1.3 Restoration Ecology

A healthy ecosystem contains many elements that work together in a delicate balance. When the ecosystem is functioning optimally, it provides habitat for native plants and animals, and ecosystem services for humans and the planet. When any one of those elements is out of balance, it affects the entire system.

Ecosystem Disequilibrium

There are many factors that could disrupt the balance of an ecosystem. Natural events like fires, floods and landslides can drastically alter geography as well as vegetation and habitat. While these events appear to have a drastic impact, they are a part of the ecosystem's natural cycle, and the system can usually recover on its own over time. The impact of human development and invasive species, however, can alter an ecosystem beyond its ability to regain equilibrium.

Invasive species are species that are non-native, and introduction of the species is likely to cause environmental or economic harm or harm to human health. Non-native species are defined as those not naturally occurring in an ecosystem. A species can be non-native, but not considered invasive if it does not spread aggressively or cause harm. Invasives have been transported to an ecosystem either intentionally or accidentally by human causes. Invasive plants and animals can travel long distances on the underside of boats and vehicles. Sometimes a plant is introduced into an area for some desirable attribute, like its flowers or fruit. When an invasive species is not contained, it has the ability to outcompete natives, due to lack of predators and other advantages outside of its native ecosystem. Invasives often outcompete native species for resources like food, water, and sunlight. When invasives crowd out native plants, it can limit the food supply and habitat for the native animals that depend on those native plants.

As discussed in *Introduction to Watershed Ecology*, in addition to invasive species, other human-caused threats to habitat include dams, development, channelizing, agriculture, and logging. Each on of these threats, by altering one component of an ecosystem, can have a ripple effect on the entire system. For example, when trees are cut for timber harvest, or cleared to make space for development and agriculture, this can affect aquatic habitat in many ways. Less downed trees in the river over time causes a decrease in important fish habitat. It also leads to increased flow rates, which can increase erosion along the river banks. Increased erosion adds sediment to the water, which can also affect the fish and insects that live in the water. There will be less shade, which will increase the temperature of the water, which at some point makes it uninhabitable for certain species of fish and their prey. The increased sun may also allow new invasive species to thrive and outcompete natives. Downstream habitat is also affected by increased temperature, sediment, and flow rates, and spreading invasive species.

Decreasing Human Impact

Development and agriculture are vital to human society. As humans are becoming more aware of the importance of ecosystem services and how humans impact ecosystems, there are many methods arising to help maintain ecosystem balance. Scientists are continually working to develop healthier ways to practice agriculture, harvest timber, build homes, and reduce waste. Doing these activities in a more conscientious way can greatly decrease our impact on the watershed. In addition to decreasing future impacts, humans can use restoration methods to help restore balance to natural areas that have already been impacted.

Restoration Motivation

Restoration is an evolving science that looks at long term solutions to restore habitats back to a balanced state in which native species can thrive. When species become endangered, it is often because their native habitat has been so severely compromised that they can no longer survive. For example, the Fenders Blue Butterfly feeds on, and lays its eggs in, just a few specific plants, one of which is called Kincaid Lupine. The Kincaid Lupine is being crowded out of its native prairie habitat by development and invasives, threatening the survival of the Fenders Blue Butterfly. When a species becomes extinct, it significantly alters the balance of its ecosystem.

Ready, Set, Restore!

There is no restoration road map. The science evolves as each restoration project is monitored to determine if the objectives were met. Each site presents a unique set of habitats, challenges, and potential solutions. Therefore the restoration process often begins with a series of questions, called an assessment, to to determine the current state of the site and identify objectives. For example: What types of habitat are present? What habitat characteristics support the plants and animals that utilize that habitat? What are some of the limiting factors for those plants and animals? If invasive plants are present, their removal is a restoration priority. Removing invasives and replacing them with native plants is the first step in restoring balance, and a major component of restoration work. It sounds simple: Remove invasives. Plant natives. Done! However, restoration sites can require years of maintenance and monitoring in order to meet the project objectives.

Monitoring and Maintenance: No Maintain, No Gain.

Project success is measured by monitoring to see if objectives were met. For example, if the objective of a restoration project is to increase the population of a native insect by improving habitat, then the project might focus on planting natives that provide food and shelter for that insect. The project can be monitored by doing insect species counts to see if the numbers of the desired species are increasing. If the goal of a restoration project is to increase the population of a native fish by decreasing stream temperature, one strategy is to plant native plants to increase shade in a riparian area. The results can be monitored by measuring stream temperature as well as monitoring the population of the native fish.

When native plants have been planted, often replanting, weeding, and other maintenance is necessary if the plants do not have ideal growing conditions. These challenges are sometimes predictable, and sometimes unforeseen. For example, plants may not get enough rain water, may be eaten by predators, or may be outcompeted by invasives.

Restoration in the Middle Fork Willamette Watershed

The MFWWC has established restoration goals for aquatic, riparian, and upland habitats.

Aquatic Habitat Goals:

- Enhance or restore stream habitat
- Remove fish passage barriers
- Improve water quality

Riparian Habitat Goals:

- Remove non-native species and enhance native species distribution
- Encourage development of mature riparian forests for canopy cover and contribution of large woody debris
- Encourage use of bioengineering for stabilizing stream banks

Upland Habitat Goals:

- Encourage diversity of upland habitats including early, mid and late-seral stage conifer forests
- Promote oak savanna habitat, natural meadows, and prairies by encouraging the use of prescribed fire and thinning
- Enhance and restore wildlife habitat

Early Detection Rapid Response (EDRR)

Invasive species are a major problem for land managers and homeowners alike. Nearly all the MFWWC restoration projects address invasive plant species. Once they become established they are very difficult to eradicate and the costs of controlling them can be high. The most effective and cost efficient way to manage invasive species is to prevent them from expanding their ranges in the first place. When prevention fails, the next best thing is to find new invaders and aggressively manage infestations when they move into new territory. This type of management is referred to as Early Detection Rapid Response (EDRR).

EDRR focuses on monitoring areas to locate and treat infestations during the earliest stages of the invasion process. If noxious weeds are detected when they first arrive in a new area, they can be managed effectively and efficiently so they don't become established and widespread. EDRR programs rely on volunteers and local professionals to watch out for EDRR-list species where they work, live, and recreate. Locations of target species should be reported to the state invasive species website (http://oregoninvasiveshotline.org/).

We need your help to eradicate new invasive plants in the Middle Fork Willamette Watershed before they get out of control! We have list of priority invasive species that we want to keep out of the watershed. These plants are either new arrivals or they haven't gotten here yet (that we know of).

