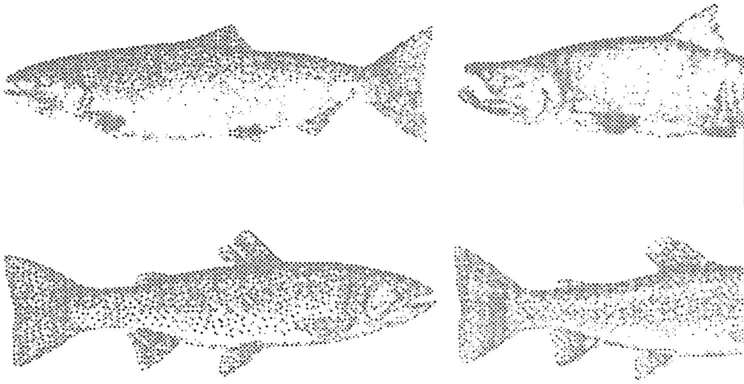


Unit 4

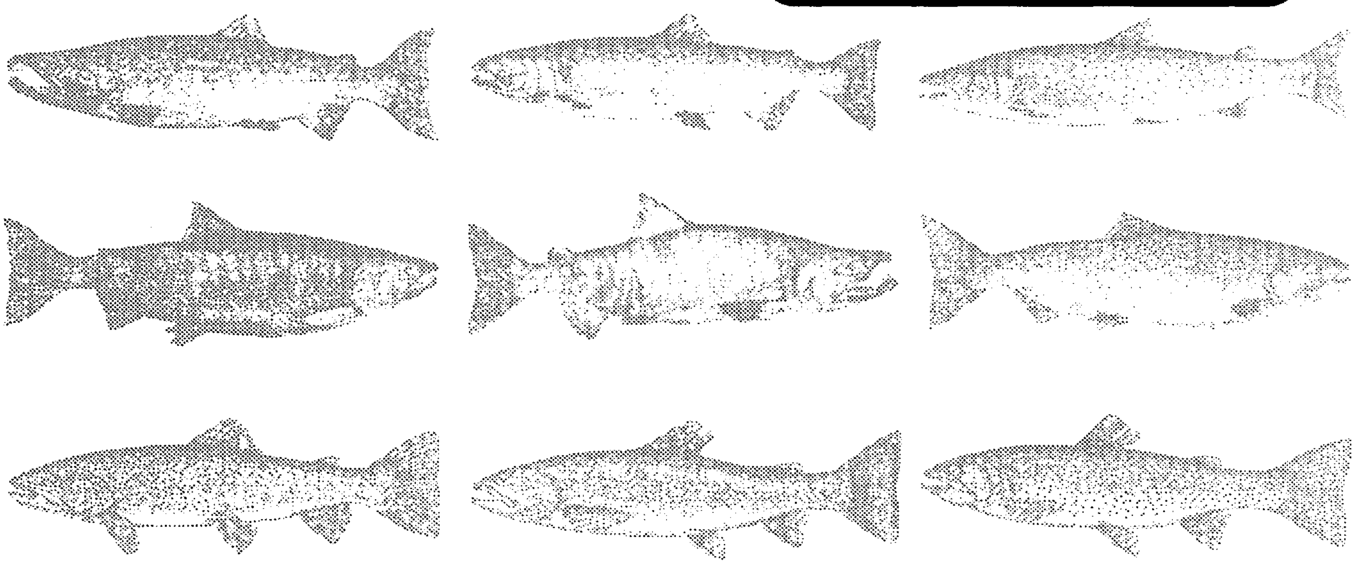
In This Unit:

Habitat the Key to Survival in the Wild

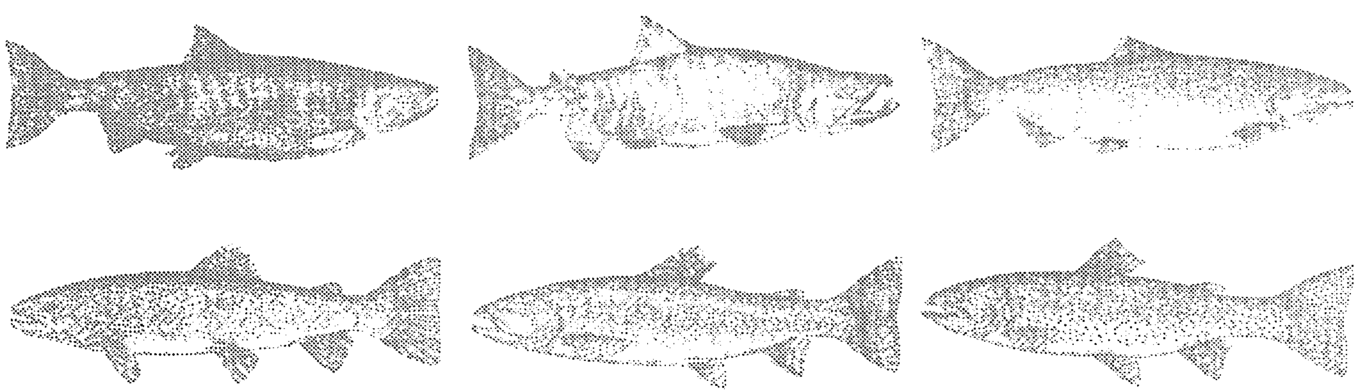
Learning Activities

Home Wet Home

Riffles and Pools



Fish Habitat Needs



Habitat:
The Key to Survival in the Wild

(Background information for learning activities "Home Wet Home," p. 153 and "Riffles," p.157)

months; and, coho are released after about 14 months.

Releasing fish is carefully planned to avoid interaction and competition with the wild fish already in the stream, river, or lake.

