# Contents

## General Information on Salmon Watch


### A Volunteer's Role

| | |
|---|---|
| Volunteer Responsibilities | VR 2 |
| Safety & Site Impact Protocols | VR 3 |
| What to Bring on the Day of Your Field Trip | VR 4 |
| Possible Field Trip Activities | VR 5 |
| Sample Field Trip Schedules: | VR 8 |
| Sample 1. | |
| Sample 2. | |
| Tips for Salmon Watch Volunteers | VR 10 |
| The Service-Learning Project | VR 11 |
| Techniques for Working with Kids in Nature | VR 12 |
| Ages and Stages of Youth Development | VR 15 |
| Positive Comments to Give to Young People | VR 16 |

### Nature Awareness

| | |
|---|---|
| Introduction | NA 2 |
| Wildlife Watching: | NA 3 |
| The Freeze Game | |
| Splatter Vision | |
| Focused Hearing | |
| The Fox Walk | |

### Salmon Biology, Numbers, and Governmental Bodies that Regulate Salmon

| | |
|---|---|
| Introduction | SB 2 |
| Natural Life Cycle of Anadromous Fish | SB 3 |
| Where are the Salmon, When? | SB 4 |
| Chinook Salmon | SB 7 |
| Coho Salmon | SB 9 |
| Steelhead | SB 11 |
| The Most- Asked Questions About Salmon in the Sandy River | SB 13 |
| Current Status of Salmon Stocks | SB 15 |
| Hatcheries | SB 22 |

### Water Quality

| | |
|---|---|
| Introduction to Water Quality Analysis, Goals, Objectives, and Procedures | WQ 2 |
| Temperature | WQ 5 |
| Dissolved Oxygen | WQ 11 |
| pH | WQ 18 |
| Turbidity | WQ 23 |
| Flow | WQ 29 |
| Wrap-up or Debrief of Field Analysis | WQ 30 |
| Resources | WQ30 |
| Water Quality Data Forms | WQ31 |

## Aquatic Macroinvertebrates


Introduction to Macroinvertebrates AM 2
Field Study AM 4
In Depth Sampling Strategies and Collecting Techniques AM 6
Native and Invasive Aquatic Macroinvertebrates AM 7
Macroinvertebrates and the Aquatic Food Web AM 10
The River Continuum AM 13
Tolerant and Intolerant Identification Charts AM 15
Resources AM 18
Quick Reference Guide to Aquatic Macroinvertebrates AM 19
Aquatic Macroinvertebrates Data Form AM 23


## Riparian Ecosystem


Introduction to Riparian Areas R 2
Riparian Ecosystem Field Study R 9
- Riparian and Aquatic Area Survey
- Riparian Transect
- Riparian Mapping
- Riparian Profile
- Soil Survey
- Canopy Cover Survey

Identification of Northwest Native Trees R 18
Actively Managed Streamside Buffers R 26
Riparian Ecosystem Data Forms R 27


## Additional Information


Glossary G 1
Internet References G 11

GENERAL
INFORMATION

# The Freshwater Trust™

**The Freshwater Trust's Education Department** works to forge a lifelong caretaking bond between students and their local watersheds.





**Education Department objectives are to: Provide students with hands-on watershed-based learning; Support teachers in integrating inquiry-based watershed learning into their classrooms; Unite schools and communities in lasting partnerships; Contribute to the development of a statewide framework for environmental education; and improve the health of Oregon's freshwater ecosystems.**

## Salmon Watch®

Since 1993, Salmon Watch has served over 5,000 middle and high school students in Oregon annually. Working collaboratively with professional fish biologists and other natural resource volunteers, students view spawning salmon and learn about the interconnectedness of the natural world.

**Salmon Watch is designed to foster:**

→ A deeper connection between humans and our ecosystems;
→ A recognition of salmon as an indicator of watershed health;
→ A greater respect of the value of restoring native wild fish stocks;
→ An understanding of the importance of salmon to native cultures.

## Student Stewardship Program

Student Stewardship Program engages students in the maintenance and preservation of their local watershed through student driven projects that address local issues related to watershed health.

**Student Stewardship Projects are designed to:**

→ Engage students in community-based restoration projects;
→ Utilize an interdisciplinary approach;
→ Work with local partners to accomplish authentic restoration project goals;
→ Create ongoing opportunities for students to foster a stewardship ethic.


## StreamWebs™

StreamWebs gets students outside by linking classrooms with local watershed projects through the power of social networking.

**StreamWebs is designed to:**

→ Support teachers and community partners seeking to engage students in watershed projects;
→ Create an online forum for students to celebrate and share their watershed projects, artwork, and stories;
→ Recognize and reward student-driven efforts to restore watershed health;
→ Offer students career and higher education pathways in natural resources.

## Student Watershed Summit

The Freshwater Trust supports students in sharing and celebrating their stewardship projects with their communities through annual watershed summits.

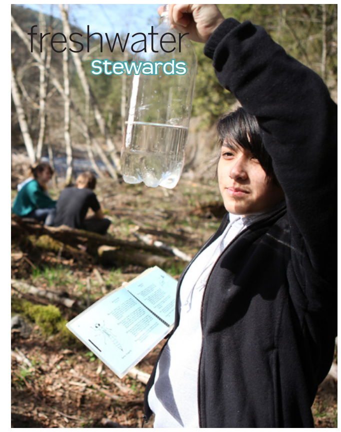

## Policy

The Freshwater Trust supports advocacy efforts aimed at re-connecting youth with the natural world including No Child Left Inside and No Oregon Child Left Inside (NOCLI) initiatives. The Freshwater Trust has assumed a leadership role in NOCLI through shepherding the legislation, coordinating the coalition, and serving as chair of the Oregon environmental literacy plan task force.

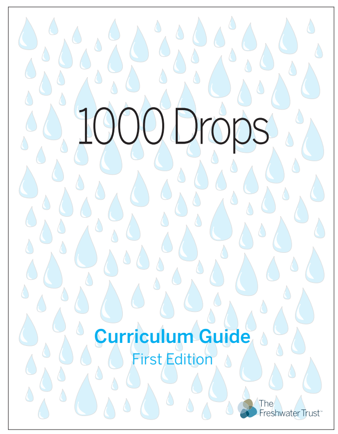

## Curricular Support

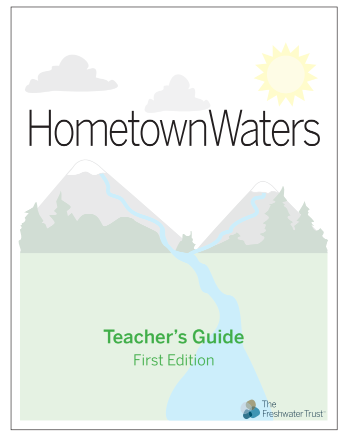
The Freshwater Trust supports teachers in the integration of watershed education through student journal publications (*freshwater kids* & *freshwater stewards*), curricular frameworks (1000 Drops & Hometown Waters) and virtual watershed tours.

**Publications:**

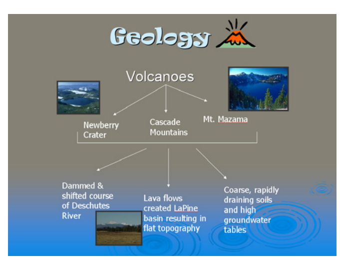

**Curricula:**

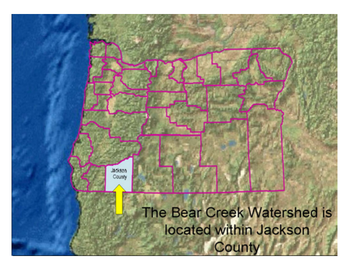



**Virtual Watershed Tours:**






The Freshwater Trust™
65 SW Yamhill Street, Suite 200
Portland, OR 97204
503.222.9091
www.thefreshwatertrust.org

VOLUNTEER'S ROLE

# Salmon Watch Volunteer Educator
# Position Description

**Position Title:** Salmon Watch Volunteer Educator

**Reports to:** The Freshwater Trust Education Staff

## Summary:

The Salmon Watch Volunteer Educator helps to teach Oregon's youth about salmon and watersheds through the Freshwater Trust's Salmon Watch program, an award-winning education program that centers on streamside field trips to view spawning salmon while learning about their life cycle and habitat.

Salmon Watch Volunteer Educators do not need an expert background in water education, but simply a desire to learn and a passion for teaching and getting kids outside. One time attendance at a free half-day training workshop in August or September is required and prepares the volunteer with knowledge about water quality, aquatic insects, streamside vegetation, fish biology and working with students.

In the fall the Salmon Watch Volunteer Educator becomes "o-fish-ial", providing the opportunity to share knowledge with middle and high school students on weekday field trips. Field trips typically begin around 9 a.m. and conclude between 1 and 2 p.m. Travel time to field trip sites averages about an hour and volunteers often carpool.

## Responsibilities:

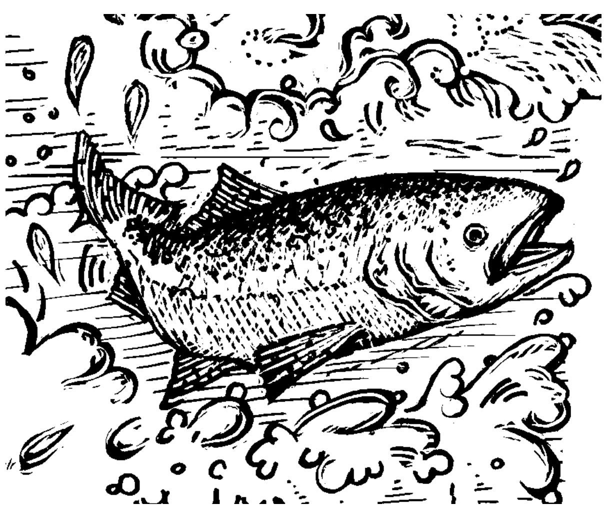
- Attend a one time half-day Salmon Watch training
- Sign-up for one or more Salmon Watch field trips to teach the learning station of your choice
- Communicate with classroom teacher prior to field trip
- Communicate with The Freshwater Trust Education Staff and teacher if available to pick up field trip equipment
- Be prepared to teach learning station on field trip through hands-on biological lessons about water, fish, habitat and the ecosystem of the river
- Arrive at stream site a minimum of 15 minutes prior to field trip to view site and prepare
- Teach learning station to four small rotations of students
- Clean up and organize field teaching equipment
- Complete volunteer evaluation
- Enhance the student experience with fun nature facts, utilizing enthusiasm and teachable moments
- Create awareness about the balance of all parts within an ecosystem
- Communicate specific strategies that students can take back "home" to protect and preserve salmon habitat
- Expand book knowledge received in school into experiential learning
- Cultivate environmental stewardship within students
- Have fun teaching students about the environment of the Pacific Northwest!

## Core Competencies:

1. Student Experience: Provide an educational experience that will catapult student minds into a greater appreciation and awareness of the environment in which they live.
2. Awareness: Provide students with appropriate "take home messages" that can be shared with their siblings, friends and parents.
3. Spawning Environmental Etiquette: Teach what is friendly environmental manner
4. Oral Communication: Express ideas clearly and concisely in an age-appropriate manner
5. Smile and Have Fun: This is the greatest field trip these students will ever have!

# A Volunteer's Role


- **Volunteer Responsibilities** **VR2**
- **Field Trip Safety and Site Impact Protocols** **VR3**
- **What to Bring on the Day of Your Field Trip** **VR4**
- **Possible Field Trip Activities** **VR5**
- **Sample Field Trip Schedules:** **VR8**
  **Sample 1.**
  **Sample 2.**
- **Tips for Salmon Watch Volunteers** **VR10**
- **The Service-Learning Project** **VR11**
- **Techniques for Working With Students** **VR12**
- **Ages and Stages of Youth Development** **VR15**
- **Positive Comments to Give to Young People** **VR16**

## Volunteer Responsibilities

- ❑ Attend the Salmon Watch Volunteer Training.
- ❑ Attend, if possible, the Salmon Watch Kick-Off Reception. Invitations will be sent to you with the date and location.
- ❑ Field Trip:
    - Sign up for one or more field trips.
    - Assist, support, and facilitate the student's field trip learning experience (the key is to find the balance between helpful and overbearing).
    - Communicate with teachers about trip agenda, equipment needs and teacher expectations.
    - Ensure safety! Make sure students understand and abide by the guidelines listed on the next page. Appropriate conduct on field trips is important because of the fragile condition and sensitive nature of the field trip sites.
    - Assist teacher with field trip as needed.
    - Participate in the evaluation of the field trip.

### Other Volunteer Opportunities (Optional)

- ❑ Service-learning Project:
    - If possible, accompany the field trip of the teacher and classroom with whom you will work on the project.
    - Communicate with The Freshwater Trust Staff or specific teacher about various opportunities within a project.
    - Assist teacher with project as needed.
    - Participate in the evaluation of the service learning project.
- ❑ Classroom Guest Speaker
    - Communicate with The Freshwater Trust Staff or specific teacher about various opportunities in the classroom.
- ❑ If interested, ask about other volunteer opportunities at The Freshwater Trust and Salmon Watch.
- ❑ Identify other interested volunteers and teachers to Salmon Watch!

## Field Trip Safety & Site Impact Protocols

**VOLUNTEER INSTRUCTORS:**

- If possible, arrive at the site 30 minutes before students arrive to discuss with all facilitators safety concerns, the day's agenda, and emergency procedures.
- If possible, bring extra clothing, rain gear, and food for unprepared students.
- Protect yourself from misunderstandings - never be alone with a student!

### ALL STATIONS

- Tread lightly, leave no trace, leave site cleaner than you found it, and never drink the water because it may cause illness.

### SALMON WATCHING

- **Salmon are a protected species under the Endangered Species Act. Harassment of any kind is in violation of federal law and will not be tolerated!** Throwing rocks or debris, getting in the water, running or jumping on the banks near the fish are all considered harassment. Students who engage in harassment will give up their opportunity to participate and will be asked to sit on the bus with a parent or teacher for the remainder of the field trip.
  Salmon are very sensitive to movement along the stream banks. To be able to see spawning fish, limit movement as much as possible during the period of observation. Whenever possible, view salmon from above (bridge, hillside, etc.). Be sure to use your Salmon Watch polarized glasses to cut the glare on the water for optimal viewing.

### AQUATIC MACROINVERTEBRATES STATION

- Macroinvertebrate sampling should be conducted well away from and downstream from salmon & redds.
- No more than four students in the stream/river at a time.
- In water above the knees, all participants are required to wear life vests.
- Avoid fast-moving water.
- Take care when walking on slippery rocks.

### WATER QUALITY TESTING STATION

- If using the LaMotte Dissolved Oxygen kit, rubber gloves and goggles are required, as potentially harmful chemicals are included in this kit.
- All refuse water from water chemistry kits must be poured and kept in the wastewater container. Dispose of wastewater back at school and not at the site.
- Rinse out all bottles and test tubes with clean water.
- Always wash your hands after water quality testing.

### RIPARIAN STATION

- No sandals or shorts are allowed on the field trip due to the potential of poisonous plants.
- Always stay with your group. Never wander off by yourself.
- Stay on the trail unless otherwise instructed by your facilitator.

## What to Bring on the Day of Your Field Trip

Please note that this list is designed to serve as a guide, and that you may not need all of the items listed below.

**<u>Personal</u>**

_____Rain Gear
_____Backpack or Knapsack
_____Lunch and Beverage
_____Notebook and Pen
_____Salmon Watch Volunteer Resource Packet
(or handouts from the packet)
_____Hat and Gloves
_____Drinking Water

**<u>Equipment for Teaching Stations</u>**

<u>Field Equipment:</u>
This includes monitoring or collecting equipment, field binoculars, field guides, ID keys needed for specific teaching stations as well as a field trip first aid kit.

(Note: The teacher is ultimately responsible for making sure equipment is available at the field site. Please coordinate the check out of field equipment with the teacher and/or The Freshwater Trust staff prior to your scheduled field trip)

**<u>Optional Items</u>**

_____ Camera and Film
_____ Extra Rain Gear for students (large plastic garbage or
leaf bags work well)
_____ Polarized Sunglasses for viewing fish

## Field Trip Activities

Described below are activities which have been used successfully by teachers on Salmon Watch field trips in the past. Teachers will be selecting activities from this list and you may be asked to lead one of these activities. More detail will be given on each activity in later sections of this handbook.

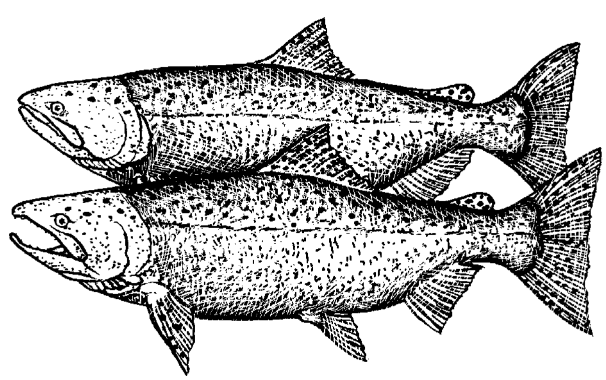
### Core Teaching Stations

- **Salmon Biology:** Usually taught by a fish biologist. Your Salmon Watch field trip is the perfect time for a discussion about the species of salmon they observe on the field trip, the life cycle, anatomy, spawning behavior and topics such as hatchery vs. wild fish.

- **Macroinvertebrates:** This activity reinforces what students have learned about water quality and the kinds of organisms that inhabit a stream with a particular water quality profile. At this station, students sample for macroinvertebrate populations in the stream and use that information to evaluate the health of the stream as salmon habitat.

- **Water Quality:** The salmon's home stream helped to form the land through which it flows, and in turn, is modified by the land and its inhabitants. First hand experience of the riparian habitat and water quality parameters will strengthen the students' connection to the salmon and illustrates other ways humans impact the salmon life cycle. Parameters to test on your Salmon Watch field trip will include temperature, pH, turbidity, and dissolved oxygen.

- **Riparian Environment:** It is important that during their Salmon Watch field trip students understand the interrelationship among salmon, humans and the watershed they share. This station allows students to understand salmon in a larger context and emphasizes the importance of high quality habitat for salmon survival. Activities that help students gain a broader perspective include: habitat evaluation, stream mapping, food webs, or human impacts.



## Optional Activities

- **Journal Writing:** Optional as the teacher will be taking the lead on journal writing. Find several areas where the forest floor is relatively clear, or the stream bank provides a place which "feels quiet". Adult volunteers can take students to these quiet places. The volunteer should sit down, and remind students of the assignment that was made in class: students are to relax and open their minds (be present) to the place where they are. When they feel ready, they can respond to the assignment that has been posed. This assignment can include describing their thoughts or feelings, writing a poem, relating their experiences to a parent in a letter, etc. Once the students are engaged, the volunteers leave and gather at a base area designated by the teacher. When students have finished writing, they also move to the base area. (They have been instructed by the teacher beforehand to do this.)

- **Native American Culture/Philosophy:** If available, a Native American who is knowledgeable about the role that salmon play in the culture of Pacific Northwest Indian tribes might share legends or other information that will allow students to better appreciate the importance of salmon to Native Americans. Encourage your students to prepare questions beforehand. Other topics might include treaty rights, tribal customs, and attitudes toward nature, music, dance, artifacts, art or food.

- **Nature Walk:** This activity encourages student to observe of their surroundings and enhance their data collection skills. Have your students identify their location on maps if available, then document observed wildlife and wildlife signs. This could also include plant identification, bird watching, and animal signs. This data could be shared with other classrooms to create an annual site profile.

- **Art/Poetry:** An art and/or poetry station has worked well for an interdisciplinary field trip and allows the students to experience nature, and the salmon, on many different levels. Past activities have included drawing, painting, making fish prints, and writing haiku poetry.

- **Guided Visualization:** The teacher may choose this activity or you can communicate with the teacher if this is something you are interested in leading. Find a quiet place for this station, one which is close to the stream. An excellent example of a recorded guided visualization is The Drought by Barry Lopez.

- **Miscellaneous Other Activities:** The game, "Hooks and Ladders", allows students to appreciate the strength, determination, and perseverance of the salmon along their life's journey. This activity takes a large open space and is best done with the whole class. Teachers may do this on the school grounds either before or after the field trip.

- **Flycasting Demonstration:** If you or one of your adult volunteers are interested in flyfishing, then a possible station might be a demonstration on flyfishing techniques, along with a discussion on issues such as catch & release fishing.

- **Salmon Politics:** This may be incorporated into the Salmon Biology station or integrated into the other teaching stations. The salmon crisis is one of the most studied issues in the Pacific Northwest today. What better time to start students thinking about these issues than when they are sitting beside a salmon stream watching the miracle of spawning? Experiencing salmon and their watershed on a personal level will give students powerful insight into discussions about historic abundance of salmon and declining runs, factors contributing to population declines, the Endangered Species Act, possible solutions, importance of salmon in the Pacific Northwest, and what individuals can do to help.

## Sample Field Trip Schedules

(Note: the time that students spend at each teaching station generally varies from 25 to 45 minutes. This is determined by the time required to travel to the site, number of rotations and when buses need to be back to school.)

---

**Sample 1.**

### SALMON WATCH 1999

Peggy Potter
HB Lee Middle School
November 1, 1999
Field Trip to Eagle Creek Site
Columbia River Gorge

| | |
|---|---|
| 9:15 | Bus leaves HB Lee |
| 10:00 | Arrive at Eagle Creek Site<br>Orientation/Introduction<br>Students will be split into 4 groups and rotate through 4 separate activities. |
| 10:20 – 10:50 | Activity 1 – Current issues. Life Cycle of the Salmon<br>Ron Garst |
| 10:55 – 11:25 | Activity 2 – Macroinvertebrates –<br>Michele Dickson and Bob Delgizzi |
| 11:30 – 12:00 | Activity 3 – Water Quality<br>Paul Sybor and Adrienne Ash |
| 12:05 – 12:35 | Activity 4 – Native American legends<br>Michelle Barnier |
| 12:40 – 1:00 | Lunch |
| 1:00 | Wrap up, thank volunteers |
| 1:10 | Board Bus and head back to HB Lee |
| 1:55 | Arrive back at HB Lee Middle School |

**Sample 2.**

## SALMON WATCH FIELD TRIP
**Camp 18 Field Site**
**November 8, 1999**

| | | |
|---|---|---|
| 8:00 | Assemble and board bus in front of school | |
| 9:15 | Arrive at Camp 18<br>Introduction of volunteers, station assignments, overview of stream | |

<u>Our helpers today are:</u>

Marianne McPherson – Macroinvertebrates
Vanessa Davis – Water Quality
Ed Hughes – Riparian Zone
Chad Hewitt – Salmon Viewing

9:30 – 12:05 Four stations in 35 minute rotations

| | |
|---|---|
| Approximately: | 9:30 – 10:05 |
| | 10:10 – 10:45 |
| | 10:50 – 11:25 |
| | 11:30 – 12:05 |

| | |
|---|---|
| Station #1 | Water Quality |
| Station #2 | Macroinvertebrates |
| Station #3 | Riparian Zone |
| Station #4 | Salmon Viewing |

| | |
|---|---|
| Group #1 | 1234 |
| Group #2 | 2341 |
| Group #3 | 3412 |
| Group #4 | 4123 |

| | |
|---|---|
| 12:10 – 12:30 | Summation and Reflection<br>Thank Volunteers |
| 12:30 – 1:15 | Lunch |
| 1:30 | Depart Camp 18 (LEAVE THE SITE AS YOU FOUND IT OR BETTER!) |
| 2:45 | Arrive at St. Mary's |

## 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.

- **Service-Learning Projects**

What is Service-Learning?

Service-learning is a method by which young people learn through active participation in thoughtfully organized experiences that:

- Meet actual community needs.
- Coordinate in collaboration with the school and community.
- Integrate into each young person's academic curriculum.
- Provide structured time for a young person to think, talk, and write about what he/she did and/or saw during the service learning activity.
- Provide young people with opportunities to apply newly acquired academic skills and knowledge to real life situations in their communities.
- Are practical applications of what is taught in the school.

Service-learning projects should address local issues and impact the community in which the students live, while providing a relevant learning experience. Students should be challenged to keep a vision, to work with community members, and to make an impact! Salmon Watch encourages teachers and student groups to utilize partner resources, especially those that support Salmon Watch.

Depending on the interests of the student body and local influences on community needs, each project will have unique opportunities and constraints. The balance struck between these features will become the ultimate plan, and represents real problem solving. Students must document each phase of planning and implementation. This will serve not only as a reference for current and subsequent projects, but also as a tool for reflection. (Journal writing is a suggested way to ensure that students keep good records of the process and meet stated objectives.)

**The Role of the Volunteer**

The role of the volunteer in planning and implementing service learning projects will be as varied as the projects themselves. One may wish to speak in the classroom on their subject of expertise, or provide leadership in the field. If interested in helping, please ask your field trip teacher or Salmon Watch staff how your skills can best be utilized!

# 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.

## Ages and Stages of Youth Development

Not all people develop in the same way at the same age, but there are certain patterns to youth development that are commonly experienced by most youth.

| **Grades 6-8** | |
|---|---|
| **Characteristics** | **Teaching Tips** |
| Can take responsibility in planning and evaluating their own work. | Give youth responsibility for group activities, including planning, and implementing and evaluating. |
| Can plan their own social and recreational activity. | Provide opportunities for youth to work together. Form committees to plan recreational and social activities. |
| Can discuss current events, international affairs and social issues with some help. | Use discussion activities and games that encourage awareness of current events and issues. |
| Want to make decisions but still depend on adult guidelines. | Establish guidelines that give parameters for youth to follow. |
| Gain skills in social relations with peers and adults. | Provide activities that foster social interaction with peers and adults. |
| Peer pressure mounts, first from same sex, then from opposite sex. | Use peer pressure to influence positive behavior. Have group give encouragement to individuals. |
| Can be quite self-conscious. | Avoid asking youth to share their work individually until they feel more comfortable with the group. |
| Strong emotional attachment to older youth and adults. | Encourage youth to participate in activities with older youth and adults. |
| Choices are often unrealistic. | Assist youth in making realistic choices. Review their plans, discuss alternatives and help them weigh options before making decisions. |

| Grades 9-12 | |
|---|---|
| **Characteristics** | **Teaching Tips** |
| Personal philosophy begins to emerge. | Use activities where youth search for experiences that will allow them to identify their own philosophies. |
| Enjoy discussing the world situations as well as personal activities. | Encourage discussion of events and feelings. |
| Abstract thinking and problem solving reach a higher level. | Put youth into real-life, problem-solving situations. |
| Strong desire for status in their peer group. | Develop a climate in which youth are encouraged and supported by peers. |
| High interest in social activity. | Encourage youth to plan and carry out their own social activities. |
| Need freedom from parental control to make decisions. | Help youth realize that their decisions have consequences. |
| Widespread feelings of inferiority and inadequacy. | Encourage and help youth see their positive worth. |

## Positive Comments to Give Young People

Try again. You can do it.

Let me show you, then you can try.

I know you can do it.

Let me explain it to you again.

Your opinion counts
.
What are some things that you could have done?

I respect your opinion.

We are a team, together we can accomplish…

You're good you have some special skills.

I'm glad you made an effort…

This is how I feel when we succeed together…

Resource List:
Larwood, Lillian, *Ages and Stages of Youth Development,* OSU Extension 4-H Youth Development, November 2003

# Nature Awareness


- **Introduction** **NA2**
- **Wildlife Watching** **NA3**

  **The Freeze Game**

  **Splatter Vision**

  **Focused Hearing**

  **The Fox Walk**


# Wildlife Watching and Setting the Tone on Field Trips

Teachers are in charge of their field trips but may not be experienced outdoor educators, and may not realize that human behavior influences what can be observed on a field trip.  Many might be very grateful for extra support in helping their students learn appropriate outdoor behavior.

Setting the tone at the very beginning of the field trip is key. Having opening and closing circles can enhance the overall quality of the field trip. Also incorporating quiet listening moments at the end of each activity can increase the opportunity for wildlife viewing. After students have been quietly absorbed in data collection a return to "baseline" can occur, which can be described as when wildlife becomes less aware or more comfortable with our presence, thus enabling their movement back into an area.

Teachers may cover the wildlife watching techniques with the students before they arrive at the site.  Setting the tone can start with the transition from the bus to the field study site by encouraging students not to talk as they move from the bus to the opening circle location. Salmon Watch staff can suggest appropriate locations for opening circles for each site.

The teacher or volunteer can help to lead the nature awareness activities during the opening circle. The closing circle is usually led by the teacher and is where students share what they have discovered on the field trip.  Also this is an opportunity to thank the volunteers and other adults who supported the field trip.

**How can you tell if Wildlife Watching Techniques are working on your field trip?**

Answer these questions to find out.  (Note- any birds or animals that have been trained to beg for food do not count as animal encounters.)

1. How many mammals and birds did your group observe, collectively?
2. How close?  Or, from what distance?
3. Was your group able to observe mammals or birds in their normal setting and with undisturbed behavior? (singing, feeding, resting, etc.)  For how long?
4. Did you see birds or mammals that others in the group did not see?  Why didn't the others see them?
5. What is the best "animal experience" story you have to tell about today?

Advanced training for interested volunteers is available through the Metro Parks Greenspaces Program.

## Wildlife Watching

**Stop** **Stop talking** – become a tree, a rock, an animal…
Stop – when there is an alarm call.
Stop – when an animal looks at you.
Stop – learn to **freeze**.

**Look** Look – with splatter vision to see movement
Look – at edges of fields and near water.
Look – for tracks and signs.
Look – at **dawn and dusk**.

**Listen** Listen – what are the birds saying?
Listen – for **alarms** or **concentric** rings.
Listen – for a rustle, snuffle, swish, crunch…
Listen – can you hear your breathing?

**Move** Move - with the **foxwalk**.
Move – in **slow motion**
Move – when an animal looks away from you.
Move – with the wind

**(a) The Freeze Game**

Would you like to know how it feels to be invisible?

At the word **freeze!** – stay perfectly still. You can breathe and you can blink – but that is all.

Stay “frozen” for a moment…Pretend that you have become a statue, a rock or a tree. If a rabbit or a deer is scared, this is what they do. Their colors blend in with the forest and allow them to disappear (camouflage).

If you are looking at a deer who has “frozen”, you should try to stay still as long as the deer can. You may have to stay still for a long time! Finally, the deer will forget that you are there. It will look away from you. Now is your chance to move closer to it! Any time the deer looks at you – **freeze!**

Use the freeze game when you are watching wildlife and also when you hear an **alarm call.** This is short, choppy call given by a bird or squirrel to let the other animals know there is danger nearby. Even a hummingbird has an alarm call! Is the alarm call nearby? Wait for it to stop before you move. Is it far away? Perhaps another animal or person is moving in the woods and birds have spotted them. Soon you can learn to understand the birds.

Invent a hand signal for **freeze!** to use on your walks. You don’t want to shout, “freeze!” and scare everything away!

---

If you have an hour or two, try finding a nice spot in a park, forest or your backyard. Then sit down, get comfortable and **freeze!** After a while, the birds begin to sing and come closer to you. Soon you will be in a new world full of surprises – animals walking, eating, playing or hunting. That’s the way the forest is when there are no people around!

You have become invisible!

## (b)Splatter Vision

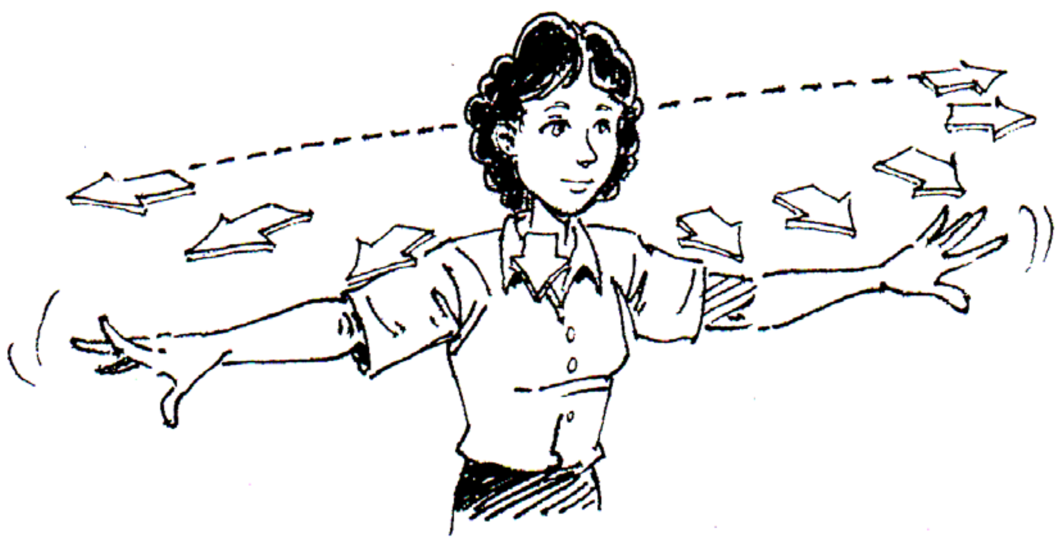
Would you like to see twice as much – even in your own back yard?

Most people have learned to focus on one small area at a time. We look at a person's face, a book or a television and blot out the surrounding areas. It is like looking through a little tube all the time.

Most animals see in a different way. They have to be aware of what is moving in the forest – is it food or will it eat me? They need to see and hear in all directions – not just in front of them. Their lives depend on this.

We can learn from our animal friends how to see much more – try **splatter vision**.

First put your arms straight out to the sides at shoulder level.
Then point your fingers forward and wiggle them.
By looking straight ahead – get so that you can see both hands:



Think of seeing out of the corners of your eyes.

Everything may seem a little blurry – but you will now be able to catch the slightest *movement* around you -–even at your sides. If a bird blinks, you'll see it. A blade of grass moving differently than the other – is there a mouse there? Every bug in the vicinity will be seen too? If you spot something you want to look at – then you can focus as you normally do.

After a few tries **splatter vision** becomes automatic and easy for anyone to do.

The next step is to sit down in your back yard, field or forest and try **splatter vision**.
Welcome to a new world!

## (c) Focused Hearing

How much can you hear? As much as a deer, a fox or an owl?
Close your eyes, take a deep breath, relax and listen.
Take your time and focus:

What is the most distant sound you hear?

What is the nearest sound you can pick out?

How about all the sounds in between the near and far?

Can you hear your own breathing?