Here is the MFWWC list of priority species:

Garlic mustard, Old man's beard, Giant hogweed, Yellow archangel, Yellow floating heart, Sulphur cinquefoil, European water chestnut, Flowering rush, Yellow starthistle, Yellow flag iris, Purple loosestrife, Lesser celandine, Knotweeds (Japanese, Giant, Bohemian, and Himalayan), Zebra and Quagga mussels

1.3 Restoration Ecology Discussion:

1. Restoration can be expensive and time consuming. Why do you think humans feel responsible for doing restoration work?

2. What are some of the benefits of restoration work?

3. What are some of the challenges of restoration work?

4. It is said that "An ounce of prevention is worth a pound of cure." How does this apply to habitat threats and restoration?

3. Invasive Species: Waging War

Water Quality Unit

INSTRUCTION PLAN

Learning Objectives: Students will:

- Learn, apply and communicate the definition of invasive species and their implications on watersheds and ecosystems.
- Examine the natural resources that plants depend upon in order to survive.
- Explore the effects of noxious weeds on natural habitat, emphasizing the role of competition with native species, interference with herbivory for other organisms, and economic cost of control efforts.
- Identify some of the competition strategies that plants have evolved to dominate in the "competition wars" for survival, including more "modern" chemical warfare.

Time Requirement: Two 45 minute class periods. (One for exploration and presentation set up and one for class presentations. Class size will determine total time needed).

Materials Needed:

- Fresh flower cuttings, including weeds (can be noxious if on the controlled list), or various colored pictures of flowers and weeds
- White board or document camera and blank paper
- Video clip (YouTube) – PBS Nature: What Plants Talk About, segment 27:10 – 36:26
- University of Idaho Extension guide: Idaho's Noxious Weeds, 5th edition http://www.cals.uidaho.edu/weeds2/IWR/iwr-v6_website/files/Download/BUL816.pdf
- Internet access, computers, printers
- Poster board, markers, scissors

Procedures:

1. **Engage:**
    a. Distribute flower cuttings or colored pictures of different native flowers and invasive or noxious weeds to students. Have them examine the flowers closely, noting individual variations among species. Ask them if they would describe any of the flowers as weeds. Then ask them to identify which flowers are "weeds" and support their explanations. Formulate a class definition of "weed." Finally, ask students what their favorite flower is and why (not necessarily from the picture cards); try to generate responses that include common "weeds" such as dandelion or buttercup. Guide students toward incorporating the sense of smell into their descriptions.
    b. Fold a piece of paper into three sections lengthwise. Title the first column on the paper "resources for survival" and have students brainstorm what resources are necessary for their favorite flowers to grow and reproduce. Have students pair up and compare their resource lists, adding new information to their lists from their discussion; have them prioritize the top three resources absolutely fundamental to survival. Emphasize the necessity of water as a top resource for even for desert plants. Utilize a student volunteer to record a master list on the front board or document camera.

c. Title the second column on the paper "role in growth and development" and have students review each resource for its role in photosynthesis and/or cellular respiration. Have students pair up with a new partner and compare their lists, adding new information to their lists from their discussion. Briefly review the role of each resource on the master list, having a student volunteer record discussed outcomes on the white board or document camera.
d. Have students recall the definition arrived upon for a weed. Introduce the terminology "invasive" or "noxious" weeds and have student elaborate on how these terms might change their definition of a weed. *Ask: Do weeds – common or invasive – also use these resources to survive? Do they share these resources with native species? How?* Have students title the third column on the paper "competition curiosities" and generate questions about the ways in which weeds might also obtain each resource and compete against native species.
e. Play the video segment from PBS Nature: "What Plants Talk About." Have students update their "competition curiosities" list with any new information obtained from the video. Encourage student pairs to discuss the different competition strategies observed in the video with the "competition curiosities" from their lists. *Ask students: How does competition among species affect an environment? Do you think other species engage in chemical warfare over natural resources? How else might plants use chemicals to improve their survival? Should we be concerned with invasive species in our environment? Should we enact laws to control invasive species within our environment?*

2. **Explore:**
   a. Organize students into small groups (3-4 students each). Have students access the University of Idaho Extension guide: Idaho's Noxious Weeds, 5th edition http://www.cals.uidaho.edu/weeds2/IWR/iwr-v6_website/files/Download/BUL816.pdf . Each student needs to clearly read the introduction to understand how the guide is organized. Encourage the student groups to explore the online guide and discuss the key features. Ask guiding questions to ensure their understanding of use of the guide (ie: ***What is an EDRR plant?*** *A noxious weed that requires statewide early detection and rapid response.* ***Where might I go to find out if a particular noxious weed exists in my community?*** *The state distribution map for each weed ID page.*)
   b. Each group should categorize and record by both common and scientific name the different noxious weeds in our area (from the map provided in the guide), including their habitats and any notable information (such as poisonous or EDRR).
   c. Students should predict the effects of each category of noxious weeds on natural habitat, emphasizing the role of competition with native species, interference with herbivory for other organisms, and economic cost of control efforts.
3. **Explain:**
   a. Have each group discuss the best graphical analysis (pie chart, bar graph, etc.) for the categories of noxious weeds in their community of Idaho, and create a

data display using Excel (or another appropriate graphing tool). Discuss the importance of key features of graphical display of data, such as titles, labels, and information keys.

b. Have each group write a brief interpretative summary explaining their graphical display.

4. **Elaborate:**
   a. Each group should pick one of the noxious weeds from their community and create an in-depth report for its identification to share with their peers. Have each group refer to their "competition curiosities" sheet to help them focus their research. Monitor selections to ensure that each group chooses a different species to explore to increase informational diversity.
   b. The report should address the noxious weeds' origins, the impacts (both identified and inferred) that it poses in the community, and current efforts for identification and containment. Encourage students to focus on the plant as an introduced species, originally intended for an aesthetic or medicinal purpose to members of the community, to help them recognize that the species is not inherently "bad" but just "bad" for our environment. The presentation should be creative and can be relayed through any attainable medium – poster board, PowerPoint, Prezi, etc.
   c. Allow students adequate presentation time in class to relay their research with their peers. As a bonus, they can create noxious weed ID cards to distribute to their peers for future reference.
5. **Evaluate:**
   a. Formative assessments can be conducted through exploration questioning and the competition curiosities sheet at the beginning of the lesson.
   b. Graphical analysis and data summary should be evaluated for accuracy and completeness, focusing on logical scientific explanation and interpretation.
   c. Noxious weed presentations should be evaluated for thoroughness, neatness, and creativity.

Modifications/Recommendations:

Background: Oftentimes the discussion of competition among species is focused on larger animals that are easily observed. However, plants also engage in fierce battles of competition over resources, uniquely constructed around their sedentary life styles. Of greater distress to many of our native ecosystems is the introduction of invasive or noxious weed species that are outcompeting native plant species and presenting new problems in erosion and sediment control, especially along riparian zones. This lesson requires that students have a firm understanding of the necessary elements needed for plants to undergo photosynthesis and cellular respiration in order to grow and develop.

