer. During a long period of warm sunshine, algae grow profusely. A summer storm can result in several days of cloudy weather. The reduced sunlight can cause a massive die-off of the algal bloom. As dead algae decompose, available oxygen is depleted. The amount of DO drops to lethal levels, causing subsequent die-off of fish and other aquatic organisms.

Maintaining productive DO levels
To maintain productive DO levels in a stream, shade should be provided to keep water temperatures cool. The presence of in-stream structures ensures mixing of water and air. Materials that can increase BOD, such as manure from feedlots or untreated municipal waste, should not be introduced.

Testing Dissolved Oxygen
Oxygen enters the water from the atmosphere and from photosynthesizing plants in the water column. Its concentration in the stream is dependent upon ambient temperature and atmospheric pressure, but is usually within 6-10 ppm (parts per million). Concentrations can greatly exceed this within dense algae growths. Large amounts of dead and decomposing organic material can reduce dissolved oxygen levels below 5 ppm, and this places great stress on salmon.

TURBIDITY BACKGROUND INFORMATION

As long as there has been water in streams, it has carried solid particles called sediments. Sediments occur naturally as products of weathering and erosion. Wind, water or frost action on rock surfaces result in the gradual breakdown of large, solid rock pieces to smaller particles such as sand and silt. Nutrients necessary to life are also transported as sediments, using rivers and streams as pipelines.

Ecosystems depend on sediments for their health but excessive amounts are harmful. Erosion and sediment transport are natural phenomena that can improve as well as degrade habitats within a watershed. Water erodes gravel banks to provide a continuing source of gravel for streams, shift gravel bars, and forms or deepens pools, all of which benefit spawning and rearing fish. However, erosion of fine-textured soils such as clays, silts, and fine sand can reduce habitat quality by compacting gravel or lowering water quality.

Sediment types

Bedload sediments are too heavy to be constantly suspended. They are rolled and bounced along the bottom of a stream. The size of a particle of bedload sediment will vary with the volume and speed of the water. Spawning gravel is often transported as bedload sediment during high winter streamflow. Periodic fluctuations in the amount of sediment and bedload being transported are natural occurrences.

Suspended sediments are those carried in suspension. Rapidly flowing water can carry more suspended sediments than slow-moving water.

A gradient of deposition exists and is determined by stream flow velocity, volume and sediment size. Heavier sediments settle out first, followed by successively lighter materials. As velocity decreases, as from the center of the stream out toward its edges, or slow water area, the finest sediments settle to the bottom, no longer suspended by the action of water.

Total suspended sediment (TSS) is a measure of how much sediment a stream is carrying. Suspended sediments can give water a murky or cloudy appearance by reducing light penetration. Turbidity is the term used to describe and measure the degree to which light is blocked.

Helpful and harmful sediments

Sediments dissolved in water can be beneficial or harmful to the aquatic community. Some are nutrients essential to life. Others can be minerals or salts that change water pH or are poisonous to life. The measure of solids dissolved in water is called total dissolved solids (TDS). TDS levels higher than 500 ppm make water unfit for consumption. In western Oregon, 200 communities get at least part of their water supply from municipal watersheds. Currently, because of its high quality, little treatment is needed to make most of this water fit for domestic use.

Manufacturing of high-quality paper products and beer depend on availability of clear, clean water. High concentrations of sediments make water unfit for these processes without expensive filtering.

Suspended sediments can block or reflect sunlight before it reaches aquatic plants. Heavier sediments can cover leaves, inhibiting photosynthesis, or even bury plants. Sediments affect insect life in a body of water. Large amounts of sediments can smother some species. A change in the bottom material and the type, number, and health of plants changes the habitat, and therefore, the species composition of the insect community.

Today, although industrial and municipal wastes receive more attention, sediments are the nation's primary water pollutants. Erosion is the source of most sediment. Agriculture is responsible for more erosion than any other single activity, but road construction and use, timber harvest, forest fires, and other sources contribute. Heavy concentrations of sediments increase the cost of municipal water treatment, can be harmful or fatal to aquatic life, and are indicators of excessive erosion.

High sediment levels also adversely affect fish. Very high concentrations of suspended sediments can irritate and actually clog gill filaments, causing fish to suffocate. Bedload sediments deposited in the channel change the composition of gravel beds used for spawning. This can reduce the amount of oxygen available to the eggs by blocking water circulation, trap fry in the gravel, or reduce the amount and types of food needed during different stages of development.

Importance of vegetation

Excessive sedimentation and the problems it causes can be controlled by reducing erosion. Surface runoff is the primary cause of erosion and can be prevented with adequate plant cover during periods of runoff. Plants and the organic material they add to t soil lessen the force of falling rain, add structure to the soil, and increase the soil's ability to absorb and hold water. When surface runoff does take place, leaves and stems of plants trap debris and sediment that would otherwise be carried into streams.

As a stream meanders across a floodplain, it moves sediments and deepens its channel. Riparian vegetation is especially important in the control of these sediments. Plants along streams help prevent bank erosion.

Testing Turbidity

Turbidity will be discussed as it relates to sediment load in a stream. Choose several areas of the stream to check for turbidity.

TEMPERATURE BACKGROUND INFORMATION

Water Temperature

Water temperature is one of the most important factors for survival of aquatic life. Most aquatic organisms acclimate to be the same temperature of the water that surrounds them. Their metabolic rates are controlled by water temperature. This metabolic activity is most efficient within a limited range of temperatures. lf temperatures are too high or too low, productivity can decrease or metabolic function cease. The organism can die. These extremes, or lethal limits, vary for different species.

Lethal limits

Within the lethal limits there is an ideal range of temperatures. In this range, an organism is more efficient, and the species has a greater chance of success. Various species of fish have adjusted to upper and lower levels of an optimum temperature range. Spawning, hatching, and rearing temperature ranges vary from species to. In this way, temperature determines the character and composition of a stream community. In the Pacific Northwest, most streams have had populations of salmon and trout, which prefer temperatures between 40° and 65° F.

In the summer when temperatures are highest and water flows lowest, juvenile fish live in the pools of smaller streams. Pools offer deeper, cooler, oxygen-rich water and increased protection from predators. Because of low water flows, fish can be confined to a limited area. A temperature rise in a rearing pool can kill fish by exceeding their lethal temperature limits.

Plant cover's role

With the exceptions of hot springs and thermal pollution, solar radiation is the cause of increased water temperatures. Shade from riparian vegetation plays a major role in keeping streams cool. During midsummer, adequate shade will keep a stream 7° to 12° F cooler than a stream exposed to direct sunlight.

Even the shade from debris in the water will help keep temperatures low. If there is enough debris, temperatures can be 3° to 8° F cooler than if there was no shade. Once water has warmed, it does not cool rapidly, even if it flows into a shady stretch. lt is important to recognize that water temperatures change from day to night and that cool water areas exist in a stream. Warmer temperatures encourage the growth of life forms that adversely affect fish and human health. Pathogens such as bacteria, as well as several parasitic organisms, thrive in warmer water.

Air temperature, surface area

As water in a stream mixes with air through exposure and turbulence at the surface, water is influenced by the air temperature. This mixing action can also increase the evaporation rate. The greater the surface area of a body of water, the greater its exposure to both solar radiation and air will be. Because of its increased surface area a wide shallow stream will heat more rapidly than a deep, narrow stream.

Streambed, streamflow, orientation and sediments

Color and composition of a streambed also affect how rapidly stream temperature rises. A dark bedrock channel will gain and pass to the stream more solar radiation than a lighter-colored channel. Similarly, solid rock absorbs more heat than gravel.

The stream flow or volume of water in a stream influences temperature. The larger a body of water, the slower it will heat. Rivers and large streams have more constant temperatures than smaller streams. The direction a stream flows also affects how much solar radiation it will collect. Because of the angle of the sun's rays, southerly flowing streams receive more direct sunlight than steams flowing north. Eastward or westward flowing streams receive shading from adjacent ridges, trees, and riparian vegetation.

Sediments suspended in water can absorb, block, or reflect some of the sun's energy depending on their color and position in the water. Particles on or near the surface can have a beneficial influence through reflection, but those with a dark color increase the total energy absorbed from the sun.