Can you hear your heart beating?

**Listen closely to what the birds are saying.**

Are they making long and musical sounds?  If they are – *singing* and all is well with them.

Are they making a short, choppy and hard to locate sound? That is called an *alarm call*. Birds use alarm calls to warn other birds and animals of approaching danger. Some alarm calls are loud and easy to hear – like a jay or a crow.  Bur even very small birds have alarm calls – it may be tiny chirp that is hard to hear.  Even the smallest alarm call is the birds' way of shouting, "There is danger coming! Hide! Run away!" to all other animals in the forest.

If you hear an alarm call near you, chances are that the bird is warning other animals in the forest that *you* are approaching! If you hear an alarm call not in your immediate area, it could mean that there is another animal moving.  Or it could be that there is a disturbance being made even further away…

You see, if a loud, scary, dangerous animal moves through the forest (like a *human* for example), the alarm calls will move outward from the source of the danger.  It is like dropping a rock in a pond – the concentric rings of disturbance move out in larger and larger circles.

Can you detect any **concentric rings**?

Birds will make different types of alarm calls for different dangers – people, deer, fox, snake, etc. You can learn to understand them!

Another type of **concentric ring** is a bird flying rapidly.  Or if the forest is very quiet it means that some danger is near, passed through recently, or that you are creating a disturbance.

Try putting on **deer ears**.  Just cup your ears with your elbows pointed *forward*.  This will let you focus and amplify the slightest rustle, swish or sound in the forest.

## (d) The Fox Walk

We can learn from our four-legged friends how to walk silently and unseen. The fox is especially good at sneaking softly through the forest.

First – **stop talking**!

Then – try the **Fox Walk**:

1. Try taking a short slow step and place only the outside edge of your foot on the ground.

2. Gently roll your foot down flat.

3. Then slowly move your weight forward.

4. Repeat with the other foot…

With this walk you can **freeze** easily (if an animal looks towards you or you hear an alarm call). If you feel a twig that might break – just pick up your foot and place it in a new spot. You don't need to look down – just feel the way.

It is best to use **slow motion**.

Try the **Rabbit Game**: Have your group form a circle with one person in the center pretending to be a rabbit. When the rabbit looks at you **freeze**! When the rabbit is not looking at you, **Fox Walk** toward it. See who can reach the rabbit first. Try two rabbits. This is the same way to sneak up on a real animal.

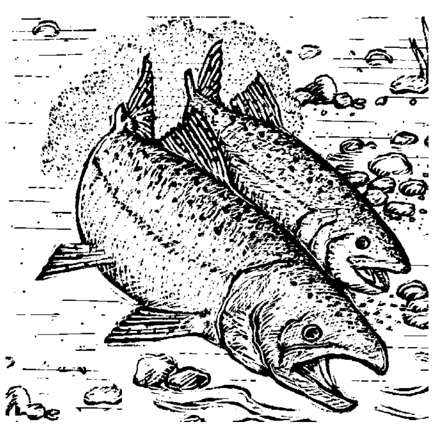
Try the **Fox Walk** at home. See if you can sneak up on a cat or dog. Don't scare them. Just try to get near them, and then let them know that you are there and just practicing.

Then go outside and try the **Fox Walk** on beetles, bugs, birds, frogs, chipmunks, squirrels, deer or anything else. With care you can get close to lots of different animals. Remember just get near and enjoy watching them, don't touch them or startle them. This is part of becoming invisible and enjoying the world of the four-legged and winged creatures!

Resource List:
For more information, see books and field guides by Tom Brown Jr.

# Salmon Biology, Numbers, and Governmental Bodies that Regulate Salmon


- **Introduction** **SB2**
- **Natural Life Cycle of Anadromous Fish** **SB3**
- **Where are the Salmon, When?** **SB4**
- **Chinook Salmon** **SB7**
- **Coho Salmon** **SB9**
- **Steelhead** **SB11**
- **The Most –Asked Questions About Salmon in the Sandy River** **SB13**
- **Status of Salmon Stocks** **SB15**
  **- Healthy Salmon Stocks of the West Coast**
  **- Factors Responsible for the Decline in Salmon Abundance and Distribution in the Pacific Northwest**
  **- Causes of Mortality, 1770-present**
  **- Government Bodies that Regulate Salmon**
- **Hatcheries** **SB22**

## Introduction to Salmon Biology

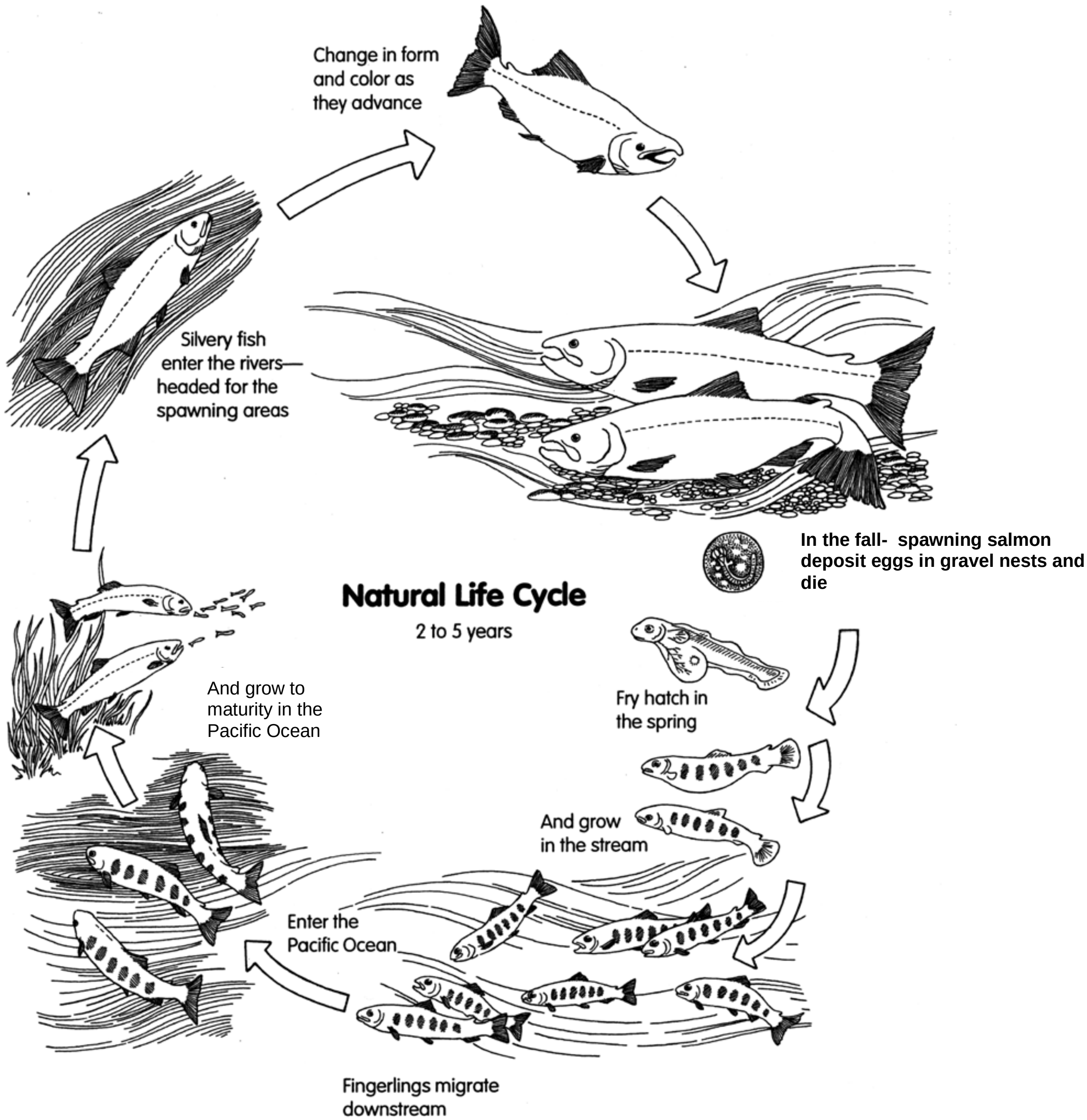
This section will provide information on the biology and life history of northwest salmon, starting with the natural life cycle of salmon and continuing with more specific information about species you may encounter on a Salmon Watch field trip.

**Table 1**: “Where Are The Salmon When?” provides a generalized life history pattern for Salmon, Steelhead and Trout in the Pacific Northwest. Some of the information included is timing of adult returns from the ocean, spawning location, a description of fresh water habitat and when juvenile migration to the ocean occurs.

**Table 2**: “Habitat Requirements for Salmonids in Northern Coastal Streams” includes specific habitat information for Fall Chinook, Spring Chinook, Coho, Chum, Winter Steelhead, Summer Steelhead and Sea Run Cutthroat Trout. Some of the habitat components listed are spawning location, substrate size, water depth and velocity, dissolved oxygen and water temperature.

This information is intended to support the volunteers leading the Salmon Biology teaching station in the field. It will also help bring together the data and observations of students as they start their stream assessments and evaluations of healthy salmon habitat.

Doug Baus, US Fish and Wildlife Service, with HB Lee students and a salmon carcass on the Salmon River.




**Length of life cycle varies with species and conditions**

**Table 1. WHERE ARE THE SALMON, WHEN?**

**Generalized** Life History Patterns of Salmon, Steelhead, and Trout in the Pacific Northwest

| | ADULTS RETURN TO STREAMS FROM OCEAN | SPAWNING LOCATION | EGGS IN GRAVEL** | YOUNG IN STREAM | FRESH WATER HABITAT | YOUNG MIGRATE DOWNSTREAM | TIME IN ESTUARY | TIME IN OCEAN | ADULT WEIGHT (average) English(Metric) |
|---|---|---|---|---|---|---|---|---|---|
| **COHO** | Sept. –Jan | coastal streams shallow tributaries | Sept -May | 1+ years | tributaries, main stem side channels, and slack water | Mar-Jul (2nd year) | few days to one month | 2 years | 5-20 lb (8) |
| **CHUM** | Sep. –Jan | coastal rivers and streams, lower reaches | Sep-Mar | days-weeks | little time spent in freshwater | shortly after young leave gravel | 7-14 days | 2.5-3 years | 8-12 lb. (10) |
| **CHINOOK**<br>**Spring run**<br>**Summer run**<br>**Fall run** | Jan. – July<br>Jun-mid Aug<br>Aug. – Nov. | main stem-large and small rivers | Jul-Jan<br>Sep-Nov<br>Sep-Mar | 1+ years<br>1+ years<br>3-7 months | main stem-large and small rivers | Dec – Mar. (2nd year)<br>Spring (2nd year)<br>Dec. - Mar (2nd year) | days-months | 2-5 years | 10-20 lb. (15)<br>10-30 lb. (14)<br>15-40 lb. |
| **CUTTHROAT (Coastal-Sea Run)** | Jul-Dec | tiny tributaries of coastal streams | Dec-Jul | 1-3 years (2 avg) | tributaries | Mar-Jun (of 2nd-4th yr) | days-months | 0.5-1year | 0.5-4 lb (1) |
| **PINK** | Jul-Oct | main stem of streams, tributaries, and lower reaches | Aug.-Jan | days-weeks | little time spent in freshwater | Dec-May | few days | 1.5 years | 3-10 lb (4) |
| **SOCKEYE** | Jul-Aug | streams, usually near lakes | Aug. –Apr | 1-3 years | lakes | Apr-Jun (of 2nd-4th yr) | few days | 1-4 years | 3-8 lb (6) |
| **STEELHEAD*****<br>**Winter run**<br>**Summer run** | Oct-Jun<br>Jun-Oct (Columbia)<br>Apr-Nov (Coastal) | tributaries and small and mid-size streams and rivers | Feb-Jul<br>Dec-May<br>Feb-Jun<br>Feb-Jul | 1-3 years<br>1-2 years<br>1-2 years<br>1-3 years | tributaries | Mar-Jun (of 2nd – 5th yr)<br>Spring & Summer (of 3rd-4th yr)<br>Mar-Jun (of 3rd-5th yr)<br>Mar-Jun (of 2nd-5th yr) | less than a month | 1-4 years | 5-28 lb (8)<br>5-20 lb<br>5-30 lb (8) |

**Adapted by Pacific State 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** (continued)
**Oregon Coastal Streams**
**Spawning (including upstream migration)**

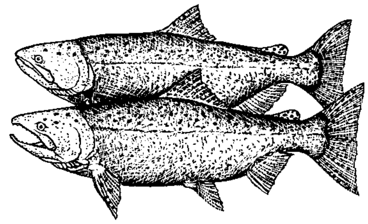
| | Migration | Spawn Time | Location | Substrate Size | Water Depth | Water Velocity | Dissolved Oxygen | Spawning Water Temp | Percent Fines Tolerable | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Chinook – Fall | Sep-Dec | Oct- Jan | Mainstem and large tributaries | Pea to orange (1.3-10.2 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 | Sep-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 |

## Salmonid Habitat Requirements
## Oregon Coastal Streams

| | Incubation | | Rearing | | | | | | Status |
|---|---|---|---|---|---|---|---|---|---|
| | Incubation Temp. | Fry Emerge | Fry Habitat | Juvenile Habitat | Preferred Temp. | Freshwater Residency Period | Estuary Residency Period | Notes | 2004 Status |
| Chinook – Fall | 0.0-20°C; best 5.0-14.4° C | Mar-May | Stream; river edges | Deeper water in main river channel | 7.3-14.6° C Growth stops at 20.3° C lethal at 25.2° C | Days to 2 or 3 months<br>Fall smolt | Extensive 5-6 months April-Oct. | Estuaries play a vital role in survival of young | Healthy and stable |
| Chinook-Spring | 0.0-20°C; best 5.0-14.4° C | Feb-Mar | Stream; River edges | Deeper water in main river channel | 7.3-14.6° C Growth stops at 20.3° C lethal at 25.2° C | Days to 2 or 3 months<br>Fall smolt | Extensive 5-6 months<br>April – Oct | Large body size limits movement over barriers | Depressed |
| Coho | 4.4-13.3° C | Feb-June | Backwater pools and stream edges | Pools in summer, off channel alcoves, ponds, dam pools with complex cover in winter | 11.8 – 14.6° C Growth stops at 20.3° C Lethal at 25.8° C | One year<br>Spring smolt | Move through 2-9 days, sometimes longer | Low pH (<5.01) can be lethal to alevins | Depressed |
| Chum | 4.4 – 13.3°C | Late Mar-Apr | Move directly into estuary | High sediment levels (15.8-54.9 g/l) will kill juveniles | 6.7 – 14.6°C Growth stops at 20.3°C lethal at 25.8°C | Hours to few days, leave quickly Spring smolt | 2-32 days | Use estuaries immediately for food and adjustment | Depressed |
| Steelhead Winter | 4.4- 13.3° C | May – June | Stream Edges | Pools, riffles, and runs of tributary, streams, complex habitat with, large woody debris, (LWD) preferred | 7.3-14.6°C Growth stops at 20.3° C Lethal at 24.1° C | 2-3 years Spring smolt | Move through in days | Good habitat =small and large wood complexity | Depressed |
| Steelhead-Summer | 4.4 – 13.3°C | May-June | Stream edges | Pools, riffles, and runs of tributary, streams, complex habitat with, large woody debris, (LWD) preferred | 7.3 – 14.6°C Growth stops at 20.3° C lethal at 24.1°C | 2-3 years<br>Spring smolt | Move through in days | Summer steelhead require deep cool pools to live in before spawning | Primarily hatchery fish |
| Sea Run Cutthroat Trout | 6.1 – 17.2°C | Mar-May | Stream Edges and backwater pools, large wood, (LWD) important | Prefer pools but are often displaced by coho or steelhead, low velocity pools, and side channels | 9.5-12.9°C Growth stops at 20.3°C lethal at 23.0°C | 2-4 Years<br>Spring smolt | Used extensively as adults before upstream migration | Rearing in estuary is common | Depressed |


1. Emmett, R.L., S.L. Stone, S.A. Hinton, and M.C. Monaco. 1991. *Distribution and abundance of fishes and invertebrates in West Coast estuaries*, Volume 11: *Species life history summaries*. ELMR Rep. No. 8
2. Groot, C. and L. Margolis, 1991. *Pacific Salmon Life Histories*. UBC Press, Vancouver, British Columbia
3. Nickelson, T., J. Nicholas, A. McGie, R. Lindsay, D. Bottom, R. Kaiser, and S. Jacobs. 1992. *Status of Anadromous Salmonids in Oregon coastal Basins*. Oregon Dept. of Fish and Wildlife. Corvallis, OR
4. Reiser, D.W. and T.C. Bjornn, 1979 Habitat Requirements of Anadromous Salmonids. In W.R. Meehan (editor), *Influence of forest and rangeland management on anadromous fish habitat in western North America*, US Forest Service General Technical Report PNW-96 Pacific Northwest Forest Range Experiment Station, Portland, OR.

# CHINOOK SALMON



**DID YOU KNOW?** Chinook salmon may spend between 1 to 8 years in the ocean before returning to their natal streams to spawn; though the average is 3 to 4 years.

**SCIENTIFIC NAME:** Oncorhynchus tshawytscha, ("on-ko-rink-us tau-wee-cha") from the Greek word onkos (hook), rynchos (nose) and tshawytscha (the common name for the species in Siberia and Alaska).

**COMMON NAMES:** King salmon, tyee salmon, Columbia River salmon, black salmon, chub salmon, hook bill salmon, winter salmon, tules and blackmouth.

**DESCRIPTION:** The chinook salmon is blue-green on the back and top of the head with silvery sides and white bellies; black spots on the upper half of its body with gray/black mouth coloration. Up to 58 inches in length and weigh up to 129 pounds; although chinook salmon are generally up to 36 inches in length and weigh up to 30 pounds.

**LIFE CYCLE:** Spawning in streams that are larger and deeper than other salmon utilize, chinook salmon spawn from late summer to late fall, depending on the run. Fry and smolts usually stay in freshwater from 1 to 18 months before traveling downstream to estuaries, where they remain up to 6 months. Chinook salmon spend 1 to 8 years at sea before returning to natal streams to spawn.

**RANGE:** Chinook salmon range from Kotzebue Sound, Alaska, to Santa Barbara, California. Spawning and rearing chinook are found in most of the rivers in this region, with significant runs in the Columbia River, Rogue River, and Puget Sound.

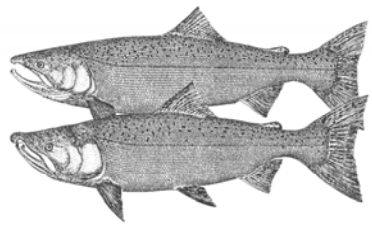
**HABITAT AND ECOLOGY:** Freshwater streams and estuaries provide important habitat for chinook salmon. They feed on terrestrial and aquatic insects, amphipods, and other crustaceans while young and primarily on other fish when older in the ocean. Eggs are laid in deeper water with larger gravel, and need cool water and good water flow (to supply oxygen) to survive. Mortality of chinook salmon in the early life stages is usually high due to natural predation and human induced changes in habitat, such as siltation, high water temperatures, low oxygen conditions, loss of stream cover and reductions in river flow. These impacts are the result of poor agricultural, and forestry practices, dams, and water diversions. Some of the causes of adult mortality are harvest, predators, poor ocean conditions, and changes in hydrology.

Estuaries and their associated wetlands provide vital nursery areas for the chinook prior to its departure to the open ocean. Wetlands not only help buffer the estuary from silt and pollutants, but also provide important feeding and hiding areas. The draining and filling of wetlands and the pollution of the estuary from industrial discharges and run-off negatively impact chinook salmon.

**ECONOMIC VALUE:** Chinook salmon are highly valued by commercial fishermen. Chinook salmon are also an important subsistence fish and a valuable recreational resource.

Prepared by the Pacific States Marine Fisheries Commission, F.I.S.H. Habitat Education Program.

# COHO SALMON



**DID YOU KNOW?** Oregon's coastal rivers produced 1.4 million coho in 1900. Runs in the 1990's hovered around 20,000, but have rebounded to 200,000 in recent years.

**SCIENTIFIC NAME**: <u>Oncorhynchus kisutch</u>, ("on-ko-rink-us ki-sooch") from the Greek word onko (hook), rynchos (nose) and kisutch, the common name for the species in Siberia and Alaska.

**COMMON NAMES**: Silver salmon, blueback salmon, salmon trout, silverside salmon and white salmon.

**DESCRIPTION:** The coho salmon is bluish-black with silver sides in saltwater; black spots on the back and upper part of the caudal fin. Smaller and slimmer than the chinook salmon; the inside of the mouth is gray or black with white gums. Coho salmon reach up to 38.5 inches in length and weigh up to 31 pounds; although they usually weigh between 6 to 12 pounds.

**LIFE CYCLE**: Spawning occurs from September to January, with the eggs hatching the following spring. Coho fry remain in streams one to two years. Moving seaward the following spring, most cohos return to spawn when they are three years old. The mature male fish which return early are known as "jacks" and in Oregon and Washington, the abundance of "jacks" are used to predict the next year's three year old return.

**HABITAT AND ECOLOGY**: Coho salmon utilize freshwater, near-shore and offshore environments during its lifecycle. Coho salmon have similar spawning habitat requirements as chinook; however, coho prefer lower stream velocity, shallower water and smaller gravel. Most coho fry stay in the stream for over a year feeding on aquatic insects, zooplankton and small fish. Adequate stream cover is important to fry survival, as is high dissolved oxygen levels, and off-stream channel habitat such as ponds and sloughs.

Mortality is especially high during freshwater life stages, often a result of poor forest and agricultural management practices that lead to siltation, which may ruin spawning beds or smother the eggs. Migrating coho salmon also face physical obstacles and high water temperatures resulting from dams, inadequate water flows due to diversions for irrigation and impoundment of water for power generation. Harvest, competition with hatchery fish, and poor ocean conditions may also contribute to mortality.

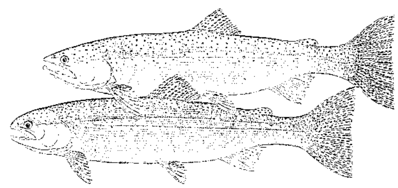
Once reaching the estuaries, coho salmon fall prey to a number of other species and may be impacted by human changes, such as shoreline development, residential drainage and the filling of marine wetlands. The time spent in this habitat is critical to the development of the species and their ability to survive in the offshore environment.

**RANGE:** Coho salmon spawn in coastal streams from Northern Japan to the Anadyr River in Siberia and from Monterey Bay in California to Point Hope in Alaska. This species can also be found in the ocean from Baja, California, to the Bering Sea in Alaska. Major U.S. spawning grounds are in Alaska, Washington and Oregon.

**ECONOMIC VALUE**: The fourth most abundant salmon species, coho salmon are a culturally and economically important resource, and an important subsistence fish.

Prepared by the Pacific States Marine Fisheries Commission, F.I.S.H. Habitat Education Program.

# STEELHEAD



**DID YOU KNOW?** Steelhead may spawn several times, unlike most salmon, which die after spawning.

**SCIENTIFICNAME:** Oncorhynchus mykiss, ("on-ko-rink-us my-kiss") previously known as Salmo gairdneri.

**COMMON NAMES:** Kamchatka salmon trout, coastal rainbow trout, silvertrout, salmon trout, steelie, hardhead and ironhead**.**

**DESCRIPTION:** In the sea, bluish from above and silvery from below – tends to be more greenish in freshwater. Small black spots on back and most fins. Up to 45 inches in length and 40 pounds in weight; although usually weighs less than 10 pounds.

**LIFECYCLE:** Spawning in streams and rivers, steelhead rear in freshwater for 1 to 4 years before migrating downstream through estuaries to the open ocean. Steelhead spend 1 to 5 years at sea before returning to natal streams or rivers. At least two categories of stocks of steelhead have developed; those that enter fresh water during fall, winter and early spring -- the winter run -- and those that enter in spring, summer and early fall -- the summer run. Steelhead do not always die after spawning; some will migrate through estuaries to the ocean again.

**HABITAT AND ECOLOGY:** Steelhead rely on streams, rivers, estuaries and marine habitat during their lifecycle. In freshwater and estuarine habitat, steelhead feed on small crustaceans, insects and small fishes. Eggs are laid in small and medium gravel and need good water flow (to supply oxygen) to survive. After emerging from the redd (nest) they remain in streams and rivers for 1 to 4 years before migrating through the estuaries to the ocean.

Because young steelhead spend a significant portion of their lives in rivers and streams, they are particularly susceptible to human induced changes to water quality and habitat threats. Poor land-use practices in both urban and rural areas can lead to siltation in streams, which may ruin spawning beds or smother the eggs. Additionally, in the Columbia River, migrating steelhead face the physical obstacles and high water temperatures resulting from dams, inadequate water flows in rivers and streams due to water diversions for irrigation, and the impoundment of water for power generation.

**RANGE:** Steelhead were originally found from northwestern Mexico to the Kuskokwim River in Alaska; however, now it is unusual to find steelhead south of Ventura River, California. Some of the significant steelhead rivers in Oregon include the Rogue, Umpqua and Clackamas Rivers.

**ECONOMIC VALUE:** Steelhead are one of the top five sport fish in North America, and are caught primarily in streams and rivers. At the present time only Native Americans are allowed to fish for steelhead commercially in Washington or Oregon.

Prepared by the Pacific States Marine Fisheries Commission, F.I.S.H. Habitat Education Program.

# Some Questions Regarding Fish Present in the Sandy River

This interpretive section was developed to help anticipate questions students and adults may have when they visit a site with spawning salmon present. The Freshwater Trust's Salmon Watch program was initially developed in the Portland Metro area and the Sandy River at Oxbow Park was one of the first sites utilized by the program. The Freshwater Trust in partnership with Metro, also provides the guided salmon walks that are part of the annual Salmon Festival at Oxbow Park.

**1. What kind of Salmon are these?**
These are fall chinook salmon, also knows as "Kings". They return to the Sandy River in August, September and October. The late-run wild fall chinook that return in late December are nearly extinct.

**2. What are they doing when they return?**
They are returning to the river where they were born, in order to build redds, spawn, reproduce and die. After generations of natural selection salmon become adapted to conditions in a specific section of the river. Through this process, separate and identifiable "stocks" develop.

**3. What are redds?**
Redds are fish nests, depressions dug in the river gravel 6 to 18+ inches deep made by the female salmon in which to lay her eggs. The water near the redds must be the proper depth and velocity, have plenty of oxygen to percolate around the eggs, and have the right sized gravel without silt. The average redd is built in water that is from 9 inches to 3 feet deep.

**4. How do salmon spawn and how long does it take?**
The female turns on her side facing upstream and digs a redd by thrashing up and down with her body and tail, alternately digging and settling back into the redd to release the eggs. A male moves in next to the female and releases sperm at the same time. Due to the shape of the redd, the oscillating water mixes the sperm with the eggs and fertilization occurs. Each egg pocket in the redd is covered by gravel as the female digs the next redd upstream. The redd increases in size upstream as the spawning is completed reaching a size of 25 to 60 square feet. Spawning may take 3 to 7 days.

**5. How many eggs are laid?**
The number of eggs laid averages about 5,000 depending upon the size of the female. Eggs incubate in the gravel and hatch the following spring. The newly hatched eggs called "alevins" remain in the gravel for 3-7 weeks. After emerging, the "fry" spend 3 months in freshwater and grow to about 4 inches long before migrating in schools to the sea. During this time they slowly undergo many physiological changes called "smolting" enabling them to adapt to the saltwater conditions in the ocean.

**6. How many fish survive?**
Only 2% to 8% of all the eggs survive to become smolts. Predation by other fish, birds and unfavorable river conditions including high water temperatures, high winter flows that wash the eggs out of the gravels, or too much silt deposited in the redds that may suffocate the eggs may hinder the survival of the fish.

**7. How many fish return to the Sandy River?**
On the average only 0.5% to 3% of all the smolts that migrate to the ocean will survive to return and spawn. Natural predation, food supply and fishermen affect ocean survival. For Sandy River fall chinook, 5% return as jacks (early maturing males) after one year at sea, 36% return after two years, 51% return after three years, and 8% return after four years.

**8. What is the white stuff on the fish skin?**
As the fish become weaker during spawning, a white fungus invades their skin and they begin to quickly deteriorate. The decaying carcasses release nitrates and phosphates into the water, providing the basis for more life.

**9. How does being raised in a hatchery affect the genetics of the wild run over time?**
In the hatchery process of spawning and rearing fish, a totally different kind of selection and adaptation takes place than occurs in the wild. Historically hatcheries tended to use fewer males to fertilize the female eggs, resulting in the loss of genetic material. Hatchery conditions with ample food supply and antibiotics are favorable to the survival of the fish. The fish do not have to capture their own food or develop natural resistance to diseases. Genetically different fish are produced within just a few generations. In addition, large numbers of hatchery fish may cause a major disruption in the existing wild population by competing for food and space, and causing genetic changes in the wild fish, thereby reducing the chance of survival for wild fish.

**10. Are fish carcasses important?**
Yes, biologists have determined carcasses play an important role in stream ecosystems. Carcasses provide food for aquatic invertebrates, juvenile fish and wildlife. Salmon store nutrients from the ocean such as nitrogen, and these nutrients fuel a complex food chain.

**11. How can the wild populations be maintained?**
The importance of maintaining high-quality habitat to ensure the existence of wild fish populations cannot be over-emphasized. Silt-free pools and riffles and cool water temperatures must be maintained. Healthy riparian vegetation must be present on the streambanks to stabilize them and prevent erosion. Healthy streambanks also store and slowly release water during critical low flows, provide thermal cover, and are a source of important woody debris and nutrients. In addition, the fisheries must be regulated to allow enough spawners to reach spawning areas, and hatcheries must be operated to minimize genetic changes in hatchery fish that may spawn with wild salmon.

**12. What can I do to help?**
Be a good steward when you use the river. Do not wade in spawning areas, dispose of your garbage in the proper containers (not the river), and get involved with volunteer efforts to protect river habitat. Support conservation management of the wild salmon and speak out on issues that come to your attention. For more information call **Oxbow Park at 503-663-4708, The Freshwater Trust at 503-222-9091, ODFW STEP Program Clackamas, OR 503-657-2000 http://www.dfw.state.or.us, Sandy River Basin council, 503-668-1646 http://www.columbia-center.org/srbc, or the Oregon Chapter of the American Fisheries Society at 541-737-4431 in Corvallis.**

# Status of Salmon Stocks

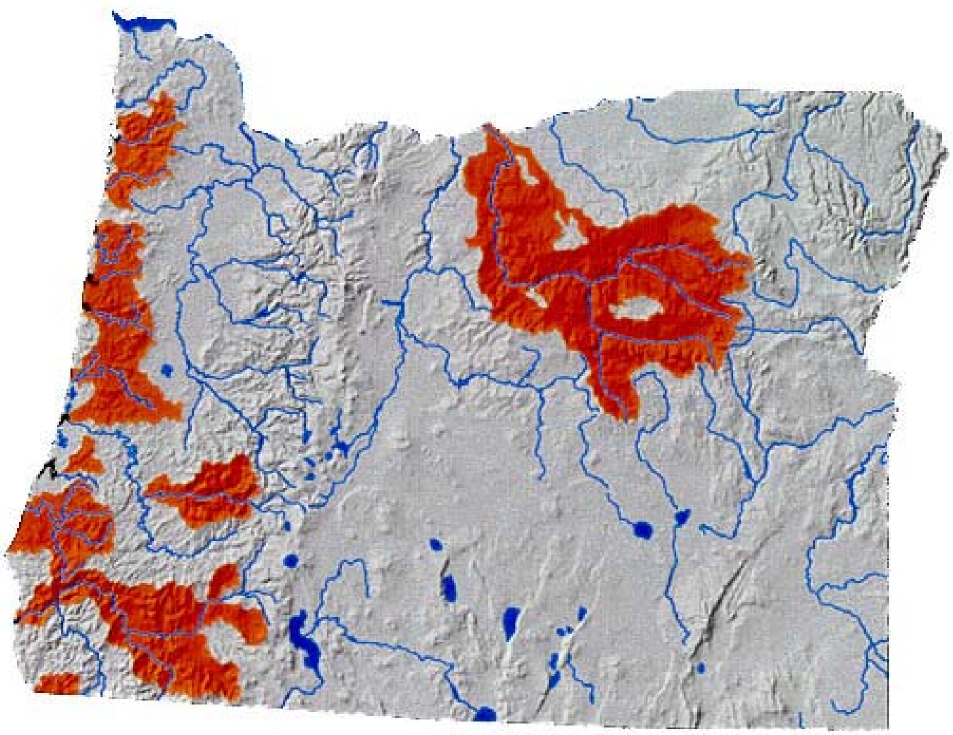
**This section will include the following topics:**

**Healthy Salmon Stocks of the West Coast**

**Factors Responsible for the Decline in Salmon Abundance and Distribution in the Pacific Northwest**

**Causes of Mortality, 1770-present**

**Government Bodies that Regulate Salmon**



**Healthy Stocks of Anadramous Salmonids in Oregon (1993)**

## FACTORS RESPONSIBLE FOR THE DECLINE IN SALMON ABUNDANCE AND DISTRIBUTION IN THE PACIFIC NORTHWEST

### MAJOR FACTORS

Agriculture *1, 2, 4, 5, 6, 8, 9, 10, 12, 18, 21, 22*
Dams *3, 9, 10, 11, 17, 18*
Drought *9, 10*
Fishing *15*, *16,*
Forestry *1, 2, 4, 6, 7, 9, ,10,11, 18, 21, 22*
Urbanization *1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 18, 22*

### POTENTIALLY IMPORTANT FACTORS*

Gravel Harvest *1, 6, 8, 10*
Irrigation *9, 12, 18*
Bycatch Mortality *16, 17, 19*
(salmon killed during fishing for other species)
Hatchery Fish Interference *19, 20*
Poor Ocean Conditions *13, 14, 15, 16*
Illegal Fishing *16, 19*

### MINOR FACTORS

Bird Predation *17*
Marine Mammal Predation *15, 16, 17*

---

1. Loss of Streamside Vegetation and Functions
2. Pesticide Exposure
3. Industrial Pollutants Exposure
4. Increased Amount of Sediment Entering Streams
5. Stream Straightening and Channelizing
6. Habitat Destruction
7. Decreased Amount of Large Logs In Streams and Loss of Deep Pools and Channel Form
8. Filling of the Side Channels of Streams
9. Reduced Fresh Water Flow in Rivers and Streams
10. Exposure to Abnormal Temperatures
11. Habitat Area Loss
12. Lack of Screening of Water Diversion, Canals to Keep Fish Out
13. Reduced Upwelling
14. Altered Ocean Currents and Flow
15. Decreased Food Abundance
16. Reduced Numbers of Adults Reaching Their Spawning Grounds
17. Reduced Numbers of Young Fish Making it to the Sea
18. Barriers Preventing Salmon from Migrating Upstream or Downstream
19. Loss of Genetic Integrity and Diversity
20. Competition Between Hatchery and Wild Fish
21. Forest Fragmentation
22. Estuary Degradation

*Insufficient data exists for an appropriate assessment of magnitude

Table based on studies of rivers in Western Oregon and Northern California. Adapted with permission by Pacific States marine Fisheries commission from **Status and Future of Salmon of Western Oregon and Northern California: Overview of Findings and Options** by Botkin, Cummins, Dunne, Regier, Simpson, Sobel, and Talbot. For a copy send $17 to The Center for the Study of the Environment, PO Box 6945, Santa Barbara, CA 93160.