The ideal wild salmon and trout *habitat* is a fast-flowing stream away from human *habitation.* The water is cold, clear, and pollution-free. It meanders at varying depths over gravel and rocks, churns around boulders and fallen trees, and now and then swirls into quiet backwater pools.

Gravel, rocks, and boulders are an essential element, as they break up the flow and allow the water to fill with oxygen. The *aerated* flows serve to cleanse salmon eggs of *silt* and waste. Rocks also provide a breeding ground for the *aquatic* insects on which young salmon feed. And boulders create whitewater areas where juvenile fish can hide from natural enemies.

The streamside - or *riparian zone* - is a critical habitat feature. Ideally, the banks are undercut by the current, forming small jutting ledges. Undercut banks offer shade and protection for young fish. At the water's edge is a lush undergrowth of shrubs, plants, and grasses and a thick canopy of overhanging *vegetation.* Root systems act as an anchor to prevent soil erosion. Vegetation stabilizes water levels by alternately soaking up rainfall and releasing moisture. Thick summer *foliage* over the stream keeps the waters shaded and cool.

Fallen trees in the stream actually help to trap gravel and create perfect spawning sites. Water flowing over the logs scours out deep, slow-flowing pools that serve as natural rearing areas.

Stream Habitats

Riffles are portions of a stream that are relatively shallow, fast and steep. The often have bedrock, cobbles, and sometimes boulders. In mountain streams, boulders and cobbles create *rapids* and *cascades.* As water rushes over these areas, the choppiness of the surface reflects the roughness of the bottom. Fish expend large amounts of energy to stay in riffle areas.

The sun shines through shallow riffle water and encourages *algae* to grow on the tops of rocks.

The ideal salmon and trout habitat has cold clear water, which is churned over rocks and logs, and quieted in shaded pools.

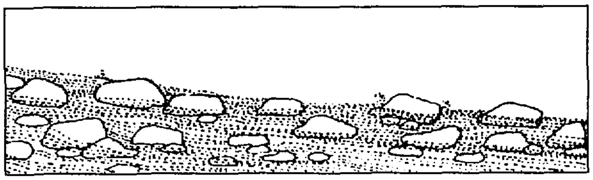
The gravel and cobble bottom of a riffle provides nooks and crannies for insect *larvae* to live and feed. A rough cobble bottom slows water just above it, providing breaks, holding places and shelter for fish. Some organic material is scoured from the rocks and sent downstream to be used as food by aquatic organisms.

Pools are areas of deeper and slower water above and below riffles, and are important feeding and resting areas for fish. They are generally formed around stream bends or obstructions such as logs, root wads or boulders.

Pools contain three distinct areas: head, body, and tailout. Each part of a pool meets different fish needs. *Turbulent* water at the head collects food carried from upstream, provides cover and more dissolved oxygen.

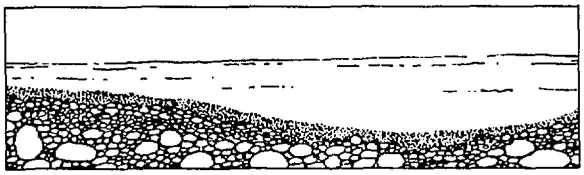
Riffles are fast-flowing steep and shallow areas

Riffles



Riffles are fast-flowing steep and shallow areas that provide nooks for aquatic insects, places for fish to rest, and a surface area for algae to grow.

Pools



Pools are deep areas of slow moving water which collect drifting materials, and provide a rest area for fish.

and nutrients needed by plants. Drifting fine organic particles provide food for *invertebrates.* Gravel collects in pool tailouts, providing spawning areas for fish. Less energy is required for fish to wait in pools for drifting insects.

The ratio of pools to riffles in a stream determines the stream's ability to provide suitable fish habitat. In general, a one-to-one (50% pools, 50% riffles) pool-to-riffle ratio is optimum fish habitat.

Lateral habitats along the edges of streams are areas of quieter, shallow water. Boulders, root wads or logs can form small pools (pocket water or *eddies*). Fine sediments and gravels are found here. Accumulations of organic materials provide rich food sources for invertebrates. These areas provide important rearing habitat for young fish. Sculpins and crayfish wait for prey in pools near boulders or rootwads.

Though the physical characteristics of a stream largely determine its ability to produce fish, survival of each new hatch is controlled by many *environmental* factors. As stated earlier, a relatively stable water flow that is free of pollutants is important for a productive stream.

Salmonids use a variety of streams. Although each species has its own specific habitat requirements, some generalizations can be made:

Spawning Habitat

Successful spawning and development from egg to fry stages requires the following:

- Absence of barriers to upstream migration of adults
- Spawning areas, usually in a riffle, with stable, porous, sediment-free gravel of the proper size and type
- A pool-to-riffle ratio that provides spawning areas and escape cover close to each other
- Constant flow of cool, well-oxygenated water through the spawning gravel.

For anadromous fish production to occur, fish must be able to move upstream to spawning areas. Log jams and other barriers can prevent this from happening. Fish can injure themselves trying to jump barriers or become weak and exhausted, reducing chances for successful spawning.

In an ideal spawning habitat, cool, well-oxygenated water flows freely through the gravel areas. For this to happen, spawning beds must be relatively sediment-free. The cleanest gravel is usually found at the tailout, or downstream end, of a pool. The streambed should be stable enough to withstand heavy flooding, which could disturb spawning beds.

