ART BASED NATURE EDUCATION: EXPLORING STEELHEAD

A PROJECT FUNDED BY
METRO REGIONAL PARKS AND GREENSPACES
AND
THE FRIENDS OF TRYON CREEK STATE PARK

ACKNOWLEDGEMENTS

Project Coordinator:	*Carlye Wilder*
Project Manager:	*Stephanie Wagner*
Artist:	*Susan Leeb*
Teachers:	*Pam Stempson, Grace Harrington, Kathy Garland, Jan Maier, Karen Bonofiglio, Debi Baurle, and Ruth Herrington*
Creative Participants:	*Second graders at Lake Grove Elementary, Third Graders at Brookwood Elementary, Fifth graders at Hayhurst Elementary*
Volunteers:	*Nature guides from the Friends of Tryon Creek State Park and parent volunteers*
In kind :	*Oregon State Parks, the Friends of Tryon Creek State Park, Oregon Trout, City of Portland BES*
Others:	*Susan Duncan, Jennifer Thompson, Dakota Inyoswan and countless others*

Thank you to Metro Parks and Greenspaces for funding this project.

METRO PARKS AND GREENSPACES
THE FRIENDS OF TRYON CREEK
ART BASED NATURE EDUCATION
FINAL SUMMARY

OVERVIEW OF ART BASED NATURE EDUCATION

The Friends of Tryon Creek State Park received a grant for $7,500 in the fall from Metro Parks and Greenspaces to coordinate an Art Based Nature Education program. The Friends' focus of this program was to give elementary children in the metro area extended exposure to natural history through the arts. Through the creation of these projects, the goal was to connect the child to their natural environment and have some real understanding of the living earth.

The committee overseeing Art Based Nature Education decided to focus on Steelhead for many reasons. Tryon Creek State Park has a winter and a spring run of steelhead; an ideal habitat for children to explore right in their community. Secondly, since steelhead are an indicator species they are a key animal in the local ecosystem. Finally, with steelhead on the threatened species list there is immediacy in getting to understand this local animal. We asked a local artist to create a steelhead sculpture prototype for a children's art project, so that they could intimately understand a steelhead through creating it.

In addition to the actual art project, this program includes outdoor investigations, natural history activities and nature journaling. This provides many inroads to understanding steelhead for the children and honor many learning styles and interests. These different approaches to understanding steelhead meet existing benchmark standards and the variety of approaches makes this program accessible to teachers.

PROGRAM OUTLINE AND GOALS

In planning this program we wanted to keep in mind the teachers and their pivotal role. Since the children spend the most time with their teachers and we would only be out a few times, it seemed important to make sure that they had a basic understanding of steelhead and their lives. This way reinforcement would come naturally in the classroom and children's questions could spark classroom conversation. To foster this approach, the goal was to create three packets for the teachers: Packet one--Foundations for Understanding Steelhead, packet two--A description of each class that would take place and the goals of each along with a list of corresponding benchmarks and Packet three--extension activities to reinforce each class and to incubate knowledge between classes.

Once teachers had a chance to digest these packets, then exploration with the children could begin. Our goals for the children included becoming connected to the steelhead by visiting habitat at Tryon Creek, gaining an understanding of fish morphology by creating steelhead sculptures, and finally visiting a site near their school. The project includes a total of six visits, four in the classroom and two outdoor adventures. Below is a brief summary of the goals of the six classes.

The six classes are centered on the following goal: **Steelhead are born to migrate, find their way home and spawn. Everything about steelhead--their structure, the way they move, their coloring and their dominant senses all work together to accomplish this migration and return.**

Build a Healthy Stream--Fieldtrip to Tryon Creek State Park
Children will:
- Walk down and explore steelhead habitat
- Find out what steelhead need to be healthy
- Take water quality samples: test for DO, temperature and Ph.
- Stream sketch
- Create a healthy stream in the Nature Center

Class One--Bones, muscles and internal structure
Children will:
- Learn about fish structure
- Begin their art project--make salmon bones