# Causes of Salmon Mortality 1770 – Present

**Mortality Circa 1770:**
Natural mortality of salmon is due to factors like natural death after spawning; **predators**, including mammals, birds and other fish; and naturally occurring population fluctuations cased by ocean and river conditions.  Tribal fisheries are the only human effects at this time.

**Mortality Circa 1940:**
The ratio of natural mortality declines due to commercial fishing.  **Trapping of beaver** reduces rearing habitat in beaver ponds; **overgrazing** damages streamside vegetation; river corridors and estuaries are affected by **urbanization**; the use of **splash dams** for logging destroys stream beds; **hydroelectric facilities** and **irrigation** dams on tributaries block access to spawning areas; **water drawn** for irrigation, industry, cities, and towns reduces river flow; and **water quality is degraded** by a wide variety of causes.

**Mortality Circa 1996**
Mortality in the ocean increases with El Nino conditions and ocean trolling in Alaska and British Columbia.  The Chief Joseph and Hells Canyon dams block passage to large areas of habitat.  Other large dams cause 5% or more mortality (per dam) for smolts descending to the sea and adult salmon returning to spawn.  Dams also change water temperatures, reduce flow of rivers, increase nitrogen levels, and allow more predation by Northern Pike Minnow and other predators.  The destruction and filling of wetlands and estuaries reduces habitat. Logging increases silt, reduces shade, and disturbs spawning beds.  The spread of cities, roads, and other development reduces habitat and increases pollution. Irrigation for agriculture reduces flow of rivers.  Unscreened water diversions trap fish in ditches (in 1990, less than 5% of the diversions in Oregon were screened). Hatchery fish may increase disease rates and reduce diversity of wild stocks. Grazing livestock harm inland spawning habitat be destroying vegetation and polluting streams.

Out of approximately 1000 native anadromous stocks in Oregon, Washington, and California, 106 are extinct and 314 are at risk of extinction.  Currently, hatcheries produce two-thirds of the salmon in the Columbia River.

Attempts to improve salmon survival include:

Improved **fish passage facilities** at dams; **streamside buffers** in logged areas; **barging** or trucking of salmon smolts past dams; **habitat enhancement**; a **Northern Pike Minnow bounty** to reduce predation; **regulation of commercial and recreational catches**; spill from reservoirs to increase flow speed during smolt out-migration and to promote more natural riverbeds; and **improved hatchery practices**.

Gilden, Jennifer, Smith, Courtland, Department of Anthropology, Oregon State University, Research funded by Sea Grant Oregon through NOAA. Sea Grant Oregon, Oregon State University 1998

# GOVERNMENT BODIES AND THEIR AUTHORITY TO REGULATE SALMON

**(created by Karl Weist of the Northwest Power and Conservation Council)**

**Confederated Tribes of the Umatilla Indian Reservation (CTUIR)**

- 1855 Treaty with the Walla-Walla, Cayuses and Umatilla Tribes established reservation
- Reserved water rights to serve the purposes of the reservation, including support of fisheries. Guaranteed the right to fish both on and off reservation at "usual and accustomed" places "in common with citizens of the United States."
- US v. Oregon and US v. Washington– court cases assured the tribe the right to 50% of the salmon harvest.
- The tribe is a party to the Columbia River Fish Management Plan that allots the in-river harvest of Columbia River salmon.

**Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO)**

- 1855 Treaty with the Tribes of Middle Oregon established reservation
- Reserved water rights to serve the purposes of the reservation, including support of fisheries. Guaranteed the right to fish both on and off reservation at "usual and accustomed" places "in common with citizens of the United States."
- US v. Oregon and US v. Washington– court cases assured the tribe the right to 50% of the salmon harvest.
- The tribe is a party to the Columbia River Fish Management Plan that allots the in-river harvest of Columbia River salmon.

**Army Corps of Engineers (COE)**

- Operates 19 major federal dams in the Columbia River Basin for flood control, hydropower, recreation, navigation, irrigation and other purposes. (Examples- Bonneville, The Dalles and John Day dams)
- Conducts other river management activities like the dredging of the Columbia for the Port of Portland's navigation channel
- Issues dredge and fill permits for rivers and wetlands under the authority of the Clean Water Act and the Rivers and Harbor Act.

**Pacific Salmon Commission (PSC)**

- Allocates harvest of five Pacific salmon species between the US and Canada.
- Established by the 1985 US and Canada Pacific Salmon Treaty to make the harvest decisions.

**National Oceanic and Atmospheric Administration (NOAA)**

- Administers the Endangered Species Act for salmon and steelhead; ESA responsibilities include listing the species as threatened or endangered, designating critical habitat, developing recovery plans, regulating "taking" of a listed species.
- Develops fishery management plans that set ocean harvest limits.
- Is a part to the Columbia River Fish Management Plan that allocates the in-river harvest of Columbia River salmon.

**US Fish and Wildlife Service (USFWS)**

- Administers the Endangered Species Act for all non-anadromous fish and other species; lists species as threatened or endangered, designates critical habitat, develops recovery plans, regulates the “taking” of listed species.
- Manages federal lands designated as wildlife refuges.

**Environmental Protection Agency (EPA)**

- Oversees states’ efforts to comply with the Clean Water Act: wetland regulations and state water quality programs.
- Administers the National Estuary Program.

**Bureau of Reclamation (BOR)**

- Operates 9 major dams and reservoirs in the Columbia River Basin, primarily for irrigation. (Example – Owyhee Dam and Reservoir)
- Operates numerous projects for secondary purposes, including hydropower generation, recreation, municipal and industrial use.
- Enters into contracts with irrigation districts and other users for the delivery of project water.

**Federal Energy Regulatory Commission (FERC)**

- Created to carry out the oversight of the Federal Power Act.
- Regulates the construction and operation of nonfederal hydropower projects. (Examples – Brownlee, Oxbow and Hells Canyon dams)
- Issues and conditions original licenses and relicensing of nonfederal hydropower projects.

**Bonneville Power Administration (BPA)**

- Markets and distributes power produced from federal hydropower projects on the Columbia and its tributaries.
- Funds the protection, mitigation and enhancement of fish and wildlife resources affected by the Federal Columbia River Power System

**US Forest Service (USFS)**

- Authorizes and monitors timber harvest, grazing, mining, recreation and other activities that occur on all national forest lands and some wilderness areas and wild and scenic river corridors in the Columbia River Basin.
- Has limited water management authority, but does monitor federal reserved water rights and regulates access to national forests for water project purposes.
- Has recently developed the Northwest Forest Plan, PACFISH and INFISH planning documents that address fish and wildlife concerns.

**Bureau of Land Management (BLM)**

- Authorizes and monitors timber harvest, grazing, mining, recreation and other activities that occur on all federal “public lands” and certain wilderness areas and wild and scenic river corridors in the Columbia River Basin.

- Has limited water management authority, but does monitor federal reserved water rights and regulates access to BLM-managed lands for water project purposes.
- Has recently developed the Northwest Forest Plan and PACFISH planning documents that address fish and wildlife concerns.

**Northwest Power and Conservation Council (NPCC)**
- Interstate compact agency (Oregon, Idaho, Montana and Washington) created by the Northwest Power Act of 1980.
- Develops regional Fish and Wildlife Program and Northwest Power Plan.
- BPA must act “consistent with” the Council Fish and Wildlife Program. COE, FERC and BOR must take the Council Program “into account.”

**Oregon Department Of Fish and Wildlife (ODFW)**
- Develops and implements state fishing regulations, licenses, length of seasons.
- Runs state-funded salmon hatcheries.
- ODFW is a party to the Columbia River Fish Management Plan that allocates the in-river harvest of Columbia River salmon.
- Participated in the development of the Oregon Plan for Salmon and Watersheds.

**Oregon Department of Environmental Quality (DEQ)**
- Implements the state water quality program under the Clean Water Act. Develops list of water quality limited streams and rivers and develops standards to comply with the Clean Water Act.
- Participated in the development of the Oregon Plan for Salmon and Watersheds.

**Oregon Department of Forestry**
- Administers the Oregon Forest Practices Act affecting the timber harvest and uses of state and private forests. Covers about 11 million acres of state and private timberland.
- Participated in the development of the Oregon Plan for Salmon and Watersheds.

**Oregon Water Resources Department (WRD)**
- Allocates and distributes water within the state; issues water rights and establishes state rules governing the use, sale and transfer of water rights.
- Participated in the development of the Oregon Plan for Salmon and Watersheds.

**Oregon Department of Agriculture**
- Regulates agricultural practices on state and private lands.
- Participated in the development of the Oregon Plan for Salmon and Watersheds

**Oregon Department of State Lands**
- Administers fill and removal laws

**Oregon Department of Land Conservation and Development**
- Monitors and implements the state land use planning program. Includes state goals to protect farm and forest land and to preserve the Willamette River Greenway and coastal shorelands.

**Oregon Watershed Enhancement Board (OWEB)**

- Allocates grant funding for local groups to perform watershed restoration work. Has $20 million in grant funding made available by the 1997 Oregon Legislature.

**Portland Bureau of Environmental Services**

- Responsible for Portland's stormwater and sewage treatment and collection system. Currently separating the stormwater and sewage systems so untreated water does not spill into the Willamette and Columbia Rivers.

**Columbia River National Estuary Program**

- Joint project of Oregon and Washington along with the EPA. A group of citizens, local and state governments, businesses and others responsible for protecting, preserving and restoring the health and water quality of the Columbia River estuary.

**Tillamook Bay National Estuary Project**

- Joint project of Oregon and the EPA. A group of citizens, local and state governments, businesses and others responsible for protecting, preserving and restoring the health and water quality of the Tillamook Bay estuary.

## Hatcheries

**Introduction:**
The first fish hatchery in the Pacific Northwest opened over 100 years ago on the Clackamas River. Since then, the region has increasingly turned to hatcheries as a way to compensate for the losses in fish populations due to human activities, mainly resulting from dams, habitat destruction and overharvest. Oregon operates 34 hatcheries, 15 remote rearing/fish collection facilities, including Salmon Trout Enhancement Program (STEP) facilities and the Clatsop Economic Development committee (CEDC) facilities. In 2001 these operations produced about 53 million salmon, steelhead and trout. The Legislatively Approved Budget for fish propagation for the 2003/05 biennium totaled $43.96 million dollars.

As we have begun to learn more about the ecological effects of hatchery fish on wild salmon populations, many have started to question the use of hatcheries as a catch-all solution to fish management problems. There are efforts underway to improve hatchery practices to minimize the negative impacts of hatchery fish on wild stocks.

Some teachers may choose to take students to a fish hatchery as a part of their Salmon Watch field trip. Trips to the hatchery tend to emphasize the pro-hatchery side of the debate. It is important that students understand that there is some disagreement about the use of hatcheries. Some information follows for your background about hatchery and wild fish.

**Some arguments in favor of hatchery fish**
1. Some hatchery fish were intended to compensate for declines in wild fish populations caused by the construction of dams. Dams are not only an important source of relatively “clean” energy for the region -- they also allow the rivers to be used as waterways for the transport of crops and other goods throughout the Pacific Northwest. If we remove dams, we will be forced to either be more serious about conservation, or find alternative forms of energy and transportation.
2. Hatchery fish help support the angling industry. Sport fishing is not only a popular hobby, but also supports the economy of the region. In 2003, anglers spent almost $623 million according to the American Sportfishing Association.
3. According to the Pacific Coast Federation of Fishermen’s Associations, Incorporated, 80% of the salmon caught by the commercial fishing industry are hatchery fish.
4. The salmon are of great traditional importance to Native Americans. The U.S. government has treaty obligations to the tribes to restore the salmon so that Native Americans may continue to use the salmon both as a food and a spiritual resource. If natural production continues to decline, we may have to increasingly rely on hatcheries to fulfill this treaty obligation.

5. If we catch only the hatchery fish for human consumption, we could leave the wild fish alone to reproduce on their own.
6. Hatchery fish could be used to supplement stocks in serious jeopardy or to reintroduce stocks that have been eliminated from their natural range, given the proper groundwork for habitat improvements and resolution of passage problems.

**Some arguments for wild fish**

1. Through a process called *natural selection*, the wild fish that are best suited to their environment are the fish that survive to spawn. However, hatcheries promote *artificial selection*, which means that humans choose the fish that will survive to spawn. Sometimes, we have made this decision based on which fish will make a good dinner, rather than on which fish will best be suited to survive in the wild. Another problem is that some hatcheries tend to spawn the first fish to return to the river to ensure that they will be able to harvest enough fish. However, this means that early breeders are more likely to be chosen to spawn. The resulting hatchery offspring tend to return too early. This is a problem if all of the hatchery fish return at the same time, and the weather is too rainy or too dry for the fish to survive.
2. *Genes* carry pieces of information that allow fish to inherit traits from their parents. In a population of fish with a lot of genetic diversity, there is a greater chance that at least some fish will have the traits necessary to survive if there is a sudden change in environmental conditions. Conversely, in populations of fish without a lot of genetic diversity, there is a greater likelihood of extinction if the fish are faced with a changing environment. Populations of hatchery fish have less genetic diversity than populations of wild fish because hatchery fish have had fewer ancestors than wild fish. Unfortunately, sometimes hatchery fish spawn with wild fish, rather than returning to the hatchery. This means that the genetic diversity of the wild fish populations decreases as well.
3. When wild fish die, their carcasses provide nutrients to the rivers and streams where they spawned. Hatchery fish are often removed from the stream to be spawned, depriving the habitat of precious nutrients.
4. We have a moral obligation to do something to repair the habitat that we have destroyed in order to assure that wild fish can continue to survive in the future.
5. Hatcheries create a false sense of abundance for people who consume fish and utilize their habitat, meaning that people are less concerned about conserving the habitat that remains. It also means that harvest levels are often based on numbers of hatchery fish. Since there are often some wild fish that are caught along with the hatchery fish, harvest can drive dwindling numbers of wild fish into extinction.
6. Wild fish use precious energy competing against hatchery fish for limited resources.

7. Hatchery fish are more prone to disease than wild fish because they are raised so closely together. Diseases from the hatchery stock can then be passed on to wild fish. This means that the presence of hatchery fish can actually weaken wild fish populations.

8. Wild fish learn to avoid predators, or they get eaten. They also learn to find food in their natal stream efficiently, or they starve. Hatchery fish, on the other hand, are hand-fed by humans. They learn to approach humans (who would normally be predators) and eat fish pellets. Then, when they are released, they are less able to find food and are less afraid of predators than wild fish. This means that, once they are released into the wild, hatchery fish are less likely to survive than wild fish.

9. Raising hatchery fish is very expensive. According to Sterne, the average cost of producing a spring chinook salmon in a state run hatchery is $27.43, although this number can reach as high as $228.93 per fish. Some might argue that this money could be better spent on habitat restoration to improve survival rates for wild chinook.

**Bibliography**

*Commercial fishing.* 1998. Tom Gentle. **A Snapshot of Salmon in Oregon.** Oregon State University Extension Service. Corvallis, OR.

*Hatcheries.* 1998. Theresa Novak. **A Snapshot of Salmon in Oregon**. Oregon State University Extension Service. Corvallis, OR.

*"Hatchery salmon unfit for life in the wild",* article says. December 3, 1998. Jonathan Brinckman. **Oregonian**.

**Oregon's Wild Fish Management Policy: Balancing Oregon's Fishery Future**. Oregon Department of Fish and Wildlife Backgrounder.

*Recreational fishing.* 1998. Tom Gentle. **A Snapshot of Salmon in Oregon.** Oregon State University Extension Service. Corvallis, OR.

*Supplementation of Wild Salmon Stocks: A Cure for the Hatchery Problem or More Problem Hatcheries?* Jack K. Sterne Jr. **Coastal Management**. Volume 23, pp. 123-152.

**Upstream: Salmon and Society in the Pacific Northwest**. 1996. National Research Council. National Academy Press. Washington, D.C.

# Water Quality


- Introduction to Water Quality & Field Study  -  WQ2
- Temperature – WQ5
- Dissolved Oxygen – WQ11
- pH – WQ18
- Turbidity – WQ23
- Flow – WQ29
- Wrap-Up & Debrief of Field Analysis – WQ30
- Resources – WQ30
- Water Quality Data Forms – WQ31


## Introduction to Water Quality

Water in the stream in which salmon live provides conditions, which allow the salmon to continue to thrive. When we measure these conditions, we say we are evaluating water quality. The tests that we will be conducting in the field will be temperature, dissolved oxygen, pH, turbidity and stream flow.

Salmon Watch trips provide an opportunity to use more than one method of data collection. Not only do we use manual, chemical based tests, but we now also use Vernier digital LabQuests and probes to obtain data for the same parameters. This provides an opportunity to not only show students different techniques for data collection but it also provides a reliable and efficient method of archiving data from all of our Salmon Watch sites. All Vernier tests are explained in full detail within this section.

Vernier LabQuests are hand held electronic devices capable of taking all of the same tests Salmon Watch trips have historically taken. LabQuests come with probes for pH, turbidity, temperature, dissolved oxygen and stream flow. Our hope is that these new tools will provide another option for teachers, students, and volunteers to explore the world of water quality as well as make available the techniques for obtaining the most accurate and reliable data possible.

# WATER QUALITY FIELD STUDY

**Objectives:** Students will understand the importance and techniques of water quality sampling by:

1) performing in stream water quality tests measuring for pH, turbidity, dissolved oxygen, temperature and stream flow
2) practicing quality and detailed data recording methods
3) analyzing and making judgments on the quality of water based on collected data from all tests.

**Teaching Tips**
Get students focused with introductions and review safety guidelines.

**Note: Caution should be taken when handling and disposing of chemicals. Waste chemicals should be poured into the container provided in the field kit and returned either to the classroom or to the The Freshwater Trust office for disposal rather than dumped into the stream or riparian area. Always wash your hands after you have completed the water quality testing procedures.**

Briefly describe the activity (What we are going to do is….). A great way to describe water quality is to use one of the following metaphors:

a) The students are doctors performing a check up and the water source is their patient. More than one test must be conducted to find to true health of the river just like a doctor conducts multiple tests before making a diagnosis. Ask the students to brainstorm tests that a doctor might do to determine the health of a human being.

b) 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. Ask the students to brainstorm tests that a mechanic might do to determine the quality of a vehicle.

**Materials:**
All needed materials are listed throughout the section within the specific water quality test descriptions. The Water Quality Data Form can be found at the end of this section and in the Field Trip Data Forms section of the binder.

**Procedure:**
All individual test procedures are listed throughout the section within the specific water quality test descriptions.

1. Divide the students into teams for each activity; temperature, dissolved

oxygen, pH, turbidity and stream flow. (temperature and turbidity are good tests to pair up for one team)

2. Pass out the equipment for each test with the directions. Have each group decide who will read the directions.

**Note: Dissolved oxygen and stream flow should be done in moving water, preferably in a riffle, if it can be safely accessed. Boots are provided for the dissolved oxygen and stream flow sampling.**

3. First help the dissolved oxygen group get started. This test takes the most time and can involve 3 or 4 students. Groups of two will work for the other activities.

   Temperature, pH, and turbidity can be done in several areas and compared if you have a larger group of students. Remember to **try to get all students involved**, and then check in with them as they move through the procedures. A comparative study can be done between the manual chemical tests and the Vernier digital LabQuests if time allows.

4. Float between students facilitating the activity.

**For Discussion/wrap up:** When all tests are complete, bring the group together to clean up, and organize the equipment.

For the wrap up, pass out the graphs and charts provided in the kit for the students to interpret their results.

Let each team report their results. Use the questions provided in the kit or formulate your own questions as they relate to the results of the tests. Include any specific characteristics of the site that may be relevant to water quality i.e. human impacts, vegetation, weather conditions, etc.

## Water Temperature Background Information

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. If 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 species. 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. It 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 is. 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.

## TEMPERATURE TESTING

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

**Objective:** Students will measure water temperature and discuss the thresholds of water temperature for salmon and other aquatic organisms. Students will become familiar with the range of temperatures in different bodies of water and discuss factors influencing temperature (e.g., amount of shade, velocity of water, etc.).

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

**Procedure with Vernier LabQuest:**

1) Power up LabQuest
2) Plug the temperature probe into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **4 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the WQ station your probes are warming up).
3) Place the tip of the temperature probe into the water source being sampled. The probe must constantly have moving water on the tip to get an accurate reading, so, be sure to keep the probe moving in a swirling motion while taking tests. **Only place the tip of the probe in, do not let the black handle touch the water.**
4) Keep the tip of the probe in the water until the reading on the screen of the LabQuest has become steady (the reading may not fully stop on one number but as long as the numbers are relatively stable then you can record the pH level). **It will take no less than 45 seconds with constant water flow over the tip of the probe to obtain an accurate ready.**
5) In order to change the unit of measurement (˚C/˚F) press the screen, using the stylus, in the box that contains the temperature reading, this will give you a drop down menu and allow you to change between units of

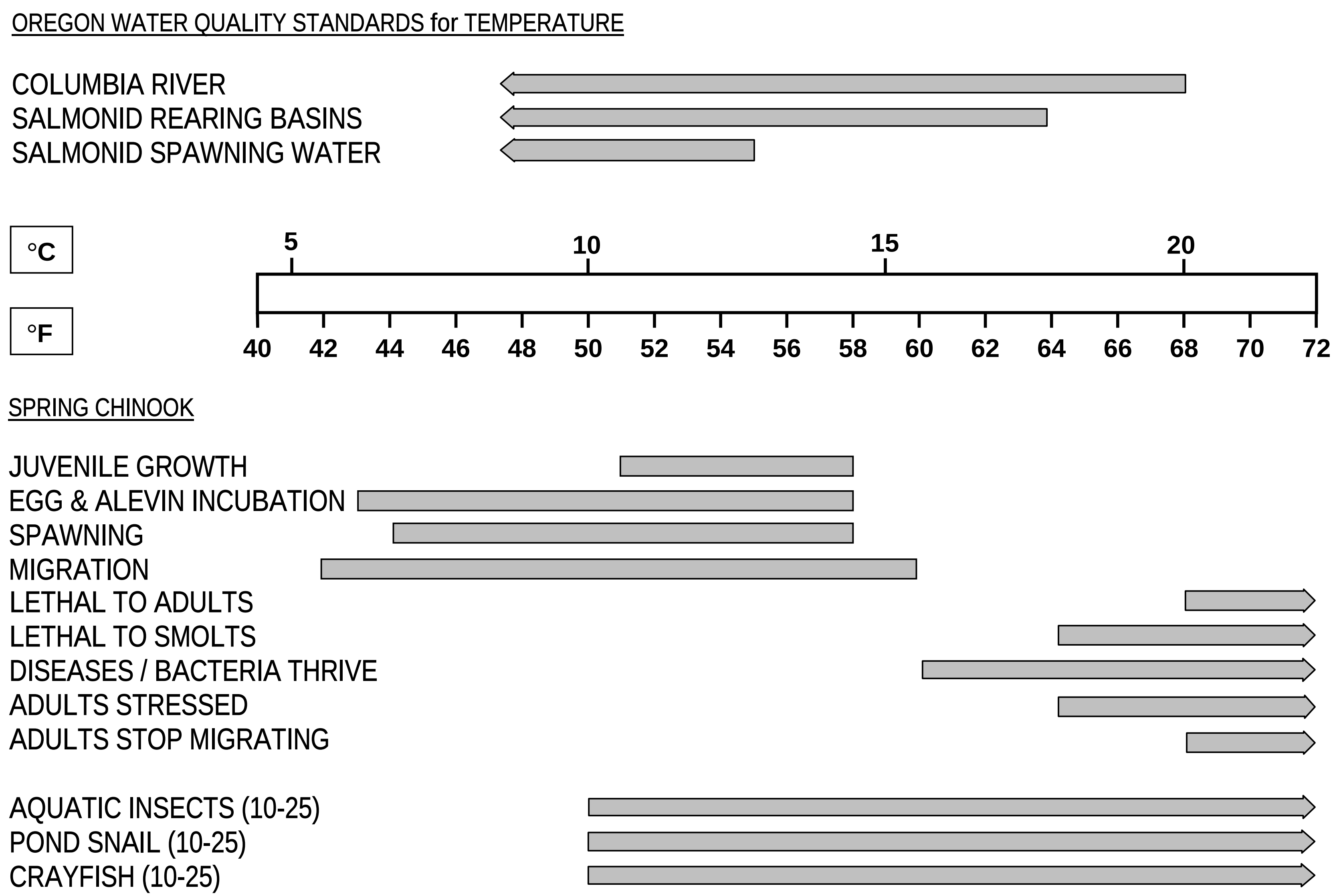
measurement. **You must perform this action while the probe is still in the water to maintain a consistent reading.**

6) Rinse the tip of the probe with distilled water and make sure the probe ha been dried off. It is now safe to unplug the probe from the LabQuest and put it away

**For Discussion:** Refer to *Optimum Temperature Limits for Aquatic Organisms* chart. How does the temperature that you recorded for this area compare to the optimum temperatures for aquatic organisms?

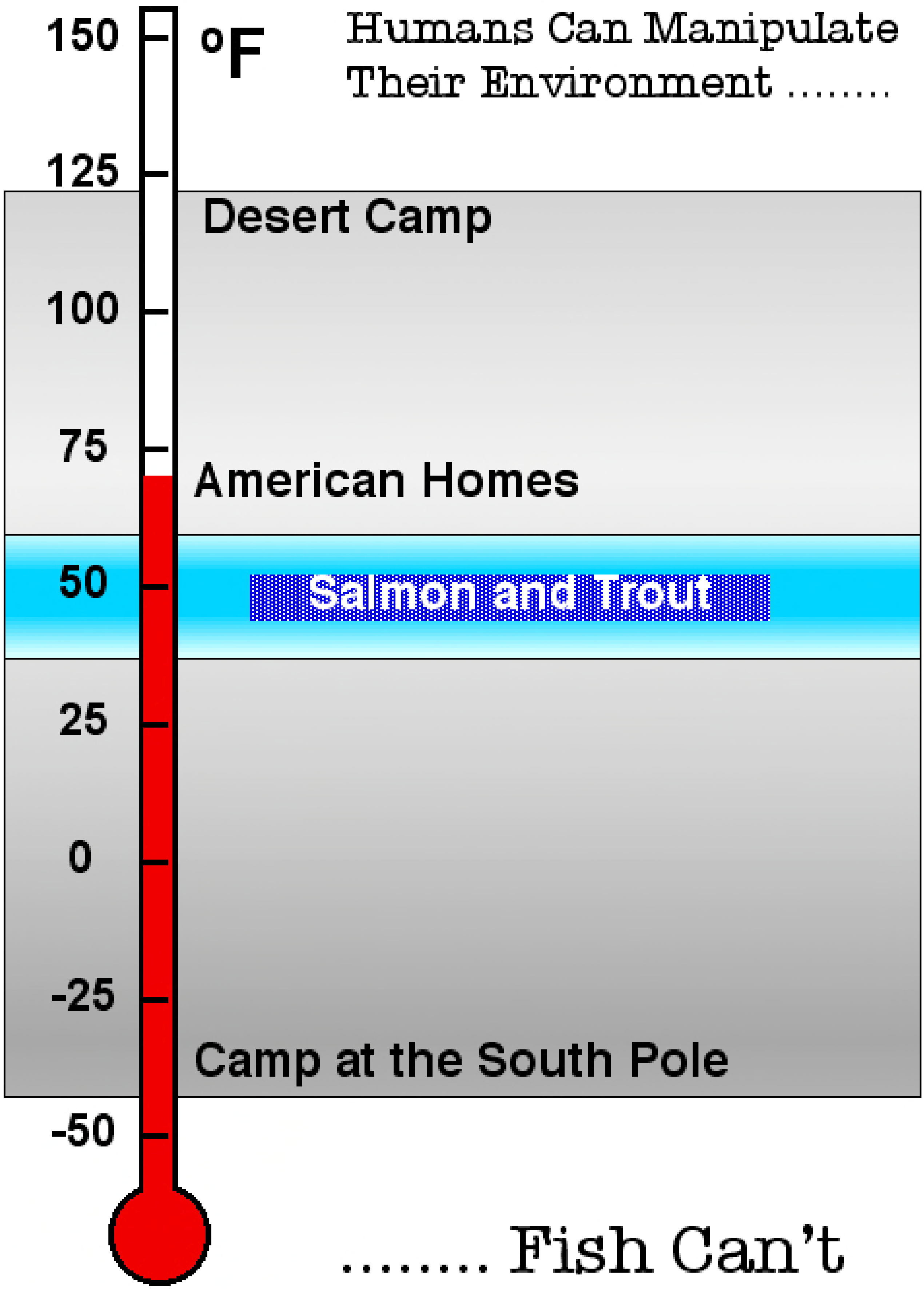
**Questions for discussion:**

- Why should we care about water temperature?
- What would happen to animals if the water was too cold/warm? To plants? To nutrients?
- How does the water in this stream get to be this temperature?
- How does the water stay cool?




# Optimum Temperature Limits for Aquatic Organisms

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


Humans Can Manipulate
Their Environment ........
°F
150
125
100
75
50
25
0
-25
-50
Desert Camp
American Homes
Salmon and Trout
Camp at the South Pole
........ Fish Can't

## 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, i.e. 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 $^{o}$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. If 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.

## DISSOLVED OXYGEN (DO) TESTING

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.

**Objective:** To determine the dissolved oxygen (DO) of the water and why this is so important to salmon and other aquatic organisms. Students will be able to conduct a dissolved oxygen test and discuss how the level affects aquatic organisms. Students will learn about the range of dissolved oxygen in different bodies of water and discuss factors influencing DO levels.

**Procedure with manual test:**

**Comments:** Stream water sampling should be done in moving water to get the most accurate measure of the DO that salmon in the stream would experience.

**When using the LaMotte Dissolved Oxygen kit, rubber gloves and goggles are required. Potentially harmful chemicals are in this kit.**

1) Rinse out the sample bottle twice with stream water. During the first rinse shake the water in the bottle to remove any precipitate present.
2) Holding the rinsed bottle upside down, immerse it in the stream. Keeping it under water, invert the bottle to allow water to enter. Allow the bubbles to stop and, while the bottle is still under water, place the cap on tightly. To test if there is no air in the bottle, turn the capped bottle upside down. If an air bubble is present, refill the bottle using the above procedure. PUT ON GLOVES
3) Add 8 drops of the Manganous Sulfate from the DO kit. Do not let the sulfate bottle touch the sample water. This step removes the oxygen from the water and makes a new compound “A” with the Manganous Sulfate.
4) Immediately add 8 drops of Alkaline Potassium Iodide Azide to the sample water. Cap the bottle and gently mix the solution several times by inverting the bottle. A yellowish cloudiness will appear. This addition reacts with the new manganese compound “A” to liberate iodine, which will be titrated (reagent added drop by drop) for in step 10.
5) Allow the precipitate formed in step 4 to settle below the shoulder (rounded part) of the bottle.

   **PUT ON GOGGLES**

6) Add 8 drops of *Sulfuric Acid* to clear the solution and to acidify. Cap and

gently shake until precipitant has dissolved

**REMOVE GOGGLES**

7) Set the sample bottle aside and rinse the testing bottle with stream water twice.

8) Fill the testing bottle to the 20 ml line (white line halfway up bottle) with liquid from the sample bottle.

9) Add 8 drops of *Starch Solution*. Place the plastic cap on the bottle and shake well. The solution will become deep purple/black in color. The starch attaches to the iodine and allows the titration (reaction with the *Sodium Thiosulfate* solution) in step 10 to proceed to a visual endpoint.

10) Fill the syringe with *Sodium Thiosulfate* reagent by inserting the syringe into the top of the *Sodium Thiosulfate* bottle, turning the bottle upside down, and drawing out the reagent until the black tip of the plunger is level with the "**1.0ml**" line on the barrel of the syringe.

11) Place the tip of the syringe in the hole in the cap of the testing bottle and **very slowly – 2 to 3 drops at a time** – add the *Sodium Thiosulfate* reagent to the testing bottle. Swirl vigorously after every addition. When the solution in the testing bottle lightens, add the reagent one-drop at a time, swirling after each addition. When the solution is clear, the endpoint has been reached. If the concentration is greater that 10 mg/L you will have to refill the syringe and continue to titrate

12) Read the number on the barrel of the syringe where the tip of the black plunger is pointing. Subtract the reading from 1.0 and multiply by 10. This is the concentration in mg/L or PPM (parts per million) of DO in the water. Record results.

13) **Dispose of the solution in both the testing bottle and the sample bottle in the plastic waste bottle to eliminate pollution of the stream by the chemical reagents.**

**Procedure with Vernier LabQuest:**

1) Power up LabQuest.

2) Plug the dissolved oxygen probe into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **4 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the WQ station your probes are warming up).

3) Remove blue cap from the tip of the dissolved oxygen probe and make sure it is not lost.