3. Invasive Species: Waging War

Water Quality Unit

Alignment with Standards:

NEXT GENERATION SCIENCE STANDARDS

Science & Engineering Practices:

- Obtaining, Evaluating, and Communicating Information

COMMON CORE STATE STANDARDS

CCSS.ELA-LITERACY.RST.9-10.4 – Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics.*

CCSS.ELA-LITERACY.RST.11-12.4 – Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics.*

CCSS.ELA-LITERACY.RST.9-10.5 – Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

CCSS.ELA-LITERACY.RST.11-12.5 – Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

CCSS.ELA-LITERACY.WHST.9-10.6 – Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

CCSS.ELA-LITERACY.WHST.11-12.6 – Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

CCSS.ELA-LITERACY.WHST.9-10.7 – Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.WHST.11-12.7 – Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

IDAHO CONTENT STANDARDS

9-10.B.1.3.2 Analyze changes that can occur in and among systems.

9-10.B.1.6.2 Utilize the components of scientific problem solving to design, conduct, and communicate results of investigations.

9-10.B.3.2.2 Explain how organisms use the continuous input of energy and matter to maintain their chemical and physical organization.

9-10.B.3.2.3 Show how the energy for life is primarily derived from the sun through photosynthesis.

9-10.B.3.2.4 Describe cellular respiration and the synthesis of macromolecules.

8. Service Learning via Riparian Restoration

Water Quality Unit

INSTRUCTION PLAN

Learning Objectives: Students will:

- Understand the value and benefit of service learning;
- Identify ways in which service learning will enhance their understanding of the riparian zone and its function;
- Identify the location and importance of the riparian zone in aquatic ecosystems;
- Identify the appropriate riparian vegetation that should exist to benefit bank stability;
- Become familiar with a service learning and environmental non-profit organization;
- Expand upon the previous water quality concepts already learned through the themes and concepts involved with riparian zone service work.

Time Requirement:

- 30-50 minutes in class for pre-lesson
- Half or full day for field experience
- 10 minutes in class for post-lesson
- *Optional extension to Problem Solving activity would require 1-2 additional class periods*

Materials Needed:

Pre-Lesson

- Computer and projector
- Student worksheets

Field Experience

- Appropriate tools, gloves, plants
- Field notebooks

Procedures:

Pre-Lesson

1. At the beginning of class, utilizing Think-Pair-Share, have students fill out the included worksheet to gauge their knowledge of service learning and riparian restoration. (Feel free to reduce/change questions as needed.) **If you have access to clickers, this would be a great time to incorporate them. You would have to turn the questions into multiple choice rather than short answer, but you would immediately see what prior knowledge the students have.
2. Move onto the *PAIR* step. Have students pair up and share what they think about service learning and riparian restoration.
3. Now *SHARE* – starting with the first question, have students share out their thoughts. Check for understanding and utilize proper questioning techniques to correct any misunderstandings. One common one may be the assumption that volunteering = service learning. The difference between the two is that through service learning, you are learning about a topic you are studying while also giving back. Rather than just giving back through volunteering.
4. To aid the discussion, provide examples of service work you have participated in or know of within the water resources field. This will spark student interest within this topic and the upcoming service learning experience.

5. Present the included PowerPoint presentation about service learning to expand students' knowledge. This also includes a discussion of the riparian zone to further educate the students on this watershed science topic and relationship to the service learning field trip. This presentation covers:
    a. Watershed Stewardship
    b. Education and outreach
    c. Benefit and necessity of service within watershed conservation
    d. Exposure to service learning organizations
    e. Riparian zone (connection to service work)
6. Ask students how they the think planting riparian vegetation will impact water quality.
7. Introduce the location of the service learning field trip and the agenda for the day, and the non-profit organization the class will be working with.

Field Experience

1. At the beginning of the day, introduce students to the adults involved and the site location. Discuss the concept of service learning and the importance of riparian restoration.
2. Provide a tour of the location with possible topics of invasive weeds present, native plants present and habitat. Focus on identifying the current state of the stream's riparian zone.
3. Use questioning to draw out water quality knowledge from the students. Ask them to make a connection between riparian restoration and water quality improvements. What parameters will be affected?
4. Assign and demonstrate field tasks and make sure expectations are clear.
5. Perform the riparian restoration tasks such as trash clean-up, removal of invasive weeds, re-stabilization of riparian saplings and seedlings, and planting of new seedlings.
6. After the work is completed, have students sit quietly on their own near the work they completed and reflect on the experience. Ask them to draw the riparian zone and creek "before" and "after" the work they did. (After can be down the road once the plants have grown.) Then ask them to write how they felt about the experience and what they learned.
7. Gather everyone back up to discuss how the day went and what the students learned.

Post-Lesson

1. Encourage students to share how they felt about the service learning experience, the highs and lows, and what they learned about riparian restoration. Review important points that students do not bring up.
2. Ask students to evaluate the effectiveness of the restoration they performed and if they have recommendations for improving the design of it.
3. *Optional extension* – it could fit well to utilize the TCP Problem Solving activities after doing the service work to allow students to think of other ways to solve water resources problems and to continue providing service to the community. See that lesson for instructions and materials.

Modifications/Recommendations:
This lesson plan can be catered to any form of water resources service learning and corresponding water resources topic. Use this lesson as a guide for other service learning topics.

8. Service Learning via Riparian Restoration

Water Quality Unit

Extension opportunity – have students do their own research on the best techniques for riparian restoration and present to the class.

Riparian restoration has been carried out with several TCP schools and partner organization; the students always really enjoy it. Oftentimes the organization provides all of the necessary equipment needed for the particular service work as well as guidance and supervision.

Potlatch HS worked with Palouse-Clearwater Environmental Institute; contact Randy Stevens rstevens@pcei.org

Post Falls HS worked with the Lands Council and a local environmental engineering firm; contact Kat Hall khall@landscouncil.org

We recommend tying this activity into a water quality or agriculture trip to reduce days needed and cost. Additionally, it can help students make connections between those concepts/activities and riparian restoration. If you tie it into these

Alignment with Standards:

NEXT GENERATION SCIENCE STANDARDS

HS-ETS1-2 – Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 – Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices:

- Constructing Explanations and Designing Solutions

IDAHO CONTENT STANDARDS

ISSS.9-10.B.5.1.1 – Analyze environmental issues such as water and air quality, hazardous waste, forest health, and agricultural production.

Pre-Service Student Questions

Name: _____ Date: _____

1. In your own words, define service learning.

2. Have you ever participated in a service learning event? If so, please explain. How did you benefit from this experience?

3. How do you think service learning and volunteering differ?

4. In your own words, please define riparian zone.

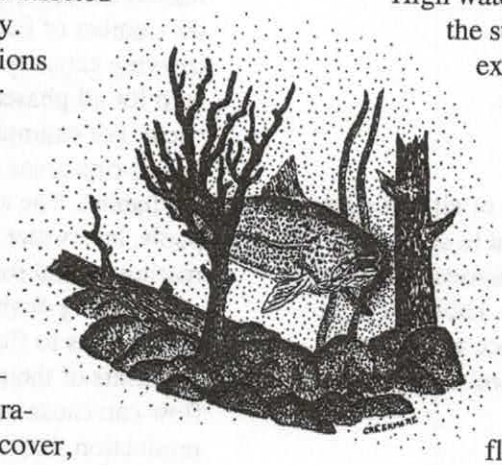
5. What is riparian vegetation? Why is this vegetation important?