Class Two--Senses
Children will:
- Add lateral line and eyes to their creation
- Explore chemoreception and mechanoreception
- Create a story about messages taken in through the lateral line

Class Three--External structure
Children will:
- Add scales and countershading
- Explore aging fish scales
- Be introduced to camouflage

Class Four--Habitat
Children will:
- Create a habitat for their hanging project
- Create macroinvertebrates for their fish

Explore Your Stream--at a stream near the school
Children will:
- Learn about migration
- Find out what lives in their stream
- Compare water quality with Tryon Creek

These goals were to be monitored by nature journaling, completion of the art project and a final parent presentation. Ultimately, our goal was to create a curriculum to extend this program into the future. Our intention was to create a complete curriculum for teachers so that they could initiate this project in their own classrooms and use the staff at Tryon Creek for natural history support and to lead the fieldtrip portion of the project.

THE PROCESS

After receiving the grant, selected classrooms were contacted. Four classrooms out in Hillsboro were chosen, two from Hayhurst in southwest Portland and one classroom from Lake Grove Elementary, for a total of 181 students. The classroom dates were set for April and May. Scheduling seemed very difficult for teachers. Some had a fairly rigid schedule that had already been determined in the fall. All were struggling with preparation and administration of testing that was scheduled for April. None of the teachers were able to give us much more than an hour for each classroom session. Each of the teachers had high enthusiasm for the project, though and made adjustments to be participants.

In January, local artist Susan Leeb was approached to prepare a steelhead sculpture prototype. As the coordinator I began research on steelhead and started to put together the first teacher packet. After this was complete, it was soon apparent that beginning work on putting the actual classes together and further communication with the teachers about what was going to take place could not happen until the prototype was complete and agreed anon. The sculpture itself was to drive most of the project.

In February, the second packet was complete as well as the content, materials and journal pages for the habitat-fieldtrip portion of the project. At this time Megan Lockett, a volunteer nature guide at the park brought in the nature journal idea that we used with the children. It was very utilitarian, natural and easy for the children to put together. Supplies were gathered for them at this time. The sculpture prototype had not been decided upon, though several differing prototypes had been created.

March was a pivotal month. The prototype was complete, agreed upon and met the criteria. Susan Leeb worked on putting together a materials list, art vocabulary list, and instructions for creating the steelhead sculpture. I worked on the classes, gathering supplies, journal pages and extension activities for teachers. Teachers were working on lining up parent volunteers, arranging for art and storage space and preparing their students for the project. During this month I also met with the teachers at their schools several times to introduce them to the project and to work out logistics.

During April and May, the fieldtrips to Tryon Creek and the four classroom sessions took place. In June, the parent presentations and Explore Your Stream were complete. During these months, a continual gathering of supplies, teaching of classes and checking in with the teachers and parent volunteers were the priority.

CHALLENGES AND SUCCESSES

Challenges and successes are addressed by grade level.

Celebration was the theme with the second graders at Lake Grove Elementary. They enthusiastically completed the fieldtrip to Tryon Creek and were very proud when the Oregonian followed them down to the creek to take pictures and ask them questions. The article hangs on their classroom wall. Since this was the smallest group we worked with and the last, they probably had the richest experience. We even added an extra class for them so that they could fully explore fins and movement of steelhead. The children brought books about fish they found and shared their favorites. Enthusiasm about fish was apparent whenever I visited this classroom.

Our challenges had to do with the time constraints. This classroom had little time outside of class to do extension activities or journaling. Everything we did was within the five classroom sessions. All fish were completed and the journals that were completed in class showed a real understanding of steelhead morphology and water quality.

Our challenges with the third graders out at Brookwood Elementary out in Hillsboro were many, but we found creative ways to overcome them. One of our greatest challenges was the size: over one hundred students. Due to distance of the school from the park and the time availability of the classrooms, we chose to teach the classes all together in the cafeteria. I taught the art and natural history portion by myself that first time. After that we tried art, natural history, and storytelling stations that the children could rotate through. For the last class we had the children stay in their classrooms, and I rotated through them teaching. Making these adjustments created very successful classes.