4) **Do not touch the bulb on the tip of the probe with fingers.**

5) Place the tip of the dissolved oxygen probe into the water source being sampled. The probe must constantly have moving water on the tip to get an accurate reading, so, be sure to keep the probe moving in a swirling motion while taking tests. **Only place the tip of the probe in, do not let the black handle touch the water.**

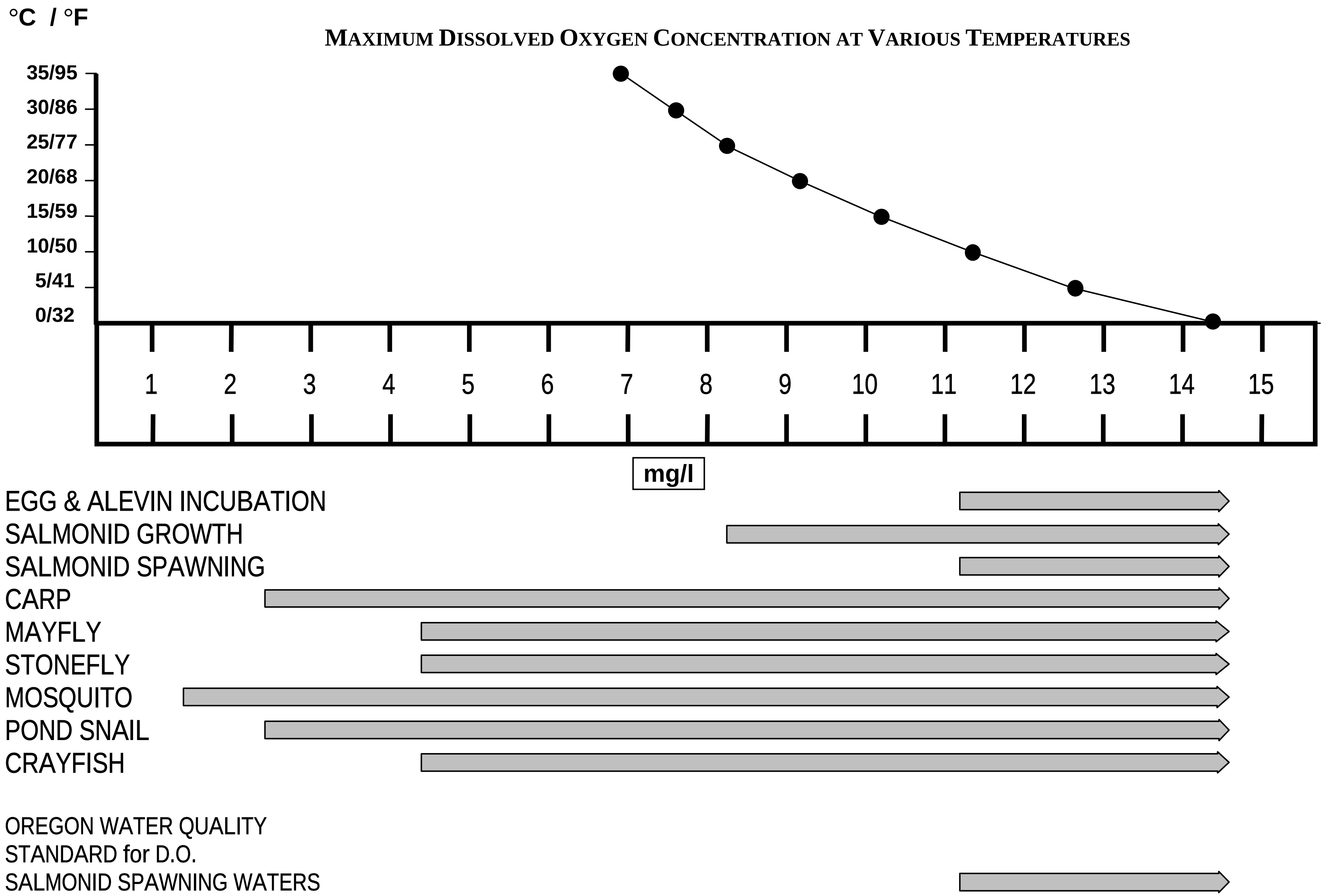
6) Keep the tip of the probe in the water until the reading on the screen of the LabQuest has become steady (the reading may not fully stop on one number but as long as the numbers are relatively stable then you can record the pH level). **It will take no less than 45 seconds with constant water flow over the tip of the probe to obtain an accurate ready.**

7) Rinse the tip of the probe with distilled water before placing the blue cap back on. It is now safe to unplug the probe from the LabQuest and put it away.

**For discussion:** Refer to the *Optimum Dissolved Oxygen Limits for Aquatic Organisms* chart. How does the amount of dissolved oxygen in the water that you tested compare to the optimum amounts of dissolved oxygen for different aquatic organisms?

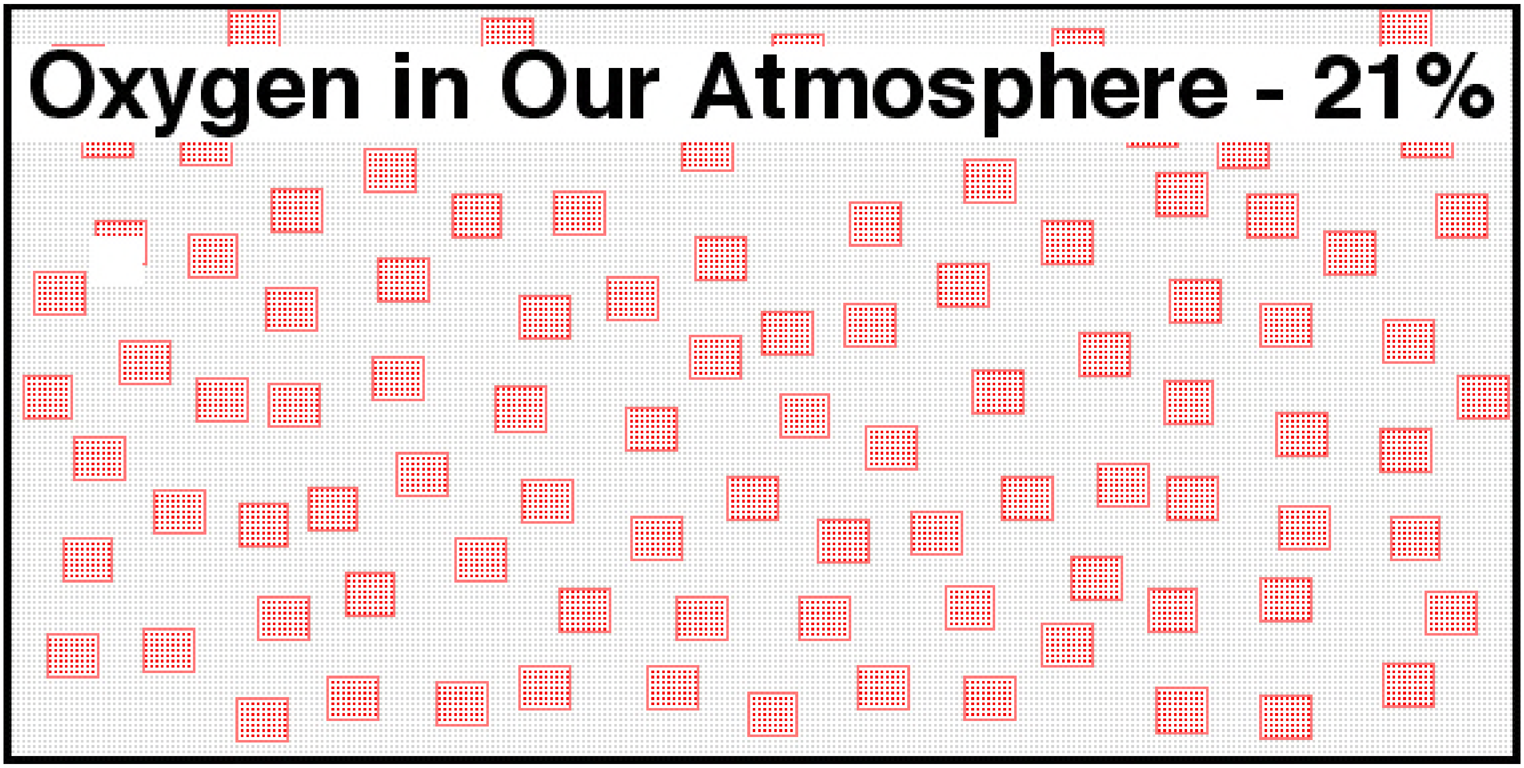
**Questions for discussion:**

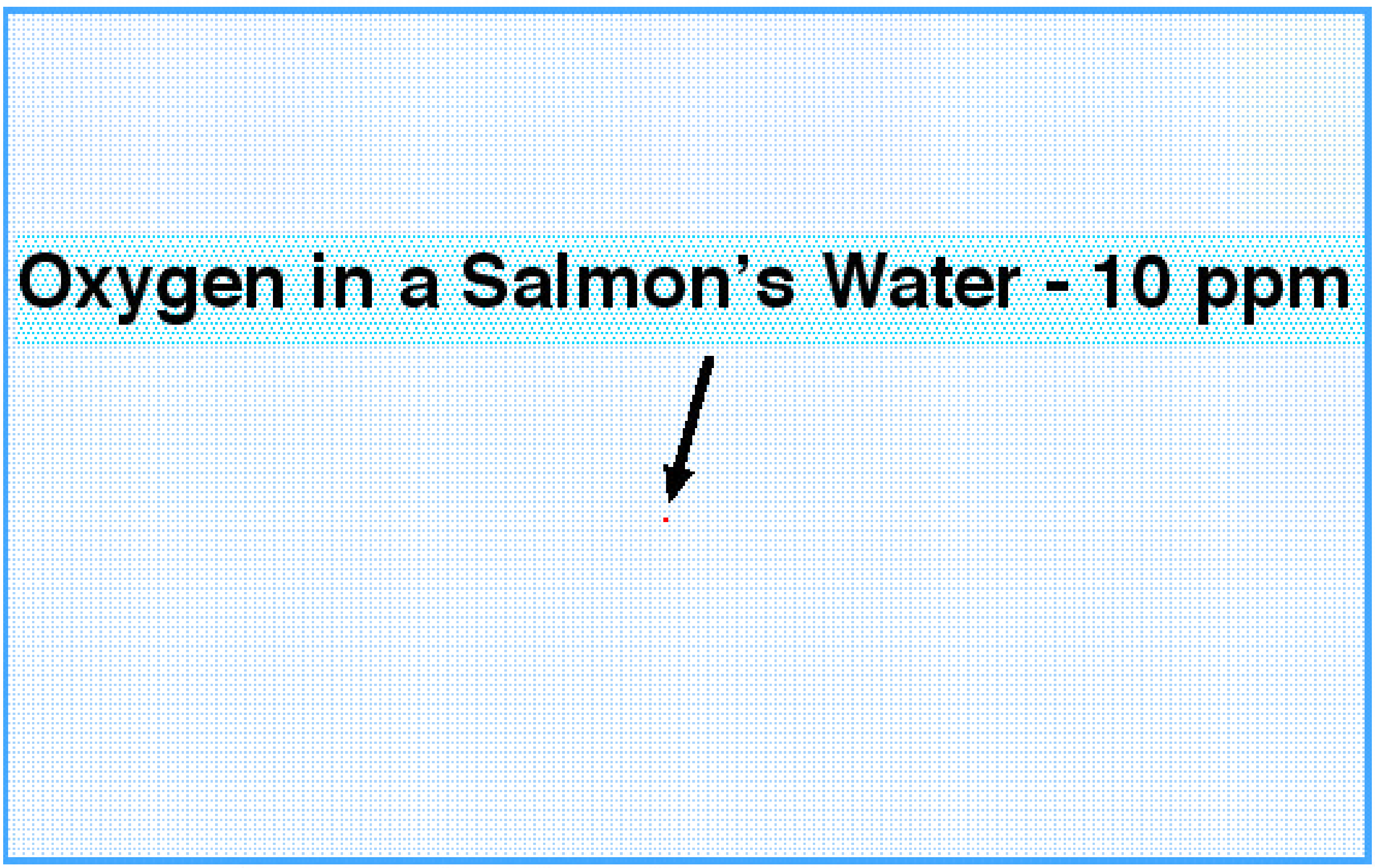
- What is DO (dissolved oxygen)?
- Who cares about DO (dissolved oxygen) and why?
- How does oxygen get into the water?
- What are DO levels affected by?




## OPTIMUM DISSOLVED OXYGEN LIMITS FOR AQUATIC ORGANISMS

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




The red square is 0.5mm x 0.5mm = 0.25 square mm
The blue rectangle is 125 mm x 200mm = 25,000 square mm
0.25/ 25,000=10/ 1,000,000 which is 10 parts per million

Landsberg
090915

## 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, others cannot tolerate a change of even one pH unit. Because of this narrow range of tolerance, pH limits where many organisms can live and the 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 5,000 times 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.

## pH TESTING

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. If the sample being measured has more H+ than OH- ions, it is considered acidic and has a pH less than 7. If 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.

**Objective:** Students will conduct a pH test, understand the pH scale and where their value falls within that scale, and discuss the importance of pH to salmon and other aquatic organisms.

**Materials:** LaMotte Wide Range pH Test Kit

**Procedure with manual test:**

1) Rinse test tube with sample water.

2) Fill a test tube to the 5.0 ml line with sample water.

3) Add 8 drops of Wide Range pH indicator. Cap and mix

4) Insert pH Octa-Slide Bar into the Octa-Slide Viewer. Insert test tube into Octa-Slide Viewer.

5) Match sample color to a color standard. Record as pH.

**Procedure with Vernier LabQuest:**

1) Power up LabQuest

2) Plug the pH probe into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **4 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the WQ station your probes are warming up).

3) Remove probe from pH storage solution. Unscrew storage solution cap and slide probe out. (Be sure to assign someone to watch the storage solution as it will have an opening unable to seal).

4) Rinse off the tip of the probe with distilled water, give special attention to the bulb at the very end. **Do not touch bulb with fingers.**

5) Place the tip of the pH probe into the water source being sampled. The probe must constantly have moving water on the tip to get an accurate reading, so, be sure to keep the probe moving in a swirling motion while taking tests. **Only place the tip of the probe in, do not let the black handle touch the water.**

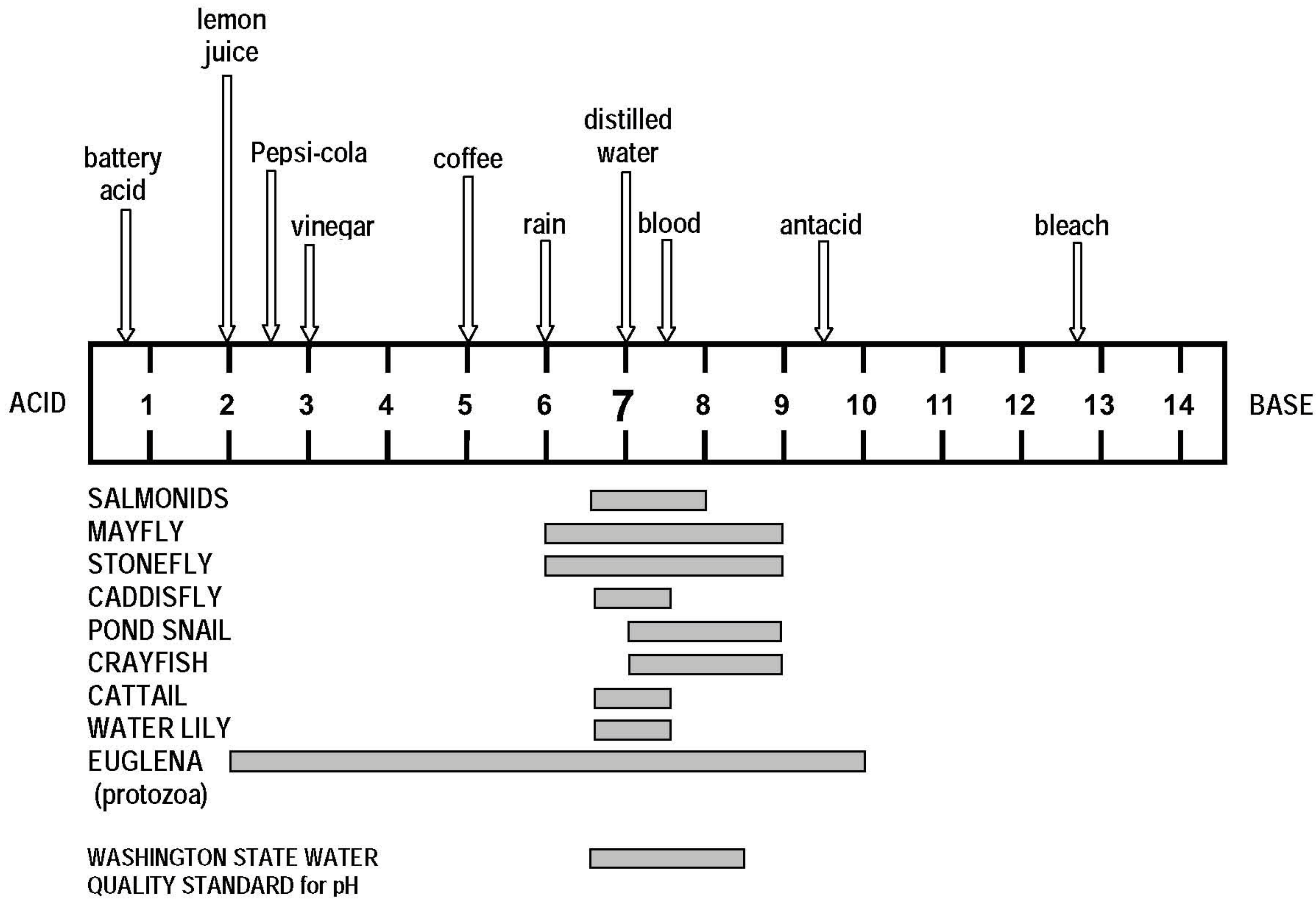
6) Keep the tip of the probe in the water until the reading on the screen of the LabQuest has become steady (the reading may not fully stop on one number but as long as the numbers are relatively stable then you can record the pH level). **It will take no less than 45 seconds with constant water flow over the tip of the probe to obtain an accurate ready.**

7) Rinse the tip of the probe again before sliding it back into the pH storage solution bottle. It is now safe to unplug the probe from the LabQuest and put it away.

**For discussion:** Refer to the *Lethal pH Limits for Aquatic Organisms* chart. 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?

**Other questions for discussion:**

- 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 the 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

## Turbidity and Sediments Background Information

In this section, turbidity will be discussed in relation to sediment load in a stream.

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, shifts 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**

There are several types of sediments. **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 a natural occurrence.

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 streamflow velocity and 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 a 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 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 much 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.

## TURBIDITY TESTING

**Objective:** To determine the relative clarity or turbidity of the stream water at your field site and to understand the impact of turbidity on water quality as it relates to the habitat needs of salmon.

**Materials:** Turbidity tube and sample collection bottle.

**Procedure with manual test:**

1) Carefully join the two pieces of the turbidity tube.

2) Fill sample bottle with stream water.

3) Shake sample thoroughly.

4) Stand with your back to the light (e.g. sunlight).

5) 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.

6) While observing the disk at the bottom of the turbidity tube, SLOWLY fill the tube with the sample until the three letters, AWT (Australian Water Technologies), appear to merge (cannot be read).

7) Then read the graduation on the side of the tube to determine turbidity. Record results. If time allows check turbidity in more than one area and compare.

**Maintenance:** Always rinse tube with clean water when testing is complete. If the tube appears dirty inside, wash with warm water and mild detergent. Do not use abrasive material or you will scratch the plastic. Disassemble tube and allow to air dry between uses.

**Procedure with Vernier LabQuest:**

1) Power up LabQuest

2) Plug the Turbidity Sensor into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **5 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the WQ station your probes are warming up).

3) Fill the empty cuvette (little glass bottle with a black cap) provided in the turbidity kit with a sample from the water source being tested. **The bottom of the meniscus should be at the top of the line for every measurement throughout this test. This volume level is critical to obtain correct turbidity values.**

4) Holding the sample by the lid, place it in the Turbidity Sensor. Align the mark (arrow) on the couvette with the mark on the Turbidity Sensor. **Important: These marks must be aligned whenever a reading is taken.**
5) It will take no longer than 45 seconds to obtain an accurate reading.

6) Using distilled water, rinse out the cuvette used to obtain samples and you are ready for cleanup.

   ******Turbidity is the only Vernier water quality test that must be calibrated in the field. However, if the LabQuest is not turned off or the turbidity sensor remains plugged in then one calibration at the start of the day should be sufficient. If your LabQuest does get turned off or the Turbidity Sensor comes unplugged simply follow the calibration steps below. This must be done first before the gourps start coming and should be ok for the remainder of the day unless the LabQuest comes unplugged or gets shut off.**

**Turbidity Calibration:** (directions taken from Vernier instruction manual)
1) **First calibration point:** Obtain the cuvette (little glass bottle) containing the Turbidity Standard (100 NTU) and gently invert it four times to mix in any particles that may have settled to the bottom. **Important:** Do not shake the standard. Shaking will introduce tiny air bubbles that will affect turbidity readings.

2) Wipe the outside of the cuvette with a soft, lint-free cloth or tissue.

3) Holding the standard by the lid, place it in the Turbidity Sensor. Align the mark (arrow) on the couvette with the mark on the Turbidity Sensor. **Important:** These marks must be aligned whenever a reading is taken.

4) Close the lid. Enter 100 as the value in NTU. In order to do this you must use the stylus to press on the box that gives you the turbidity reading. A drop screen will appear, select the "calibrate" option. Select the "calibrate now" option located in the top left corner of the screen. Enter "100" using the number pad that appears in the bottom right hand corner and press the "keep" bottom on the left hand side of the screen.

5) Remove the standard.

6) **Second calibration point:** Prepare a *blank* by rinsing the empty cuvette with distilled water, then filling it to the top of the line with distilled water. **Important:** The bottom of the meniscus should be at the top of the line for every measurement throughout this test. This volume level is critical to obtain correct turbidity values.

7) Screw the lid on the cuvette. Wipe the outside with a soft, lint-free cloth or tissue.

8) Holding the cuvette by the lid, place it into the slot of the Turbidity Sensor. Make sure that the marks are aligned. Close the lid.

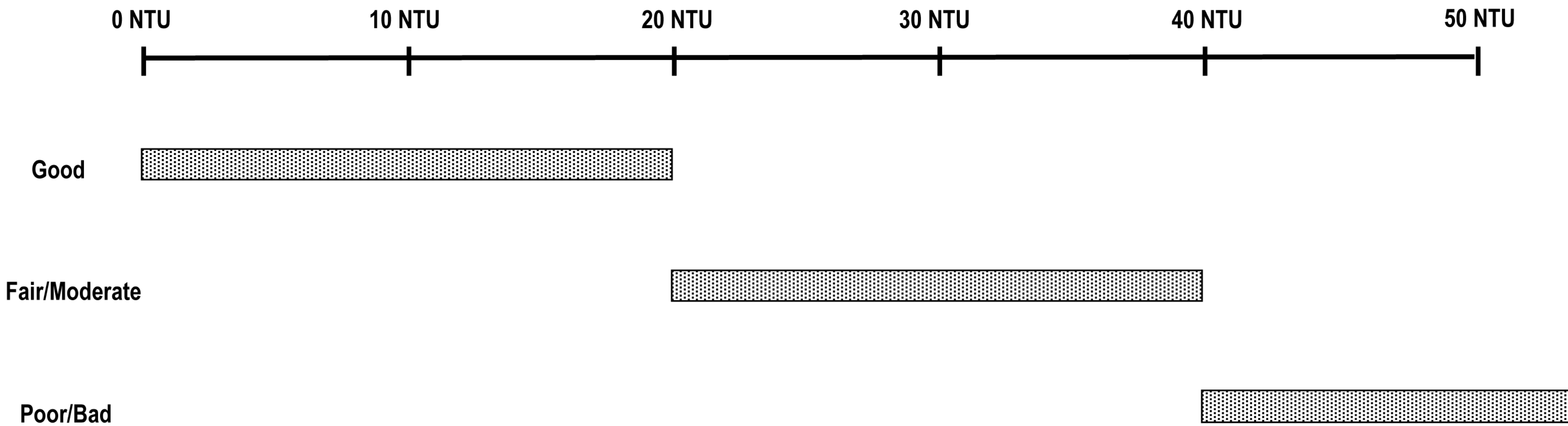
9) Enter 0 as the value in NTU by using the number pad and then press “keep” in the middle of the screen. Press “OK” and you are now ready to collect turbidity data. Simply use the bottle from the “0” NTU calibration to obtain samples from the water source being tested.

**For discussion:** Refer to the *Optimum Turbidity Levels for Aquatic Organisms* chart. How does the turbidity that you recorded for this area compare to the optimum turbidity levels for aquatic organisms?

**More questions for discussion:**

- 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 turbidity reading?
- What, if anything, could be done to try to decrease the turbidity at this site?

# 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.

## Flow Monitoring Background Information

Every summer, many streams across Oregon go dry or nearly dry. Often, more water is authorized for out of stream uses than naturally flows in the stream. As water becomes scarce, the stream's temperature increases and oxygen and water quality decrease. More importantly, less water means fewer habitats.

In many parts of Oregon, the water in our rivers and streams is over-appropriated – landowners have more rights to divert water for industrial and agricultural use than are actually in the river or stream. When periods of naturally low flows (typically, in the summer) coincide with withdrawals, many streams suffer from inadequate streamflows. In fact, some are dewatered entirely. When this happens, the ecology of the river system, the watershed and the basin are all negatively affected because the stream can no longer support aquatic habitat.

It is not an easy task to reallocate our scarce water resources in a way that accommodates industry, agriculture and the resource. Since irrigation accounts for 82% of total surface water withdrawals in the state, The Freshwater Trust devised a system to address instream flow, while still keeping agricultural lands productive. By using the instream water rights act, The Freshwater Trust works collaboratively with landowners and compensates them to leave all or a portion of their water rights instream in lieu of using it for out-of-stream purposes. The Freshwater Trust also works with these landowners to improve irrigation practices so that even more water can be kept instream.

**Procedure using Vernier LabQuest:**

*Stream Flow*

1) Power up LabQuest
2) Plug the Flow Sensor into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **5 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the WQ station your probes are warming up).
3) Assemble Flow Sensor by connecting the alternating black and white plastic rods together (two black rods, one with propeller and one without, and two white rods).
4) Submerge the entire propeller( facing up stream) into the stream; as long as the propeller is completely submerged you will obtain an accurate reading. **Do not stick the rod so far in that the cords get wet**. It is best to get a reading as close to the middle of the stream as possible, keep in mind the safety of the students and only take a sample that is no more than knee deep.
5) In order to change the unit of measurement (m/s and f/s) press the screen, using the stylus, in the box that contains the flow reading, this will give you a drop down menu and allow you to change between units of measurement.
6) Once the reading has become steady and you have properly recorded data, carefully disassemble the pieces of the Flow Sensor and you are ready for cleanup.

**Water Quality Activity Wrap Up:**

- What are some of the things we can do to determine whether a stream is healthy?
- What do animals living in and near the stream need?
- What does a stream need to be considered healthy for salmon?
- Do you think that it's healthy today?
- How about 100 years ago? How about in 100 years?
- What kind of activities, events, will affect the future condition of salmon bearing streams?
- What are some of the things we can do to help reduce our impact on streams?

**There will be a laminated copy of these discussion questions in the water quality field kit.**

**Resource List:**

Murdoch, T., Cheo, M. and O'Laughlin, K., **Streamkeeper's Field Guide, Watershed Inventory and Stream Monitoring Methods,** The Adopt-A-Stream Foundation, Everett, Washington 1991.

Stapp, W., and Mitchell, M., **Field Manual for Global Low-Cost Water Quality Monitoring**, Second Edition, Kendall/Hunt Publishing Co., Dubuque, Iowa 1995.

**The Stream Scene, Watersheds, Wildlife and People,** Oregon Department of Fish and Wildlife, Second Edition, Portland, Oregon 1999

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

# WATER QUALITY DATA FORM

School: ______________________________ Teacher: ______________________________

Date: ________________ Time: ____________ Weather: ______________________________

Stream/Site Name: ______________________________

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*

The Freshwater Trust™

Salmon Watch®

Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

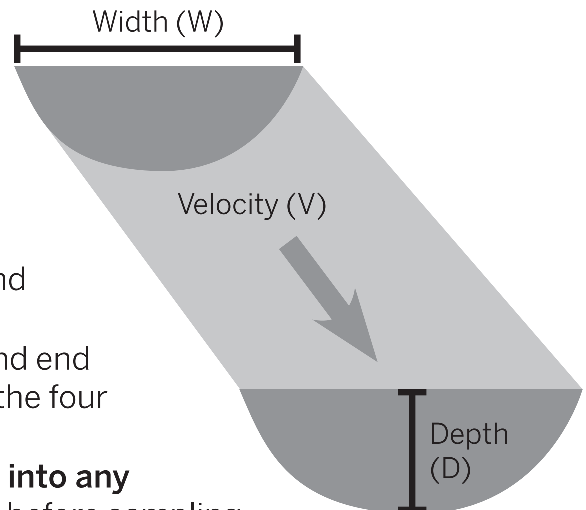
## STREAM FLOW DATA FORM

School: ________________________________ Teacher: ________________________________

Date: ________________ Time: ____________ Weather: ________________________________

Stream/Site Name: ________________________________

*Measuring Stream Flow with Vernier*




**What You Need:**

- ☐ Measuring staff
- ☐ Measuring tape
- ☐ LabQuest
- ☐ Flow Rate Sensor

**Procedure:**

1. Measure the <u>Width (W)</u> of the stream at your start and end points and get the average.
2. Measure the <u>Depth (D)</u> at two points for both the start and end points of your section of stream, and find the average of the four measurements.
3. Plug the Flow Sensor into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **5 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the water quality station your probes are warming up).
4. Assemble Flow Rate Sensor by connecting the alternating black and white plastic rods together (two black rods, one with propeller and one without, as well as two white rods.
5. Submerge the entire propeller half way to the bed of the stream. **Do not stick the rod so far in that the cords get wet.** It is best to get a reading as close to the middle of the stream as possible, keep in mind the safety of the students and only take a sample that is no more than knee deep.
6. Using the stylus, change the unit of measurement by pressing the screen in the box providing the <u>Velocity (V)</u> reading (m/s and f/s), this will give you a drop down menu and allow you to change between units of measurement.
7. Once the reading has become steady and you have properly recorded data, carefully disassemble the pieces of the Flow Rate Sensor and you are ready for cleanup.

---

**Width (W):**

Width (ft) = __________

**Depth (D):**

Depth (ft) = __________

**Velocity (V):**

Velocity (ft/s) = __________

**Stream Flow (Q):**

Stream Flow (Q) = _______ (ft) (W) x _______ (ft) (D) x _______ (ft/s) (V) = __________ cubic feet per second (cfs)

# Aquatic Macroinvertebrates


- Introduction to Macroinvertebrates – AM 2
- Field Study – AM 4
- In Depth Sampling Strategies & Collecting Techniques – AM 6
- Native and Invasive Aquatic Macroinvertebrates – AM 7
- Macroinvertebrates and the Aquatic Food Web – AM 10
- The River Continuum – AM 13
- Tolerant and Intolerant Identification Charts – AM 15
- Resources – AM 18
- Quick Reference Guide to Aquatic Macroinvertebrates – AM 19
- Aquatic Macroinvertebrates Data Form – AM 23


# Introduction to Aquatic Macroinvertebrates

**What are macroinvertebrates?**

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, and depend on healthy aquatic and upland ecosystems to survive.

Aquatic macroinvertebrates are beautiful, fascinating animals with many different body shape and structure adaptations that allow them to live in different parts of streams or lakes. Some mayflies (Ephemeroptera) that live on rocks in fast flowing water have very flattened, streamlined bodies, and some even have a suction cup-like structure on the underside of their bodies to help keep them from being washed off the substrate; other types of mayflies have curved tusks to help them dig into soft substrate (Ephemeridae, common burrowing mayfly). Black flies (Simuliidae) use hooks to anchor themselves to a little pad of silk they place on the rocks, while caddisflies (Trichoptera) build a variety of cases from sand, stones, pine needles, bark, or leaves and live and feed within their protective houses.

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 leaflike 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”.

Aquatic macroinvertebrates are affected by multiple different physical and chemical factors in both the stream and the surrounding watershed. The structure and composition of the aquatic macroinvertebrate community tells an important story about the biological health of our rivers and streams.

**What is biological assessment?**

Biological assessment uses the characteristics of biotic (living) communities, such as fish, invertebrates, amphibians, or plants, to provide data about the biological “health” of a body of water. It allows us to detect biological responses to the effects of pollution and disturbance. Measuring water chemistry 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 the invertebrates live in that water all the time. They are constantly exposed to whatever chemicals, sediments, or changes in 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 taxa have different known responses to specific stressors; and they are a critical part of the stream food web. Changes in the presence, condition, diversity, community composition, and relative abundances of specific groups of macroinvertebrates can signal pollution or disturbance occurring in a stream or its watershed.

Macroinvertebrate monitoring tells a story about the biological health or integrity of a stream. If you monitor the same stream across time and see a shift from a diverse population with many different types of invertebrates, including stoneflies, mayflies, and caddisflies, to a population with fewer overall types of invertebrates and a lot of worms, midges, snails, and sideswimmers, you know that the stream is degraded, even if you don’t yet know the exact cause of impairment. For example, freshwater mussels can live for 30-100 years, but they require a constant water flow. If a perennial stream that used to flow year-round is altered (by dams, development, irrigation, etc.) so that it becomes intermittent and dries out for a few weeks or months of the year, it will no longer be a place where mussels can live, since they die when they dry out, and are unable to migrate to a new stream. Stoneflies require cool, clean, fast-flowing water, and a healthy stonefly population is not expected in a stream that dries down or becomes too warm or polluted. However, some macroinvertebrates, such as aquatic earthworms and midge flies, can be quite tolerant of warm or polluted water, and may be the most abundant organisms in a highly disturbed, degraded stream.

## AQUATIC MACROINVERTEBRATES FIELD STUDY

**Objectives:** Students will understand the importance and roles of macroinvertebrates in the aquatic ecosystem by:
1) collecting macroinvertebrates from different instream microhabitats. (if present)
2) counting, and recording invertebrates from each habitat. (if present) (data form is available at the end of this section and in the Field Trip Data Forms section)
3) analyzing the data to determine the health of the stream. (in accordance with background materials)

**<u>Teaching Tips</u>**
Get students focused with introductions.

**Review safety guidelines and site protocols:**
- Macroinvertebrate sampling should be conducted well away from and downstream from spawning salmon and redds.
- No more than four students per teaching station in the stream/river at a time.
- In water above the knees, all participates are required to wear life vests.
- Avoid fast-moving water.
- Take care when walking on slippery rocks.
- Never drink the water – it could make you sick

Briefly describe the activity.