Effects of thermal pollution

Thermal pollution occurs when heated water is discharged into cooler streams or rivers. This heated water generally has been used to cool power plants or industrial processes and can be as much as 20° F warmer than the water into which it is discharged. This increase in temperature can have drastic effects on downstream aquatic ecosystems.

Water temperature is crucial for salmon survival. Salmon can survive in water ranging in temperature from 42-77 degrees Fahrenheit, but do best in water around 55° F. A chart is provided that illustrates the Optimum Temperature Limits for Aquatic Organisms

OSU Oregon State University Extension Service

StreamWebs™
Student Stewardship Network

WATER QUALITY DATA FORM

Share your field data quickly and easily using StreamWebs. Find out what the macroinvertebrates you found say about your stream, keep track of your photopoints, graph water quality data, upload a video, and much more.

www.streamwebs.org

School: ___________________________________

Teacher: __________________________________

Date: __________________ Time: _____________

Stream/Site Name: _________________________Lat__________________Long__________________

Any fish present? ☐ Yes ☐ No # of live fish: ____ # of carcasses: ____

TEST	Sample 1	Sample 2	Sample 3	Sample 4
Water Temperature ☐ °C ☐ °F				
Equipment used?	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐
Air Temperature ☐ °C ☐ °F				
Equipment used?	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐
Dissolved Oxygen (mg/L)				
Equipment used?	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐
pH				
Equipment used?	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐
Turbidity (NTU)				
Equipment used?	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐	Vernier ☐ Manual ☐

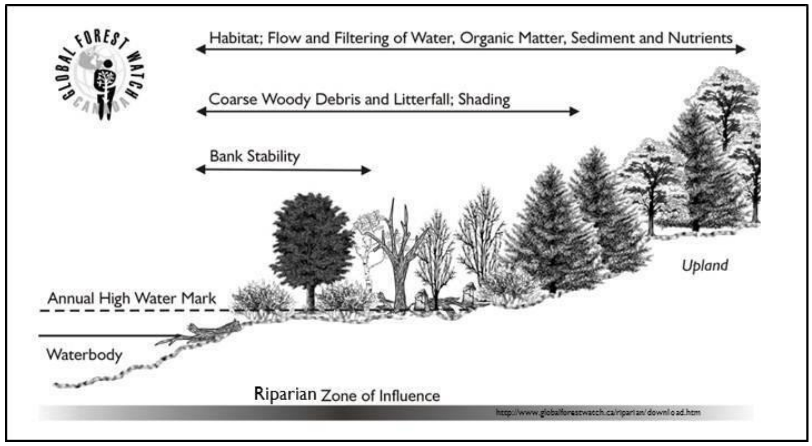
Adapted from: Environmental Services City of Portland

Riparian Ecology Station

OBJECTIVES

Students learn

- The basic definition of a riparian area.
- The condition of any riparian area greatly affects the water quality and aquatic habitat of the water body it surrounds.
- Riparian areas provide functions or 'jobs' in the watershed, but only if they are in healthy, functioning condition. Students can name four main functions.
- Many aspects of the riparian area AND the stream channel must be studied to understand conditions and make management decisions.



INTRODUCTION (10 minutes)

A riparian area is the area of land surrounding a water body. We also call them stream banks and river banks, or shores. All water bodies have riparian areas, even puddles, oceans, wetlands, rivers and lakes etc. Do all riparian areas have trees? No, some riparian areas have been modified into parking lots or buildings, but they are still riparian areas.

Riparian areas are important to know about because *healthy* riparian areas serve several *functions* in the watershed. Functions are like jobs or services that nature does to help keep the watershed healthy.

Riparian functions include: **bank stability, shade, water storage and filtering, and wildlife habitat**. Laminated signs are displayed for each function.

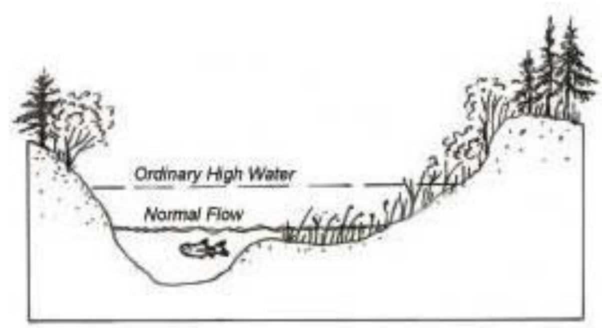
Bank Stability (or erosion control) Lots of roots hold the soil in place, especially during winter floods. Erosion is the separation of soil particles by water or wind. Some erosion is natural, but too much erosion is a form of pollution. A mix of native trees, shrubs, and grasses is best for stabilizing stream banks. Willow trees are really good at holding soil in place because their roots grow so fast and the trees don't mind being broken by floods, they just keep growing. Turbidity is a measure of how much fine soil (or sediment) particles are in the water. Fine soil particles can suffocate fish eggs and clog the gills of fish. Students may have measured turbidity already at the water quality station.

Shade is another important function of healthy riparian areas. What makes a riparian area shady? Tall trees! Shade helps keep the water cool in the stream, which is really important to salmon and trout because cooler water holds more oxygen, and fish need dissolved oxygen to survive. Ask if they tested for dissolved oxygen in the water quality station. Warm water is actually a pollutant and is a problem in our watersheds.

Water storage and filtering. When water flows over the ground it is called runoff. It picks up pollution and carries it to the nearest water body. This occurs during heavy rains and excess irrigation. The pollution might be animal waste from pets or livestock, loose soil at a construction site, or litter and oil on the road. Ask if students can think of other types of pollution. Runoff can be slowed down by riparian vegetation and allowed to infiltrate the soil below, which stores and cleans the water.

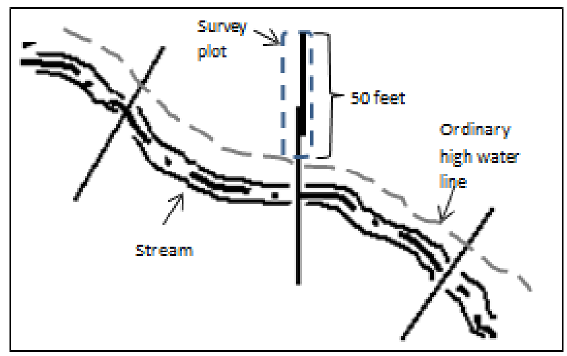
Wildlife habitat. Riparian areas are places where wildlife can find food, shelter, and a safe place to rear their young. Riparian areas have water on one side and uplands on the other side, which creates habitat diversity. Native plants, such as trees, shrubs, and flowering plants, provide important food for insects, birds, and other wildlife. Aquatic organisms benefit from riparian vegetation as well. Macroinvertebrates eat the leaves and wood that drops into the stream. Insects and other macroinvertebrates then get eaten by fish and fish become food for humans or other wildlife, or they die and become fertilizer for riparian plants. When trees fall into the stream they help create important habitat structure for salmon by forming pools, little water falls, and places for young fish to hide from predators.

SITE PREPARATION



GEOLOGIST AND HABITAT BIOLOGIST STATIONS

1. Use a tape measure to measure out a 100 ft line along the stream.
2. Place cones or pin flags along the line to divide it into 4 equal sections.



BOTANIST STATION

1. Start at the water's edge and look away from the stream. Find the **ordinary high water line**, or where *most* of the plants begin growing on the bank.
2. Measure or estimate 50 feet from this line up into the riparian area. Visualize a 10 foot wide strip along this 50 foot line. That is your **survey plot**. (If available, use the second measuring tape and 10 ft rope to delineate survey area.)

ACTIVITY (25 minutes)

Students perform the duties of different types of scientists. They will conduct a *quick* assessment of the riparian area. In the professional world, scientists study many different things in and surrounding a riparian area to understand how healthy it is. Then they make recommendations about how to improve the *function* of the riparian area. This is much like a doctor uses test data to understand how healthy your body is, and then prescribes a treatment, if needed.

Split group into 4 small teams, preferably each with an adult. Each team receives the corresponding data sheet, a clipboard, and pencil or wet erase marker. Materials for each team are listed on the instruction sheet. Each team will appoint a recorder. Remind students they have less than 20 minutes to complete the survey, so they must use the time efficiently!