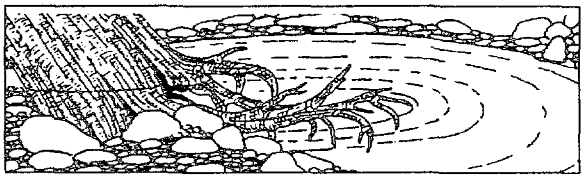
Rearing Habitat

As young fry leave the gravel to seek food, they are vulnerable to predators. High stream velocities can carry fry far downstream or strand them in floodplain pools. To enhance the survival of fry, pools for rearing as well as cover for temperature regulation and hiding should be close to each other.

Lateral areas along the edges of the stream make up quiet shallow waters which are important for rearing young fish and stream organisms. Productive juvenile rearing habitat, for both natural and hatchery fingerlings, should exhibit the following characteristics:

- Low to moderate stream gradient and velocity
- Diversity of pool and riffle habitat
- Variety of substrate types to provide habitat for juvenile fish and fish food organisms
- Undercut banks, stable natural debris, and overhanging vegetation to provide protection for juvenile fish, and leaf litter for aquatic insect production

Lateral Habitat



Lateral areas along the edges of the stream make up quiet shallow waters which are important for rearing young fish and stream organisms.

- Sufficient nutrients to promote algal growth and decomposition of organic material

As young salmonids grow, they seek progressively higher velocities, often moving from the edge of a stream to midstream to take advantage of increased insect drift. Facing upstream or into the current allows a fish to conserve energy while watching for food drifting downstream.

In winter, all species seek areas of lower water velocity to conserve energy while food and growing conditions are poor.

Habitat Preferences

Though basic requirements are the same, salmonid species differ in types of habitat they use. For example, juvenile coho choose pool areas of moderate velocity in summer. They prefer eddies or backwaters near an undercut bank, root wad or log. In winter, they are found in slow, deep pools or side channel areas, seeking cover under rocks, logs and debris.

During winter, spring chinook use riparian edges, where vegetation has grown over a stream, providing cover and shelter. Streambanks must be covered with vegetation to provide this feature. Broken or degraded streambanks do not provide suitable winter habitat for young fish. Rearing densities can increase dramatically where good streambank recovery has occurred.

Juvenile steelhead spend from one to three years in fresh water, and their habitat needs must be considered throughout that time. In the first summer after hatching, young steelhead stay in relatively shallow, cobble-bottomed areas at the tail of a pool or shallow riffle. In winter, they hide under large boulders in shallow riffle areas.

Older steelhead juveniles prefer the heads of pools and riffles with large boulder substrate and woody cover in the summer. The turbulence created by this substrate is also important cover in these areas. During winter, older steelhead juveniles are found in pools, near streamside cover and under debris, logs or boulders.

Trout habitat requirements are similar to those of steelhead, and although chinook juveniles tend to rear in large streams, their requirements parallel those of coho.

Limiting Factors

Limiting factors must be considered for all phases of a salmonid's life cycle. The quantity and quality of riffle areas and spawning gravels in a stream are limiting factors for spawning production. The quantity and quality of juvenile nursery areas or pools is a limiting factor for rearing juvenile salmonids and producing smolts ready for migration to the ocean.

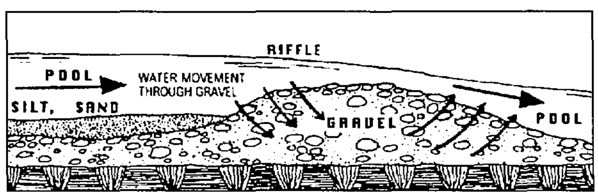
When spawning grounds are limited, excessive numbers of adults in spawning beds dislodge previously deposited eggs. If too many juveniles exist in rearing areas, competition for food and space force some to move into less suitable areas. These areas may have limited food and shelter from predators.

These limiting factors establish the salmonid *carrying capacity* of a stream. Within the limits of the habitat available, salmonid populations fluctuate from year to year because of varying environmental factors.

Streamflow, for example, causes wide variations in survival and production of coastal salmonid populations. Extended low flows may keep adults from moving into streams, drain their limited energy reserves and affect upstream distribution and spawning success. High winter flows can destroy eggs and sac fry by scouring spawning beds or depositing sediments. Low stream flows during winter incubation periods can cause exposure and freezing of spawning beds. Low summer flows often not only increase temperatures, but also reduce rearing areas for juveniles.

Stream temperatures may also affect survival indirectly. Abnormally high temperature conditions during migration have contributed to outbreaks of disease among adults, causing them to die before spawning. High winter temperatures increase the rate of development from egg to fry, and may cause fry to emerge from the gravel before the spring increase in food supplies.

Water Movement



A healthy stream will percolate water through the gravel bed, carrying oxygen and nutrients to fish eggs, fish fry, and other aquatic organisms.

A critical issue in eastern Washington is the buildup in streams of heavy ice (anchor ice). Anchor ice can trap fish in pockets where they freeze and die. Healthy riparian systems and stable streambanks help to reduce heavy anchor ice and winter mortality of juvenile fish.

Recommended habitat conditions

As a stream is surveyed and analyzed, habitat needs and limitations must be considered to ensure the best possible management of the resource. Following is a list of other conditions that may improve the quality of fish habitat in streams. This list was prepared by the Riparian Habitat Subcommittee of the Oregon and Washington Interagency Wildlife Committee. Included is an explanation of how each contributes to salmonid health and survival.

1. Between 60 and 100 percent of a stream surface should be shaded from June to September during the hours of 10:00 A.M. to 4:00 P.M.

◈ Solar radiation is greatest during this season and time of day. Streamside vegetation provides shade to keep water temperatures from becoming lethal during hot summer months.

2. Streambank vegetation is also important habitat for terrestrial insects and is the main nutrient source for aquatic insects. Shade is most important on small streams (less than 50 feet wide). Water depth and turbulence help compensate for the lack of shade on large streams.