6. Please list one service learning organization that you know of that focuses on outreach and education.

Fish habitat restoration

Aquatic habitat restoration activities are one of the key issues in the Oregon Plan for Salmon and Watersheds. The concept of "habitat restoration" covers a multitude of ways to improve watershed function—water quality, water quantity, increased channel complexity, flood plain interaction, and the quality of riparian vegetation. Reintroducing wood to stream channels, repairing culverts, planting trees and shrubs, and opening up historical stream channels are all examples of habitat restoration projects.

A stream's or estuary's ability to support fish and other forms of aquatic life is affected by its ability to function properly. Stream or estuary habitat conditions are dependent on land and water management actions including road building, development, grazing, agricultural practices, forestry practices, controlled fires, and other human and natural activities within a watershed.



Fish survival in aquatic habitats is dependent on water temperature, water quality and quantity, cover, and food supply. Fish have different requirements at various stages of their lives and different species use different habitats for spawning and rearing. Understanding the different life cycle requirements and interactions among species plays an important role in sound habitat restoration.

Successful spawning and development from egg to fry require:

- absence of barriers at all flows to upstream migration of adult fish;
- spawning areas with sediment-free substrate and adequate water flows;
- a balance of pools and riffles to provide spawning and holding areas, especially deep, cool pools for species like spring chinook salmon;
- instream and streamside cover to protect adult fish from predators and to provide shaded resting areas; and
- an adequate flow of cool, well-oxygenated water through the spawning gravel.

Development from eggs to fry is a delicate process. Many things can happen to limit the number of fish that survive this stage of the life cycle. High water flows may scour eggs from the streambed. Low water can expose the redd and allow the eggs to die from temperature extremes. High sediments loads may smother the eggs in the redds and large numbers of adults spawning in a limited area may uncover eggs in one redd while building another.

Young emergent fry require quiet, slow stream flows, backwaters, or stream margins. Juvenile migratory fish live and grow in the stream for one to three years, while resident fish need suitable habitat throughout their lives. Rearing fish also need clear access to move up and down the stream, including access to the ocean for migratory fish.

Productive fish rearing habitat requires:

- low to moderate slope and streamflow velocity;
- a balance of pool and riffle habitat to provide food and cover appropriate to the species;
- a variety of substrate types to provide hiding cover for young fish and places for aquatic insects to live;

- undercut banks, stable natural debris such as fallen trees, and overhanging plants to provide cooling shade, protection for young fish and leaf litter for aquatic insect food;
- nutrients, particularly from salmon and lamprey carcasses in areas where these species were historically found, to promote growth of naturally occurring plants and other organisms beneficial to the stream;
- barrier-free migration for upstream and downstream movement;
- a stream channel that interacts with the floodplain during high water periods; and
- meandering streambanks and backwater channels to slow streamflow, add diversity, and increase the amount of habitat available to fish.

What is fish habitat restoration?

Habitat restoration is the repair of altered streams or creation of productive habitat in streams, riparian areas, uplands, and estuaries. In a properly functioning natural system, habitat restoration can help watersheds produce and support increased numbers of salmon, trout, and other wildlife.

Why are fish habitat restoration projects needed?

Many of Oregon's watersheds have suffered from the effects of human activities and support fish populations well below their historic levels. Loss of wetland and estuary habitat, spawning areas, rearing areas, streamside vegetation, instream woody debris, beaver ponds, and access to former fish production areas are all results of our treatment of the land, aquatic environment, and aquatic wildlife

To understand the need for habitat restoration, we must first recognize how land use activi-

ties affect a stream's character and how fish populations respond to reduced habitat quality within a stream. Certain aquatic and riparian habitat conditions, or limiting factors, establish the number of fish a stream can support — its carrying capacity. Limiting factors are considered for all phases of a salmon or trout's life cycle. For example, the amount and quality of gravel-rich areas are limiting factors for spawning habitat. The amount and quality of deep pools, backwater pools, or beaver dam areas limit rearing habitat for young fish.

Varying environmental factors cause fish populations to fluctuate from year to year within the limits of their habitat. Extremes in streamflow can cause wide variations in survival and production. Extended low flows may keep adults from reaching spawning areas. High winter flows can destroy eggs by scouring spawning beds or depositing sediments. Stream temperatures also affect survival. Variable ocean conditions affect smolt and adult survival. Fish populations in healthy habitats generally recover quickly from these natural events. But when habitat quality is degraded, serious reductions in fish numbers occur.

Many fish habitat problems are overcome with changes in land and water management practices, but habitat restoration activities may get the stream system on a fast track to recovery. Restoration projects are not an alternative to

improvements in land and water management, but can bridge the time between past disturbances and a return of natural functions that will maintain productive fish habitat.

It is important to understand which management activities or habitat conditions are limiting fish populations so efforts to improve the situation are not misdirected, harmful, or wasted. Once limiting factors are identified by surveys or other evaluation processes, habitat restoration projects can address specific habitat needs in a given stream. Restoration practices should target the most limiting factors first.

What are some fish habitat problems?

✔ Water quality and quantity

Most aquatic organisms rely on a relatively narrow temperature range for survival. Shade plays an important role in determining water temperature. Air temperature, adjacent land forms, upslope vegetation, and land and water use also affect water temperatures. Various types of pollution negatively affect fish and aquatic insect production. Minimum streamflows are necessary to maintain good fish habitat, especially during natural low flow periods of the year. Lack of beneficial nutrients, such as those from salmon and lamprey carcasses in areas where these species were historically found, also affects water quality.

✔ Abused riparian areas

Healthy streambank conditions are important to fish production. Good riparian plant growth along a stream helps the soil store water for late summer flows, provides shade to keep water cool, holds the soil together to reduce sediment input to the stream, and contributes insects to the fish food menu.

✔ Barriers to migration

Roadway culverts, dams, dikes, and other man-made structures may artificially block spawning, rearing, and smolting migrations of fish.

✔ Lack of natural instream structure

Large and small woody debris accumulations create resting areas, scour deep pools, provide cover for fish, collect gravel for spawning beds, and are homes for aquatic insects.

✔ Lack of spawning or rearing areas

Salmon and trout species have different habitat requirements during the various stages of their life cycles. They need a balance of spawning and rearing areas with both riffles and pools in a given stream section. Suitable spawning areas have clean, porous, proper-sized gravels with an adequate flow of cool well-oxygenated water. Rearing areas with undercut streambanks, side channels, beaver ponds and other pools, instream cobble and boulders, and large woody structures, such as fallen trees, provide young fish with an environment suitable for survival and growth.