1. **Botanists** will study VEGETATION TYPES and RIPARIAN WIDTH.
2. **Aquatic biologists** will conduct a STREAM SURVEY and an INSTREAM HABITAT SURVEY.
3. **Forest biologists** will conduct a CANOPY COVER SURVEY.
4. **Geologists** will conduct a SUBSTRATE SURVEY (rocks and sediment that cover the ground).

REPORTING & WRAP UP (10 minutes)

Each team reports on what they found. **The group totals all station scores to get a RIPARIAN HEALTH score**. Ask students if they think this is a healthy riparian area based on what their teams found. Ask students if they think this riparian area can support salmon. Wrap up with discussion on how the riparian area supports each of the functions.

Plant Identification and Riparian Function Walk - 25 min.

Set students up with expectations for the walk, stay on trail, if your feet are moving your mouth is closed, respect each other, the speaker, and our place. *Prior to starting the walk distribute plant identification guides/plant ID cards to students to share in pairs.*

- **Provide Shade** (like the umbrella): Water temperature is related to riparian canopy cover; cooler water temperatures are linked to dissolved oxygen availability for aquatic life. Inquiry along hike: Have students pair share their thoughts and at the end of the walk we will invite the pairs to share with the group.
  - Which plants will thrive near the edge of the waterway, what adaptations will they need to survive? What are the threats from water-loving invasive species; are there any invasive plants at the site?
  - Invasive Plants: See marionswcd.net for local invasive plants. Characteristics of invasive plant species: fast growing, seed dispersal characteristics, production of seeds, take over native plant habitat and cause: higher water temperature, more soil erosion, loss of habitat for insects that fish feed on and terrestrial species loose habitat communities or ecosystems.
  - Native Plants: See marionswcd.net for local native plants. Characteristics of native plant species: adapted to local climates and soils, can tolerate cool, wet winters and warm dry summers, once established after a year or two they rarely need supplemental water.
  - Evergreen: Trees that stay green all year around
  - Deciduous: Trees that lose their leaves in the fall.
- **Wildlife habitat** (Aquatic and Terrestrial): What do wildlife need to survive in their habitat? (Food, shelter, space, and water) These 4 components of habitat, when in the correct arrangement, support and contribute to overall ecosystem health. Riparian habitat provides travel corridors for wildlife. Woody debris from riparian areas add in-stream structure for fish and insects, control and change water flow, and adds nutrients for insect food.
- **Erosion Control**: Native plants and trees have roots that help stabilize soil on stream banks and keep it out of the water. This helps keep the water clear, sediments low, and oxygen levels higher. What activities might lead to increased losses of streambank soil to erosion? (cows in the creek, off-trail biking and recreation, logging in the riparian zone, turf grass up to the edge of the stream on private property, Willamette River floodplain and vegetation over the time etc.)
- **Water storage and filtration**: Silty/clay/loam soils are prominent in our region. Clay particles in the soil have a positive charge which binds negatively charged pollutants to the soil. Water that can enter the soil takes much longer to reach the streams than water that flows directly overland into the waterbodies. This helps streams stay wet in the dry summer months. Plants play a key role in filtering pollutants like mercury, zinc from the environment. Can you name any pollutants that would affect water quality? (Pesticides, herbicides, fertilizer, oil) Where do these pollutants come from? How do these affect water quality?

Riparian Habitat Scavenger Hunt or BINGO - 15 min.

Using the skills and knowledge from the first two activities we invite you to explore the designated area in the riparian habitat to complete one of the following activities.

Option A: Habitat Scavenger Hunt

- Find and list 2 different types of cover that help protect fish from predators.
- How many different kinds of evergreen trees are there in this area?
- How many kinds of berries can you find? (do not eat them!)
- Find three different kinds of seeds or cones. Can you identify which tree the cones came from, list your answer below.
- Is there an eroded stream bank in the area? If so, what do you think caused the erosion?
- Find three types of wildflowers. Draw your favorite below.
- Find a sword fern. Make a sketch or rubbing of the fern below.
- Find a non-native plant. Can you identify the plant and write its name below?
- Is there any evidence that beavers use this area? If so, what is it?
- Find an insect that lives on the ground, under a rock in the water, or flying in the air. Draw it.
- Find and list 3 different types of evidence that birds occur in the area.

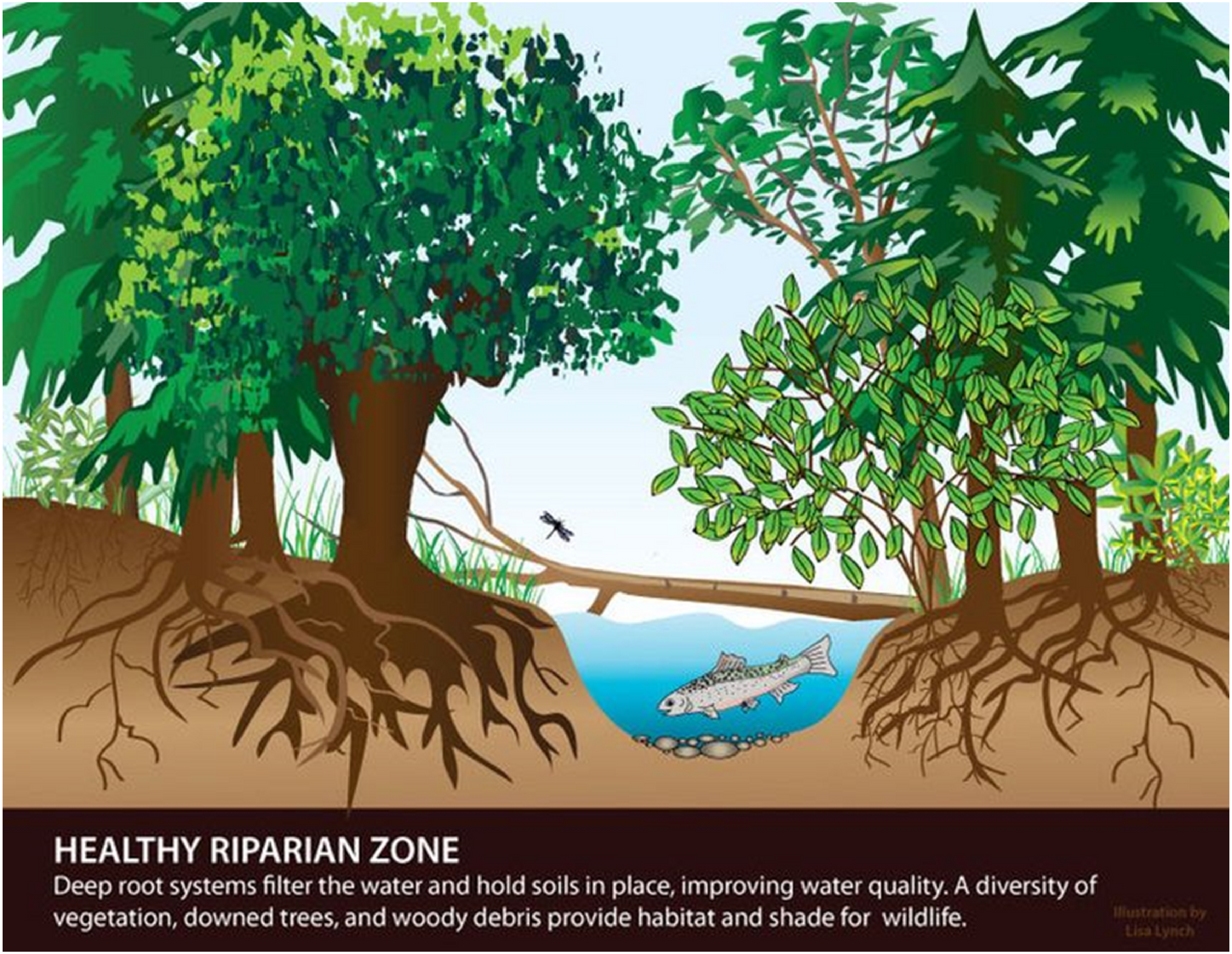
Option B: Riparian BINGO

In small groups, work together to get a BINGO using the laminated BINGO cards provided. Discuss what items are present and absent and what that might mean for the health of the riparian area. How might the fish be impacted?