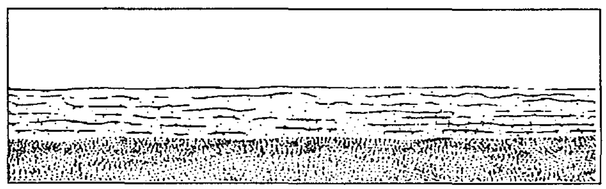
◈ These are both important sources of fish food.

3. Stream banks should have 80 percent or more of their total linear distance in a stable condition. Stable well-vegetated streambanks help maintain stream channel integrity. They provide cover for fish and reduce temperature increases from solar radiation. In winter, they keep water temperatures slightly warmer, reducing ice buildup and decreasing winter mortality of juvenile fish. Sediments from streambanks are reduced, protecting the water quality of the entire system. Vegetation reduces bank erosion and helps hold the soil in place. Sediments are trapped and mature grasses and forbs form a strong sod.

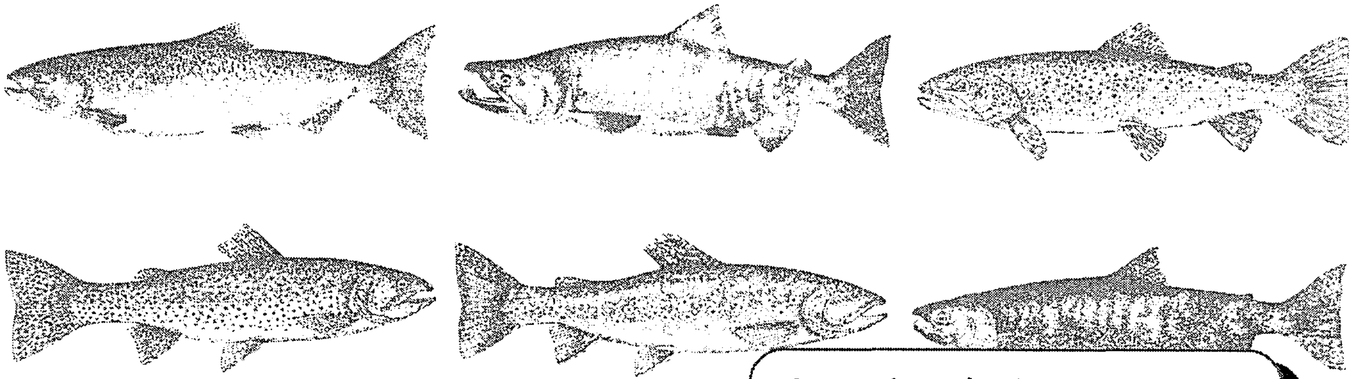
4. No more than 15 percent of stream substrate should be covered by inorganic sediment.

◈ Aquatic insects, developing salmonid eggs and recently hatched fry still in the gravel depend on a continuous supply of cool, oxygen-rich water for survival. Fine sediments in large amounts clog the spaces between gravels. This prevents water from percolating through and causes fish and insect mortality. If pools are filled with sediments, rearing and hiding habitat is reduced or eliminated.

Fine Sediment



Fine sediments clog the spaces between the gravel and prevents oxygen-rich waters from percolating through.

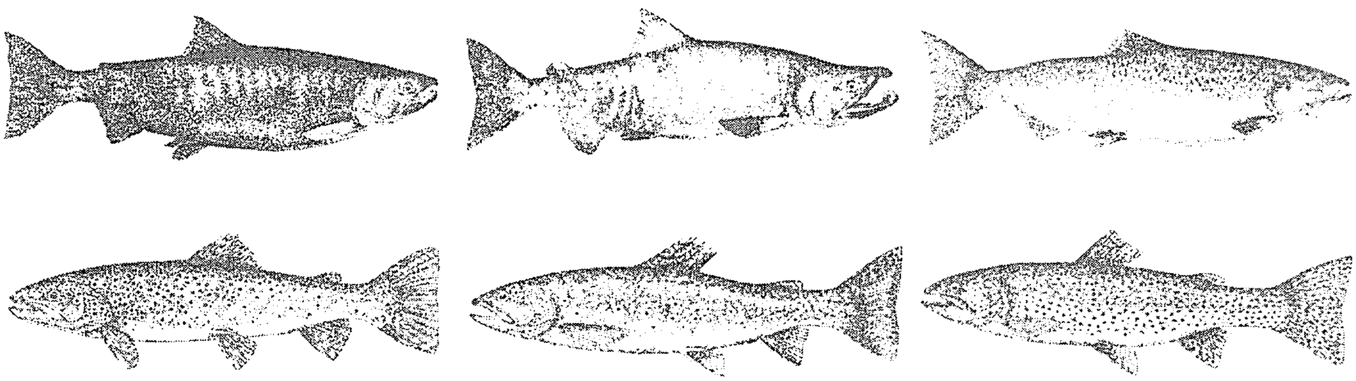


Learning Activities:

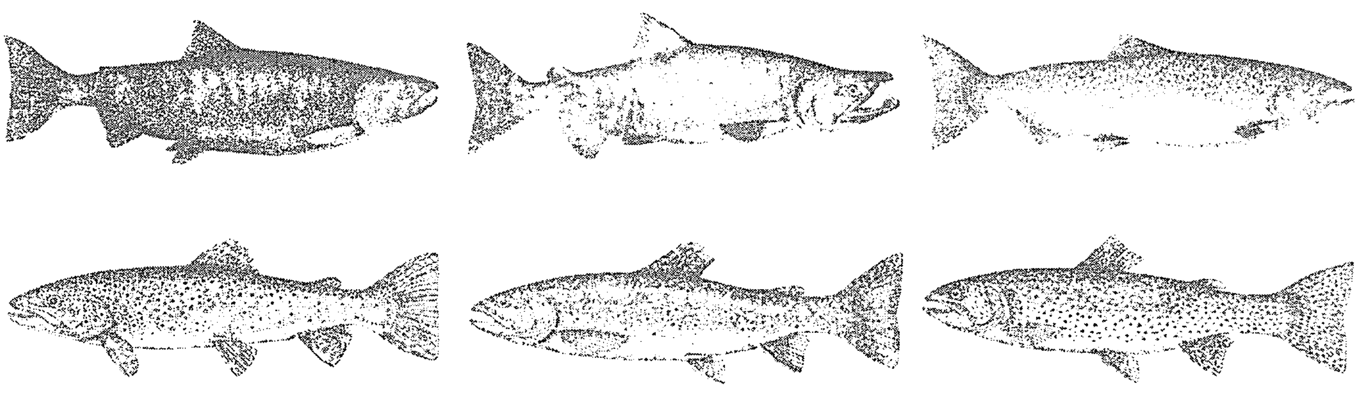
Home Wet Home

Riffles and Pools

Unit 4



Fish Habitat Needs



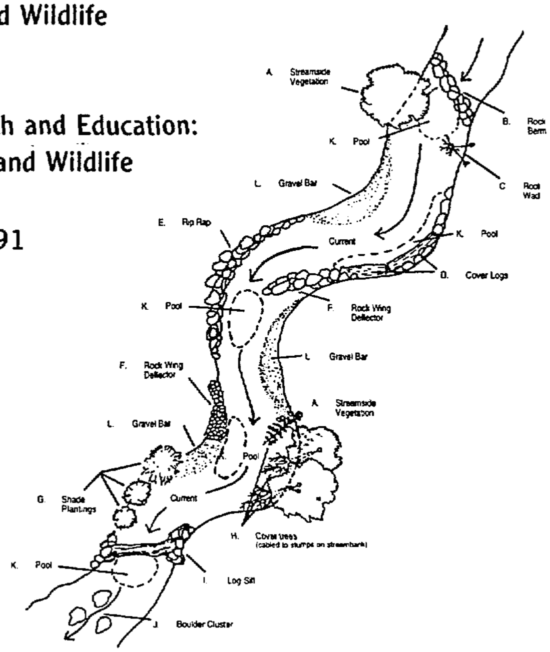
Unit 4

Home Wet Home

This activity was adapted from:

The Stream Scene
Watersheds, Wildlife and People
by Patty (Farthing) Bowers et al
Oregon Department of Fish and Wildlife
1990

For more information, contact Outreach and Education:
Washington Department of Fish and Wildlife
600 Capital Way N
Olympia WA 98501-1091



Key Concepts:

- Salmonids need certain habitat components to live in a stream.
- Structures in and near streams have benefits for fish.

Teaching Information

Students should read the background material provided in the activity, analyze the stream diagram and describe how each item noted develops or provides suitable fish habitat. This activity fosters ideal small group work.

Once students have completed the activity, visit an actual stream where they can identify the stream components used in the activity. Since most hatcheries have streams on or next to the hatchery grounds, this could be done during the hatchery visit.

Materials

Copies of student sheets (Home Wet Home...)

A. Streamside Vegetation
Provides cover in addition to shade for temperature regulation. In autumn, leaves drop into stream and eventually provide food for invertebrates that are eaten by fish.

B. Rock Berm
Slows the water, traps gravel for spawning, and creates pools.

C. Root Wad
Provides shade, cover, and resting areas, and produces spot scouring.

D. Cover Logs
Provides shade, cover, and resting areas, and produces spot scouring.

E. Rip Rap (rocks and vegetation)
Protects banks from erosion

F. Rock Wing Deflector
Redirects water flow, causes gravel deposition, and creates pools or pocket water and resting areas.