Does a fish habitat problem exist?

Before starting a habitat restoration project, find out if a habitat problem exists. Volunteers can help determine the status of fish populations and the condition of aquatic habitats through a variety of survey projects. Aquatic Habitat Inventories provide information about the quality of fish habitat in streams. Fish Population Surveys determine the species present and their abundance and distribution within a given stream. Spawning Surveys document the amount of spawning activity in a stream system. Another survey might document migration barriers caused by poorly functioning culverts. Others measure streamflows or monitor water temperatures to develop stream temperature profiles. Biologists train volunteers to conduct the surveys and help evaluate the results.

Information gathered during the surveys helps biologists identify and assess factors limiting fish production. If habitat restoration is appropriate, proceed with the following steps.

✔ Identify the problem

What is missing and what are associated limiting factors? What are the "most limiting" among the limiting factors?

✔ Develop a plan

What actions can correct the problem? Identify the best approach and develop an organized plan with clear objectives and measurable outcomes. Consider the cost/benefit factors of your actions. Use a Habitat Restoration Project Planning Worksheet provided by your local Oregon Department of Fish and Wildlife STEP biologist or habitat biologist to guide your thought process. ODFW staff can also provide a copy of the *Oregon Aquatic Habitat Restoration and Enhancement Guide*, which includes information about permits, approvals needed, and who to contact.

✔ Implement the plan

Carry out the selected action under the supervision of the STEP Biologist or other experienced habitat biologist.

✔ Evaluate the project

Include time and dollars in your plan to evaluate both the short and long term success of the project. Is it accomplishing the desired results? Are more fish present in the stream following the project? What are the measurable outcomes of the project?

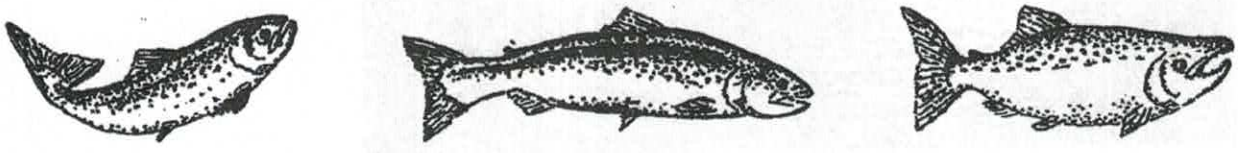
✔ Maintain the project

Some projects require periodic inspection and maintenance to assure the project or structure functions properly. Include time and funding to cover maintenance costs in your plan.

Remember, stream habitat is dynamic over time. Collections of gravel, large wood, and stream meanders will change seasonally and over the years. Large wood or other instream structures often work best if allowed some movement with natural flow events. In less heavily degraded watersheds nature can place the wood and other structures in arrangements that work best for fish.

What next?

Each project requires individual consideration to tailor the action to the need and the site. There are many techniques for accomplishing the various actions. Consult the *Oregon Aquatic Habitat Restoration and Enhancement Guide* for suggestions and ask your local ODFW fish biologist, STEP biologist, or habitat biologist for assistance in planning a restoration project.



Habitat restoration techniques

Remember one very important thing when considering habitat restoration work: Mother Nature has taken care of her watersheds and streams for a long time. Only when human interaction began affecting the picture did the function go awry.

If the problem with the stream is one of human management, that is, convincing people to change their actions or management strategies (such as limiting livestock access or restricting timber harvest), then the best form of habitat restoration is to follow nature's lead and allow the stream to recover naturally. There is no reason to place structures in the stream, just because it seems like the thing to do.

A "light touch" is best and all work done in a stream should blend into the natural pattern.

If the stream has time to recover on its own, any remaining problem areas will be evident. Those areas should be evaluated and receive appropriate attention. A "light touch" is best and all work done in the stream should blend into the natural pattern. Never underestimate the power of flowing water when planning your habitat work.

Habitat restoration is the repair of damaged streams so they may produce and support increased numbers of salmon and trout. Habitat enhancement is the creation of better or more suitable habitat within a stream. Habitat enhancement may not mean more fish, but may mean an increase in other values related to overall watershed health.

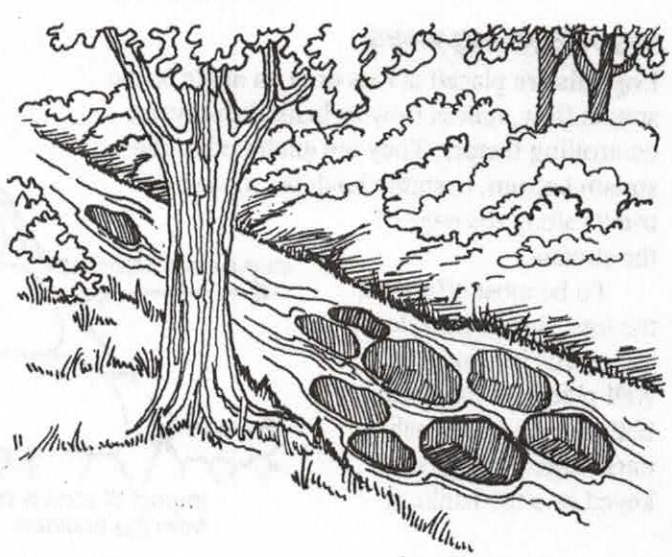
Various techniques exist for restoring and enhancing fish habitat. For any habitat rehabilitation or enhancement work to be successful, it must meet two criteria. It should be placed where it will best aid creation of the desired habitat condition and it should be designed to last for a relatively long period of time.

Restoration techniques

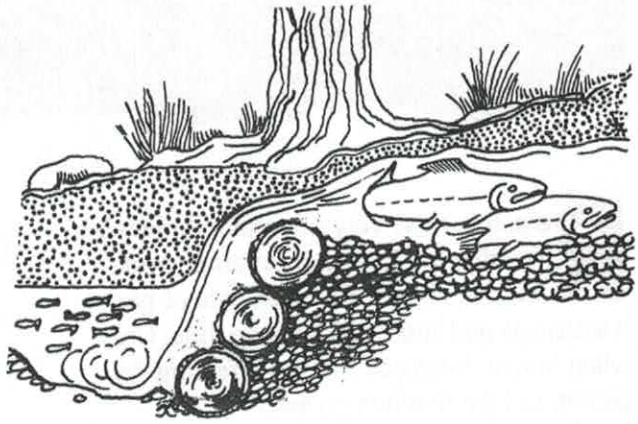
Following are a few examples of habitat restoration techniques. Many other techniques exist for specific problem areas in streams. If you and your students want to get involved with habitat restoration work, contact the local STEP biologist or district fish biologist for assistance.

Boulders

Very large irregular boulders create "pockets" or hiding and resting places for fish. Boulders also change the flow pattern of the water, creating greater habitat diversity. They are most often used when there is too much riffle and limited pool and hiding areas. Depth is increased by scouring, a result of the faster water velocities around the rock.