Sense-Making and Reflection - 5 minutes

Using your Nature Notes write or draw your answers to these questions:

- What are the four main functions of riparian habitats?
- How do we play a part in healthy riparian habitats?


HEALTHY RIPARIAN ZONE
Deep root systems filter the water and hold soils in place, improving water quality. A diversity of vegetation, downed trees, and woody debris provide habitat and shade for wildlife.
Illustration by Lisa Lynch

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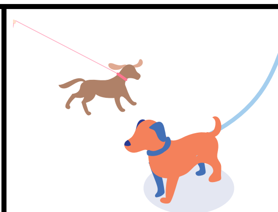
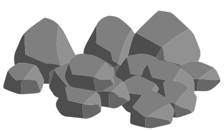
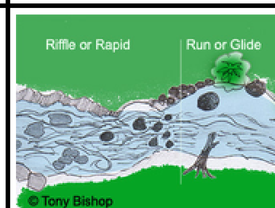
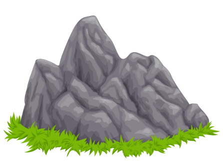
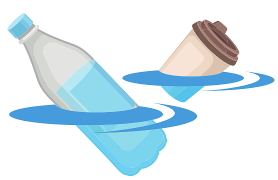
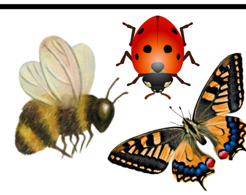
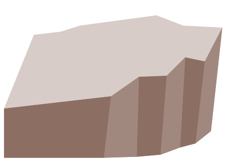
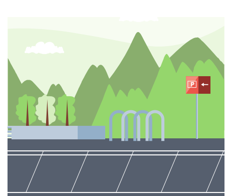
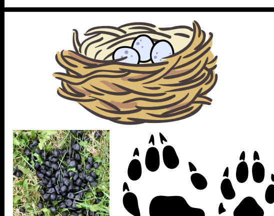
RIPARIAN BINGO

4 Riparian Functions
- Wildlife Habitat
- Shade
- Bank Stability
- Water Storage & Filtering

Substrate	Plants	Negative Impacts	Animals	Stream Parts
 Some Bare Soil for ground-nesting bees	 Low-growing Plants	 Invasive Plants	 Dogs	 Woody Debris
 Gravel	 Ferns	 Erosion	 Birds	 Leaf Packs
 Cobbles	 Salal	FREE	 People	 Riffles &/or Runs
 Boulders	 Oregon Grape	 Litter	 Insects	 High Water Marks
 Bedrock	 Shrubs - Snowberry, etc	 Pavement	 Animal Signs	 High Water Marks

Shade

Shade keeps water cool; colder water holds more dissolved oxygen.

RIPARIAN BINGO

4 Riparian Functions

- Wildlife Habitat
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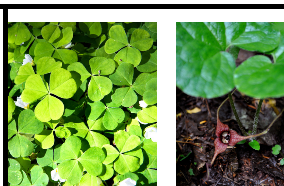
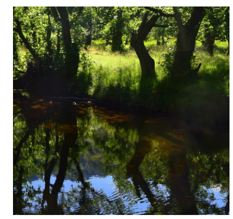
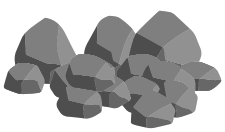
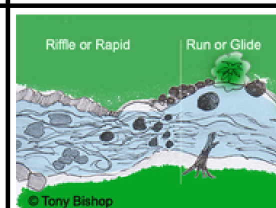
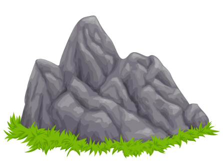
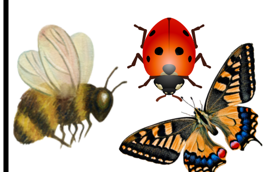
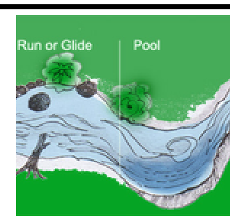
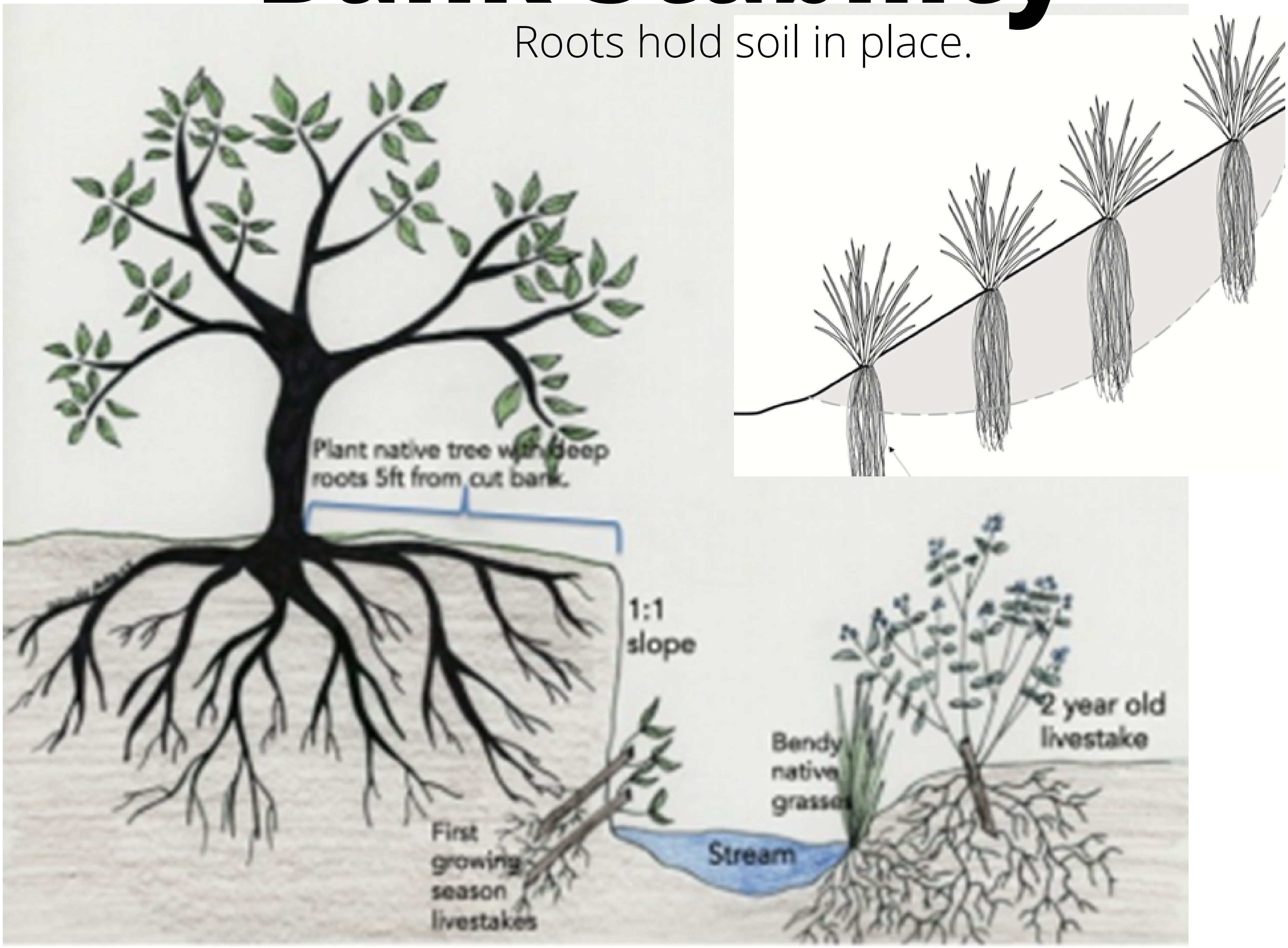
Substrate	Plants	Negative Impacts	Animals	Stream Parts
 Duff, Plant Litter	 Low-growing Plants	 Invasive Plants	 Dogs	 Woody Debris
 Some Bare Soil for ground-nesting bees	 Ferns	 Erosion	 Squirrel	 Shade
 Cobbles	 Douglas-fir	FREE	 People	 Riffles &/or Runs
 Boulders	 Cottonwood	 Pet Waste	 Insects	 Runs &/or Pools
 Roots	 Big Leaf Maple	 Litter	 Animal Signs	 High Water Marks

Bank Stability

Roots hold soil in place.