G. Shade Plantings
Provides shade for water temperature regulation and food for invertebrates when leaves fall

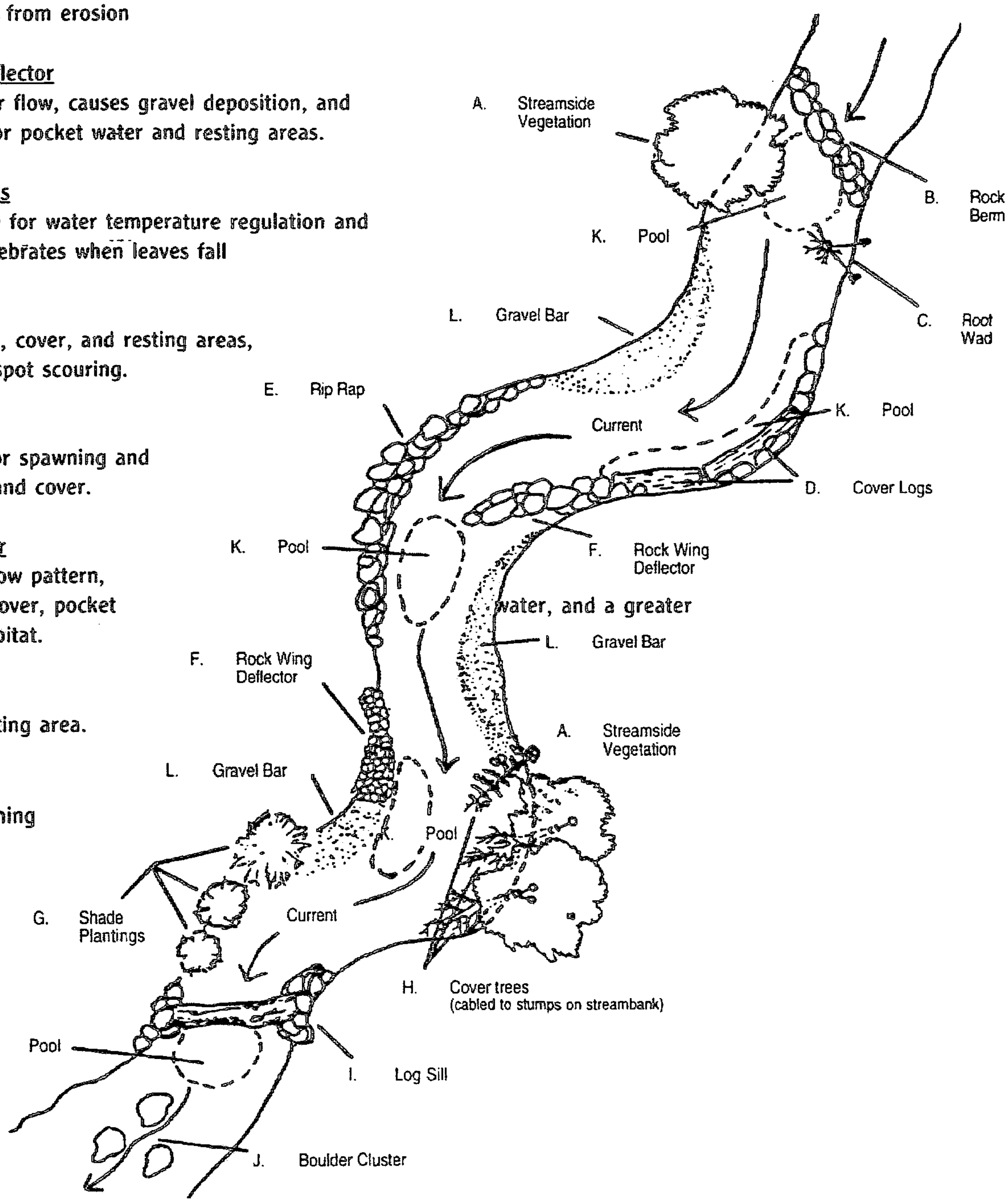
H. Cover Tree
Provides shade, cover, and resting areas, and produces spot scouring.

I. Log Sill
Traps gravel for spawning and creates pools and cover.

J. Boulder Cluster
Changes the flow pattern, and provides cover, pocket water, and a greater diversity of habitat.

K. Pool
Provides a resting area.

L. Gravel Bar
Provides spawning habitat.



HOME WET HOME

STUDENT ACTIVITY

Do you know...

Salmon and trout (salmonids) are important to anglers. Salmonids are also important to biologists because their presence helps indicate the health of the stream in which they live.

Salmonids are one of the first organisms to be affected if their watery home starts to change or if their habitat is unsuitable. Biologists refer to sensitive animals like salmonids as "indicator" species.

Because salmonids are so significant, fish biologists have developed many ways to improve stream habitat to enhance fish survival. In some cases, biologists can produce a fishery where none was previously found.

The ecological requirements of salmonids are:

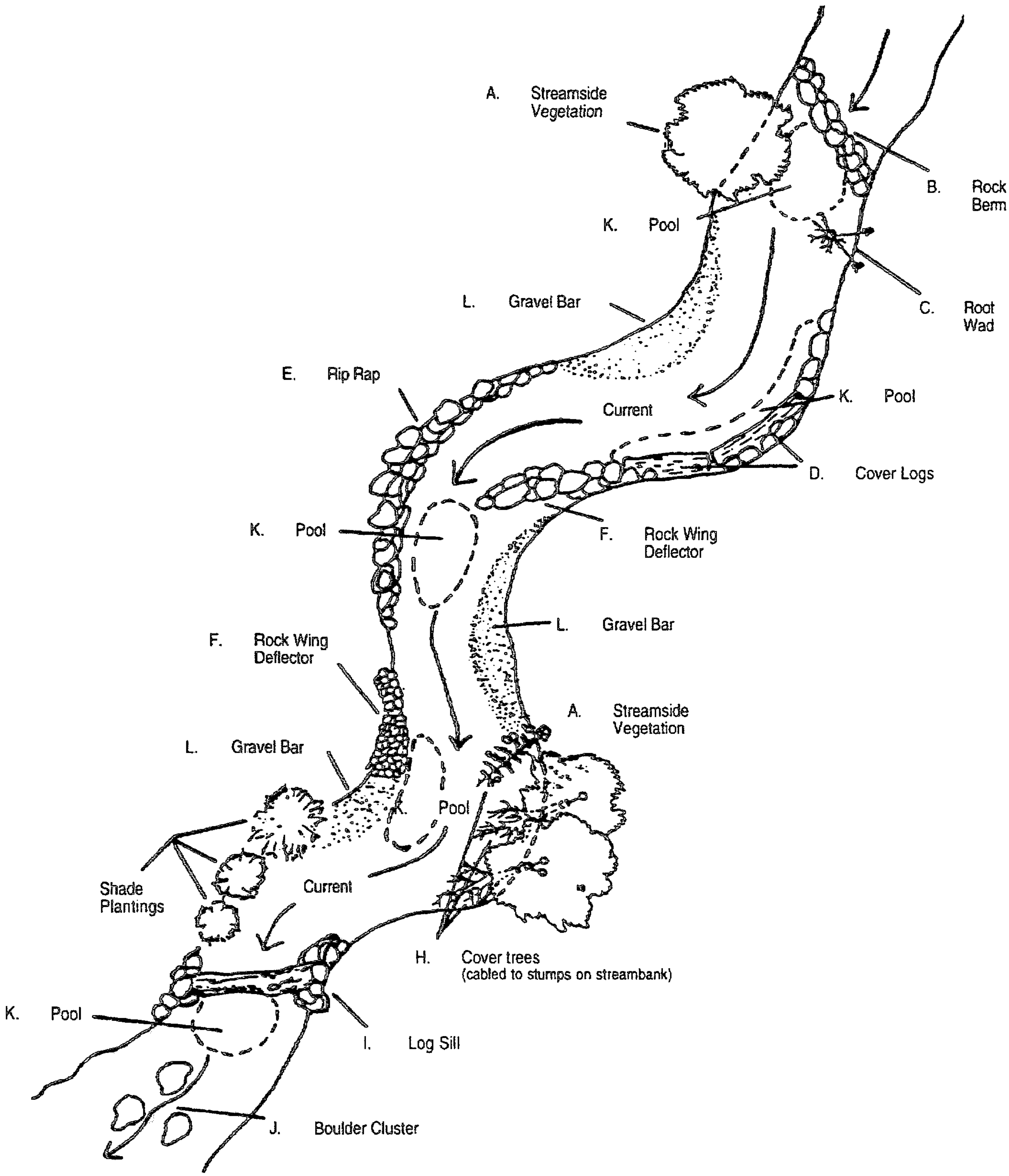
- Cool, clear, well-oxygenated water
- Sections of gravel bottom for spawning
- Occasional pools for feeding and resting
- Adequate food (aquatic and terrestrial insects, the latter usually falling from streamside vegetation)
- Cover for protection from predators