Generally, boulders are placed in clusters or along the edges of streams to create small backwater areas. Streambanks should be stable or well protected in areas where boulder placement is considered.



Rock weirs (or boulder berms)

Rock weirs are constructed in areas where long shallow riffle areas exist and sufficient spawning gravel is limited.

A rock weir consists of a collection of rocks and cobble used in combination with large boulders (which may already be found in the stream) to form a dam-like arrangement. Rocks are piled across the stream using already present boulders as a base. The rock weir is constructed with a somewhat vertical, downstream face and a gradually sloping upstream side. This design spreads the water's force over the entire structure, lessening the chance of wash out. The height of the weir varies depending upon the channel.

A rock weir reduces a stream's velocity, collects spawning gravels, and help restore the water table. Downstream, water plunging over a weir scours a pool and recruits gravel that is sent downstream by the flow to the next collection site.

Rock weirs are best used in series to create habitat diversity (increased pool-to-riffle ratios). Streambanks must be stable or well-protected in rock weir placement areas.

Log sills (or log weirs)

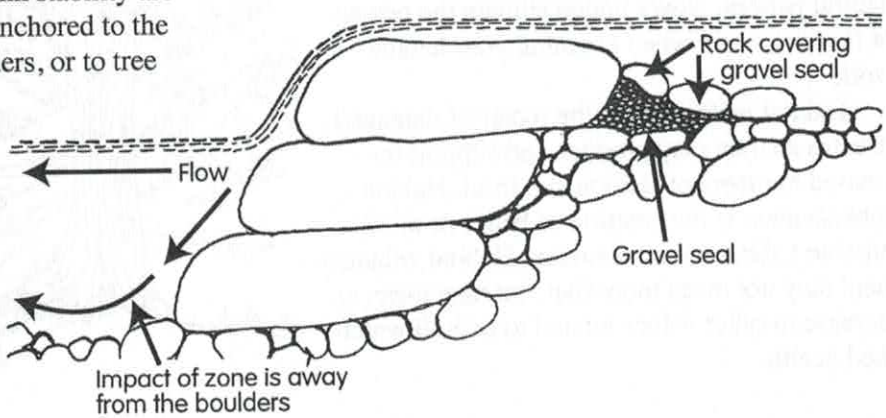
Log sills are placed across or at an angle to the stream flow, unless flow or bank stability are controlling factors. They are anchored to the stream bottom, to stable boulders, or to tree trunks along the edge of the stream.

To be most effective, the logs should be at least 12" to 16" in diameter, well placed in the stream bottom to reduce washouts under the logs and keyed into the banks at least a third of their length. Often, a layer of heavy wire and erosion fabric is anchored to the log. This is placed on the streambed on the upstream side of the log sill to help complete the seal, reducing washouts under the log. Gravel collects behind the log, providing spawning area above the structure and a rearing pool on the downstream side.

Plantings

Stabilizing stream banks with tree plantings or reseeding with other vegetation can help restore streamside vegetation. Consult with local professionals, like the Natural Resources Conservation Service, to select the right species for the site.

The condition of the streambanks is related to water quality and fish production. Shade provided by the vegetation helps keep streams cool. Root systems help control erosion that would add sediments to the stream. Silt can clog gravel, smother eggs and reduce aquatic insect production.



Cover logs

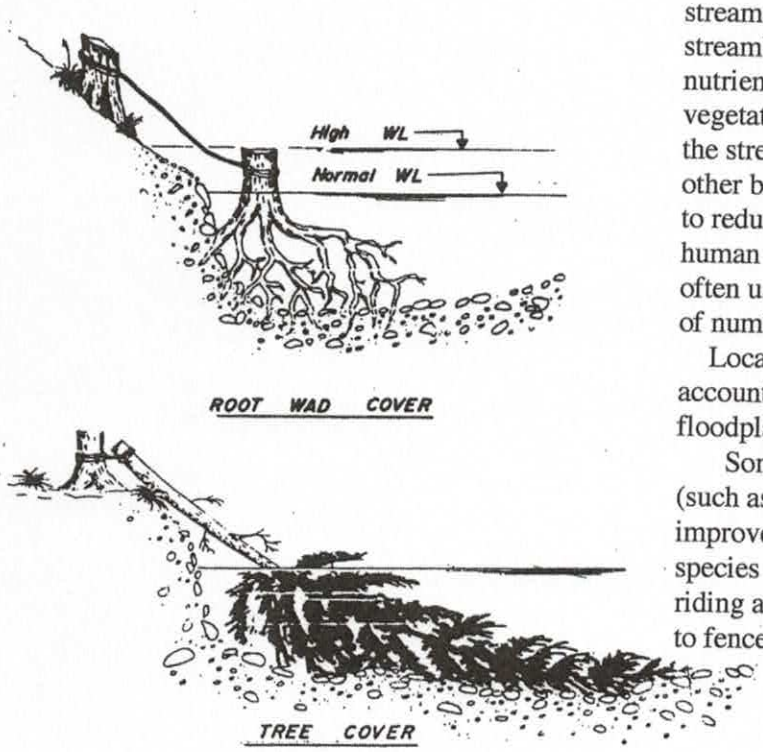
Cover logs provide overhead cover in sections of a stream where the water depth is adequate but cover is lacking.

Cover logs can be any shape, length or size, but the best results are obtained by using large crooked logs with limb stubs extending several inches. Root wads are also used. Both provide an irregular surface resulting in maximum turbulence and spot scouring along the edge of the structure.

Logs are anchored to the stream bottom or the bank. Ideal locations are open pools or glides at least 6" to 8" in depth. Logs are placed parallel or at slight angles to the flow. Cover logs have the added advantage of presenting a natural appearance in the stream.

Cut trees (juniper) that are placed against and anchored to the banks are beneficial in bank stabilization. Green trees with a bushy crown work best.

The trees and their branches reduce water velocities, allowing sediments to collect. Native plants then colonize these new seed beds, improving banks, narrowing and deepening the channel, and enhancing salmonid habitat.



Source: *Stream Enhancement Guide,* Government of Canada, Province of British Columbia, Vancouver, B.C., 1980.

Streambank fencing

Fencing, or otherwise limiting usage of disturbed streamside areas, can help restore deteriorated streambanks, reduce excessive or unnatural nutrient and sediment loads, and protect riparian vegetation. Healthy riparian vegetation shades the stream, reduces bank erosion, and provides other benefits to fish. Fencing may be necessary to reduce impacts from agricultural or other human activities on streambanks, but it is most often used to control livestock grazing in terms of numbers of animals, season, and timing of use.

Location of riparian fences should take into account potential damage from ice, high flows, floodplain levels, and debris.

Some grazing systems and/or techniques (such as alternative water developments, upland improvements, planting of nutritious, palatable species well away from riparian areas, and/or riding and herding practices) can reduce the need to fence.