RIPARIAN BINGO

4 Riparian Functions

- Wildlife Habitat
- Shade
- Bank Stability
- Water Storage & Filtering

Substrate	Plants	Negative Impacts	Animals	Stream Parts
 Duff, Plant Litter	 Low-growing Plants	 Erosion	 Squirrel	 Leaf Packs
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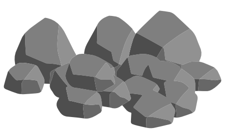
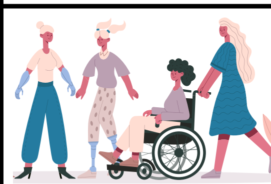
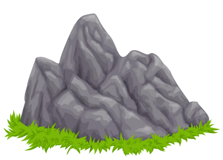
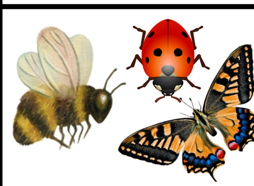
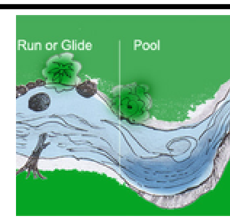
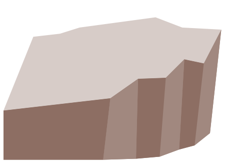
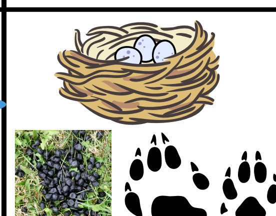
 Cobbles	 Salal	FREE	 People	 Riffles &/or Runs
 Boulders	 Red Alder	 Cows in the Creek	 Insects	 Runs &/or Pools
 Bedrock	 Shrubs - Snowberry, etc	 Litter	 Animal Signs	 High Water Marks

Wildlife Habitat

Shade keeps water cool; colder water holds more dissolved oxygen.

RIPARIAN BINGO

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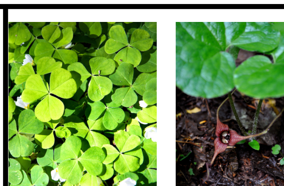
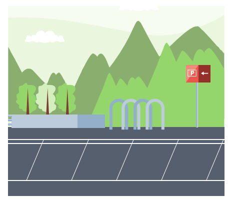
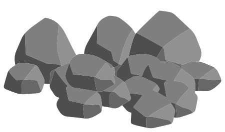
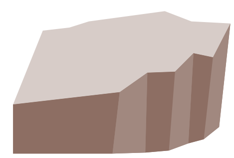
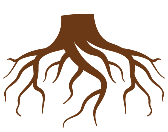
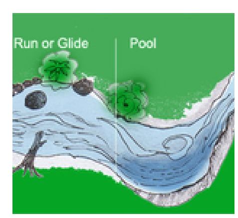
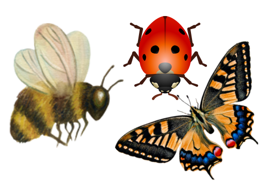
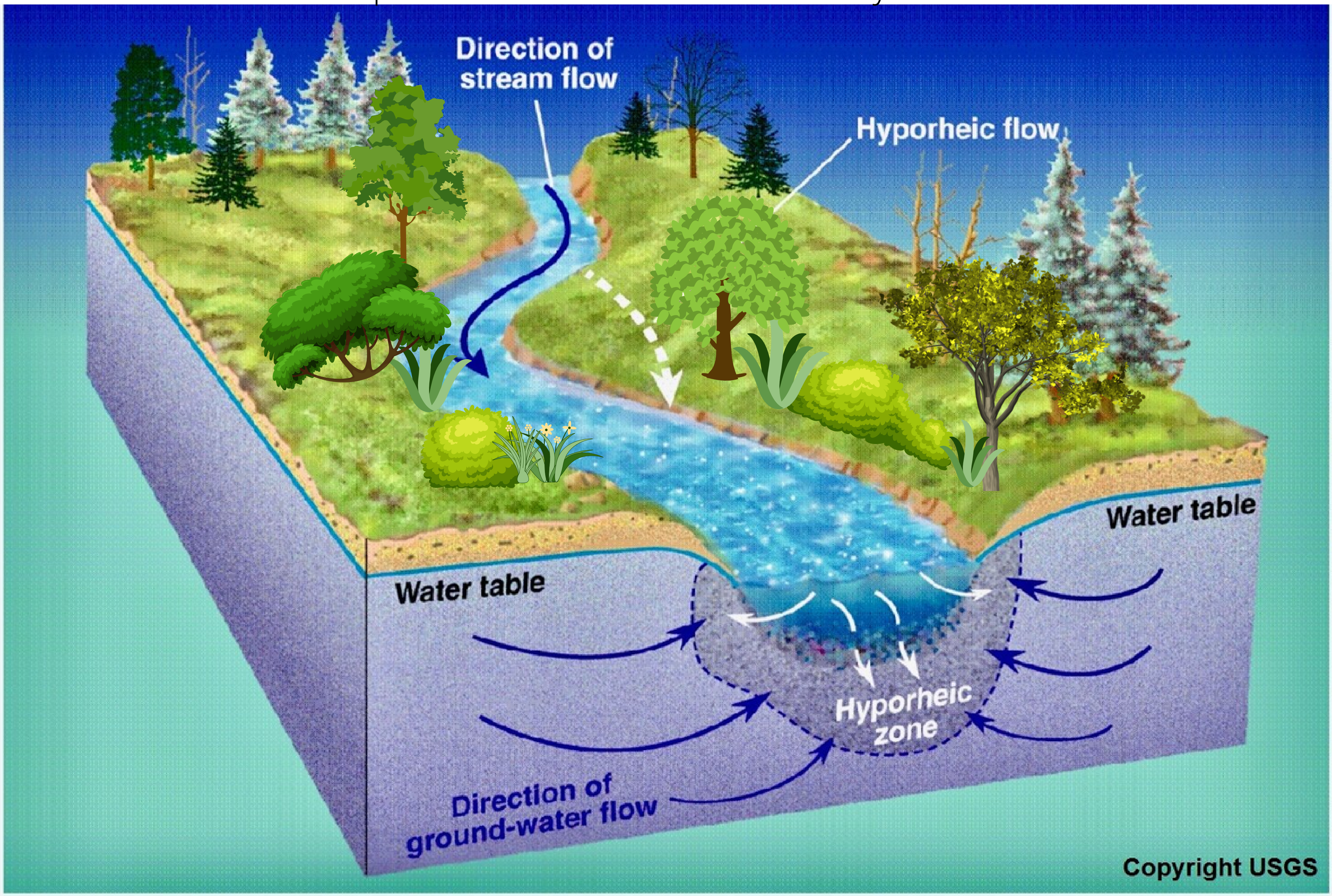
- Water Storage & Filtering

Substrate	Plants	Negative Impacts	Animals	Stream Parts
 Duff, Plant Litter	 Low-growing Plants	 Pavement	 Dogs	 Woody Debris
 Gravel	 Red Alder	 Erosion	 Birds	 Riffles &/or Runs
 Cobbles	 Salal	FREE	 Animal Signs	 Bedrock
 Roots	 Oregon Ash	 Litter	 People	 Runs &/or Pools
 Some Bare Soil for ground-nesting bees	 Shrubs - Snowberry, etc	 Pet Waste	 Insects	 High Water Marks

Water Storage and Filtering

Vegetation slows down runoff; soil soaks up water, then filters out pollutions and releases it slowly to the stream.



BOTANISTS

Survey Methods

1. Observe your survey plot and place an "X" in the box that corresponds to each vegetation type you see.
2. Then record the total number of vegetation types you observed by placing an "X" in the corresponding box of the Vegetation Cover data table. Circle the score.
3. Using the same survey plot, observe how far back the plants and trees are growing from the edge of the stream bank. For our purposes, this will represent the extent of the riparian area. Compare the width of the riparian area to the width of the stream behind you. Record your guesstimate by placing an "X" in the corresponding box on the Riparian Area Width data table. Circle the score.
4. In the Plants Identified data table, write the name of any plants or trees you can identify, such as willow or Oregon ash or Reed canarygrass, and write about its role in the health of the riparian area for discussion purposes. See data table for examples.