Successes at Brookwood definitely should be handed to the teachers, students and parent volunteers. Teachers at this school became very creative and created extension to fit their own classroom's needs. Many are very original and will be used with permission in the curriculum. Journals were more than complete, some with stories that illustrated a real understanding of the fragile lives of salmon. More than twelve parent volunteers helped out during the art portion of the project, most more than once. Without this kind of teamwork it would be very difficult for one hundred children have a quality experience.

Hayhurst Elementary in southwest Portland was at a definite advantage. The sixty fifth grade students there had been testing the water quality down at Vermont Creek near their school once a month since the fall. They were already beginning to celebrate their successes and were ready for the next step. They had begun nature journals previously and the activities we had planned fit in nicely. The children in these classes seemed particularly interested in the journaling and the natural history portion and excelled in these areas. They persisted, completed the steelhead sculptures, and presented them to the parents in May. These students showed a very solid grasp of what makes a stream healthy and the particulars of their home stream. They showed a new level of awareness and interest for what might be living in their stream.

EVALUATION

Evaluation can be divided into two sections: evaluation of program development, and evaluation of what the children learned. This will be investigated from our perspective and the perspective of the teachers. Evaluation of implementation can be found under the heading "Process".

In reviewing program development, it is apparent that the Friends accomplished a great deal. What is also apparent is that we attempted to accomplish what could have been the equivalent of two grants. The development of the teacher packets was enormously successful, especially the first one. Exit interviews with the teachers revealed that Foundations for Understanding Steelhead gave the teachers the background they needed to lead the children to successfully completing their projects. Packet two addressed corresponding benchmarks. Teachers remarked that this was necessary in securing support from the principals at their schools. They also offered that they needed to know exactly which parts of the project were going to correspond with the benchmarks. Our approach to benchmarks was fairly ambitious and the children excelled at between six and eight of them. This is quite an accomplishment for six hours of class.

The third packet was to provide extension activities for teachers to support what the children were learning during the art portion. Since every classroom situation and grade level was so different, this became an informal process. After hearing teacher requests, it was much more effective to address them individually and help them find the extension activities that worked best for them, then to put together a formal packet. Further, these extension activities will work well in the curriculum. Some resourceful teachers even designed their own creative extension activities and have given us permission to use them in an upcoming curriculum.

Teachers seemed very pleased about the content of what the children were learning and what they were assimilating. After reading the children's nature journals I would have to agree. The information that the children seemed to absorb the most was: What it takes to make steelhead habitat healthy and how steelhead take information in through their senses. One teacher commented that she felt their learning had just begun about fish, because the students had so many questions. Another teacher mentioned, " I just know our children look up at these fish they have created and say 'wow'. I just know they will never look at fish the same again." The fish sculptures the children created are quite amazing. At the end of the project it was obvious that the children had become intimate with the life and workings of steelhead.

FUTURE PLANS

This program was quite a success from the view of the Friends, the schools involved and the community. In addition, the Friends of Tryon Creek feel a responsibility to continue educating the public about steelhead and water quality. Because of this, we would like to extend this program into the future.

Our first step would be to create a curriculum around the Art Based Nature Education steelhead program. The curriculum is already in the works, but the Friends of Tryon Creek may seek further grants to make them the highest quality and offer them at a low cost or free to teachers who are interested. The teachers would be able to pick up the curriculum and teach the art portion without much assistance. The Friends of Tryon Creek would be here for natural history support and habitat fieldtrips.

An inservice would be part of this curriculum offering and would give teachers a solid foundation for understanding steelhead and their habitat. In addition, the teachers would actually create a steelhead sculpture themselves, giving them an excellent understanding of the materials and a first hand exposure to morphology. The inservice would be offered in the winter through Portland State University.

Eventually, our goal is to market this program to the schools, have the teachers become excited about integrating nature education into their classrooms and ultimately have the children become connected to their local areas and the incredible life there. The children who become connected to the living earth now will perhaps work to protect it when they become older.