Model in-stream collecting techniques.

Divide the students into teams for each activity: collecting, sorting, identifying, etc. Insects can be divided by order (broad categories mayfly, stonefly, caddisfly, other groups).

Use field guides and cards to determine insect types.

Tolerant/Intolerant to Pollution cards can be passed out for de-brief/wrap up.

**Materials:**
D-frame nets or kicknets
Large shallow pans for sorting
Ice cube trays for specific sorting
Hand lens or 2-Way Magnifying Viewer
Forceps, brushes, turkey basters, eye droppers for picking up invertebrates
Guide to Pacific Northwest Aquatic Invertebrates *Second Edition*
Pollution tolerance group key
Tolerant/Intolerant to Pollution Macro Cards
Clipboard, data sheets, pencils
Rubber knee boots or hip boots (NECESSARY to collect insects)
The Macroinvertebrate Sampling Data Form; can be found at the end of this section and in the Field Trip Data Forms section of the binder.

**Procedure:**

1. Review safety procedures.
2. Identify the microhabitat(s), i.e. riffle, pool, glide, backwater, to be sampled.
3. Collect a sample from a 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, stocks or other leaf litter to remove any invertebrates. The invertebrates should flow into the net. Replace the rocks.
4. Repeat in up to **3 other locations** if necessary. (5 minutes at each location)
5. Remove net contents into a large shallow tray for sorting into groups in ice cube trays.
   **Tip: It can help to use the analogy of a zoo when discussing the reasoning for sorting. In the zoo all animals are not in the same cage. You wouldn't see a lion in the same cage as an elephant; therefore we do our best to put all the mayflies with the mayflies and caddis flies with the caddis flies.**
6. Count the different kinds of invertebrates and numbers of each kind for each of the four functional feeding groups. Use the field guides to help with identification.
7. Macros can also be sorted by habitat type or where found in the stream.
8. Record these numbers on the data sheets provided by the teacher.
9. If time allows students can sketch, label, and describe their favorite macro, how they move, feeding habits, breathing adaptations, etc.
10. Gently return macroinvertebrates to the stream.

**For Discussion/wrap up:**

Determine the health of the stream by the number and variety of insects found. Use the tolerant/intolerant insect group cards provided. Which group best reflects the insect community found in the stream sampled?

**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 may contain the most diverse assemblage of insects?
What species would be more likely found in stagnant areas with more fine sediments?
What kind 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 supports 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?

## In-Depth Sampling Strategies and Collecting Techniques

Macroinvertebrates can be found just about anywhere in streams—fast-flowing riffles, slower glides, and quiet pools, as well as in tangled rootwads overhanging the stream bank, matted leafpacks, and piles of large woody debris in the water. Riffles are shallower areas with medium to fast current where the flowing water breaks and churns over a mixed gravel, cobble and boulder substrate, and are the preferred sampling habitat because they:

- Contain the greatest diversity of macroinvertebrates.
- Are the most likely place to find pollution-sensitive species.
- Have fairly consistent habitat throughout the riffle.
- Are shallow and easy to access.
- Are easy to recognize.

Riffle sampling is done using a D-frame dipnet with 500 micron mesh, which is a small enough mesh to retain even tiny macroinvertebrates. Place the net base firmly against the stream bottom at the desired sampling location with the opening facing the current, and stand behind or to the side of the net to avoid obstructing the flow of water into the net bag. Make sure the water is not deeper than the top of the net (or you will lose organisms over the top), and that the base of the net is flush against the substrate (or you will lose organisms under the net bottom). If the net base is resting on rocks, carefully move the rocks to the net opening and rub them gently to dislodge any clinging organisms, then set them aside. One the net rim is flush against the substrate, pick up any large rocks or cobble present in a 1-foot square area in front of the net, and gently rub them clean while holding them at the net opening so that any dislodged organisms are carried into the net by the current. Set the cleaned rocks gently aside. Then use your boot heel or a small hand rake to thoroughly disturb the substrate in the same 1-foot square area in front of the net to a depth of about 2-3 inches for ~30-60 seconds. When finished, carefully tilt the nest handle slightly backwards to avoid losing your sample, lift the net out of the water and empty the contents into a large bucket or plastic tray for sorting and observation.

After allowing the sample to settle for a few minutes, macroinvertebrates can be picked out carefully from the debris using forceps (tweezers) and pipettes (eyedroppers or turkey basters). Most of these animals are dark colored and cryptic, blending in with the background, so they may be difficult to see at first. Individual organisms can be transferred to the chambers of white ice cube trays filled with water for easier viewing. Remember that many of these animals are predators, and if you mix together different kinds of invertebrates in the same ice cube chamber they may start eating each other!

Students can use the identification cards and field guides provided to help identify and record the numbers of each different general type (order or family) of invertebrate found. They can also use the pollution tolerance levels and sensitivity ratings in the guides to determine if they have found more invertebrates from the tolerant (midges, black flies, snails, aquatic worms) or intolerant groups (mayflies, stoneflies, caddisflies). These tolerance levels are based in part on the Hilsenhof Biotic Index (HBI), a numeric value related to an organism's sensitivity or tolerance to nutrient enrichment (resulting from fertilizer runoff, manure, or sewage) in a stream or lake. Low values (0 to 4) indicate an organism is sensitive to nutrient enrichment, while high values (8-10) indicate tolerance.

Students can also calculate the overall community richness, i.e. the number of different groups present. Most students will be able to identify the number of different invertebrate orders present, and some may be able to identify different families and even a few genera. A healthier aquatic system should support a greater number of different organisms, including more pollution-sensitive types, while a degraded community becomes has lower overall richness, and is dominated by one or a few pollution-tolerant types.

## Field Guides:

**Example from the Northwest Guide to Macroinvertebrates (R. Haefele):**

### Western March Brown

**Order**: Ephemeroptera
**Family**: Heptageniidae
**Genus**: *Rhithrogena*
**Common Name**: Western March Brown
**# of Species**: 5 common in the N. W.
**Status**: Common
**Habitat**: Moderate to fast flowing sections of cool streams and rivers with a gravel substrate.
**Behavior**: Clings to surface of substrate; uncommon in drift.
**Feeding Type**: Scraper
**Key ID Features**: Flattened dorso-ventrally. Three well developed tails. Head is widest part of body. Gills enlarged and overlap under abdomen.
**Pollution Sensitivity**: One of the more pollution sensitive mayflies.
**HBI Pollution Index**: 1
**Adult Activity**: March - June

## Native Versus Invasive Species of Aquatic Macroinvertebrates

Biomonitoring is also useful because regular monitoring of stream macroinvertebrates can reveal the presence of groups of special interest, such as threatened or endangered species, or invasive species.

**Native aquatic macroinvertebrate species at risk: freshwater mussels**

Freshwater mussels are among the most endangered organisms on the planet; over 70% of mussels in North America are imperiled, and 35 species may have gone extinct in past 100 years. Although North America has the highest diversity of freshwater mussels in the world, there are only ~7 species west of Continental Divide in three genera: *Margaritifera falcata* (western pearlshell); *Gonidea angulata* (western ridged mussel); and *Anodonta* species ("floaters"). Freshwater mussels are intricately linked to native fish populations. Mussels rely on specific species of fish to act as hosts for larval mussels (glochidia); without native fish hosts, larval mussels are unable to disperse or survive. Mussel beds in a stream can help improve fish habitat, as their filter-feeding activity can improve water quality and clarity, making it easier for fish to find prey. Mussel fecal pellets also provide nutrients for small macroinvertebrates that salmon fry rely on for food, and mussel beds provide physical habitat for macroinvertebrates, again increasing the food supply available for native fish. Mussels can be important biological indicators. They have a long lifespan (20-100 years, depending on the species) and low mobility, so they accumulate any contaminants in the system and can reflect ecosystem quality. Mussels are sensitive to toxins, low dissolved oxygen, sedimentation, and loss of host fish, so changes in mussel populations can reflect changes in ecosystem health.

**Invasive aquatic macroinvertebrate species:**

Invasive species are non-native species that are transplanted to a new ecosystem, either deliberately or accidentally. In their new habitat, which lacks the predators and diseases with which they evolved, they experience explosive population growth that can drive native species to extinction and alter entire ecosystems. Aquatic invasive species may have be introduced as a food source; arrive as hitchhikers on boats, in ballast water, or in the muddy cleats of waders or boat trailer tires; or be dumped out of bait buckets. Eradicating established populations is difficult to impossible, and very costly, so monitoring and early warning systems are crucial.

**Freshwater macroinvertebrate invaders in Oregon:**

- **New Zealand mudsnail** (*Potamopyrgus antipodarum*), is a tiny (5-6 mm) snail with a smooth brown conical shell. These snails are native to New Zealand, and were 1$^{st}$ discovered in the United States in 1987 in the Snake River in Idaho; since then, they have spread to all western states except New Mexico. These snails can reach population densities of 100,000 per square meter in some rivers, and may comprise up to 95% of the total macroinvertebrate biomass.

- **Asian clam** (C*orbicula fluminea*) is a small (2.5-5 cm), yellowish to light brown clam with prominent growth ridges on its triangular to oval shell. It was introduced into North America from southeast Asia in early 1900's and is now established in Oregon, California, and Washington. These clams can reach densities of >10,000 square meter in a stream.

- **Zebra & quagga mussels** (*Dreissena polymorpha* & *D. rostriformis bugensis*) arrived in the U. S. in the 1980's from Eastern Europe and spread quickly throughout the Great Lakes and Mississippi River watershed. Zebra mussels are small (0.6-3.8 cm); their shells are triangular with a flattened edge and are usually striped, but may be very dark or light & lack obvious striping. Quaggas are larger (up 5 cm), with a more rounded shell. Unlike our native mussels, zebras and quaggas attach to hard surfaces (including native mussels) using strong byssal threads. These species are not yet present in Oregon, but in 2007 quagga mussels were discovered in Lake Mead (NV), and Havasu & Mohave Lakes (CA-AZ border). More recently a boat being towed through Spokane, WA from Lake Mead was intercepted and found to be infested with quagga & zebra mussels.

- **Three species of *Orconectes* crayfish** have been found in the Northwest--rusty crayfish (*O. rusticus*), ringed crayfish (*O. neglectus*), and virile crayfish (*O. virilis*)—although only the ringed appears to be established, and is present in the Rogue, John Day, and Umpqua Rivers in Oregon. The red swamp crayfish (*Procambarus clarkii*) has also been introduced into Oregon and Washing. These crayfish species are all native to other parts of the U. S.

For more information on aquatic invaders, visit the National Invasive Species Information Center (www.invasivespeciesinfo.gov/index.shtml) or the Oregon Invasive Species Council (www.oregon.gov/OISC/). To report an invasive species sighting, call the toll-free Oregon Invasive Species hotline, 1-866-INVADER or visit http://oregoninvasiveshotline.org/.

## 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.

Macroinvertebrates have a wide variety of shapes, sizes, appearances, and mouthparts, 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:

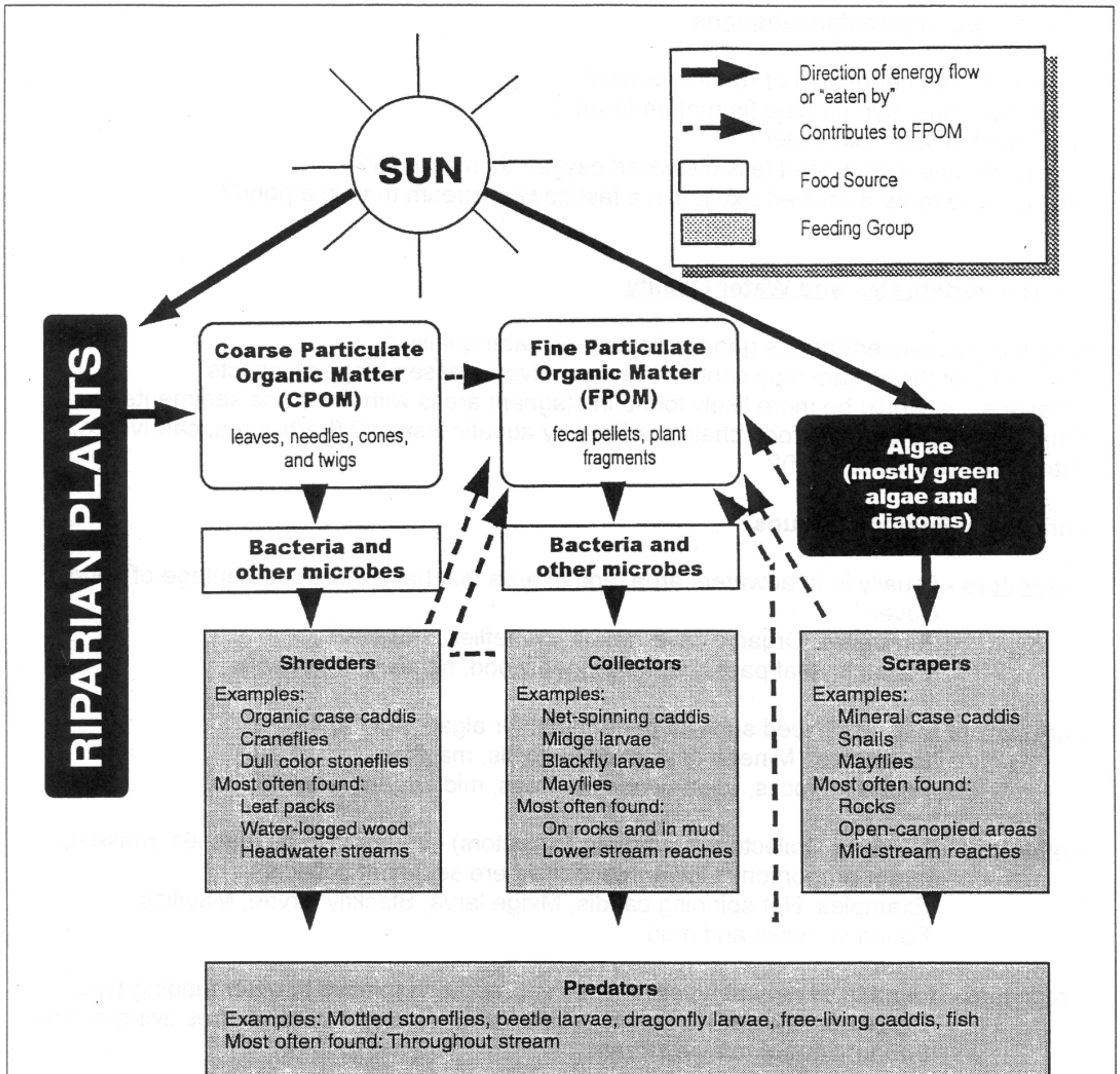
**Shredders:**
Chew on intact or large pieces (>1 mm) of plant material
Usually found in headwaters and areas with a high percentage of canopy cover
Examples: giant stoneflies, Northern caddisflies
Found in: leaf packs, water-logged wood, headwater streams

**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

**Pathways of energy from the sun to the four main macroinvertebrate groups. Some scientists add salmon carcasses as another source of energy.**




Food processing in streams. (*Adopted from ""From Headwater Streams to Rivers," by Ken Cummins, American Biology Teacher, May 1977, p. 307*)

## 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.

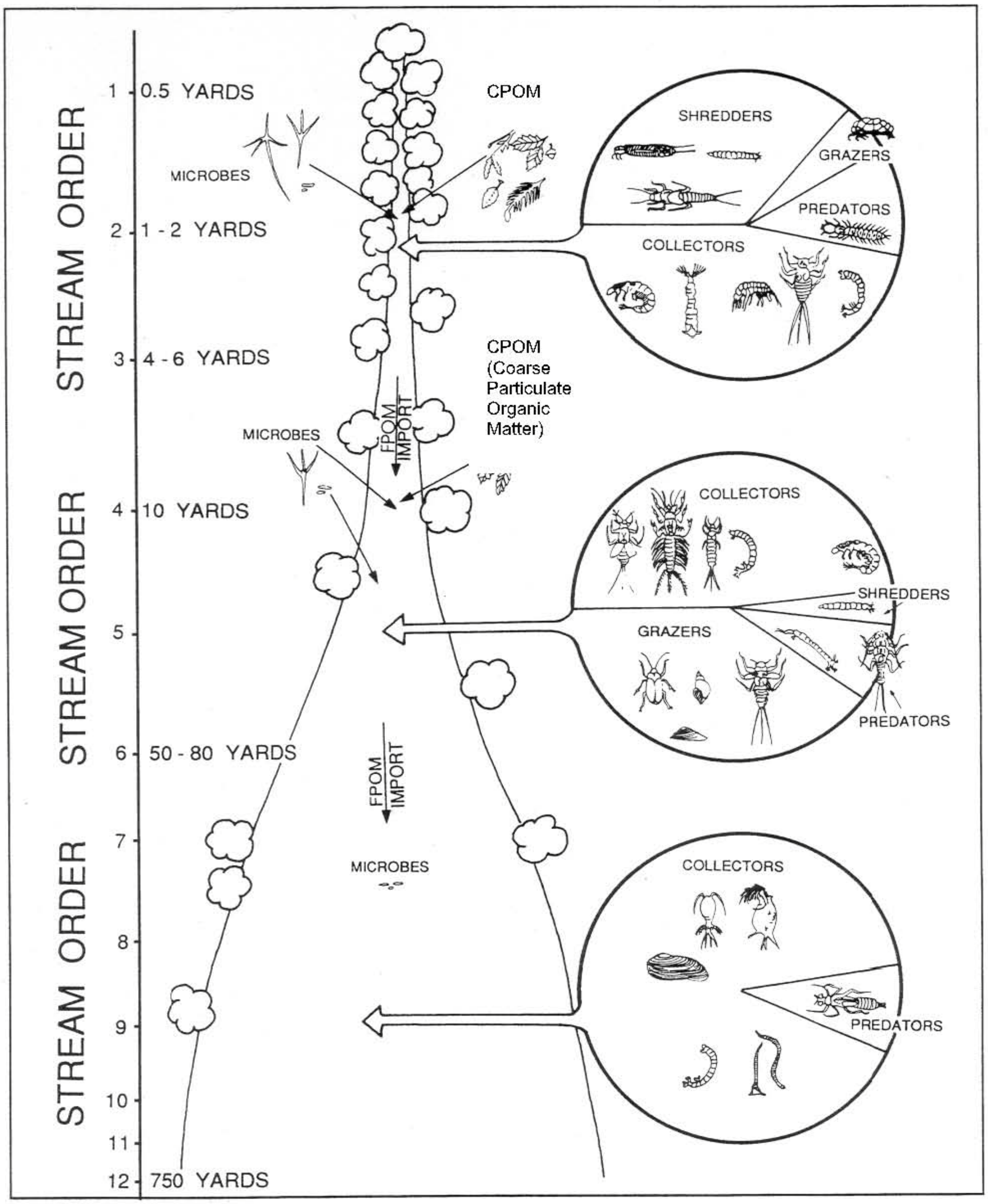
Forests at the headwaters (1st- to 3rd-order streams) have less influence as a stream gets larger. With less input from the riparian habitat, the energy base relies more on algae that is produced as additional sunlight penetrates through the open canopy, and on processed material carried in from intermediate 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 midreacstreams 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 comminutes are important in these areas.

RCC predictions RCC work particularly well for forested mountain streams.  There are exceptions to the pattern outlined in **The River Continuum Concept**, but the concept shows what might be expected in a stream system. If community is “out of place” or missing, it can be a red flag, encouraging further investigation.

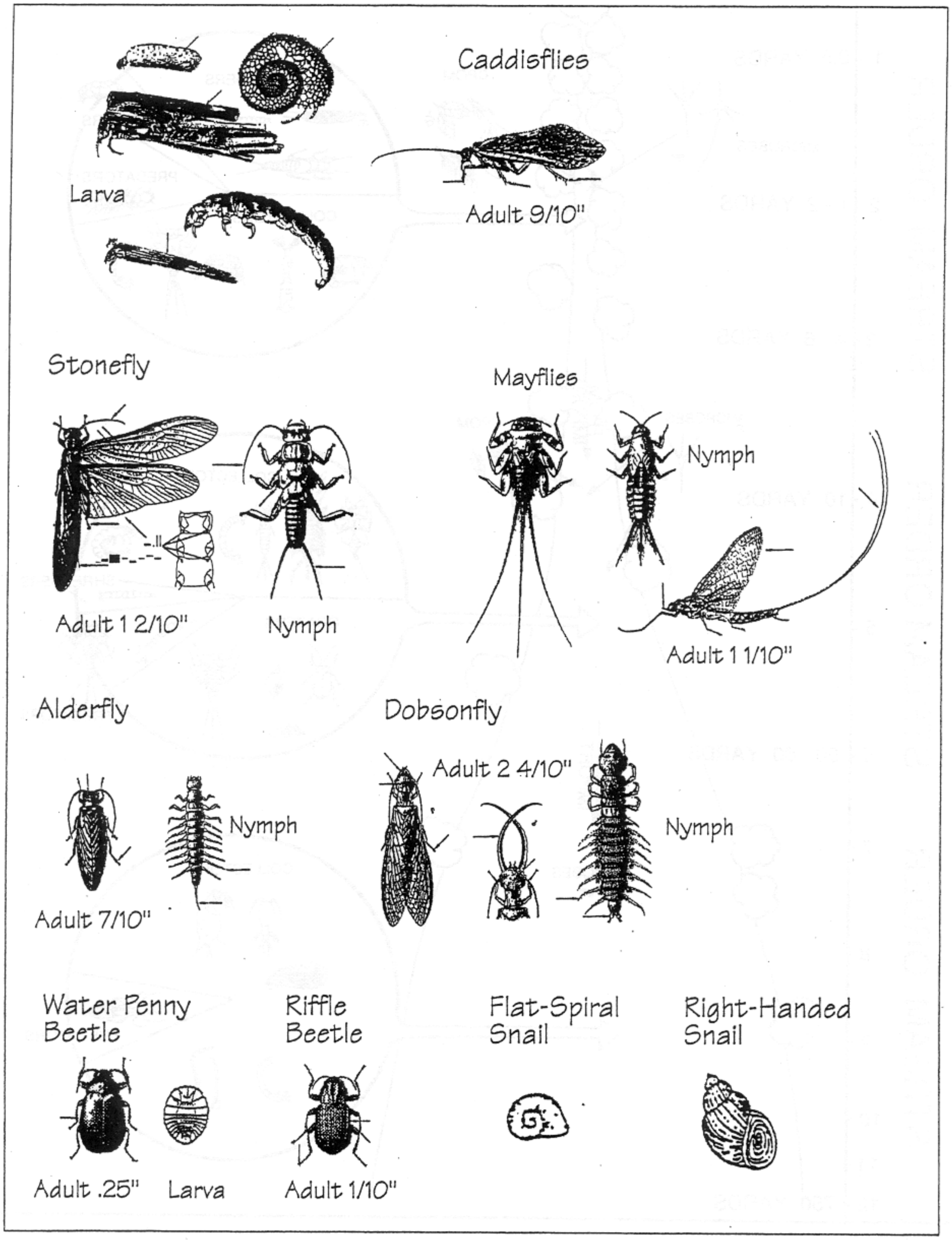
**The River Continuum Concept (after Vannote *et al*., 1980).**
Changes in functional feeding groups accompany changes in stream morphology and energy inputs.



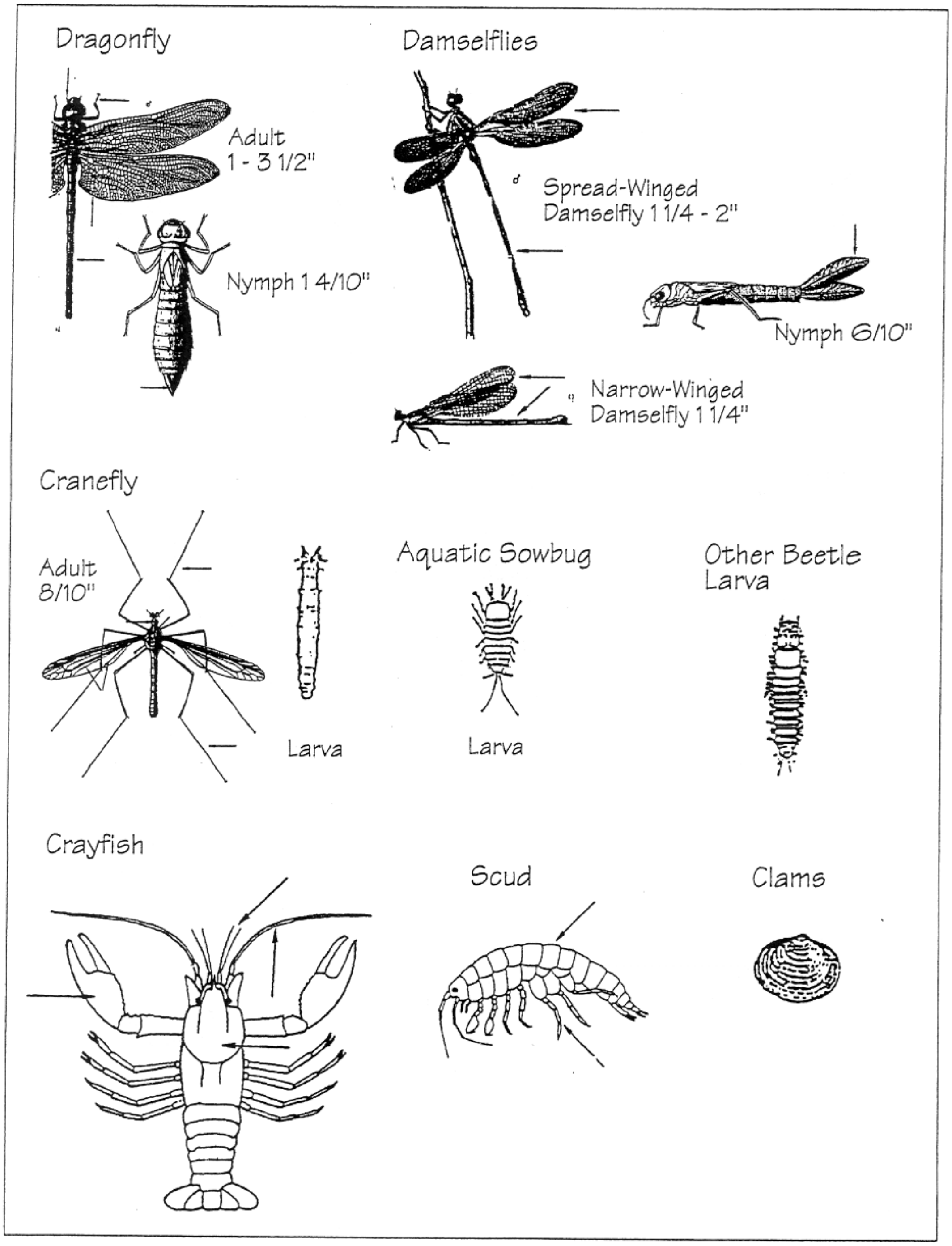

Top: Sampling with D-Net
Bottom Left: Two-way magnifying viewer used for identification
Bottom Right: Sorting insects and recording data

**INSECT GROUPS ARRANGED BY TOLERANCE TO POLLUTION**

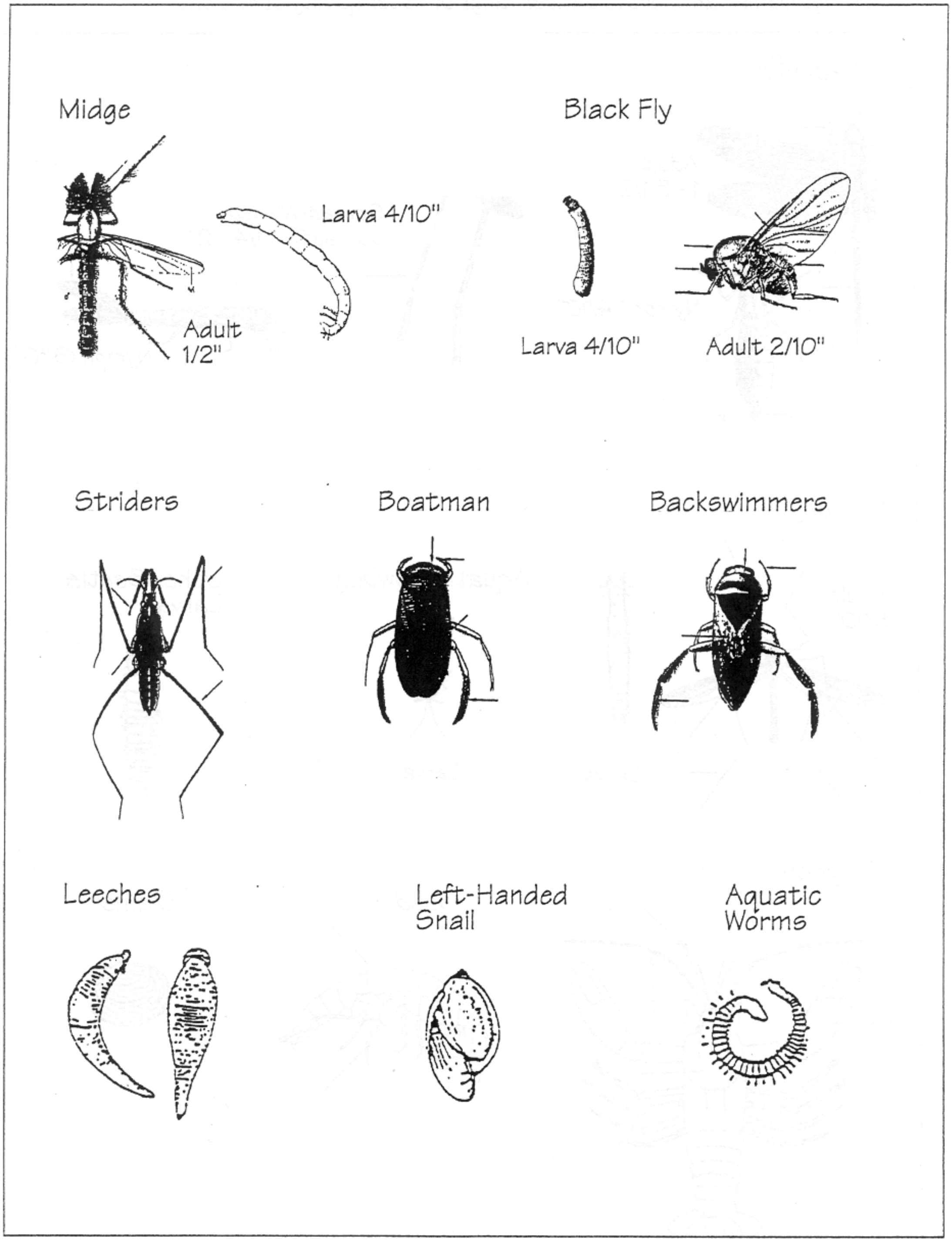
**Group 1: Intolerant**
These organisms are sensitive to pollution.
Their dominance generally suggests good water quality.



**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.



## Resource List


Adams, J., M. Vaughan, and S. Black. 2004. Stream Bugs as Biomonitors: A Guide to Pacific Northwest Macroinvertebrate Monitoring and Identification. The Xerces Society for Invertebrate Conservation, Portland OR.

The Cascade Streamwatch Experience, Wolftree, Inc. March, 1996.

Farthing, P., B. Hastie, S. Weston, and D. Wolf. 1990. The Stream Scene, Watershed, Wildlife, and People, Oregon Department of Fish and Wildlife.

Hafele, R. and S. Hinton. 2003. Guide to Pacific Northwest Aquatic Invertebrates, 2nd ed.

Kellog, L. 1992. Monitor's Guide to Aquatic Macroinvertebrates, Izaak Walton League of America.

Lehmkuhl, D. M. 1979. How to Know the Aquatic Insects. William C. Brown Publishing Company.

McCafferty, W. P. 1988. Aquatic entomology: the fishermen's and ecologists' illustrated guide to insects and their relatives. Jones and Bartlett Publishers, Sudbury MA. 448 pp.

Mitchell, M. K. and W.B. Stapp. 1994. Field Manual for Water Quality Monitoring, 8th ed. Thomson-Shore, Inc., Dexter, Michigan.

Murdoch, T., M. Cheo and K. O'Laughlin. 2001. Streamkeeper's field guide: watershed inventory and stream monitoring methods. Adopt-A-Stream Foundation, Everett WA. 296 pp.

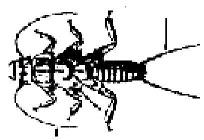
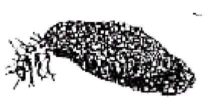
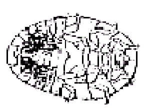
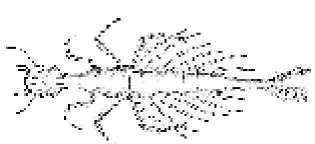
Nedeau, E. J., A. K. Smith, J. Stone and S. Jepsen. 2009. Freshwater mussels of the Pacific Northwest, 2nd ed. The Xerces Society for Invertebrate Conservation, Portland OR. 51 pp.

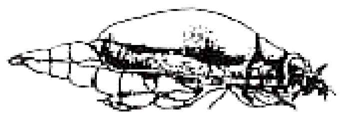
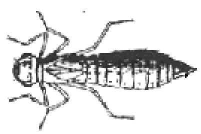
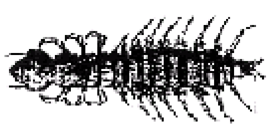
Voshell, J. R. 2002. A guide to common freshwater invertebrates of North America. McDonald & Woodward Publishing Company, Blacksburg, VA. 442 pp.

Wiedemer, S. and S. Chan. 2008. On the lookout for aquatic invaders: Identification guide for the Pacific Northwest. Oregon Sea Grant, Oregon State University, Corvallis OR. 71 pp.

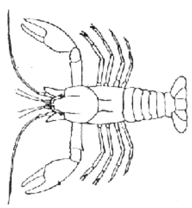
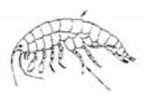
Yates, S. A. 1988. Adopting a Stream, University of Washington Press, Seattle.