Analysis

- Did you find all vegetation types in your plot or just one or two? *The more types you found, the better diversity you have which is good for riparian function. Bare ground or gravel does not count as a vegetation type.*
- Of the vegetation you found, was there a lot of each type? *This would be good.* Was there a lot of bare ground? *The soil could easily erode into the stream. Bare ground also means there aren't as many plants for wildlife habitat.*
- Is the riparian area at least as wide as the stream width? *This would be good. A wider riparian area can better provide functions for the watershed.* Is this riparian area providing these functions? *Riparian functions: erosion control, shade to the channel, filtering runoff, providing habitat.*

Conclusions

- How healthy is this riparian area? How could this riparian area be improved? What would you plant and why? Would you preserve it the way it is?

BOTANIST DATA SHEET

School:____Date:__________________________

Stream name:_____________________________________Weather:________________________

Materials: field guides, data sheet and instructions, clipboard and pencil or wet erase marker

Vegetation Type	**Shrubs & Short trees**	**Coniferous canopy trees**	**Deciduous canopy trees**	**Grasses & Ferns**	**Small Plants**	**Gravel**	**Bare Soil**
Place an **X** in the box for each vegetation type observed							

Vegetation Diversity	**4-5 vegetation types present, cover dense**	**4-5 vegetation types present, cover sparse**	**1-3 vegetation types present**	**Bare ground and gravel > 30% of the plot**	**Bare ground and gravel > 50% of the plot**
Place an **X** in the corresponding box					
SCORE	10	7	4	2	0
	Excellent	Healthy	Fair	Unhealthy	Poor

Riparian Area Width	**Greater than 1 stream width**	**Approximately equal to the stream width**	**Less than ½ the stream width**
Place an **X** in the corresponding box			
SCORE	10	7	5
	Excellent	Healthy	Fair

Plant Species Identified	**Significance to riparian area** *(ex-low habitat value, outcompetes natives, provides food, provides shelter, erosion control)*

BOTANY SCORE 1 (Vegetation Diversity) _____________________

BOTANY SCORE 2 (Riparian Area Width) _____________________

AQUATIC BIOLOGISTS

Survey Methods

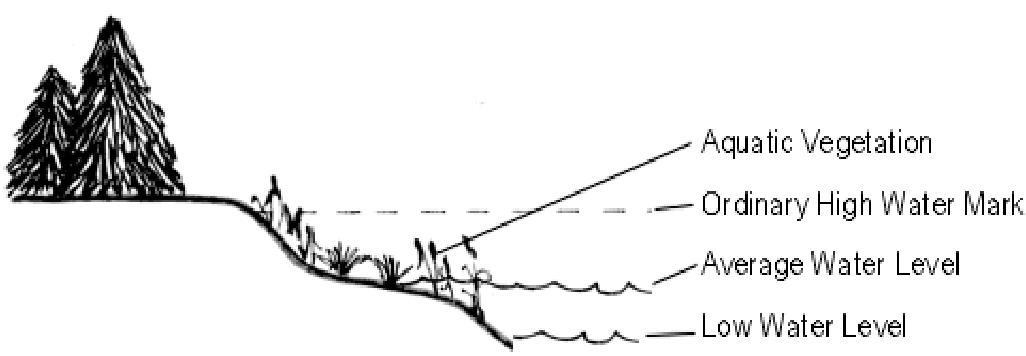
1. You will survey along the 100 ft line, which is broken into 4 equal sections, or reaches, marked by cones or pin flags.
2. Note whether the number of pools and riffles are equal, close to equal or unequal by placing an X in the corresponding box on the Pools & Riffles data table. Circle your score.
3. Walk your reach again, noting the presence or absence of the habitat types listed on the Instream Habitat Assessment data table. Count every habitat type observed between the ordinary high water marks on either bank. Place an "X" in the box for each habitat type found. Tally how many types were found overall. Circle the score that corresponds to the number of habitat types found.