Now it's your turn...

The figure on the next page shows several ways a stream can be improved to provide salmonid habitat. Each structure has been used to meet the special needs of these sensitive fish. Next to each feature, describe the contribution it will make towards creating a healthy and comfortable environment for fish.

Home Wet Home

Student Page



Unit 4

Riffles & Pools

This activity was adapted from:

The Stream Scene
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For more information, contact Outreach & Education:
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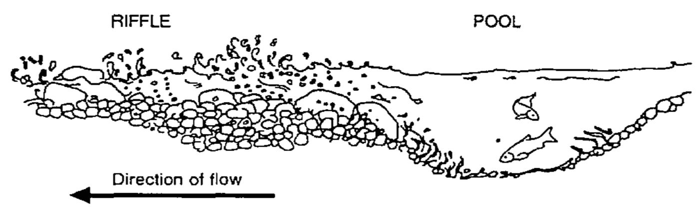
Key Concept:



- Riffles and pools are necessary to meet the needs of salmon and trout.

Teaching Information

Students will apply concepts learned about salmonid habitat needs during their life cycle by reading a short informational piece and completing a worksheet analyzing riffles and pools.

Materials

Copies of student sheets (Riffles and Pools...)

Answers

1) Will the dissolved oxygen concentration be higher at the bottom of the pools or theriffles?

Generally, riffles should have more dissolved oxygen than pools, as a result of air and water mixing in the more turbulent water of the riffles.

2) Which would give more shelter or protection to salmonid eggs, pools or riffles? Why?

Riffles. The gravel usually found in the riffles would protect the eggs. Pools are more likely to have collections of fine sediments rather than gravels.

3) What happens to aquatic insect larvae as the current enters a pool and slows down?

They settle to the bottom or are eaten by predators (other insects or fish).

4) Where would be the best place for salmonid fry to wait for lunch? Why?

At the head of a pool or tail of a riffle. To be first in line for drifting insects.

5) Where would salmonid fry use the most energy catching food? Why?

On the riffles. It is harder to maintain position in the faster water of a riffle.

6) Chum salmon fry only spend as much time in the stream as it takes to get to the ocean (one day to three weeks). Coho salmon juveniles live for a year in the stream before heading to the ocean. Steelhead and sea-run cutthroat juveniles live up to three years in the stream before heading to the ocean. If a stream has good spawning habitat but not much rearing habitat, will it be more likely to support chum or coho salmon fry? Why?

Chum. Because chum salmon fry immediately begin moving toward the sea; they do not need extensive rearing habitat in the stream.

7) If a stream has both spawning and rearing habitat, which salmonid species might it support? Why?

Both. Coho salmon fry could live there because of the availability of rearing habitat.

Riffles and Pools

Student Activity

Do you know...

All Pacific salmon are anadromous. They begin their lives in freshwater, migrate to the ocean, and return to freshwater to spawn and die. Salmon are important to Oregon s commercial and recreational fisheries.

The salmon life cycle begins when eggs are deposited and fertilized in the gravel of cool, clean rivers and streams. Until they hatch, the cold (40 to 65 F) water flowing through the gravel itself protects the eggs from predators.

In late winter or spring, the eggs hatch. The young fish, called sac fry, are less than one inch long. They still depend on cold, well oxygenated water for their survival and stay in the gravel for shelter. During this time they are fed from a yolk sac that protrudes from their bellies. As the yolk sacs are used up, the fish, now called fry, emerge from the gravel in late spring or summer, approximately one to three months after hatching.

The fry of some species head directly for the sea, but others might stay in freshwater for a few months to a few years. Fry depend on streamside vegetation and turbulent water at the beginning of pools for cover. Aquatic invertebrates provide most of the food for salmon fry.

When they are ready to migrate to the sea, they go through smoltification, a physiological change, and are known as smolts. Smolting prepares them for life in saltwater. Once in the sea they spend up to five years, depending upon the species, feeding and growing before they are ready to return to fresh water.

Salmon return to spawn in the same stream where they hatched. No one knows for certain how they find their way back to the same stream, although one theory is that they can smell or actually taste the water chemistry of their home stream. When they enter fresh water, salmon stop feeding. Their journey upriver is made on the energy stored while living in the ocean.