UNIT 7 SERVICE LEARNING PROJECTS
STUDENT HANDOUTS

STUDENT HANDOUT 7A

What is Service Learning?

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

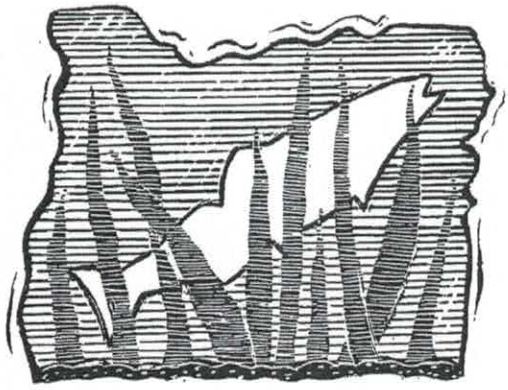
- Meet actual community needs.
- Coordinate in collaboration with the school and community.
- Integrate into each young person's academic curriculum.
- Provide structured time for a young person to think, talk, and write about what he/she did and saw during the service activity.
- Provide young people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

From Alliance for Service-Learning in Education Reform March 1995

The Effective Service-Learning Project

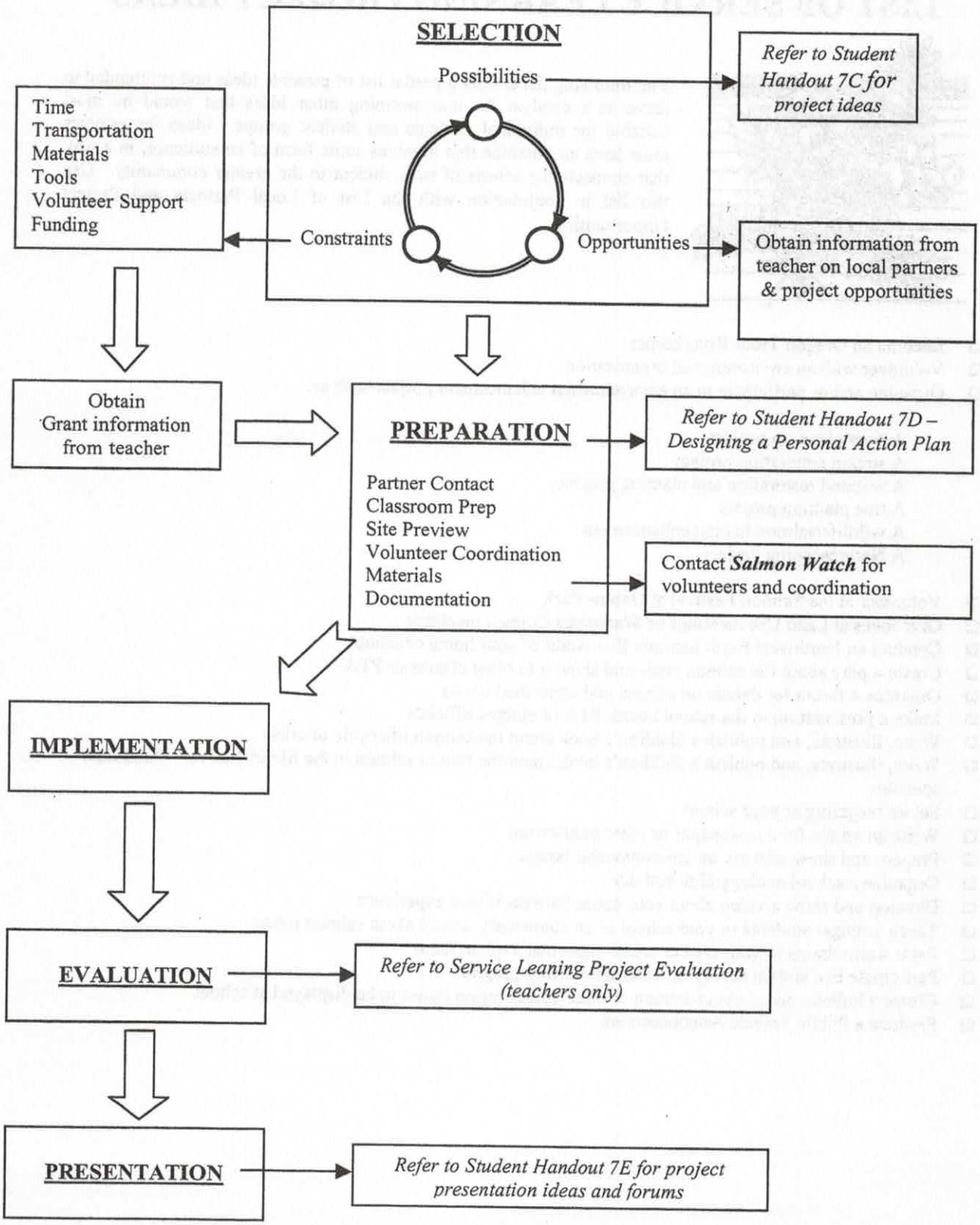
An effective service-learning project is achieved with a clear objective for both service and learning. Projects should address local issues and impact the community in which you live, while providing a relevant learning experience. The challenge is to keep a vision, work with community members, and make an impact! Salmon Watch encourages teachers and student groups to utilize partner resources, especially those at Salmon Watch, to create new opportunities and relieve project constraints and undue anxiety.

Depending on your interests and the local influences on community needs, each project will have unique opportunities and constraints. The balance you strike between these features will become the ultimate plan, and represents real problem solving. You 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. (Journaling is a suggested way to ensure good records of the process and that you're meeting your objectives.)



STUDENT HANDOUT 7B

SERVICE LEARNING PLANNING FLOW CHART



STUDENT HANDOUT 7C

LIST OF SERVICE LEARNING PROJECT IDEAS

The following list is only a partial list of possible ideas and is intended to serve as a catalyst for brainstorming other ideas that would be most suitable for individual students and student groups. Ideas for projects must have an outcome that involves some form of an audience, in a way that connects the efforts of each student to the greater community. Use this list in conjunction with the List of Local Partners and Project Opportunities.