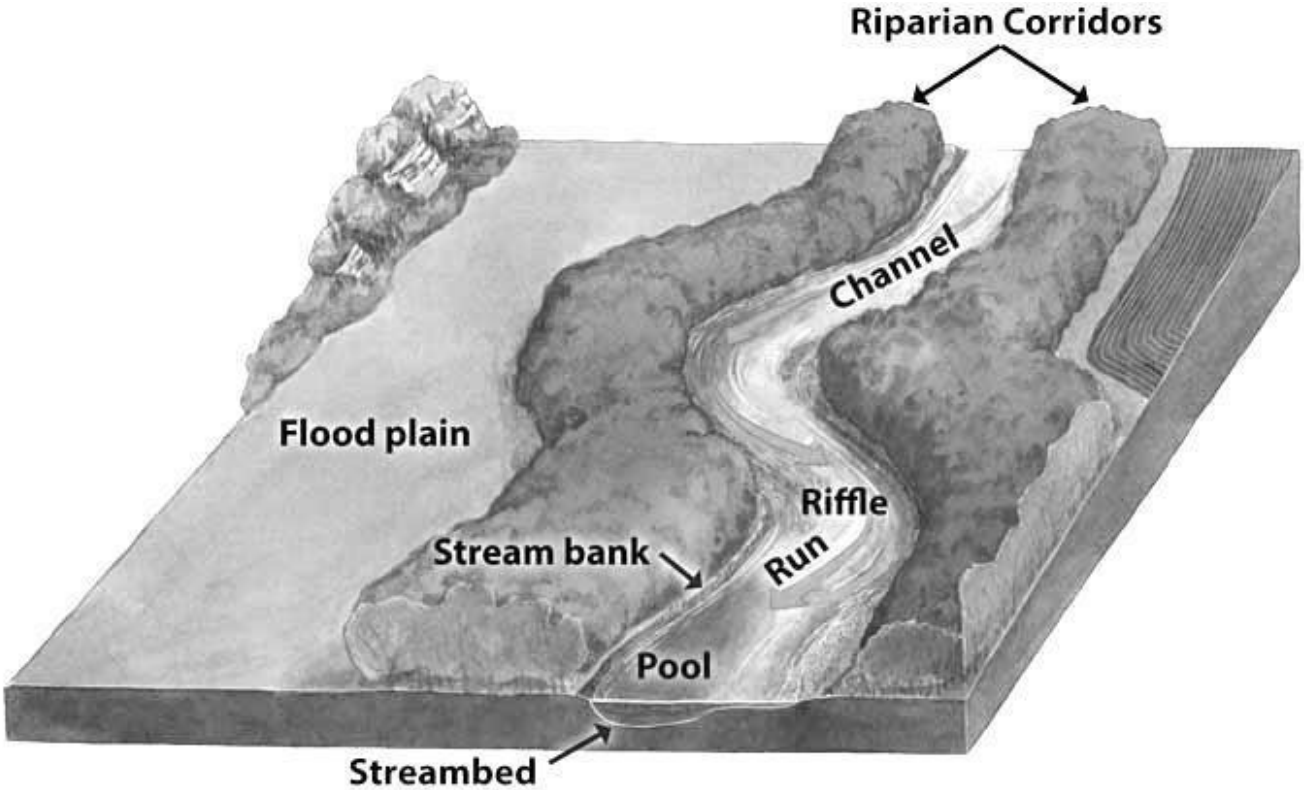
Analysis

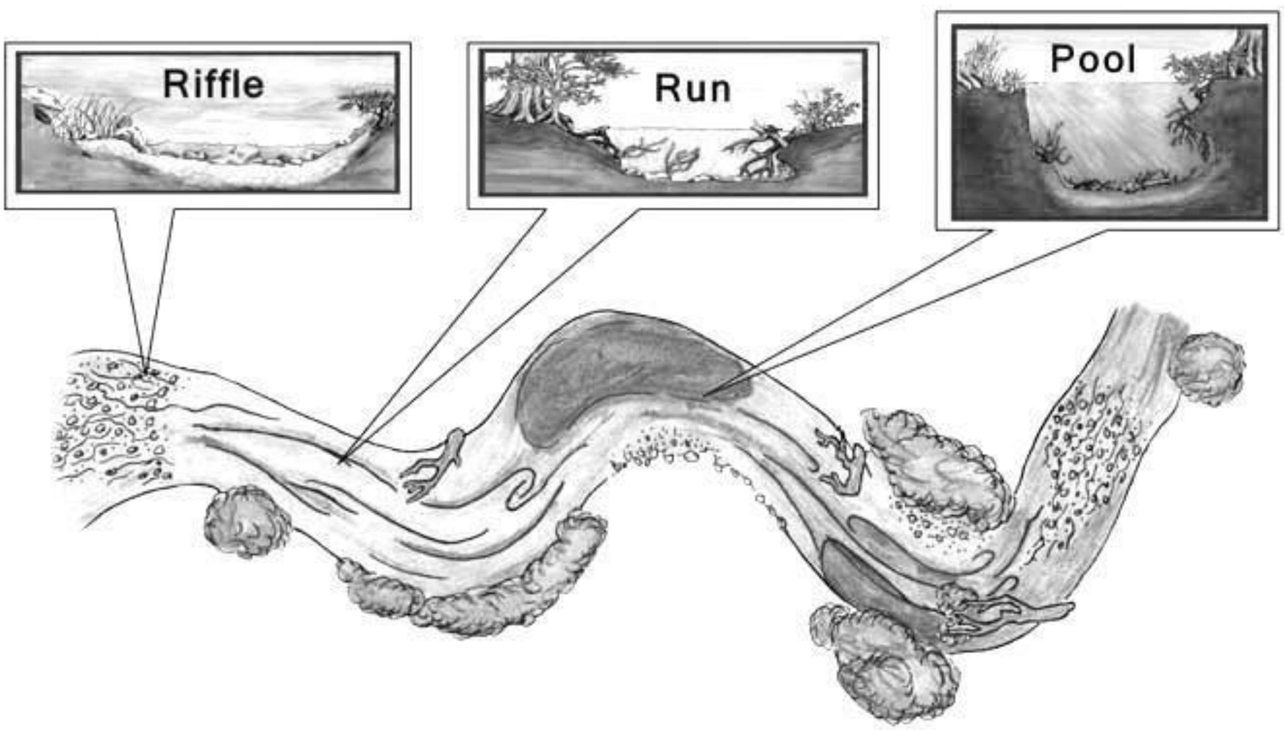
- Riffles or rapids add dissolved oxygen to the water. *The best habitat for salmon has 1/3 or more riffle area in the stream. Do you see many riffles in the reach?*
- What would happen to the riffles if there was a landslide or lots of erosion upstream? *They might fill in with sediment and become smooth.*
- Did you see all eleven habitat types? *Habitat diversity is important for a healthy stream. Having habitat diversity means that more animals (fish, macroinvertebrates, etc.) can utilize the riparian and stream habitats.*

Conclusions

- What would you recommend for management?
- How would you create more pools in the stream, if needed?
- Will large wood naturally fall into the stream or should it be placed there?
- By looking at your stream reach, do you see signs of erosion upstream, or erosion in the reach?







RIFFLE: Shallow water; fast current' turbulent surface; substrate gravel to boulders. In big rivers these are called rapids.

RUN: Deeper than a riffle, with moderate to fast current; surface not as turbulent; substrate small gravel to rubble.

POOL: deep, slow-moving water with a flat surface; substrate usually silt, sand or small gravel.

AQUATIC BIOLOGIST DATA SHEET 1 (POOLS and RIFFLES)

School:____Date:_________________________

Stream name:___________________________________Weather:_______________________

Materials: Measuring tape Clipboard / pencil

Stream Survey	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Total**
# of riffles					
# of pools					
# of runs					
Comments/ Notes					

Pools & Riffles	**Equal number of pools & riffles.**	**Close to equal number of pools & riffles**	**Many more of one or the other**	**No pools or riffles**
Place an **X** in the corresponding box				
SCORE	10	7	3	0
	Excellent	Healthy	Unhealthy	Poor

AQUATIC BIOLOGY SCORE 1 (Pools & Riffles) ___________

AQUATIC BIOLOGIST DATA SHEET 2 (INSTREAM HABITAT)

Instream Habitat Assessment	Reach 1	Reach 2	Reach 3	Reach 4
Small Woody Debris – 6-12 inch diameter and over 10 feet long. Count all pieces, above and below the water, from high water line to high water line.				
Logs / Large Woody Debris – Over 24 inch diameter and over 35 feet long. Count all pieces, above and below the water, from high water line to high water line.				
Pools – Smooth, undisturbed surface, slow current.				
Riffles – Broken water surface, rocky or firm substrate, moderate to swift current.				
Overhanging Vegetation – Trees, shrubs, vines, or other plants hanging immediately over the stream surface.				
Boulders/Cobbles – Boulders are larger than a bowling ball, cobbles are baseball to bowling ball sized.				
Undercut Banks – Eroded areas extending horizontally beneath the surface of the bank forming underwater pockets.				
Thick Root Mats – Dense mats of roots and rootlets at or beneath the surface of the water form invertebrate habitat and fish cover.				
Thick Stands of Water Plants – Beds of emergent, floating, or submerged aquatic plants provide invertebrate habitat and fish cover.				
Disconnected Pools or Side Channels– Pools that have been cut off from the main stem of the stream provide macroinvertebrate habitat.				
Leaf Packs – Floating and submerged packs of leaves provide habitat for macroinvertebrates and fish cover.				

Instream Habitat	9-11 habitats present	7 – 9 habitats present	5 – 6 habitats present	3 – 4 habitats present	1 – 2 habitats present
Place an **X** in the corresponding box					
SCORE	10	7	5	3	1
	Excellent	Healthy	Fair	Unhealthy	Poor

AQUATIC BIOLOGY SCORE 2 (Instream Habitat) _______________

FOREST BIOLOGISTS

CANOPY COVER

Materials: spherical densiometer, canopy cover data sheet

Survey Methods:

With a partner take one sample of canopy cover in each cardinal direction

1. Imagine your spherical densiometer (SD) has letters in each square proceeding alphabetically corresponding to the data sheet.
2. Standing at the edge of the water, hold the SD 12” – 18” in front of your body at elbow height so that your head is just outside of the grid area. Do your best to keep the SD steady.
3. Facing the stream, tell your partner which lettered boxes to fill in based on the boxes that are covered more than 50% by shade. (Your partner may want to hold the data sheet up next to the SD to make it easy to relay the letters of the shade covered boxes.)
4. Repeat step 3 while facing away from the stream, downstream and upstream.
5. Add shaded boxes for all directions to get your estimated canopy cover percentage.
6. Place an “X” in the corresponding box of the data table to indicate the amount of canopy cover you estimated and record this score as the FOREST BIOLOGY SCORE below the table.

Analysis:

Was the area at least 75% shaded? Why is this important? *By keeping the sun’s rays from reaching the surface of the water, shade helps keep water temperatures down. Salmon are cold water fish, and can only survive and breed in cool water.*

Conclusion:

- Is there sufficient shade along the stream?
- What would you recommend for management?
- What would happen if trees were cut down along the stream?