# 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 |

Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

The Freshwater Trust™

Salmon Watch®

# MACROINVERTEBRATE SAMPLING DATA FORM

School: ______________________ Teacher: ______________________

Date: ______________ Time: __________ Weather: ______________________

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

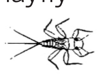
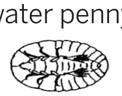
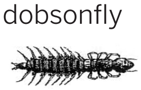
\# of people sorting/identifying: ________ ☐ Riffle ☐ Pool

**Directions:**

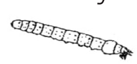
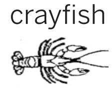
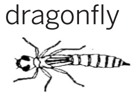
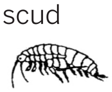
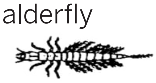
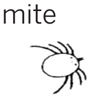
1. Record the number of each type of organism found in the **# found** column of each section.
2. Then circle the number in the **score** column (3, 2, or 1) if any of that organism was found.
3. Complete the equation at the bottom by adding up the circled numbers from each score column.

## *SENSITIVITY TO POLLUTION*

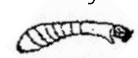
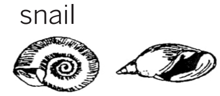
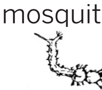
### Sensitive / Intolerant

| | # 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*

# Riparian Ecosystem


- Introduction to Riparian Areas – R 2
- Riparian Ecosystem Field Study – R 9

  Riparian & Aquatic Area Survey
  Riparian Area Transect
  Riparian Mapping
  Riparian Profile
  Soil Survey
  Canopy Cover Survey

- Identification of Northwest Trees – R 18
- Actively Managed Streamside Buffers – R 26
- Riparian Ecosystem Data Forms – R 27


## Introduction to Riparian Areas

Plants along the streambed influence the entire stream ecosystem. This green zone is called a **riparian area** and has several unique properties. A riparian area is linear, has a water transport channel and floodplain, and is interrelated with upstream and downstream ecosystems. Riparian habitat is a combination of three areas; each is distinctive and contributes to the entire ecosystem:

**Aquatic area:**
The aquatic area of streams, lakes, and wetlands is generally wet. During dry periods, aquatic areas have little or no water flow. Any side channels or oxbows containing freshwater ponds are included in this area.

**Riparian area:**
The riparian area is a terrestrial zone where annual and intermittent water, a high water table, and wet soils influence vegetation and microclimate. Since these areas are next to water, they tend to have more moisture, and plants and soils that reflect wetter conditions. For example, they may have more tree species such as cottonwoods or alders that need more saturated soils.

**Area of influence:**
This is a transition area between a riparian area and upland cover. An area of influence has soil moisture and is characterized by a noticeable change in plant composition and abundance. Trees in this area contribute shade, leaves, woody debris and insects to the stream. In the Pacific Northwest, the area of influence includes ground covers, shrubs, and understory trees (usually deciduous) on the floodplains, and canopy trees (usually coniferous) on hillsides. This stair-stepping of vegetation provides a variety of wildlife habitat.

**Role of Riparian Vegetation**
Riparian vegetation provides cover for aquatic and terrestrial animals.
Shade created by the riparian vegetation moderates water and air temperatures.
This vegetation limits water contamination, slows water velocities, and filters and collects large amounts of sediment and debris. Uncontrolled sediments can kill fish and destroy spawning areas.

## Functions of Riparian Vegetation as They Relate to Aquatic Ecosystems

| Riparian Vegetation Site Component Function | | |
|---|---|---|
| Above ground-Above channel | Canopy and stems | Shade- controls temperature and in-stream photosynthetic productivity Source of large and fine plant debris Source of terrestrial insects |
| In channel | Large debris derived from riparian vegetation | Control routing of water and sediment Shape habitat—pools, riffles, cover Substrate for biological activity |
| Streambanks | Roots | Increase bank stability Create overhanging banks--cover |
| Floodplain | Streams and low-lying cover | Retard movement of sediment, water, and floating organic debris in flood flows |

Source: William Meehan et al., *Influences of Riparian Vegetation on Aquatic Ecosystems With Particular References to Salmonid Fishes and Their Food Supply*, 1977, p. 137.

Stream food chains depend on organic debris for nutrients. In small headwater streams, 99 percent of the energy for organisms comes from the vegetation along the stream, and only 1 percent from photosynthesis. The leaves, needles, cones, twigs, wood, and bark dropped into a stream are a storehouse of readily available organic material that is processed by aquatic organisms and returned to the system as nutrients and energy.

A diverse population of insects depends on this varied food base. Sixty to 70 percent of the debris is retained and processed in the headwaters by bacteria, fungi, insects, and abrasion, with very little leaving the system until it has been processed.

Riparian areas have a high number of edges (habitat transitions) within a very small area. The large number of plant and animal species found in these areas reflects habitat diversity. Since they follow streams, riparian areas are linear, increasing the amount and importance of edge effect. Extensive edge and resulting habitat diversity yield an abundance of food and support a greater diversity of wildlife than nearly any other terrestrial habitat.

**Floodplains**

Floodplains are an important part of a riparian area. Floodplain vegetation that shades or directly contributes material to a stream is considered part of the riparian area.

Stream channels rely on natural flooding patterns. Frequency of flooding and groundwater supply are the major factors controlling the growth of floodplain trees. Floodplains and backwaters act as reservoirs to hold surplus runoff until peak floods are past. This controls and reduces downstream flooding. Floodplains also spread the impact of a flood over a larger area as vegetation helps collect debris and sediment.

Composition of riparian plant communities depends on the water pattern (fast or slow moving or dry or wet periods). Both wet and dry phases are necessary in this area to complete the stream's nutrient cycle and food chain. Flooding is critical to the exchange of nutrients and energy between the stream and the riparian area.

When healthy, vegetated banks in the riparian area act as natural sponges. They help maintain soil structure, allow increased infiltration, and reduce bank erosion. Vegetated streambanks also contribute to aquifer (groundwater) recharge. Precipitation is filtered through the riparian soils and enters underground reservoirs called aquifers. Good cover slows the flow and increases percolation into underground aquifers. Stored water is then available during drier periods to maintain and improve minimum flow levels. A major benefit of this aquifer recharge is maintenance of year-round streamflow.

Riparian vegetation uses large amounts of water in transpiration. Often, vegetation needs the most water during the period of lowest streamflow. At these times vegetation may actually reduce streamflow.

**Soils in riparian areas and floodplains**

Soil types in both riparian areas and associated floodplains can tell a lot about the current and historic conditions of the stream. In addition to providing helpful information about current soil composition, an understanding of soil types can reveal the location of historic streambeds, floodplain location, and moisture content of the soil. Examining the types of rock materials found within the soil can unearth gravel, cobble, sand, loam, or clay. Certain soil types such as gravels and cobbles might indicate that you are standing on an ancient flooplain!

**Wildlife in riparian areas**

Riparian ecosystems provide the essentials of wildlife habitat—food, water, and cover. In general, the area within two hundred yards of a stream is used most heavily by wildlife. In western Oregon, of 414 known species of wildlife, 359 use riparian ecosystems extensively and 29 species are tied exclusively to this area. While riparian areas cover less than one percent of the land in eastern Oregon, 280 of 379 species use this area extensively.

Riparian areas provide migration routes and corridors between habitats for many animals. The riparian area provides cover, food, and water during these movements. Woody plant communities in the riparian area provide cover, roosting, nesting, and feeding areas for birds; shelters and food for mammals; and increased humidity and shade (thermal cover) for all animals.

Birds are the most common and conspicuous form of wildlife in a riparian ecosystem. In this important breeding habitat, as many as 550 breeding pairs have been found per 100 acres. Bird density is just one indicator of the productivity of a riparian area.

Mammals of all sizes are found in riparian areas. Many rodents are parts of various food chains. Some, such as beaver, may modify riparian communities. Amphibians and reptiles are another indicator of riparian quality. Nearly all amphibians depend on aquatic habitats for reproduction and overwintering. Certain turtles, snakes, and lizards also prefer riparian ecosystems.

Animal populations in riparian areas are affected by the size and diversity of available habitat. Adjacent land-use activities may have a direct impact on wildlife population size within a riparian area. Fish populations can be an indicator of watershed and riparian ecosystem health. Large woody materials, such as fallen trees and limbs, create pools, and protective cover—necessary components of fish habitats. This woody debris also increases the diversity of invertebrates, which are a basic part of the food chain on which fish depend.

**People in riparian areas**

Since the land along streambanks and floodplains is often fairly flat, riparian areas are attractive locations for roads. Roadbuilding may increase sedimentation, which can adversely affect aquatic life, especially fish. Runoff from roads can carry oil, antifreeze, and other contaminants into the stream. Road construction can also damage valuable wildlife habitat. Traffic, a hazard in itself, may disturb or displace many wildlife species.

Roads probably have a greater and longer lasting impact on riparian areas than any other human activity. Routes should be selected and designed with careful consideration of potential long-term impacts.

Riparian vegetation is often cleared for farming purposes. This often weakens bank structure, making it more susceptible to erosion and a contributor to sediment deposition downstream. Landowners who convert riparian areas to farmland for short-term gains in agricultural production may lose in the long run. The loss of vegetation on stabilized banks could cause the stream to wash away that same valuable land during periods of high flow.

Livestock, like wildlife, area attracted to shade, water, and forage in riparian areas. If mismanaged—allowing the area to be grazed excessively or at the wrong time—livestock can severely affect the riparian area's value. Livestock can compact the soil near the water, reducing its infiltration capacities. When riparian vegetation is damaged—either by trampling or overgrazing—shading is reduced, erosion potential is increased as streambanks slough away, water tables are lowered, and water quality is affected. Animal wastes may also threaten water quality. Livestock can be managed, thus the impact of livestock can be reduced by controlling access and grazing levels along stream banks.  By utilizing good management techniques, ranchers can actually increase economic gains as well as enhance the value of their property.

Residential and commercial development has occurred near riparian areas throughout history. Development in these sites has generally degraded the value of the resources. Degradation has included filling and altering of stream channels, removing vegetation for building construction, and paving large amounts of land for roadways.

Some problems associated with development can be avoided by good planning and site design. Residential communities can be planned with riparian area values in mind. Construction sites can avoid steep slopes, wetlands, and sensitive biological sites. Areas that offer the amenities of a relatively healthy riparian area often have an increased real estate value.

Construction of campgrounds and recreation sites in riparian areas encourages use by anglers, birdwatchers, hikers, boaters, and others. This use, especially irresponsible acts like littering or erosion caused by improper use of off-road vehicles, may conflict with the welfare of wildlife and reduce water quality.

Streams and their riparian areas are the source of domestic water for many cities. High water quality is important for these uses. To maintain it, riparian areas must be carefully managed. Mining in and near streams has severe impacts on riparian ecosystems. Mining often increases sedimentation and disrupts spawning areas by moving large amounts of gravel, rock and soil. In addition, mining may introduce poisonous or toxic heavy materials into streams.

**Forest canopy in riparian areas**

The upland forest that sits adjacent to the riparian area along a stream provides an important function. Although it is not directly connected to the stream, the upland area that contains taller trees also provides valuable shade that keeps streams cool. A dense overhead canopy cover can shade the riparian area as well as the stream channel to reduce the potentially harmful effects of water warming from the sun. By assessing the canopy cover, or density of shading that is associated with upland trees, instream and riparian health can be better understood.

**Timber harvest in riparian management areas**

Timber harvest in riparian areas requires careful management. Until the Oregon Forest Practices Act, which regulates state and private land, was enacted in 1971, clearcuts commonly went to the stream's edge. In addition to removing trees that shade streams, the understory and groundcover were heavily damaged. A future source of woody debris in streams was eliminated and erosion increased. Historically, direct destruction of spawning grounds occurred by dragging logs through streams, building roads along banks, and transporting logs down streams and rivers. These practices affected water flow, bank erosion, siltation, and temperature fluctuations.

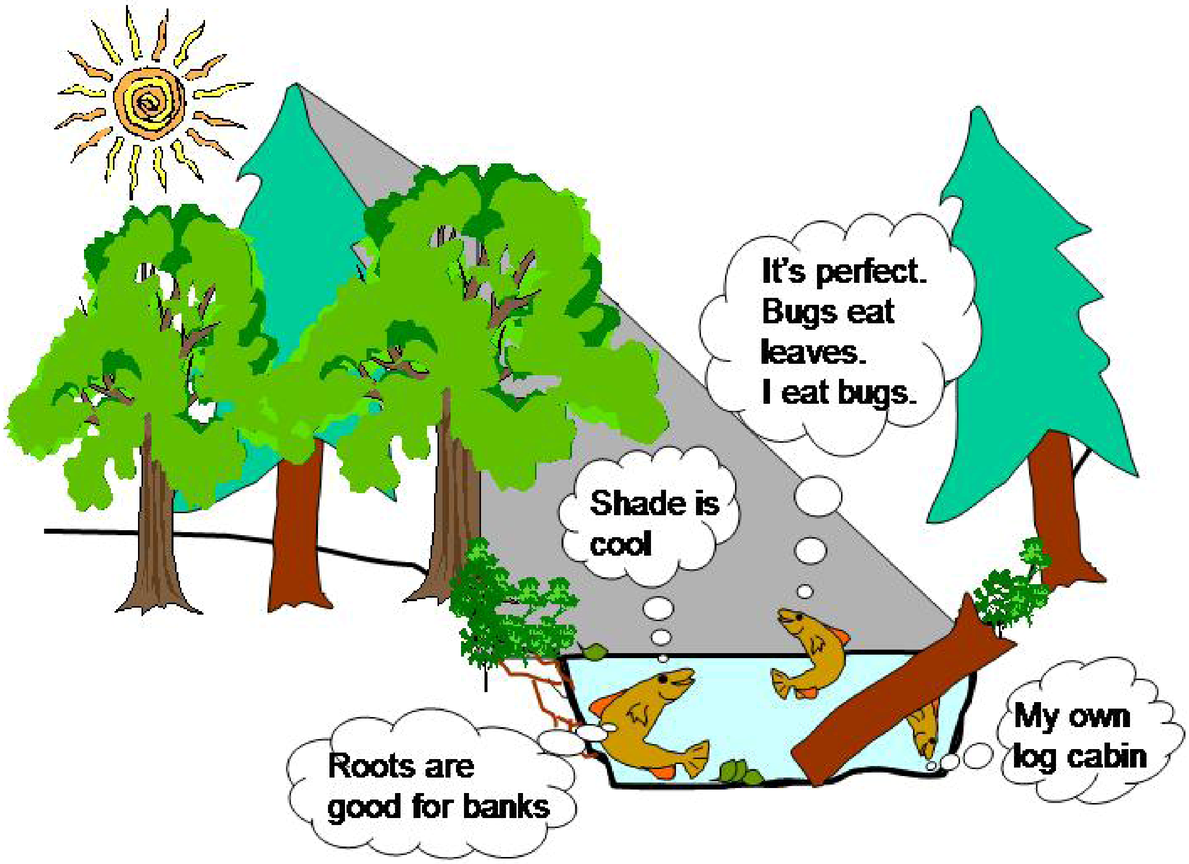
Modern forest management calls for the maintenance of vegetation buffer strips along the sides of streams, lakes, estuaries, and wetlands. These riparian management areas (RMAs) are designated by the Oregon Forest Practices Act, the State Board of Forestry, and federal management agencies because they protect fisheries, domestic water supplies, and recreational water use.

A riparian management area includes both sides of a stream and usually includes the riparian area and riparian area of influence. Its width on each side of the stream is required by law to average three (3) times the stream width. It cannot average less than twenty-five feet, nor require an average of more than one hundred (100) feet. Width may vary with terrain and other circumstances and is generally the average width over the length of the stream where logging operations will occur.

Not all streams are protected, however. To qualify for protection, streams must fit guidelines set by the Oregon Forest Practices classification system. Under the Oregon Forest Practices Act, all forest activities—including road-building, timber harvesting, chemical use, and slash disposal—must be planned, approved, and completed in a manner that protects riparian areas, as well as other forest resource sites. The act is enforced and records show that only a very small number of forest operations are conducted in violation of the Act’s rules.

The Oregon Forest Practices Act provides other regulations for responsible timber harvest management. Seventy-five percent of the initial shade potential that existed over an aquatic area must remain to protect stream water temperatures. Fifty percent of the original tree canopy material must be left to provide organic material essential to a stream and a source of insects for fish food. All downed timber in an aquatic and riparian management area is to be left to provide instream structure as habitat for fish and aquatic insects and den sites or burrows for other forms of wildlife. All snags (dead standing trees) not designated as a safety hazard, as well as future down logs or instream woody debris, must be left to provide habitat for insects, birds and small animals. Live conifer trees must be left in the riparian management area, preferably in clumps, to provide better wildlife habitat.

**Benefits for fish habitat from healthy riparian areas. (Reiter, 2004)**



# RIPARIAN ECOSYSTEM FIELD STUDY

**Objectives:**
The objective of this station is to provide students with an opportunity to:

1) Explore the riparian and aquatic ecosystems in the riparian area,

2) Understand the link between riparian and stream ecosystems with the focus on the four most important components that riparian areas provide to create fish habitat and maintain water quality:
a. Shade
b. Food sources
c. Erosion control
d. In-stream structure

3) Consider the intersection of the riparian zone with the upland forest.

**Activities:**
There are different ways to explore riparian areas. The following six activities can be used (in any combination, feel free to use one or many) to give students an awareness of what the riparian area of a stream "looks like," and how the components of the riparian area affect Salmon. For instance, students may use the Riparian & Aquatic Area Survey to gain a general idea of the components that constitute the riparian area, then use the Riparian Mapping Activity to illustrate specific components of the riparian area that they think are important. The Soil Survey activity helps students to examine what is right under their feet and the Canopy Cover Survey guides them to look up! By evaluating what is above and below them, students are encouraged to consider how all elements of the riparian zone interact and play important roles in the creation of healthy habitat conditions for salmon and steelhead.

**Note:** Volunteers are responsible for communicating with the teacher to ensure that students will have the appropriate datasheets for each activity that the teacher wants covered.

**Riparian & Aquatic Area Survey**
**Riparian Area Transect**
**Riparian Mapping**
**Riparian Profile**
**Soil Survey**
**Canopy Cover Survey**

**<u>Teaching Tips</u>**
Through each of the above activities, (or through any combination of the activities) students should leave the Riparian Ecosystem station with a basic idea of what the riparian area is, how it relates to salmon, and why healthy riparian

ecosystems are important to the health of both the streams and the animals that live there.

In addition, and wherever possible, information that connects to the other three stations (water quality, macroinvertebrates and fish biology) should be emphasized so as to paint the most complete picture possible for students, so that they understand that the concepts covered at each of the four stations are interrelated.

**Materials:**
All necessary materials are listed within each activity below and on the Riparian Data Forms in the "What You Need" section of each form. Data Forms can be found at the end of this section and in the Field Trip Data Forms section of the binder.

**Procedure:**
All procedures are listed throughout the section within the specific riparian activities below.

**For Discussion/wrap up:** All discussion suggestions are listed throughout the section within the specific riparian activities below.

# RIPARIAN & AQUATIC AREA SURVEY

**Objective:** To give students an introduction to common components which constitute the riparian and aquatic zones.

**Outcome:** Students will complete each of the survey categories below, and answer the wrap up questions.

**Materials:**
Riparian & Aquatic Area Survey (data form is available at the end of this section and in the Field Trip Data Forms section)

Form ID books/charts.

**Procedure:**

1) Direct students (either individually, in pairs, or in small groups) to complete the survey and answer questions.

2) Gather group together to share.

**Riparian & Aquatic Area Survey Discussion Questions:**

1) What features of this riparian area do you think are the most significant? Why?

2) What important features seem to be missing? How does this affect the stream (and salmon)?

3) In what ways do salmon affect this riparian area?

4) How is this riparian area similar to riparian areas near your school? How is it different?

## RIPARIAN AREA TRANSECT ACTIVITY

**Objective:** To provide students with an opportunity to 1) explore the riparian area of a stream, and 2) identify and discuss differences in the components of the riparian area that they observe.

**Outcome:** Students should leave this activity with an awareness of what the riparian area of a stream "looks like," and some specific examples of its components.

**Materials:**
100-foot tape measure
15-foot rope with a ring attached in the middle of its length
Instructions
Data sheet (data form is available at the end of this section and in the Field Trip Data Forms section)
Plant and tree identification books or charts.

**Procedure:** Look for a place where students can get down to the shoreline safely. Students will set up a transect and count conifer and hardwood trees, shrubs and percentage of land occupied by grasses along the transect at each location.

1) **Set the transect.** Organize the students into pairs. Assign one pair to stretch the transect tape measure from the water's edge or a clearly discernible high water line perpendicular to the stream into the riparian area. They should hold the two ends so that the tape is stretched out to its full 100' length. The tape is divided into five parts, each 20 feet long. These divisions arbitrarily mark off five 20-foot "zones" in the riparian area, "Zone 1," "2," "3," etc.


2) **Count trees.** Assign one pair to place the ring on the 15-foot rope over the transect tape. Start from the 0-foot mark, and walk parallel to the transect tape towards the 100 foot mark. Each time they reach one of the 20-foot marks, have them check to see if the rope touches any trees, shrubs, etc, by using the rope to measure out a circle with a diameter of 15 feet (an area with a radius of 7.5 feet, with the attached ring as the centerpoint- see diagram below.) Identify any plants within the diameter of the area that the rope covers. Then tell the recorders (see Data Sheet) whether the plants

are conifers or hardwood trees; shrubs; or types of grasses, and the zone that they are in.

3) **Record data.** Assign one pair to record data on the data sheet provided. The recorders should fill out the information about the transect site at the top of the data sheet, add their names at the bottom of the sheet, then record numbers and types of conifers, hardwood trees and shrubs, and percentage of land covered by grass as this information is called out. Additional comments about dead wood, side channels, etc., may also be recorded. Either during the data collection or after, the recorders enter data on the graph on the reverse of the data sheet. They do this by filling shading in the box above the appropriate zone in either the conifer or hardwood category. Shade one box per tree tallied.

**Riparian Area Transect Discussion Questions:** Ask the group to review the data and graph, and look for patterns and changes.

**1. Are there any differences in the numbers and species of plants that were found the various "zones"? What may account for these differences?**
Depending on the site, students may find that grasses and shrubs are most dominant in the zones closest to the stream, with hardwoods primarily growing in the "middle zones" and conifers growing farthest away from the stream. This trend is due to the different requirements that each species has for the amount of water it needs to survive and grow.

**2. How does the riparian area influence the stream?**
Riparian vegetation provides cover for aquatic and terrestrial animals. Shade created by the riparian vegetation moderates water and air temperatures. This vegetation also limits water contamination, and provides the organic debris that is a major food source for aquatic and terrestrial insects. In-stream wood slows water velocities, provides protection for juvenile fish and can protect spawning areas from being scoured out during high-water events, and filters and collects large amounts of sediment and debris.

**3. How does the stream influence the riparian area?**
The stream provides crucial water to the many various species of plants that rely on large amounts of water for growth. Seasonal flooding or high-water events may deposit sediment and nutrients into the riparian area. The stream is also a water source for the many types of wildlife that live in riparian areas.

**4. What do salmon provide to the riparian area?** Nutrients from salmon carcasses provide food sources for many animals (both aquatic and terrestrial) in the riparian area. Trees and plants also obtain nutrients from carcasses.

# RIPARIAN MAPPING & PROFILE ACTIVITY

**Objective:** To provide students with an opportunity to 1) creatively explore the riparian and aquatic zones, and 2) identify and discuss important differences in the components of the riparian area that they observe from a "birds-eye-view" or "cross section".

**Outcome:** Students should leave this activity with an awareness of what the riparian and aquatic zones of a stream look like and some specific examples of its important components.

**Materials:**
Riparian Area Profile and Mapping Data Form (data form is available at the end of this section and in the Field Trip Data Forms section)
Pencils

**Procedure:**
1) Give each student a copy of the Riparian Area Profile and Mapping Data Form.
2) Giving them clear boundaries, ask them to locate an area where they can sit and draw individually.
3) Give the students 10-15 minutes to draw a map or profile.
4) Regroup the students to share and discuss their maps.

**Discussion:** Ask the students to share their map or profile and discuss the important components of each.

## SOIL SURVEY ACTIVITY

**Objective:** To introduce students to the importance of soil and why it needs to be studied. To guide students through soil survey and characterization activities to assess the types of soil present at their site.

**Overview/Discussion:** Students can begin to consider why understanding soil types is important. Students learn about the types of soil that are found in riparian areas, floodplains, and in streams. By characterizing the types of soil present at their Salmon Watch site using the soils characterization key to indentify the factors that form a unique soil profile, students can unearth the secrets that lie beneath their feet!

**Outcome:**
Students will understand the importance of soil science.
Students will be able to provide reasons for studying soil.
Students will understand how soil properties are determined by the seven soil forming factors.
Students will understand the types of soil and parent materials present at their stream study site.

**Materials:**
Riparian Soil Survey Data Form (data form is available at the end of this section and in the Field Trip Data Forms section)
Soil Auger
Spray Bottle

**Procedure:**
Identify a location where an auger can be used to expose a soil profile.

1) Remove the surface vegetation.
2) Place the auger at the top of the soil and turn the auger one complete revolution (360°) to dig into the ground. Do not turn the auger more than one complete circle (360°) to prevent the soil from being compacted.
3) Remove the auger with the sample from the hole
4) Keeping the soil sample inside the auger, identify if you have more than one soil horizon in your sample. If no, use the soil characterization key to identify your sample. If yes, use the soil characterization key to identify all different soil horizons.
5) For each soil horizon found, collect a small sample in your hand (about the size of a ping-pong ball). Using the spray bottle, moisten the soil and work between your fingers until it is the same moisture throughout. Begin the soil characterization key.

# CANOPY COVER SURVEY ACTIVITY

**Objective:** To introduce students to the concept of a forest canopy and guide students to understand the role that the forest canopy plays in the health of the stream and fish habitat conditions.

**Overview/Discussion:** The overhead canopy cover in a forest plays an important role in affecting the amount of sunlight that reaches either the forest floor or the stream channel. In the forest, when a large amount of sunlight is allowed to penetrate areas of the canopy, a dense understory can develop. Along a stream, when a large amount of sunlight breaks through the forest canopy, the water in the stream may heat up more rapidly which can create conditions that are inhospitable for fish and other aquatic species. Scientists classify forest canopies as open (10-39% of the sky is obstructed by tree canopies), moderately closed (40-69% of the sky is obstructed by tree canopies) or closed (70-100% of the sky is obstructed by tree canopies).

A densiometer is used to measure the amount of light that penetrates the forest canopy. A simple densiometer is a device with a mirror apparatus inside that reflects the canopy above. It works somewhat like a periscope. The viewer sees a mirror image above, which allows him/her to estimate how much of the sky above is blocked by tree canopies.

**Outcome:**
Students will understand what a forest canopy is.
Students will conduct a survey to determine the density of the forest canopy at their study site.
Students will be able to make connections between forest canopy cover and stream health.

**Materials:**
Spherical Densiometer
Compass
Canopy Cover Data Form (data form is available at the end of this section and in the Field Trip Data Forms section)

**Procedure:**
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) Hold the SD 12”-18” in front of your body at elbow height, so that operators head is just outside of grid area. Do your best to keep the SD steady by utilizing the provided level.

3) Tell your partner which lettered boxes to fill in based on the boxes covered more than 50% by shade. (Your partner may want to hold the data form up next to the SD to make it easy to relay the letter of the shade covered boxes.)
4) Repeat step 3 for North, South, East and West.
5) Add shaded boxes for all directions, the result is your estimated canopy cover for your location.

## Identification of Northwest Native Trees

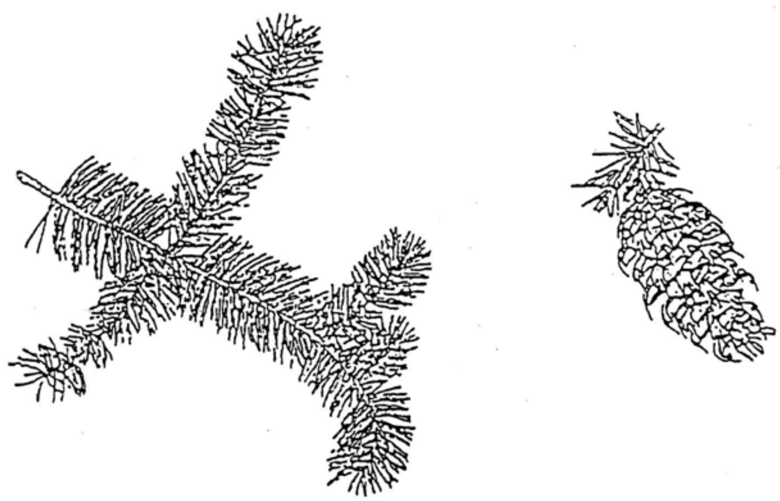
The following native trees are commonly found in areas west of the Cascades. Their presence and placement can help define riparian zones characterized by plant communities arranged by their tolerance to wet soils. Native American cultural uses are also included for each species listed.

**Douglas Fir (Pseudotsuga menziesiki) Family – Pinaceae**

**Description:** A very common and familiar tree in western Oregon, Douglas fir is a massive (up to 300 feet), elegant, fast growing conifer. It commonly grows in mixed stands with hemlock and cedar. It can be identified by its tall, straight trunk, deeply furrowed, corky brown bark, and its cones, which stay on the tree year-round. The three to four inch cones of leathery brown scales reveal protruding papery, three-pointed seed bracts (look for the mice hiding in the cones).

**Habitat:** Throughout the Pacific Northwest, in all but the wettest and driest sites.

**Notes:** Douglas fir bark and wood were thought to be an excellent fuel, but it also had a reputation for throwing sparks and giving slivers to those who handled it. The wood was used to make items such as spear handles, harpoon shafts, spoons, dip-net poles, fire tongs, salmon weirs, caskets, and halibut and cod hooks. Its pitch was used for sealing joints of implements such as harpoon heads and fishhooks as well as for caulking canoes and water vessels. The pitch was also used to make a medicinal salve for wounds and skin irritation.

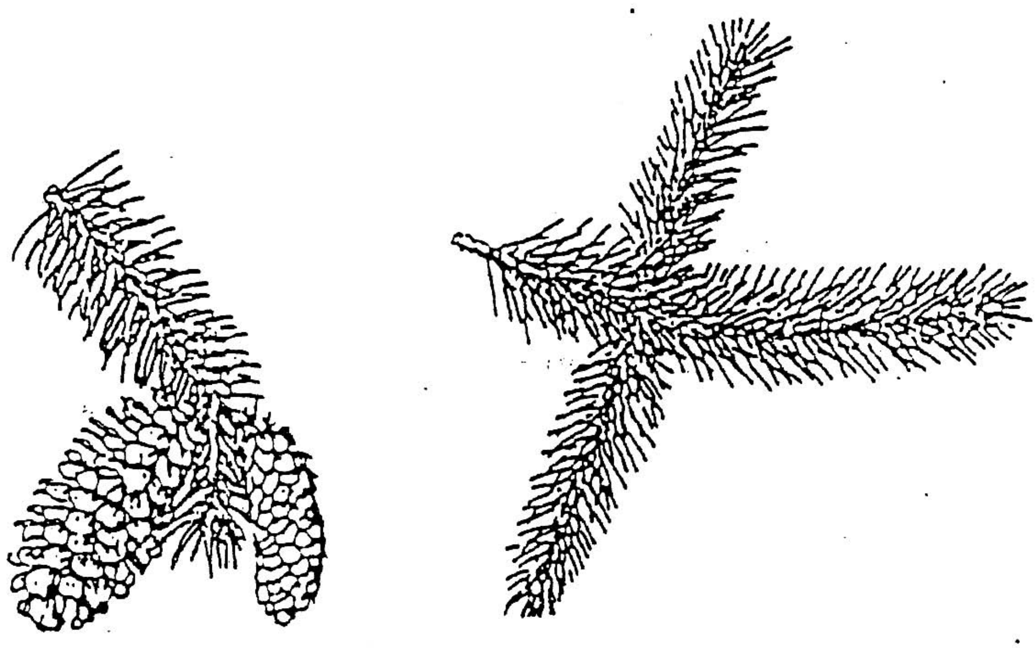


**Sitka Spruce (Picea sitchensis) Family:  Pinaceae**

**Description:** Sitka spruce is a majestic conifer found in moist lowland sites. It can be identified by its gray, "scaly" bark, sharp pointed needles, and four-inch-long papery cones. It grows rapidly and can attain massive proportions.

**Habitat:** Found in low-lying, moist forests and forested bogs.

**Notes:** A quick way to identify Sitka spruce is to grasp a branch in your hand: the stiff, sharp needles pointing out on all sides of the branch hurt. The sharp needles of spruce were believed to give it special powers for protection against evil thoughts. The Ditidaht and other Nuu-chah-nulth peoples used the boughs in winter dance ceremonies to protect the dancers and to "scare" spectators. Some central and northern coast peoples ate the inner bark fresh or dried it into cakes and ate it with berries. The pitch was often chewed for pleasure and was also used as medicine for burns, boils, slivers and other skin irritations. The roots of the Sitka spruce were used to make beautifully twined watertight hats and baskets.

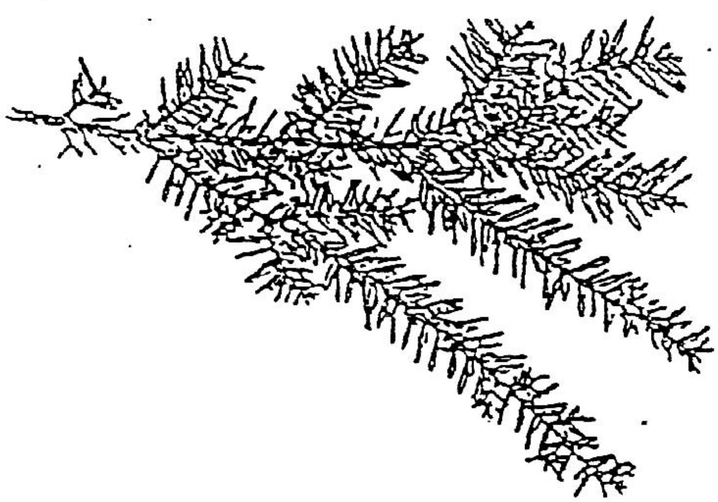


## Western Hemlock (Tsuga heterophylla) Family: Pinaceae

**Description:** Hemlock is an evergreen conifer that can grow as tall as 180 to 225 feet, with drooping branches and furrowed, dark brown to reddish-brown bark. It can be identified from a distance by its drooping leader at the top of the tree. The needles are flat and distinctly grooved, glossy yellow-green on top, with two broad white stripes on the bottom. Needles are of unequal length (one-quarter to three quarters of an inch long), and spread at right angles to the branches to form flat sprays. Cones are abundant, one inch long, oval, and directly attached to the branch. They turn from green to brown at maturity and fall intact to the ground.