- ❑ Become an Oregon Trout Riverkeeper
- ❑ Volunteer with an environmental organization
- ❑ Organize and/or participate in an environmental enhancement project such as:

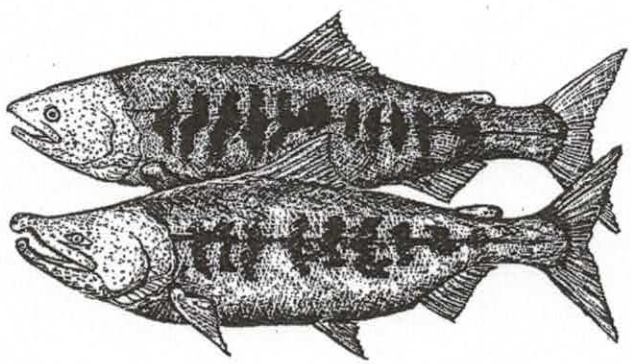
  A river clean-up project
  A stream restoration project
  A wetland restoration and planting project
  A tree planting project
  A wildlife/salmon habitat enhancement
  A Naturescaping project

- ❑ Volunteer at the Salmon Festival at Oxbow Park
- ❑ Give ideas at Land Use meetings or Watershed Council meetings
- ❑ Conduct an Northwest Earth Institute Eco-Audit of your home or school
- ❑ Create a play about the salmon crisis and show it to other classes or PTA
- ❑ Organize a forum for debate on salmon and watershed issues
- ❑ Make a presentation to the school board, PTA or elected officials
- ❑ Write, illustrate, and publish a children's book about the salmon life cycle or crisis
- ❑ Write, illustrate, and publish a children's book about the role of salmon in the life of Native American societies
- ❑ Set up recycling at your school
- ❑ Write an article for a newspaper or other publication
- ❑ Prepare and show artwork on environmental issues
- ❑ Organize a school ecology club activity
- ❑ Develop and show a video about your entire Salmon Watch experience
- ❑ Teach younger students in your school or an elementary school about salmon issues
- ❑ Paint storm drains in your area or create signs that explain them
- ❑ Participate in a stream survey or water monitoring program
- ❑ Create a bulletin board about salmon or other conservation issues to be displayed at school
- ❑ Produce a Public Service Announcement

STUDENT HANDOUT 7D

SERVICE LEARNING PROJECT
PRESENTATION IDEAS AND FORUMS

Advertisement
Animated movie
Art gallery
Bulletin board
Charts/Graphs/Diagrams
Clay sculpture
Collage
Comic strip
Computer program
Data base
Debate
Demonstration
Detailed illustration
Diorama
Display
Editorial
Etching
Experiment
Film
Filmstrip
Game
Graph
Illustrated story
Interview (published)
Large scale drawing
Learning center
Letter to the editor
Map with legend
Mural
Museum exhibit
Newspaper story
Oral report
Painting
Pamphlet
Paper mache
Petition
Photo essay
Pictures
Play
Poetry
Press conference
Puppet show
Radio program
Sculpture
Skit
Slide show
Survey
Tapes –audio-video
Television program
Timeline
Travel brochure
Write a new law
Video film



FORUMS FOR PRESENTATIONS

School symposiums/education fairs
Watershed Councils
Watershed Fairs
Land use planning meetings
County Commission meetings
City Council meetings
Environmental Celebrations like Earth Day
State or county fairs
Agencies like Oregon Dept of Fish and Wildlife
Organizations like Sierra Club or Cattlemen's Assoc.
NW Earth Institute's Earth Club Challenge

STUDENT HANDOUT 7E

DESIGNING A PERSONAL ACTION PLAN

The following worksheet is designed to help organize the planning and preparation work necessary to achieve an effective service-learning project. Though some questions may be difficult to answer at the preliminary stage in the planning, we encourage you to make an attempt at all the answers now and send in the worksheet to Oregon Trout Salmon Watch for review, comments, and assistance. You can go back later and make modifications or changes as developments arise during the course of this planning. We intend that this form be used after brainstorming sessions and some consensus review.

The questions on this form are intentionally similar to those found on typical mini grant applications. If you are planning to apply for grant monies, this form may be useful as a preliminary draft.

SALMON WATCH

Date_____

STUDENT SERVICE-LEARNING PROJECT ACTION PLAN

Student name_____

Teacher name_____

School name_____

Project Title_____

Please list any resources you would like Salmon Watch to provide:

What is the goal(s) of the project?_____

_____

_____

Why have you selected this project?_____

_____

_____

Who is the Project Partner(s)_____ Partner phone_____

_____ _____

What role will the partner(s) play in your project?_____

_____

_____

What other resources (people, materials, etc.) will you utilize?_____

_____

What obstacles will you face with this project? How will you resolve these problems?_____

_____

Who will see the results of your project?_____

_____

How do you plan to document the project?

- ☐ Photographs
- ☐ Charts & Graphs
- ☐ Artwork
- ☐ Essay
- ☐ Other_____

(SEE BACK SIDE)

Please return this form to:

Oregon Trout
Salmon Watch
117 SW Front Avenue
Portland, OR 97204

Describe the steps you will take towards achieving your project goal on the timeline provided below. Please use the months on the right as a guide.

FALL

SEPTEMBER

OCTOBER

NOVEMBER

WINTER

DECEMBER

JANUARY

FEBRUARY

SPRING

MARCH

APRIL

MAY

SUMMER & BEYOND

JUNE

Date_____

Service-learning Project Evaluation

We would like to know about your classroom's Salmon Watch Service-learning project experience(s) during this past year. Your candid and thoughtful comments will help us improve Salmon Watch for future years. Thank you for your support! Please return this evaluation by May 31.

Teacher's name_____ School Year_____

School name_____

About how many students were taught from the Salmon Watch curriculum during this school year? _____

About how many of those students participated in a Service-learning project during this school year?_____

Were the service-learning projects done individually, in small groups, or with the entire class? _____

Project name(s)_____ Date(s) of implementation _____

Project location(s)_____ _____

Project description(s)_____

_____

_____

What were the major difficulties in planning the project(s)? Comments?

- ❑ Time
- ❑ Budget
- ❑ Materials
- ❑ Other_____

_____

_____

_____

_____

What were the successes during the planning phase?_____

_____

_____

What were the major difficulties in the implementation? Comments?

- ❑ Coordination
- ❑ Transportation
- ❑ Other_____

_____

_____

_____

What were the successes in the implementation? _____

_____

_____

How did your students document and/or evaluate the project ? Was it an effective tool?

- ❑ Journal _____
- ❑ Photographs _____
- ❑ Other_____ _____

How did your students present the information/materials from the project? To what audience?_____

_____

We would like to show our volunteers, partners, and the public the products (displays, art, etc.) of your projects at training sessions, symposiums, and other events. Would you be willing to share these with Oregon Trout? If yes, please describe.

- ❑ YES _____
- ❑ No _____

How useful was the curriculum in planning, implementing and evaluating the project?

❑ Excellent ❑ Very Good ❑ Good ❑ Fair ❑ Poor

Comments:

How effective was Salmon Watch in assisting you and your students with your project?

❑ Excellent ❑ Very Good ❑ Good ❑ Fair ❑ Poor

Comments:

In what ways can Salmon Watch better support your efforts in service-learning?_____

_____

_____

Salmon Watch is considering developing long term Salmon Watch Service-learning sites in partnership with other local organizations. What is your interest in developing such a site with other Salmon Watch Classrooms in your area?

- ❑ Definitely Participate
- ❑ Might Participate
- ❑ Would Not Participate

Please make suggestions:_____

_____

_____

Please add any additional comments below.

Please return this form to:

Oregon Trout
Salmon Watch
117 SW Naito Pkwy
Portland, OR 97204

Thank you for your support of the program!