FOREST BIOLOGIST DATA SHEET

StreamWebs™
Student Stewardship Network
Canopy Cover Survey

Share your field data quickly and easily using StreamWebs. Find out what the macroinvertebrates you found say about your stream, keep track of your photopoints, graph water quality data, upload a video, and much more.

www.streamwebs.org

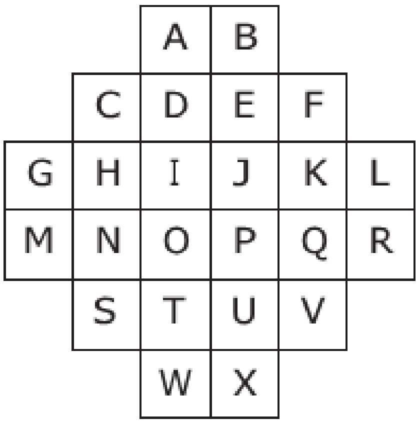
Name: ______________________________

School: ______________________________

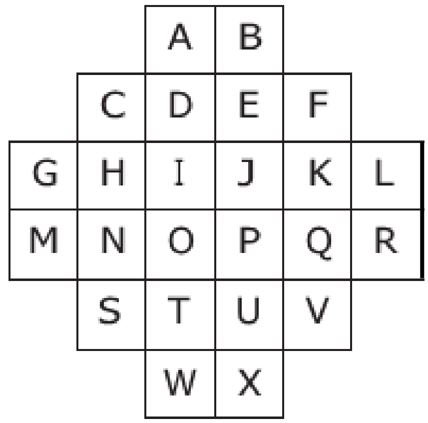
Teacher: ______________________________

Date: ________________ Time: __________

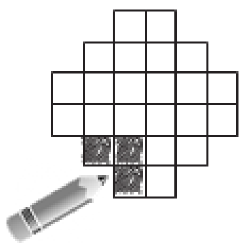
Stream/Site Name: ______________________________________ Weather: ________________

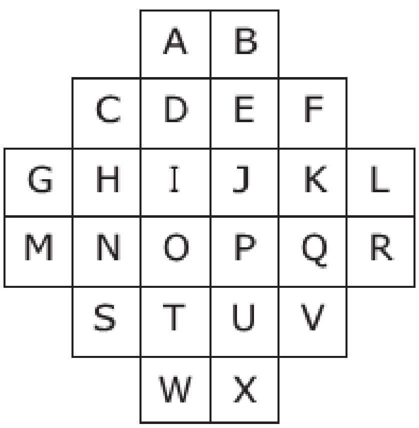


Facing stream
\# Shaded Boxes __________

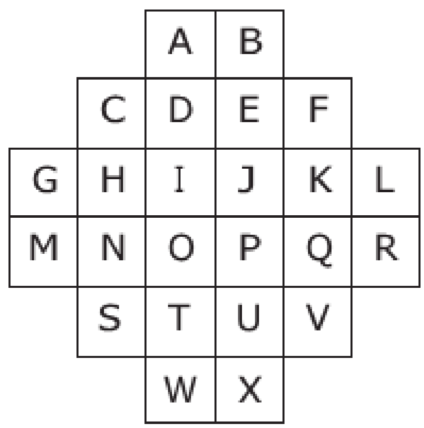


Facing away from stream
\# Shaded Boxes ____________





Downstream
\# Shaded Boxes __________



Upstream
\# Shaded Boxes __________

__________ + __________ + __________ + __________ = __________

Facing stream + **Away from stream** + **Downstream** + **Upstream** = ***Estimated %***

Canopy Cover	**> 75% shaded**	**50 – 75% shaded**	**20% – 50% shaded**	**< 20% shaded**
Place an **X** in the corresponding box				
SCORE	10	7	3	1
	Excellent	Healthy	Unhealthy	Poor

FOREST BIOLOGY SCORE ______________

GEOLOGISTS

SUBSTRATE TYPE

Survey Methods

1. This survey will study the substrate on the channel bottom between the high water marks. If water is too high, too fast, or too cloudy to see through, this survey cannot be performed.
2. You will survey along the 100 ft line, which is broken into 4 equal sections, or reaches, marked by cones or pin flags.
3. Take a moment to observe the whole unit and determine which types of substrate are present.
4. Make estimates of the percentage of each substrate type on the data sheet. **Percentages in the column for each stream unit should equal 100.** Use the pictures above the data table to help with percentage estimates.
5. Note if there is any erosion observed in or near the stream reach or if there are areas of the reach that are not visible. Do not go into the water above mid-calf. Record your observations in the comments section of the Substrate Type data table.
6. Note whether gravel and cobble make up 80% or more of the total reach area (all four reaches), and the percentage of silt observed. Record your answers in the data table by placing an "X" in the corresponding box and circle your score.
7. Record the score as the GEOLOGY SCORE at the bottom of the data sheet.

Analysis

- Did you see very much silt or fine sediment? Where do you think it came from? Is this a good thing? *Fine sediment is natural, but too much can clog fish gills and suffocate fish eggs.*
- Describe in what parts of the stream you found the smaller particles like silt and sand. Where were the larger particles like cobble and boulders? How did they get there? How is this placement related to the amount of stream flow?
- If there was more large wood in the stream, how would the substrate change? *Large wood helps slow down the water, so smaller substrate can fall out of suspension upstream of the large wood. It may also scour out the finer sediments downstream of the large wood as water spills over the large wood and picks up speed.*
- Do you think salmon would want to spawn here? *Salmon want to spawn in clean, cobbley and gravely riffles.*
- What does the substrate tell you about watershed conditions? Does the stream usually flow fast or slow here?

Conclusions

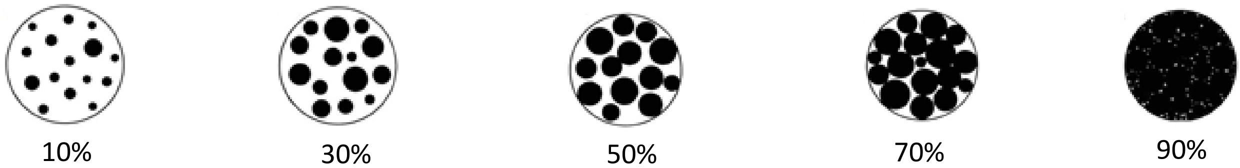
- What would you recommend for management upstream, and what would you change in this reach to make better habitat?

GEOLOGIST DATA SHEET

School:____Date:___________________________

Stream name:______________________________________Weather:_________________________

Materials: Measuring tape, boulders and substrate data sheet and instructions, clip board and pencil



Substrate Type	Percent Substrate in Reaches (%)			
	1	2	3	4
Silt / organic matter (silt is smooth like mud)				
Sand (settles to the bottom when disturbed)				
Gravel (pea to baseball size)				
Cobble (baseball to bowling ball size)				
Boulders (larger than a bowling ball)				
Bedrock (solid rock)				
TOTAL (= 100%)				
Gravel + Cobble				

Substrate Suitability	**Gravel + Cobble > 80% in 3-4 reaches**	**Gravel + Cobble > 80% in 2 reaches**	**Gravel + Cobble > 80% in 1 reach**	**Gravel + Cobble > 80% in no reaches**
Place an **X** in the corresponding box				
SCORE	10	7	5	1
	Excellent	Healthy	Fair	Poor

Notes or Comments:

GEOLOGY SCORE: Substrate Suitability ___________

OVERALL RIPARIAN HEALTH

Survey	Significance	Riparian Function	Score
Botany 1: Vegetation Diversity	Insects, birds, and animals use different plants for survival. The more types of native plants present, the more species can live here.	Bank Stability Shade Water Storage & Filtering Wildlife Habitat	
Botany 2: Riparian Area Width	The quality of the riparian zone increases with the width and complexity of the vegetation within it.	Bank Stability Shade Water Storage & Filtering Wildlife Habitat	
Aquatic Biology 1: Pools and Riffles	Pools are important resting and feeding sites for fish. Riffles are critical for maintaining high species diversity and for serving as spawning and feeding grounds.	Wildlife Habitat	
Aquatic Biology 2: Instream Habitat	A variety of physical habitats in the stream provide shade and cover, allowing fish to hide from predators and have enough oxygen throughout the year.	Shade Wildlife Habitat	
Forest Biology: Canopy Cover	The canopy shades the riparian area and the water, helping to keep the water cool and limit algal growth. Cold water can hold more oxygen than warm water.	Bank Stability Shade Water Storage & Filtering Wildlife Habitat	
Geology: Substrate Suitability	Salmon need gravel to cobble-sized rocks for their redds. Too much sediment can suffocate fish and their eggs.	Wildlife Habitat	
TOTAL			

Riparian Health	Total ≥ 50	Total 35-49	Total 15-34	Total < 15
Enter your score in the corresponding box.				
Riparian Value	**Excellent**	**Healthy**	**Fair**	**Unhealthy/ Poor**
	This riparian area is very healthy and provides excellent erosion control, shade, habitat for wildlife, water storage and filtering.	This riparian area is healthy and provides adequate erosion control, shade, habitat for wildlife, water storage and filtering.	This riparian area could be in better condition. It provides some functions to some degree and may not provide one or more functions adequately.	This riparian area is not healthy, and does not provide some or any of the functions necessary to the watershed.

DISCUSSION QUESTIONS

Is our riparian area healthy?

Does it provide the necessary conditions for a healthy watershed?