**Habitat:** Hemlock is found throughout the region, especially in moist conditions. It is tolerant of deep shade and often grows near other conifers like cedar and Douglas fir.

**Notes**: Western hemlock bark has a high tannin content and was used as a tanning agent, pigment, and cleansing solution. The hemlock bark was made into a solution for tanning hides and soaking spruce-root baskets to make them watertight. The hemlock bark solution was also used as a red dye to color mountain-goat wool and basket materials, and as a facial cosmetic and hair remover. The hemlock wood was carved into implements such as spoons, roasting spits, dip-net poles, combs, spear shafts, wedges, children's bows, and elderberry picking hooks. The hemlock tree was used extensively as medicine by most groups of the Northwest Coast. Hemlock pitch was applied topically for a variety of purposes, including poultice or poultice coverings, liniments rubbed on the chest for colds and when mixed with deer tallow as a salve to prevent sunburn. A hemlock bark tea was made for internal injuries and hemorrhaging.

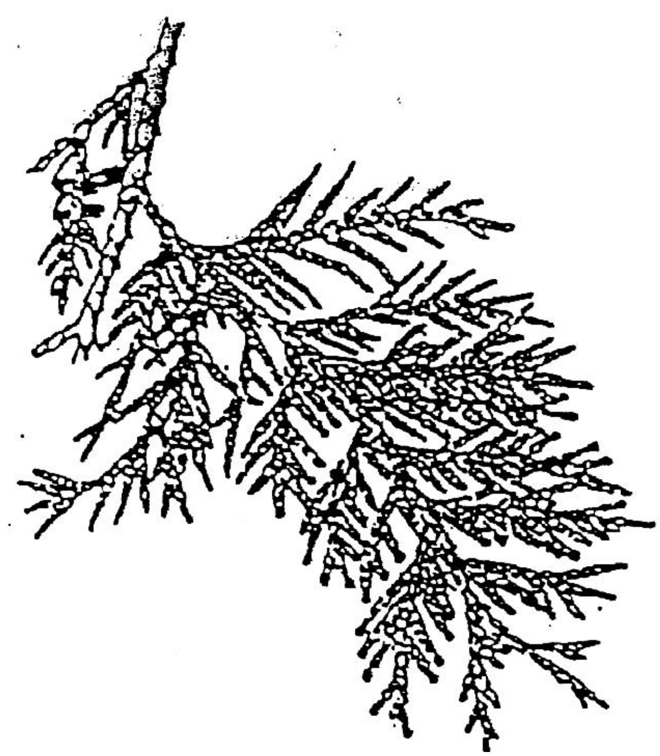


**Western Redcedar (Thuja plicata) Family: Cupressaceae**

**Description:** The most common cedar of the Northwest forests has a massive tapering trunk, buttressed at the base. Western redcedar can be as tall as 200 feet with thin, shaggy, reddish bark that easily peels off into long strips. Its branches tend to spread, droop slightly, and turn up at the ends. Cedar needles are flat and overlap like scales. The flattened branches are shiny bright green above and paler below. Clustered near the ends of branches, cones start small and bluish-green and develop into half-inch brown cones with woody scales.

**Habitat:** Cedar ranges from moist or swampy soils to dry upland sites and grows from lowlands up to 4500 feet.

**Notes:** Redcedar has been called "the cornerstone of the northwest coasts Indian culture" and the large-scale use of its wood and bark delineates the cultural boundary of the northwest coast peoples within its range. The easily split, rot resistant wood was used to make important cultural items such as dugout canoes, house planks and posts, totem and mortuary poles, bentwood shafts, harpoon shafts, spear poles, barbecue sticks, fish spreaders and hangers, dip-net hooks, fish clubs, masks, rattles, benches, cradles, coffins, herring rakes, canoe bailers, ceremonial drum logs, combs, fishing floats, berry-drying racks, fish weirs, spirit whistles, and paddles. Redcedar was considered an excellent fuel, especially for drying fish, because it burns with little smoke. Redcedar was used for a variety of ailments.



**Bigleaf Maple (Acer macrophyllum) Family:  Aceraceae**

**Description:** This large broad-leaved deciduous tree can grow to 75 or more feet with a spread of 50 feet, and can have leaves up to a foot in diameter. It has the distinctive form of a single squat trunk that separates into several large, spreading upright limbs. The leaves have five simple lobes, and the winged fruits disperse the seeds by flying "helicopter style." The foliage turns a distinctive bright orange-yellow in the fall.

**Habitat:** Found throughout lowland areas in dry sites. Bigleaf maple grows in mixed stands with conifers, along stream banks, and in the open.

**Notes:** Preparations were made from the bigleaf maple for internal medicines and to treat sore throats. The leaves of the bigleaf maple were rubbed on a growing man's face so that he would not grow thick whiskers. This maple is called the 'paddle tree' because the wood was used to make paddles. It was also used for spindle whorls and various other implements. The sap can be used to make a passable maple syrup, but it takes several times more bigleaf maple sap than eastern-sugar-maple sap to make a given quantity of syrup.

**Red Alder (Alnus rubra) Family: Betulaceae**

**Description:** Red Alder is an aggressive, fast-growing, but short-lived hardwood that can grow up to 120 feet tall. The bark is thin, gray, and smooth, often with white patches of lichens. With age the bark becomes scaly at the base and the wood and inner bark turn rusty-red when cut. Alternate leaves are broadly elliptic and sharp-pointed at the base and tip. Leaf margins are doubly serrated and tightly rolled under and the veins are very straight. Male and female flowers in hanging cylindrical spikes (catkins) appear before the leaves. Fruits are clusters of brownish cones that remain on the tree over the winter and contain oval, winged nutlets.

**Habitat:** Moist woods, streambanks, floodpains, slide tracks, and recently cleared land, often in pure stands at low elevation.

**Notes:** Red alder is the most common broad-leaved tree in western Oregon. Alders shed their leaves while still green, and therefore, return many nutrients directly to the soil. Also, alder roots contain bacteria filled nodules that capture nitrogen from the air for the tree's use and when these roots die, the nitrogen is returned to the soil, greatly enhancing soil productivity. Red Alder wood is considered to be the bet possible fuel for smoking salmon. It is soft and even-grained and is still used for making feast bowls, masks, rattles and a variety of other items. Its bark is used to make a red or orange dye and is especially valued for coloring inner red cedar bark.

## **Ponderosa Pine (*Pinus ponderosa*) Family: Pinaceae**

**Description:** Ponderosa pine is a large tree that lives 300 to 600 years and reaches heights of 90 to 150 feet tall and one to five feet in diameter. The oldest trees can exceed 200 feet in height and six feet in diameter. The bottom one-half of the straight trunk is typically without branches. The crown of ponderosa pine is broadly conical to round-shaped. The bark is characteristically orange-brown with a scaly plate-like appearance. Twigs are stout, orange-brown, and rough. Needles are eight to ten inches long, thin and pointed with toothed edges, occur in bundles of three, and give a tufted appearance to the twig. Male cones are orange or yellow and are located in small clusters near the tips of the branches. The female cone is oval, woody, and has a small prickle at the tip of each scale. Flowering occurs from April to June of the first year, and cones mature and shed winged seeds in August and September of the second year.

**Habitat:** Ponderosa pine trees can be found in pure stands or in mixed conifer forests. Ponderosa grows on a variety of soils from shallow to deep, and from gravelly sands to sandy clay loam. Once established, it withstands very cold winters and can survive hot and dry conditions, exhibiting medium to good drought tolerance. Ponderosa generally grows at elevations between sea level and 3,000 m. The populations at higher elevations usually occur within the southern part of its range. Shrubs and grasses typically associated with ponderosa pine within its range include ceanothus, sagebrush, oak, snowberry, bluestem, fescue, and polargrass.

**Notes:** Native Americans used various parts of ponderosa pine for medicinal, building, food, and ceremonial purposes. Needles were used as dermatological aids and were found to reduce coughs and fevers. The pitch was used as an ointment for sores and scabby skin, backaches, rheumatism, earaches, inflamed eyes, and as a sleeping agent for infants. The boughs of the plant were used in sweat lodges for muscular pain, as decoctions for internal hemorrhaging, and as infusions for pediatric treatments. The roots of ponderosa pine were used to make blue dye and needles were used as insulation for underground storage pits. The wood was used extensively for fence posts, boards for general construction, and to fabricate snowshoes. Single logs were used to make dugout canoes. Bark was used to cover houses. Most parts of the plant were used for food, including the pitch, seeds, cones, bark, buds, and cambium. The pollen and needles were used in healing ceremonies. Red-winged blackbirds, chickadees, mourning doves, finches, evening grosbeak, jays, Clark's nutcracker, nuthatches, rufous-sided towhee, turkeys, chipmunks and squirrels consume the seeds of ponderosa pine. Blue and spruce grouse use ponderosa pine needles for nesting material. Mice, porcupines, and other rodents use the bark for nesting material. The trees are also important to various birds for cover, roosting and nesting sites.

**Oregon Ash (Fraxinus latifolia) Family: Oleaceae**

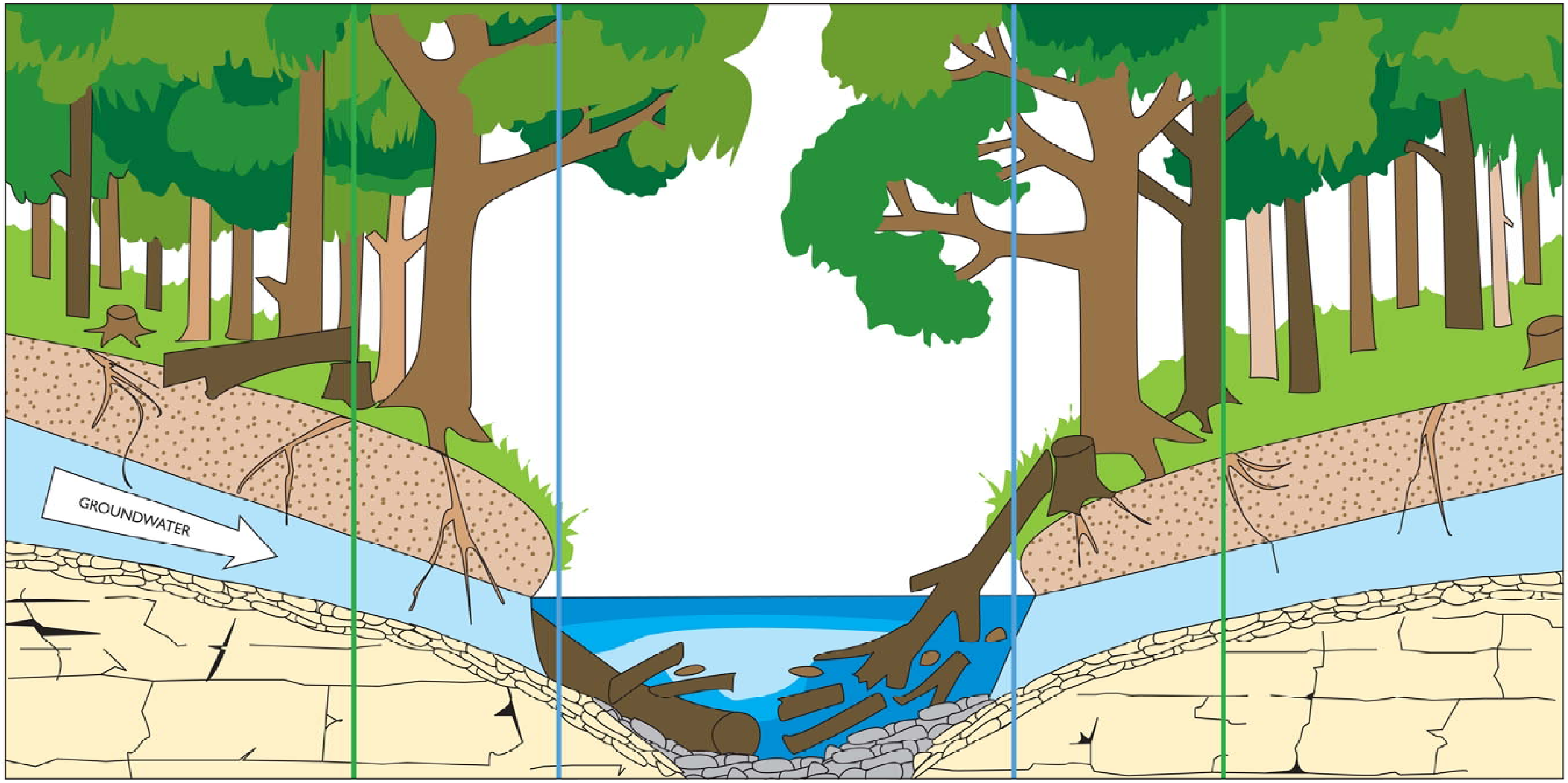
**Description:** The Oregon ash is a straight-trunked tree of up to 60 feet bearing opposite branches and compound leaves. The leaves grow up to 12 inches long with five to seven bright green, broadly tapered leaflets which turn yellow in the fall. Dense clusters of greenish flowers (male and female on separate trees) bear winged fruits. The bark is dark gray or brown, and thick, furrowed into forking, scaly ridges.

**Habitat:** Low-lying areas, wet soils along streams.

**Notes:** One use of Oregon ash seems to be for protection from snakes. Traditional wisdom suggests that rattlesnakes will not crawl over an Oregon ash stick, and areas where this tree grows are free from poisonous snakes. The wood of the Oregon ash is often used in the manufacturing of furniture and tool handles.

# Example of a Stream Profile

## Actively Managed Streamside Buffer




| Zone 2 Managed Forest | Zone 1 Undisturbed Forest | Stream Bottom | Zone 1 Undisturbed Forest | Zone 2 Managed Forest |
|---|---|---|---|---|
| Filtration, deposition, plant uptake, anaerobic denitrification and other natural processes remove sediment and nutrients from runoff and subsurface flows. | Maturing trees provide detritus to the stream and help maintain lower water temperature vital to fish habitat. | Debris dams hold detritus for processing by aquatic fauna and provide cover and cooling shade for fish and other stream dwellers. | Tree removal is generally not permitted in this zone. | A riparian management area includes both sides of a stream and usually includes the riparian area and riparian area of influence (above). |

| | |
|---|---|
| Note – this illustration is provided to give the reader a general visual idea of what a riparian area might include. Specific requirements governing forest activities in Oregon are included in the Oregon Forest Practices Act | USDA Forest Service, Northeastern Area State & Private Forestry Forest Resources Management |

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

# RIPARIAN & AQUATIC AREA SURVEY DATA FORM

School: ______________________ Teacher: ______________________

Date: ____________ Time: __________ Weather: ______________________

Stream/Site Name: ______________________

**What You Need:**

☐ Riparian & Aquatic Area Survey data form ☐ ID books/charts ☐ 100 ft tape measure

| STREAM SURVEY | | | |
|---|---|---|---|
| Survey Area | | | |
| Length of stream (in feet): | | | |
| # of riffles: | | | |
| # of pools: | | | |
| Substrate | Very Little | Some | A Lot |
| Silt/Organic matter *(stays suspended)* | | | |
| Sand *(settles to bottom when disturbed)* | | | |
| Gravel *(pea to baseball size)* | | | |
| Cobble *(baseball to bowling ball size)* | | | |
| Boulders *(larger than a bowling ball)* | | | |
| Bedrock *(solid rock)* | | | |
| Instream Woody Debris | Very Little | Some | A Lot |
| Small *(6 inch diameter x 10 ft length)* | | | |
| Medium *(12 inch diameter x 20 ft length)* | | | |
| Large *(24 inch diameter x 35 ft length)* | | | |
| Comments: | | | |
| Vegetation Type | Very Little | Some | A Lot |
| Coniferous trees *(with needles)* | | | |
| Deciduous trees *(with leaves)* | | | |
| Shrubs | | | |
| Small plants | | | |
| Ferns | | | |
| Grasses | | | |

| PLANTS IDENTIFIED | |
|---|---|
| Species | Significance to Riparian Area |
| | |
| | |
| | |
| | |
| | |
| | |

| WILDLIFE & BIRDS IDENTIFIED | |
|---|---|
| Type, Species, or Track/Sign | # or Comments |
| | |
| | |
| | |
| | |
| | |
| | |

***More to identify?*** *Use the back of this form.*

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

# RIPARIAN AREA TRANSECT DATA FORM

School: ______________________________ Teacher: ______________________________

Date: ________________ Time: ____________ Weather: ______________________________

Stream/Site Name: ______________________________

**What You Need:**

- ☐ 100-foot tape measure
- ☐ Riparian Area Transect data form
- ☐ 15-foot rope with a ring attached in the middle of its length
- ☐ Instructions
- ☐ Plant and tree identification books or charts

**Procedure:**

**1. Set the transect.** Stretch the transect tape measure from the water's edge or a clearly discernible high water line perpendicular to the stream into the riparian area. Hold the two ends so that the tape is stretched out to its full 100' length. The tape is divided into five parts, each 20 feet long. These divisions mark off five 20-foot "zones" in the riparian area, "Zone 1," "2," "3," etc.

**2. Count trees.** Place the ring on the 15-foot rope over the transect tape. Start from the 0-foot mark, and walk parallel to the transect tape towards the 100-foot mark. Each time you reach one of the 20-foot marks, check to see if the rope touches any trees, shrubs, etc, by using the rope to measure out a circle with a diameter of 15 feet (an area with a radius of 7.5 feet, with the attached ring as the centerpoint). Identify any plants within the diameter of the area that the rope covers. Then tell the recorders whether the plants are conifers or hardwood trees; or shrubs; and the zone that they are in.


**3. Record data.** Record your data on the back of this form. The recorders should fill out the information about the transect site at the top of the data form, record the number of conifers, hardwood trees and shrubs. Additional comments about dead wood, side channels, etc., may also be recorded. Either during the data collection or after, enter data on the graph on the reverse of this form. Shade in the box above the appropriate zone in either the conifer or hardwood category. Shade one box per tree tallied.

## RIPARIAN AREA TRANSECT

| | | | | |
|---|---|---|---|---|
| Date: | | | | |
| Student's Names: | | | | |
| Stream: | | | | |
| Estimated slope (rise/run) of stream bank: | | | | |
| Zone | Conifers | Hardwoods | Shrubs | Additional Comments |
| **1**<br>Set 15' rope at 20' from water | | | | |
| **2**<br>At 40' from the water | | | | |
| **3**<br>At 60' from the water | | | | |
| **4**<br>At 80' from the water | | | | |
| **5**<br>At 100' from the water | | | | |
| Other Observations: | | | | |

## RIPARIAN AREA TRANSECT DATA GRAPH*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Conifer | Hardwood | Conifer | Hardwood | Conifer | Hardwood | Conifer | Hardwood | Conifer | Hardwood |
| **ZONE 1** | | **ZONE 2** | | **ZONE 3** | | **ZONE 4** | | **ZONE 5** | |

**Shade in the box above the appropriate zone in either the conifer or hardwood category. Shade one box per tree tallied.*

The Freshwater Trust™

Salmon Watch®

# RIPARIAN AREA MAPPING DATA FORM

School: ______________________________

Teacher: ______________________________

Date: _______________ Time: __________

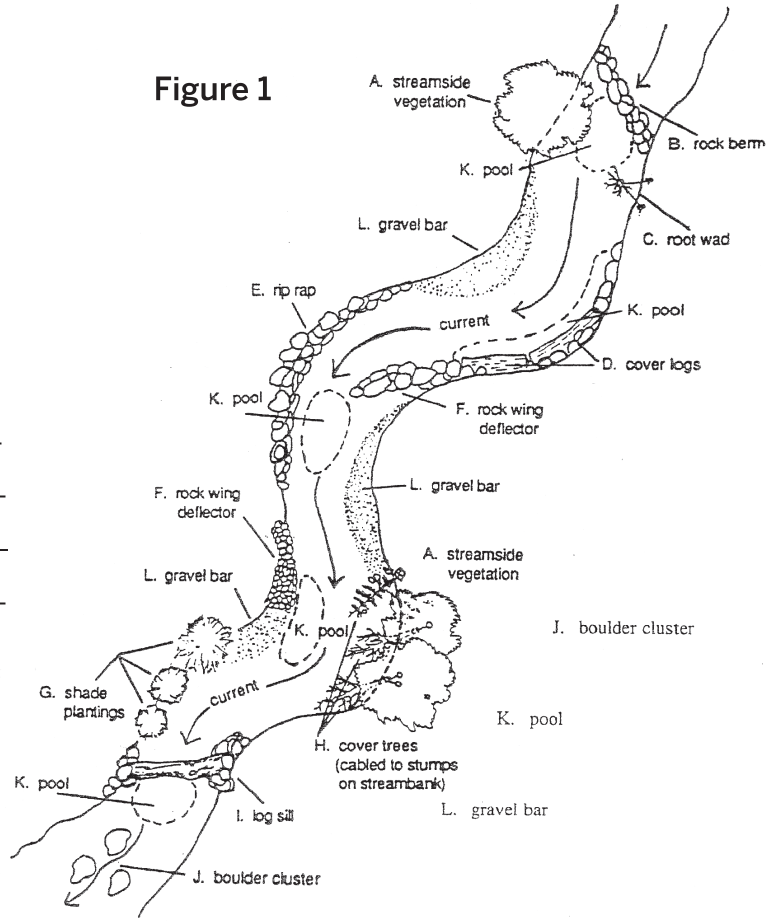
Weather: ______________________________

Stream/Site Name: _____________________

**Directions:** Use this space to make a map of the part of the stream that you think is important (imagine the stream from a "bird's-eye-view"). Be sure to map both the aquatic and riparian zones. Draw in all the features you think are important (see **Figure 1**).

Turn over for profile activity. ⟶

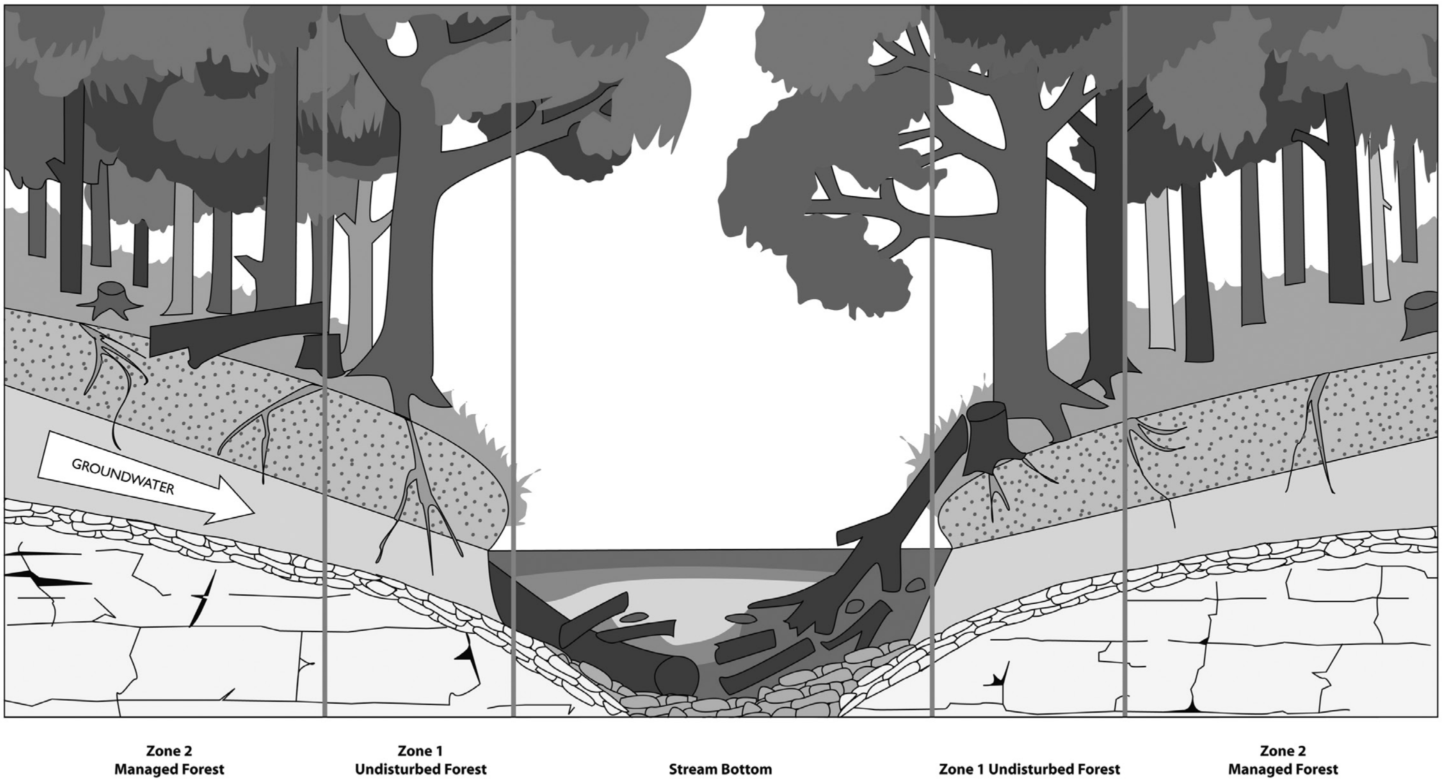
**Figure 1**



# RIPARIAN AREA PROFILE DATA FORM

**Directions:** Pick a place along the stream that you particularly like. Draw a profile (cross-section, see **Figure 2**) of this place. Include the near bank, stream, and opposite bank in your drawing. If you aren't sure how to do this, ask your adult group leader. Show the water level in your drawing. Now, draw in features of the riparian zone that you think are important to salmon.

Figure 2



The Freshwater Trust

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

## RIPARIAN SOIL SURVEY DATA FORM

School: ______________________ Teacher: ______________________

Date: ____________ Time: __________ Weather: ______________________

Stream/Site Name: ______________________

**Landscape Position:**
- ☐ Summit
- ☐ Slope
- ☐ Depression
- ☐ Large Flat Area
- ☐ Stream Bank

**Cover Type:**
- ☐ Bare Soil
- ☐ Rocks
- ☐ Grass
- ☐ Shrubs
- ☐ Trees

**Land Use:**
- ☐ Urban
- ☐ Agricultural
- ☐ Recreation
- ☐ Wilderness
- ☐ Other

Distance from stream: ______________________

Distinguishing site characteristics:

______________________

______________________

______________________

______________________

*Reference: GLOBE® 2005 Appendix- 2 Soil*

## SOIL CHARACTERIZATION SURVEY ACTIVITY

**Task:** Use an auger to expose a soil profile to determine soil characteristics within the riparian zone.

**What You Need:**
- ☐ Soil auger
- ☐ Spray bottle
- ☐ Riparian Soil Survey data form

**In the Field:**

*Exposing the Soil Profile*

1. Identify a location where an auger can be used to expose a soil profile.
2. Remove the surface vegetation.
3. Place the auger at the top of the soil and turn the auger one complete revolution (360˚) to dig into the ground. Do not turn the auger more than one complete circle (360˚) to prevent the soil from being compacted.
4. Remove the auger with the sample from the hole
5. Keeping the soil sample inside the auger, identify if you have more than one soil horizon in your sample. If no, use the soil characterization key to identify your sample. If yes, use the soil characterization key to identify all different soil horizons.
6. For each soil horizon found, collect a small sample in your hand (about the size of a ping-pong ball). Using the spray bottle, moisten the soil and work between your fingers until it is the same moisture throughout. Begin the soil characterization key (on the back).

## SOIL CHARACTERIZATION KEY

**START**

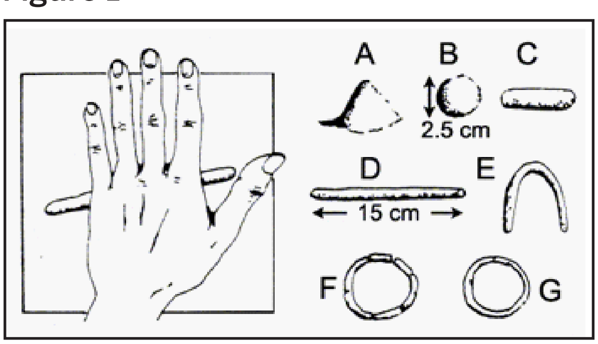
*CIRCLE YOUR ANSWERS*

| | | | |
|---|---|---|---|
| **A** | Soil remains loose and single-grained; can only be heaped into a pyramid. | YES → SAND / NO ↓ | |
| **B** | The soil contains sufficient silt and clay to become somewhat cohesive; can be shaped into a ball that easily falls apart. | YES → LOAMY SAND / NO ↓ | |
| **C** | Same as for loamy sand but can be shaped by rolling into a short, thick cylinder. | YES → SILT LOAM / NO ↓ | |
| **D** | About equal sand, silt, and clay means the soil can be rolled into a cylinder about 15 cm long that breaks when bent. | YES → LOAM / NO ↓ | |
| **E** | As for loam, although soil can be bent into a U, but no further, without being broken. | YES → CLAY LOAM / NO ↓ | |
| **F** | Soil can be bent into a circle that shows cracks. | YES → LIGHT CLAY / NO ↓ | |
| **G** | Soil can be bent into a circle without showing cracks. | YES → HEAVY CLAY | |

**The letters refers to the corresponding image in Figure 1 below.**

**My soil type is:**

### Figure 1




*Method and drawing after Ilaco (1985)*

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

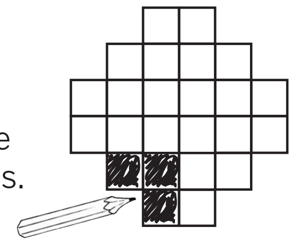
## CANOPY COVER DATA FORM

School: ______________________ Teacher: ______________________

Date: ______________ Time: __________ Weather: ______________________

Stream/Site Name: ______________________

**Directions:** Working with a partner, take one sample of canopy cover in each cardinal direction using the spherical densiometer. Once you have the densiometer positioned correctly, fill in the areas on this worksheet that are covered with canopy shade. **If the square is 50% shaded or more, fill in the entire square.** Record the number of shaded boxes for each sample. Add up the numbers for all four samples. The result is your estimated percent canopy for your location.



| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

North

**# Shaded Boxes** ________

| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

East

**# Shaded Boxes** ________

| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

South

**# Shaded Boxes** ________

| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

West

**# Shaded Boxes** ________

______ + ______ + ______ + ______ = ______________

**North** + **East** + **South** + **West** = ***Estimated % Canopy***

## CANOPY COVER

**What You Need:**

- [ ] Spherical Densiometer
- [ ] Compass
- [ ] Canopy cover data sheet

**Procedure:**

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. Hold the SD 12"-18" in front of your body at elbow height, so that operators head is just outside of grid area. Do your best to keep the SD steady by utilizing the provided level.

3. Tell your partner which lettered boxes to fill in based on the boxes 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 for North, South, East and West.

5. Add shaded boxes for all directions, the result is your estimated canopy cover for your location.

## Resource List

**Northwest Native Plants: Identification and Propagation,** King County Department of Public Works: Surface Water Management Division.

Arno, Stephen F. and Hammerly, Ramona P. 1977. **Northwest Trees, Identifying and Understanding the Region's Native Trees.** The Mountaineers, Seattle, Washington

Meehan William R., et al., "Influences of Riparian Vegetation on Aquatic Ecosystems With Particular References to Salmonid Fishes and Their Food Supply", Presented to the Symposium on the Importance, Preservaiton, and Managament of the riparian Habitat, Tuscon, Arizona, July 9,1977.

Pojar, Jim and Andy MacKinnon. 1994. **Plants of the Pacific Northwest Coast.** Lone Pine Publishing; Redmond, WA.

Reiter, Marianne. 2004. "Benefits for fish habitat from healthy riparian areas."

Ross, Charles R., **Trees to Know in Oregon,** Oregon State University and the Oregon Department of Forestry August 1999

**The Stream Scene**, 1992.

*Actively Managed Streamside Buffers*, USDA- Forest Service, Northeastern Area State & Private Forestry; Forest Resources Management, US Government Printing Office: Radnor, Pennsylvania 1998.

Vitt, Dale H., Marsh, Janet E. and Bovey, Robin B. 1988. **Mosses. Lichens, & Ferns of Northwest North America.** Lone Pine Publishing; Redmond, WA

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

## WATER QUALITY DATA FORM

School: ______________________ Teacher: ______________________

Date: ____________ Time: ________ Weather: ______________________

Stream/Site Name: ______________________

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

| TEST | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|---|---|---|---|---|
| **Water Temperature** ☐ **ºC** ☐ **ºF** | | | | |
| **Equipment used?** | Vernier ☐ Manual ☐ | Vernier ☐ Manual ☐ | Vernier ☐ Manual ☐ | Vernier ☐ Manual ☐ |
| **Air Temperature** ☐ **ºC** ☐ **ºF** | | | | |
| **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*

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

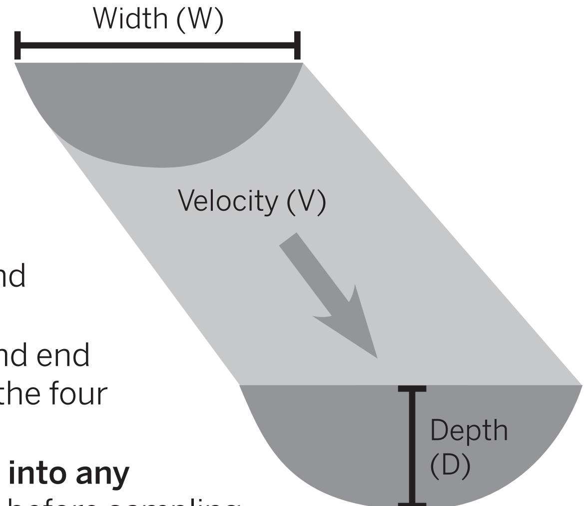
# STREAM FLOW DATA FORM

School: ______________________________ Teacher: ______________________________

Date: ________________ Time: ____________ Weather: ______________________________

Stream/Site Name: ______________________________

*Measuring Stream Flow with Vernier*




**What You Need:**

- ☐ Measuring staff
- ☐ Measuring tape
- ☐ LabQuest
- ☐ Flow Rate Sensor

**Procedure:**

1. Measure the Width (W) of the stream at your start and end points and get the average.
2. Measure the Depth (D) at two points for both the start and end points of your section of stream, and find the average of the four measurements.
3. Plug the Flow Sensor into the LabQuest right away **(plug into any channel)** to ensure a warm up time of at least **5 minutes** before sampling. (This should be done as your next group is in transition to your station so while you are welcoming them and explaining the water quality station your probes are warming up).
4. Assemble Flow Rate Sensor by connecting the alternating black and white plastic rods together (two black rods, one with propeller and one without, as well as two white rods.
5. Submerge the entire propeller half way to the bed of the stream. **Do not stick the rod so far in that the cords get wet.** It is best to get a reading as close to the middle of the stream as possible, keep in mind the safety of the students and only take a sample that is no more than knee deep.
6. Using the stylus, change the unit of measurement by pressing the screen in the box providing the Velocity (V) reading (m/s and f/s), this will give you a drop down menu and allow you to change between units of measurement.
7. Once the reading has become steady and you have properly recorded data, carefully disassemble the pieces of the Flow Rate Sensor and you are ready for cleanup.