Salmon spawning beds are generally found in the shallow headwaters of a stream and other suitable areas in the mainstems of streams. Weeks or months after they have reached their gravel beds, the female digs a nest, or redd. Here she deposits up to 5,000 eggs. The male fertilizes the eggs by covering them with milt, a milky substance that contains the sperm. The female finishes the spawning process by covering the eggs with gravel. After spawning, the salmon s life is finished. Within a short time, it dies and the carcass drifts downstream, decaying and contributing its nutrients to the stream from which it originally came.

Note: Trout, with the exception of steelhead and some cutthroat, are not anadromous. However, they are closely related to salmon and have similar needs during their time in fresh water.

Now it's your turn...

Think about the last time you were at a stream. Let's review some of the things you might have observed or remember about good fish habitat.

- What is dissolved oxygen? Why is it important to streams and fish?

- What are pools? What are riffles? What kind of habitat do they provide for fish? Since salmonids spawn in gravel, and gravel is usually found in riffles, riffles are often called "spawning habitat." The amount of gravel and riffles in a stream (if of good quality) determine the number of salmonids that can spawn there. The places in a stream that provide a place to eat, a place to rest, and a place to hide are called "rearing habitat."

- Stoneflies and other aquatic insect larvae live on, around, and under rocks in the bottom of a stream. Some are shredders, feeding on decomposing leaves. Others are scrapers, grazing on algae growing on the rocks. Still others are predators that eat other invertebrates. To move to new rocks these aquatic insects detach themselves and drift downstream. Because they are carried by the current, most are found where the current is strongest. Salmonid fry eat these larvae (or floating sandwiches) as they drift past.

- Look carefully at the drawings.

- Answer the questions based on your own experience and the introductory information in this exercise.

QUESTIONS ON RIFFLES AND POOLS

1. Will the dissolved oxygen concentration be higher at the bottom of the pools or the riffles?

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2. Which would give more shelter or protection to salmonid eggs, pools or riffles? Why?

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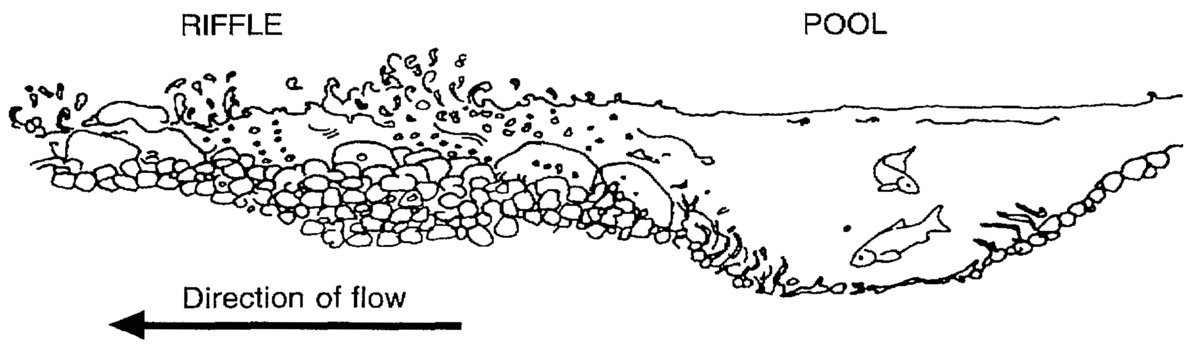
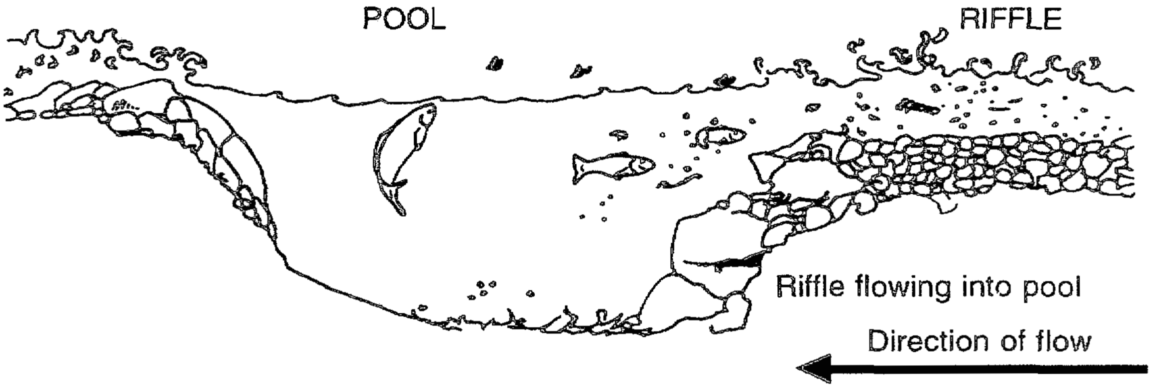
Refer to this diagram as you answer questions 1 & 2.



Refer to this diagram as you answer questions 3 - 5.



3. What happens to aquatic insect larvae as the current enters a pool and slows down?

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4. Where would be the best place for salmonid fry to wait for lunch? Why?

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5. Where would salmonid fry use the most energy catching food? Why?

6. Chum fry only spend as much time in the stream as it takes to get to the ocean (one day to three weeks). Coho salmon juveniles live for a year in the stream before heading to the ocean. Steelhead and sea-run cutthroat juveniles live up to three years in the stream before heading to the ocean. If a stream has good spawning habitat but not much rearing habitat, will it be more likely to support chum or coho salmon fry? Why?

7. If a stream has both spawning and rearing habitat, which salmonid species might it support? Why?