---

**Width (W):**

Width (ft) = __________

**Depth (D):**

Depth (ft) = __________

**Velocity (V):**

Velocity (ft/s) = __________

**Stream Flow (Q):**

Stream Flow (Q) = _______ (ft) (W) x _______ (ft) (D) x _______ (ft/s) (V) = __________ cubic feet per second (cfs)

The Freshwater Trust™

# Salmon Watch®

Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

## MACROINVERTEBRATE SAMPLING DATA FORM

School: ______________________ Teacher: ______________________

Date: ____________ Time: ________ Weather: ______________________

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

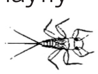
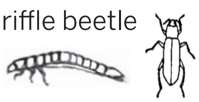
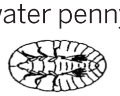
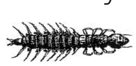
# of people sorting/identifying: ________ ☐ Riffle ☐ Pool

**Directions:**

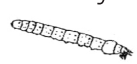
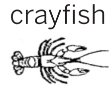
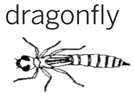
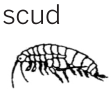
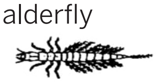
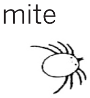
1. Record the number of each type of organism found in the **# found** column of each section.
2. Then circle the number in the **score** column (3, 2, or 1) if any of that organism was found.
3. Complete the equation at the bottom by adding up the circled numbers from each score column.

### *SENSITIVITY TO POLLUTION*

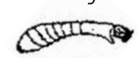
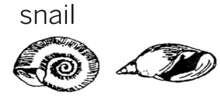
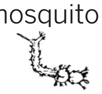
**Sensitive / Intolerant**

| | # 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*

The Freshwater Trust™

Salmon Watch®




## RIPARIAN & AQUATIC AREA SURVEY DATA FORM

School: ______________________ Teacher: ______________________

Date: ______________ Time: __________ Weather: ______________________

Stream/Site Name: ______________________

**What You Need:**

☐ Riparian & Aquatic Area Survey data form ☐ ID books/charts ☐ 100 ft tape measure

| STREAM SURVEY | | | |
|---|---|---|---|
| Survey Area | | | |
| Length of stream (in feet): | | | |
| # of riffles: | | | |
| # of pools: | | | |
| **Substrate** | **Very Little** | **Some** | **A Lot** |
| Silt/Organic matter *(stays suspended)* | | | |
| Sand *(settles to bottom when disturbed)* | | | |
| Gravel *(pea to baseball size)* | | | |
| Cobble *(baseball to bowling ball size)* | | | |
| Boulders *(larger than a bowling ball)* | | | |
| Bedrock *(solid rock)* | | | |
| **Instream Woody Debris** | **Very Little** | **Some** | **A Lot** |
| Small *(6 inch diameter x 10 ft length)* | | | |
| Medium *(12 inch diameter x 20 ft length)* | | | |
| Large *(24 inch diameter x 35 ft length)* | | | |
| Comments: | | | |
| **Vegetation Type** | **Very Little** | **Some** | **A Lot** |
| Coniferous trees *(with needles)* | | | |
| Deciduous trees *(with leaves)* | | | |
| Shrubs | | | |
| Small plants | | | |
| Ferns | | | |
| Grasses | | | |

| PLANTS IDENTIFIED | |
|---|---|
| Species | Significance to Riparian Area |
| | |
| | |
| | |
| | |
| | |
| | |

| WILDLIFE & BIRDS IDENTIFIED | |
|---|---|
| Type, Species, or Track/Sign | # or Comments |
| | |
| | |
| | |
| | |
| | |
| | |

***More to identify?*** *Use the back of this form.*

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

# RIPARIAN AREA TRANSECT DATA FORM

School: ______________________________ Teacher: ______________________________

Date: ________________ Time: ____________ Weather: ______________________________

Stream/Site Name: ______________________________

**What You Need:**

- ☐ 100-foot tape measure
- ☐ Riparian Area Transect data form
- ☐ 15-foot rope with a ring attached in the middle of its length
- ☐ Instructions
- ☐ Plant and tree identification books or charts

**Procedure:**

1. **Set the transect.** Stretch the transect tape measure from the water's edge or a clearly discernible high water line perpendicular to the stream into the riparian area. Hold the two ends so that the tape is stretched out to its full 100' length. The tape is divided into five parts, each 20 feet long. These divisions mark off five 20-foot "zones" in the riparian area, "Zone 1," "2," "3," etc.

2. **Count trees.** Place the ring on the 15-foot rope over the transect tape. Start from the 0-foot mark, and walk parallel to the transect tape towards the 100-foot mark. Each time you reach one of the 20-foot marks, check to see if the rope touches any trees, shrubs, etc, by using the rope to measure out a circle with a diameter of 15 feet (an area with a radius of 7.5 feet, with the attached ring as the centerpoint). Identify any plants within the diameter of the area that the rope covers. Then tell the recorders whether the plants are conifers or hardwood trees; or shrubs; and the zone that they are in.


3. **Record data.** Record your data on the back of this form. The recorders should fill out the information about the transect site at the top of the data form, record the number of conifers, hardwood trees and shrubs. Additional comments about dead wood, side channels, etc., may also be recorded. Either during the data collection or after, enter data on the graph on the reverse of this form. Shade in the box above the appropriate zone in either the conifer or hardwood category. Shade one box per tree tallied.

| RIPARIAN AREA TRANSECT | | | | |
|---|---|---|---|---|
| Date: | | | | |
| Student's Names: | | | | |
| Stream: | | | | |
| Estimated slope (rise/run) of stream bank: | | | | |
| Zone | Conifers | Hardwoods | Shrubs | Additional Comments |
| **1**<br>Set 15' rope at 20' from water | | | | |
| **2**<br>At 40' from the water | | | | |
| **3**<br>At 60' from the water | | | | |
| **4**<br>At 80' from the water | | | | |
| **5**<br>At 100' from the water | | | | |
| Other Observations: | | | | |

**RIPARIAN AREA TRANSECT DATA GRAPH***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Conifer | Hardwood | Conifer | Hardwood | Conifer | Hardwood | Conifer | Hardwood | Conifer | Hardwood |
| **ZONE 1** | | **ZONE 2** | | **ZONE 3** | | **ZONE 4** | | **ZONE 5** | |

**Shade in the box above the appropriate zone in either the conifer or hardwood category. Shade one box per tree tallied.*

The Freshwater Trust™

Salmon Watch®

## RIPARIAN AREA MAPPING DATA FORM

School: ______________________________

Teacher: ______________________________

Date: ________________ Time: ____________

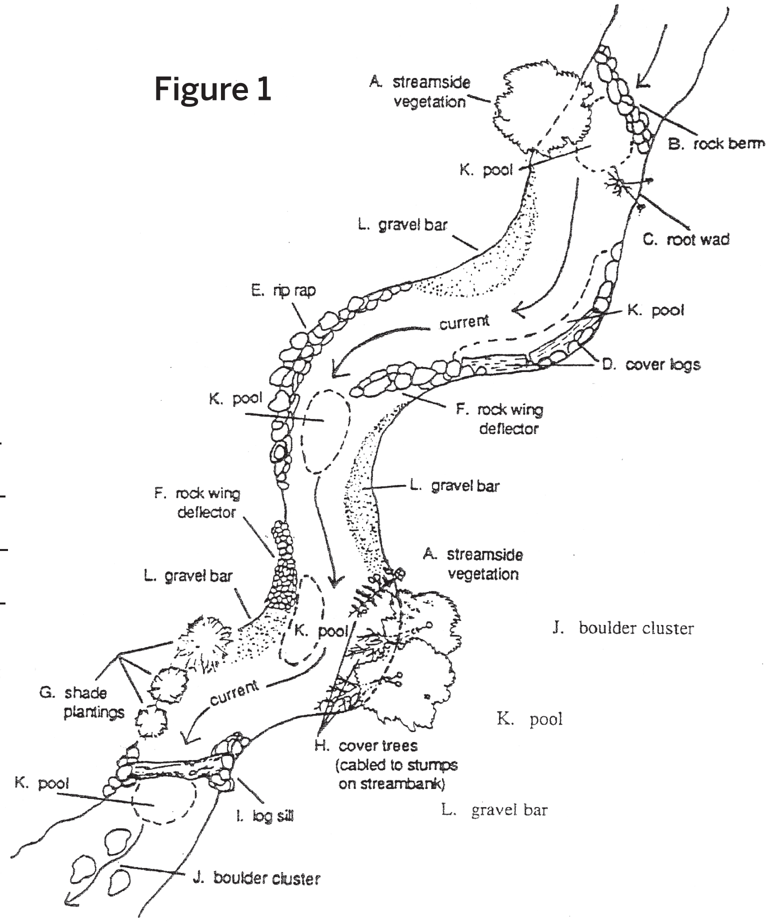
Weather: ______________________________

Stream/Site Name: _____________________

**Directions:** Use this space to make a map of the part of the stream that you think is important (imagine the stream from a “bird’s-eye-view”). Be sure to map both the aquatic and riparian zones. Draw in all the features you think are important (see **Figure 1**).

Turn over for profile activity. ⟶

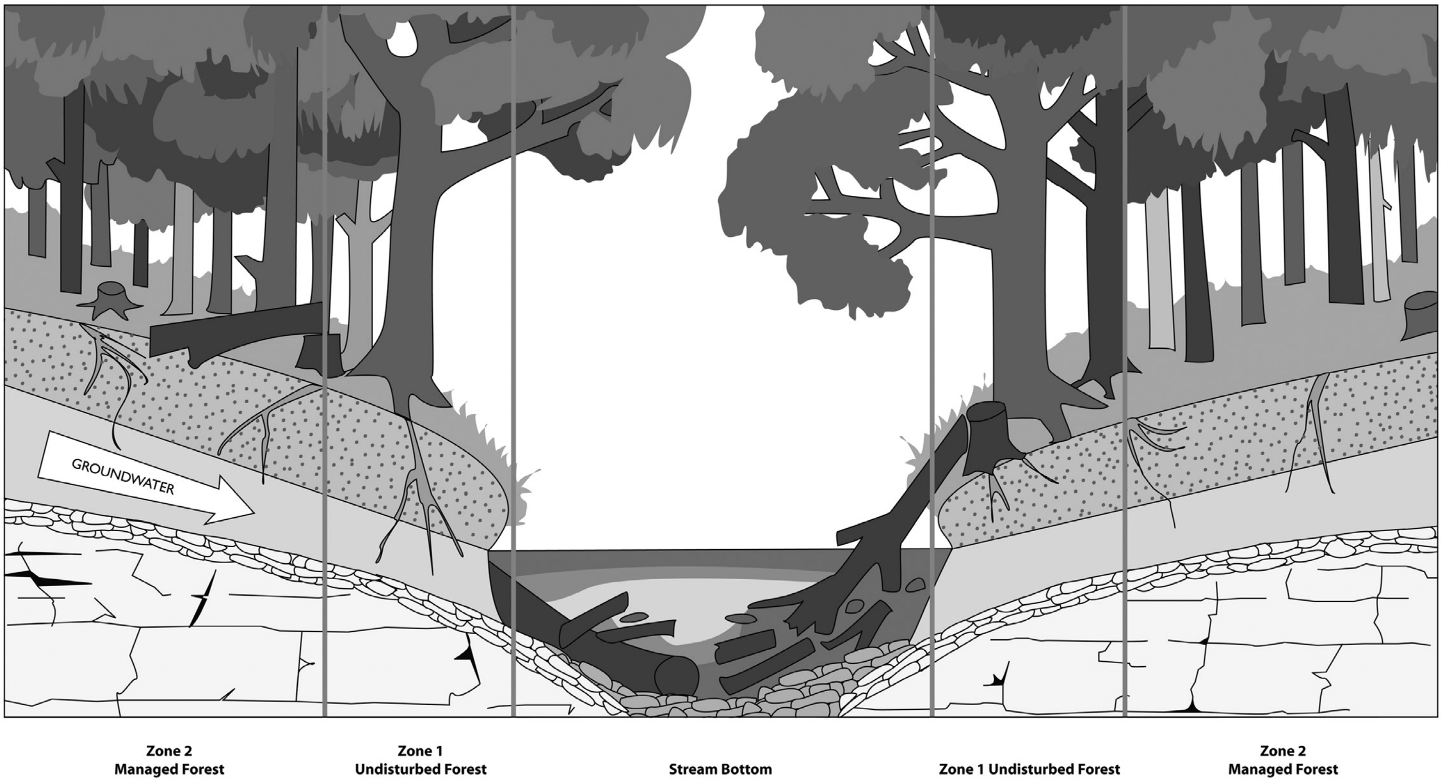
**Figure 1**



# RIPARIAN AREA PROFILE DATA FORM

**Directions:** Pick a place along the stream that you particularly like. Draw a profile (cross-section, see **Figure 2**) of this place. Include the near bank, stream, and opposite bank in your drawing. If you aren't sure how to do this, ask your adult group leader. Show the water level in your drawing. Now, draw in features of the riparian zone that you think are important to salmon.

Figure 2



The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

## RIPARIAN SOIL SURVEY DATA FORM

School: ______________________________ Teacher: ______________________________

Date: ________________ Time: ___________ Weather: ______________________________

Stream/Site Name: ______________________________

**Landscape Position:**
- ☐ Summit
- ☐ Slope
- ☐ Depression
- ☐ Large Flat Area
- ☐ Stream Bank

**Cover Type:**
- ☐ Bare Soil
- ☐ Rocks
- ☐ Grass
- ☐ Shrubs
- ☐ Trees

**Land Use:**
- ☐ Urban
- ☐ Agricultural
- ☐ Recreation
- ☐ Wilderness
- ☐ Other

Distance from stream: ____________________________________________

Distinguishing site characteristics:

____________________________________________

____________________________________________

____________________________________________

____________________________________________

*Reference: GLOBE® 2005 Appendix- 2 Soil*

## SOIL CHARACTERIZATION SURVEY ACTIVITY

**Task:** Use an auger to expose a soil profile to determine soil characteristics within the riparian zone.

**What You Need:**

☐ Soil auger ☐ Spray bottle ☐ Riparian Soil Survey data form

**In the Field:**

*Exposing the Soil Profile*

1. Identify a location where an auger can be used to expose a soil profile.
2. Remove the surface vegetation.
3. Place the auger at the top of the soil and turn the auger one complete revolution (360˚) to dig into the ground. Do not turn the auger more than one complete circle (360˚) to prevent the soil from being compacted.
4. Remove the auger with the sample from the hole
5. Keeping the soil sample inside the auger, identify if you have more than one soil horizon in your sample. If no, use the soil characterization key to identify your sample. If yes, use the soil characterization key to identify all different soil horizons.
6. For each soil horizon found, collect a small sample in your hand (about the size of a ping-pong ball). Using the spray bottle, moisten the soil and work between your fingers until it is the same moisture throughout. Begin the soil characterization key (on the back).

## SOIL CHARACTERIZATION KEY

**START**

*CIRCLE YOUR ANSWERS*

**A** Soil remains loose and single-grained; can only be heaped into a pyramid.
YES → SAND
NO ↓

**B** The soil contains sufficient silt and clay to become somewhat cohesive; can be shaped into a ball that easily falls apart.
YES → LOAMY SAND
NO ↓

**C** Same as for loamy sand but can be shaped by rolling into a short, thick cylinder.
YES → SILT LOAM
NO ↓

**D** About equal sand, silt, and clay means the soil can be rolled into a cylinder about 15 cm long that breaks when bent.
YES → LOAM
NO ↓

**E** As for loam, although soil can be bent into a U, but no further, without being broken.
YES → CLAY LOAM
NO ↓

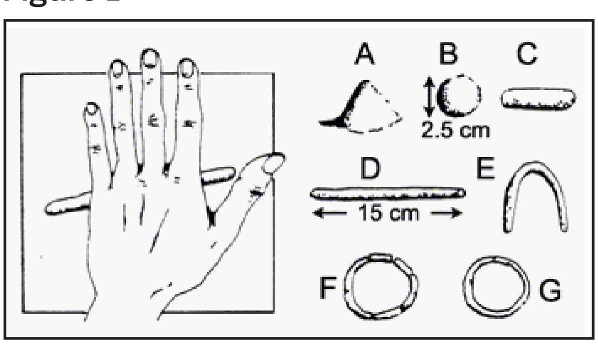
**F** Soil can be bent into a circle that shows cracks.
YES → LIGHT CLAY
NO ↓

**G** Soil can be bent into a circle without showing cracks.
YES → HEAVY CLAY

**The letters refers to the corresponding image in Figure 1 below.**

**My soil type is:**

### Figure 1




*Method and drawing after Ilaco (1985)*

The Freshwater Trust™

Salmon Watch®


Now you can share your Salmon Watch® data quickly and easily using StreamWebs™. You can graph your water quality data, compare your macroinvertebrate count with other schools, and learn more about your home watershed. To find out more, visit: **www.streamwebs.org**

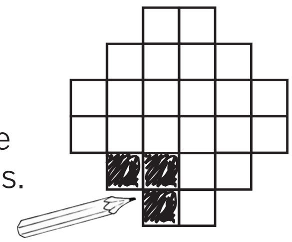
## CANOPY COVER DATA FORM

School: ______________________ Teacher: ______________________

Date: ______________ Time: __________ Weather: ______________________

Stream/Site Name: ______________________

**Directions:** Working with a partner, take one sample of canopy cover in each cardinal direction using the spherical densiometer. Once you have the densiometer positioned correctly, fill in the areas on this worksheet that are covered with canopy shade. **If the square is 50% shaded or more, fill in the entire square.** Record the number of shaded boxes for each sample. Add up the numbers for all four samples. The result is your estimated percent canopy for your location.



| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

North

**# Shaded Boxes** ________

| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

East

**# Shaded Boxes** ________

| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

South

**# Shaded Boxes** ________

| | | | | | |
|---|---|---|---|---|---|
| | | A | B | | |
| | C | D | E | F | |
| G | H | I | J | K | L |
| M | N | O | P | Q | R |
| | S | T | U | V | |
| | | W | X | | |

West

**# Shaded Boxes** ________

______ + ______ + ______ + ______ = ______________

**North** + **East** + **South** + **West** = ***Estimated % Canopy***

## CANOPY COVER

**What You Need:**
- ☐ Spherical Densiometer
- ☐ Compass
- ☐ Canopy cover data sheet

**Procedure:**
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. Hold the SD 12"-18" in front of your body at elbow height, so that operators head is just outside of grid area. Do your best to keep the SD steady by utilizing the provided level.

3. Tell your partner which lettered boxes to fill in based on the boxes 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 for North, South, East and West.

5. Add shaded boxes for all directions, the result is your estimated canopy cover for your location.

# GLOSSARY

| | |
|---|---|
| **abundance pattern** | the establishment of an identifiable increase in a population over a period of time |
| **adaptations** | inherited physiological or behavioral mechanisms which enable an organism to survive |
| **adipose fin** | located on posterior dorsal surface; no bones or spines; contains fatty deposits, hence name; often removed on hatchery fish for easy identification |
| **adult** | an organism which has matured to a stage capable of reproduction |
| **alevin** | newly hatched salmonid; yolk sac attached |
| **anadromous** | migratory life cycle which begins in fresh water, moves to salt water, then returns to fresh water to spawn; derived from Greek - *up running* |
| **anatomy** | the component parts of a living multicellular organism; the study of those parts |
| **aquatic** | pertaining to water |
| **attitude** | assumptions based on implied beliefs and values, with a predicted behavior; e.g., “Foxes should not be controlled” |
| **belief** | an information-based assumption; may be right or wrong; i.e., “Where there are more pheasants, there are more foxes” |
| **bypass screens** | very fine screens which allow water, but not fingerlings to pass; used to protect fish from areas such as turbines or irrigation ditches |
| **caddis fly larvae** | tube-making aquatic insect larvae |

| | |
|---|---|
| **carrying capacity** | the concept that each ecosystem or environment's nutrient and energy resources will support a maximum number of each species due to limited resources |
| **catadromous** | migratory life cycle which begins in salt water, moves to fresh water, then returns to salt water to spawn; derived from Greek – *down running* |
| **caudal fin** | located on the distal posterior end of the spine; largest fin; often referred to as tail fin |
| **channel area** | area of a plane transect across a stream |
| **channel gradient** | degree of slope of stream channel; steepness |
| **channel movement** | lateral movements of a stream channel in response to kinetic energy of stream; can be initiated by flooding |
| **chinook** | *Oncorhynchus tshawytscha*, ("on-ko-rink-us tau-wee-cha) species of salmon characterized by large body size, large irregular spots on back, upper sides and tail, black gums (king salmon) |
| **chum** | *Oncorhynchus keta*, (on-ko-rink-us kee-ta") a species of salmon characterized by purple, yellow, and pink streaks on sides during spawning; broadest migratory range (dog salmon) |
| **coho** | *Oncorhynchus kisutch*, ("on-ko-rink-us ki-sooch") a species of salmon characterized by blue black and silver flanks at sea, turning dark green and bright red in fresh water; white gums (silver salmon) |
| **coloration** | the hues and patterns with which an organism is colored |
| **conservation** | careful planning and use of resources to save and protect them |
| **contour** | a line on a map which represents a particular altitude or height above sea level |

| | |
|---|---|
| **cover** | brush or other material which provides shade or a camouflaged hiding place |
| **cutthroat** | *Oncorhynchus clarkii*, ("on-ko-rink-us clark-ee-i") species of Pacific trout characterized by blue-green coloration on back and silver on sides; vivid red "slash" along lower jaw |
| **debris** | dead plant material in stream or coarse woody material which provides shelter for fry and fingerlings |
| **decadal shift** | a change over a decade, such as population numbers |
| **detritus** | Undissolved organic or inorganic matter resulting from the decomposition of parent material. |
| **dichotomous key** | a written procedure which uses couplets of questions for taxonomic identification, as found in field guides |
| **discharge** | fluid which flows from land or a structure in the water into a river, stream or lake |
| **dissolved oxygen (D.O.)** | oxygen in an aquaeous solution as molecular oxygen ($O_2$) |
| **diversity** | the kinds and numbers of species in an ecosystem or environment |
| **dorsal fin** | located mid-dorsally on the spine; generally a large fin |
| **ecological** | pertaining to the interactions between and among the biotic and abiotic (physical) elements of an ecosystem; derived from Greek – *house (ecos) knowledge (logos)* |
| **ecosystem** | all of the living and non-living components of an environment |
| **eddies** | Area of reverse flow in an aquatic system |
| **egg** | In plants and animals, the cell produced by ovaries; in most cases, they begin development into an individual organism upon fertilization by sperm |

| | |
|---|---|
| **embedded** | set or fixed firmly in a surrounding mass; applies equally to physical objects and concepts |
| **endangered** | threatened with extinction |
| **Endangered Species Act** | federal law which protects species which are threatened with extinction |
| **environment** | the place within which phenomena occur; often refers to our natural world |
| **evidence** | facts which are observable and measurable |
| **exponential** | a number increased to a power; in populations, growth which is measured as a power |
| **fertilized** | an egg whose membrane has been penetrated by the nucleus of a sperm |
| **fingerling** | stage in salmonid life cycle between fry and smolt; salmon are "finger-sized" in this stage |
| **fishery** | geographical location where fish are commercially caught; species or type of fish caught by anglers |
| **fleet** | boats or ships which engage in coordinated movements |
| **food web** | all of the plants and animals in an ecosystem organized into an interrelated "who eats whom" structure |
| **fox walk** | a technique used to approach wildlife quietly; involves rolling of the foot from outside to inside when walking |
| **fry** | young salmon which have absorbed their yolk sac and begun to feed |
| **generation** | all of the offspring produced in a given season or time period |
| **gill cover** | bony plate which protects gill tissue |

| | |
|---|---|
| **gravels** | beds of small rocks, up to several inches in diameter, in a stream, where salmon deposit their eggs and milt |
| **habitat** | the environment in which an organism lives; its "address" |
| **hatcheries** | constructed facilities where milt from returning male salmon is used to artificially fertilize eggs taken from returning female salmon; development from egg to fingerling takes place within the confines of the facility |
| **heat stress** | physiological response to elevated temperatures; extremes can lead to coma and death |
| **home stream** | the stream where a return salmon had hatched from an egg |
| ***in situ*** | occurring in the place in the environment; literally, "in the place;" opposite *in vitro*, literally, "in the glass;" in the lab |
| **indicator species** | a species of plant or animal which exhibits a strong sensitivity to an altered range of environmental conditions; used to indicate health of the ecosystem |
| **individual sensitization** | the idea that each person must develop his or her own empathy with organisms in their environment |
| **inference** | arriving at a conclusion or decision from known facts |
| **irrigation** | water diverted from streams or rivers or pumped from groundwater, often used for crops |
| **issue** | a situation, event or phenomenon which is disputed |
| **life cycle** | life history in stages, e.g. begins in fresh water, moves to salt water, then returns to fresh water to spawn |
| **litter** | the plant debris deposited on a forest floor or streambed |
| **macroinvertebrates** | animals without backbones large enough to identify with the unaided eye; often aquatic insects |

| | |
|---|---|
| **mating behaviors** | observable and predictable kinetic behaviors which result in the fertilization of animal eggs by animal sperm |
| **methodology** | the steps and protocols which contribute to the application of a process |
| **microhabitat** | within a habitat, this is the actual zone of interaction between the organism and its home environment |
| **migratory** | behaviors which result in the movement of an organism from one location to another; cyclical, often synchronized with seasons or stage in life cycle |
| **monitor** | to observe and record, especially over time |
| **Native American** | people who are indigenous to the Americas |
| **niche** | the physical habitat and function of an organism in its ecosystem; its “occupation” |
| **nitrogen bubbles** | nitrogen in the gaseous state in water; concentrations are increased by aeration and/or rapid submersion to depth |
| **Northern Pike Minnow** | A species of fish with a large digestive system, capable of holding several fish at a time; prey on salmon in reservoirs |
| **observations** | records of sensory inputs according to protocols which include operationally defined criteria |
| **Oncorhynchus (“on-ko-rink-us”)** | a genus of animals refering to NW salmon, steelhead, and cutthroat trout; derived from Greek – *hook nosed* |
| **opinions** | a belief not based on certainty; a judgement |
| **organism** | a living thing |

| | |
|---|---|
| **out of phase** | An anticipated cycle which shifts unexpectedly out of its pattern |
| **parameter** | a specific entity or condition which is measured, and whose value varies with its conditions |
| **parr** | salmonid fry before smoltification |
| **pectoral fin** | lateral anterio-ventral fin; analogous to arms in a human |
| **pelvic fin** | lateral posterio-ventral fins; analogous to legs in a human |
| **pH** | a measure of the activity of hydrogen ion in an aquaeous environment |
| **physical structure** | the abiotic components of a stream |
| **physiological adaptations** | cellular and molecular adaptations of organisms to their environments or reproductive strategies |
| **pink** | *Oncorhynchus gorbuscha*, ("on-ko-rink-us gor-boo-scha") most abundant species of Pacific salmon; large oval black spots on tail and back; rigid two-year life cycle |
| **pool** | place where water in a stream exhibits a very weak current |
| **population** | the number of individuals in a species within a prescribed area |
| **porous** | state of having holes; absorbs water |
| **reproduce** | to make a copy of; in living organisms, to produce ofspring |
| **resource** | something which is ready to use or put to a purpose |
| **riffle** | graded place in a stream where water runs over gravels and its surface is broken |

| | |
|---|---|
| **rights** | that which a person has a just claim to |
| **riparian** | area containing a stream and its associated plants and floodplain |
| **root wad** | the twisted roots of a tree which has fallen from the stream bank into a stream; provides protection for small fish |
| **runoff** | water which lands on a surface, is not absorbed, and runs into a stream or other water body |
| **salmon** | a group of bony fish; members of the family Salmonidae |
| **salmonids** | common name, or contraction of Salmonidae |
| **sampling** | using a portion of an environment or population for measurement or observation |
| **scour** | the abrasive effect of rapidly moving water on the sides and bottom of a stream, creating deeper water habitat and pools |
| **sediment** | geological material which has moved from land to stream and settles to the bottom |
| **sediment-free** | stream bottoms which contain no land-derived fine geological material |
| **smolt** | stage in salmonid life cycle in which some fingerlings undergo the physiological changes necessary for movement into salt water |
| **sockeye** | *Oncorhynchus nerka*, ("on-ko-rink-us ner-ka") a species of salmon whose greenish blue finely speckled back and silver sides turn bright red on return to fresh water; some remain in fresh water all of their lives (kokanee); juveniles prefer lakes to streams |

| | |
|---|---|
| **spawning area** | that part of the stream bottom which contains gravels suitable for depositing eggs |
| **species** | the definitive taxonomic group; a group of organisms which interbreed , but do not breed with other related organisms |
| **spores** | asexual reproductive cells of some plants, fungi and protoza |
| **stable** | in a state of dynamic equilibrium, and not subject to easy disturbance |
| **steelhead** | *Oncorhynchus mykiss*, (on-ko-rink-us my-kiss") a species of anadramous trout with metallic blue back and silver sides; a red band on sides during spawning |
| **stream** | water flowing toward base and its bed |
| **streambed** | the rock, gravel and sediments which form the bottom of a stream |
| **stream channel** | in cross-section, the land structure which holds a stream; consists of a main path and lateral channels, which may not be immediately obvious |
| **stream flow** | water running through a stream channel; movement of water through its channel as measured in meters per second |
| **stream gradient** | steepness of the longitudinal slope of a stream bed |
| **substrate** | the nutrients and physical composition of a streambed |
| **surface area** | the square measure of the exterior of an entity |
| **taxa** | a group or category, at any level, in a system for classifying plants or animals |
| **taxonomy** | the study of characteristics of organisms which differentiate them from others |
| **temperature** | amount of kinetic energy in a system |

| | |
|---|---|
| **temperature tolerance** | the range of temperatures which an organism endures without mortality |
| **thermal responses** | all of the behavioral and physiological responses of an organism to a range of temperatures |
| **treaty** | an agreement, binding and legal, between two or more sovereign nations; sovereignty refers to the right of self-government and self-determination, or the ability of people to make decisions for themselves |
| **turbidity** | the amount of suspended matter in a water body; a measurement of such suspended matter |
| **turbines** | large bladed shafts which are turned by water, and whose rotary motion is used in dams to generate electricity |
| **value** | a worth attached to some event, place, idea, etc.; e.g., “Foxes are beautiful and important creatures” |
| **water quality** | an assessment of the content of a water body such as its chemical composition, temperature, pH |
| **watershed** | the basin which holds a water system including main channels and tributaries |
| **watershed management** | using the geology, hydrology, sociology and biology of watersheds to plan their use |

# INTERNET REFERENCES

http://www.blm.gov – US Department of the Interior Bureau of Land Management

http://www.bpa.gov - Bonneville Power Administration

http://www.cdc.noaa.gov - This web site supplies information on climate variations in time periods from a month to centuries including data on precipitation and oceanic influences.

http://www.critfc.org - The Columbia River Inter-Tribal Fish Commission describe the cultural importance of salmon to the Confederated Tribes of the Nez Perce, Warm Springs, Yakama, and Umatilla.

http://www.dfw.state.or.us - The Oregon Department of Fish & Wildlife web site with information about their programs, policies, staff and facilities.

http://www.deq.state.or.us/ - The Oregon Department of Environmental Quality (DEQ) is a regulatory agency whose job is to protect the quality of Oregon's Environment.

http://www.epa.gov/surf3 - The EPA Surf your watershed site allows your to narrow in on your home watershed. The site has an array of maps and resources.

http://www.fs.fed.us - USDA Forest Service

http://www.fws.gov - US Fish and Wildlife Service

http://www.metro-region.org/ - Metro Regional Parks and Greenspaces

http://www.nmfs.noaa.gov/ This web site provides a variety of links to salmon resources.

http://www.nwr.noaa.gov/1salmon/salmesa/pubs/1pgr.pdf – Endangered Species Act Status of West Coast Salmon and Steelhead

http://www.nwf.org The National Wildlife Federation has information on endangered species including several species of salmon.

http://www.nwp.usace.army.mil This web site for the Army Corps of Engineers has regional information on fish passage and dam improvements. Adding /op/FishData/daily to the web address will provide daily fish passage information by dam and by ladder. It also contains data on water turbidity, depth, temperature, discharge, and fish counts by species.

http://www.nwcouncil.org The Northwest Power and Conservation Council site has information on the hatchery, habitat, harvest, and hydropower issues impacting salmon including the text of many reports.

http://www.odf.state.or.us/ - Oregon Department of Forestry

http://www.oregon-plan.org This web site contains the text for the Coastal Salmon Restoration Initiative (Governor's Plan) as well as maps, monitoring references, and other useful information.

http://www.oregonstate.edu – Oregon State University

http://www.thefreshwatertrust.org - The Freshwater Trust's home page with policy and education information on native fish.

http://www.oweb.state.or.us/ - Oregon Watershed Enhancement Board

http://www.riverdale.k12.or.us/salmon.html - This web site is produced by Riverdale School in Portland, OR. It provides general information on salmon and salmon education.

http://seagrant.oregonstate.edu/ - Oregon Sea Grant works to further knowledge of the marine and coastal environments of the Pacific Northwest, and the forces – natural and human – that shape their destiny.

http://www.streamnet.org - This web site from Pacific States Marine Fisheries Commission contains an online database about salmon, extensive data on salmon habitat, species specific information and color pictures.