ART BASED NATURE EDUCATION
PROJECT SUPERVISION

MONTH	HOURS	TASKS
December 1999	16	produce project outline, discuss research topics coordinate classroom participation
January 2000	20	provide back ground material on fish biology and morphology, brainstorm art project and materials
February 2000	25	review and edit handouts for teachers, develop Create A Healthy Stream format, facilitate final art project
March 2000	32	present Create A Healthy Stream field trip classes, facilitate final art project, review materials
April 2000	33	present Create A Healthy Stream field trip classes, facilitate final art project, review materials, assist with Brookwood lateral line presentation
May 2000	6	review final projects
June 2000	16	review final report, prepare financial report
TOTAL	148	COST @ $15.00/HR = $2,220

ART BASED NATURE EDUCATION
PROJECT COORDINATOR

MONTH	HOURS	TASKS
December 1999	80	research, letters, teacher coordination
January 2000	152	research, meeting Packet One
February 2000	160	meeting with artist, teachers, Packet Two, Create A Healthy Stream, research
March 2000	120	develop class curriculum, gather, buy and prepare materials, develop nature journal prototype
April 2000	88	prepare and teach classes, continue to gather, buy and prepare materials, consult with teachers, develop extention activities
May 2000	88	prepare and teach classes, continue to gather, buy and prepare materials, consult with teachers, develop extention activities
June 2000	96	help teachers prepare for parent night and Explore Your Stream, exit interviews, preparation for Metro presentation, prepare final report
TOTAL	784	COST @ $11.00/HR = $8,228

728.00

VOLUNTEER SIGN UP SHEET

Date ____________________

Place Tryon Creek State Park

PROJECT NAME Nature Explorations through Art

NAME	SIGNATURE	DATE	TIME/HOURS WORKED
Cassie Platz	on file	3/30	2.5
Chris Shaeffer	"	3/30	2.5
MacKenzie Galvin	"	3/31	2.5
Monica Erhart	"	3/31	2.5
Sharon Hawley	"	3/31	2.5
Chris Shaeffer	"	4/19	2.5
Sabrina Peters	"	4/19	2.5
Cindy Ellison	"	4/19	2.5
Amy Monahan	"	4/19	2.5
Joan DeChaine	"	4/19	2.5
Cassie Platz	"	4/7	2.5
Jeff Heeren	"	4/7	2.5
Parent helpers	15 chaperones - one per hiking group		37.50
Total			67.5 hrs.

Project manager signature [signature] ____________________

- 99-00 billing forms-ALL

VOLUNTEER SIGN UP SHEET

Date April 5-26, 2000

Place Brookwood Elementary School

PROJECT NAME ______________________

NAME	SIGNATURE	DATE	TIME/HOURS WORKED
Chris Shaeffer	Chris Shaeffer	4/19	5 hrs.
Stephanie Wagner	Stephanie Wagner	4/12	5 hrs.
Susan Leeb	on file	4/5, 4/12	10 hrs.
12 parents	2hr per session for 4 sessions	4/5, 12, 19, 26	96 hrs.
Total			116 hrs.

Project manager signature Stephanie Wagner

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Susan R. Leeb, artist and educator
1050 SW. Englewood Drive
Lake Oswego, OR. 97034
Ph: 503-246-1798
Fax: 503-228-2907
E-mail: rslsrl@juno.com

April 11, 2000

To: Stephanie Wagner, Education Director
Friends of Tryon Creek State Park
Re: Metro Art Grant/Salmon Prototype

Invoice 2000-6

Services rendered in creation & development of art project (12/3/99-4/10/00)
Salmon prototype for Nature Explorations Through Art Program
Materials used to develop the prototype
Field testing of prototype with one participating class

FRIENDS OF TRYON CREEK PARK, INC. 6/28/2000 4306

Susan R. Leeb
Contractor art consultation for metro grant 2,000.00

Checking Art consultation for Metro Grant 2,000.00

TEACHER PACKET #1

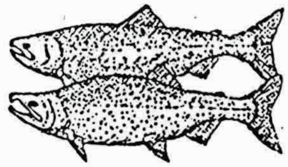
FOUNDATIONS FOR UNDERSTANDING STEELHEAD

CONTENTS:

- THE JOURNEY OF THE WILD PACIFIC SALMON
- LIFE CYCLE STAGES
- EXTERNAL STRUCTURE AND FUNCTION OF SALMONIDS
- HABITAT REQUIREMENTS
- STEELHEAD AND THE ENDANGERED SPECIES ACT
- EFFECTS OF URBAN DEVELOPMENT ON STEELHEAD

STUDENT HANDOUT 1A

THE JOURNEY OF WILD PACIFIC SALMON



BEFORE READING THIS TEACHER PACKET

We would like to thank Oregon Trout for making the first eight pages available for our use from their curriculum **Pacific Northwest Salmon and Watersheds, Oregon Trout, 1999.** *If you would like a copy of this Middle and High School Curriculum please call Oregon Trout at (503) 222-9091. We would also like to thank the City of Portland for supplying the last four pages of this packet. If you would like reprints or have questions about them, please call Mary Abrams at Environmental Services (503) 823-7032.*

For nearly 10,000 years, salmon have used the rivers and streams of the Pacific Northwest to travel from their birthing streams to the ocean and back. A century ago, between 10 and 16 million salmon returned from the ocean each year to spawn in Northwest rivers. Today less than a million return.

Nothing is more awe-inspiring and remarkable in nature, and nothing defines the character and beauty of the Northwest better than the migratory journey of salmon. It represents life as a cycle, the power of survival and endurance, and the promise of return.

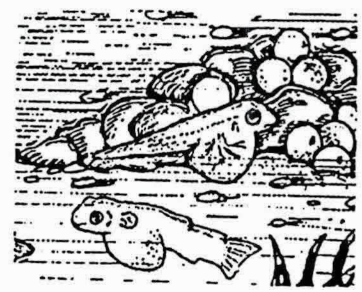
Pacific salmon are extremely important for several reasons. First, they are an important food source. They have been the mainstay for survival for the peoples of the region, and a significant food resource worldwide. Second, salmon are an **indicator species.** Because salmon migrate thousands of miles, moving from streams and rivers through estuaries to the ocean and back, they provide a valuable indication of environmental conditions in those habitats. Third, salmon play a central role in maintaining biologically diverse and productive ecosystems. For example, they are prey for a multitude of species, and their carcasses bring ocean-rich nutrients to relatively nutrient-poor freshwater environments. And finally, Northwest Native American cultures and spiritual beliefs are deeply connected with the great silver fish. In fact, the Chinook salmon takes its name from a Northwest tribe.

The salmon have evolved with incredibly strong instinctive patterns. Born in freshwater streams, **anadromous** or sea-run species like salmon are uniquely compelled to travel to the ocean. The vast ocean food chain supports a growth rate that freshwater members of the same species could never hope to achieve. However, travel to and from the ocean is a very risky venture. Travelling up to a thousand miles, migratory fish are inherently vulnerable to a variety of threats, both human and natural, along the way. Only the strongest, luckiest and most tenacious fish withstand the journey to reproduce. Of the 3,000 to 7,000 eggs in a nest, only one spawning pair will likely make it back to its original spawning habitat.

1. EGG STAGE

Salmon begin their lives in shallow gravel beds within the **substrate** of the freshwater streams and rivers in which their parents were born. The fertile, reddish-orange eggs develop in the safety of the gravel. Cold, clean **sediment** free water must wash the eggs and bring them oxygen. Eggs lie in the gravel through the winter, as the embryos develop. **Incubation** may take 50 days or longer. The colder the water, the longer the incubation period.

2. ALEVIN STAGE

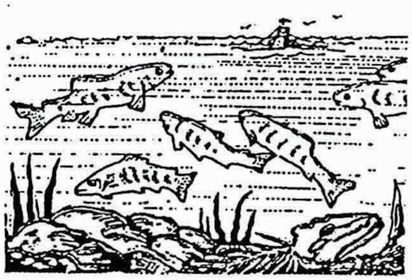


In late winter or spring, young translucent fish with large protruding eyes, called **alevins** (sometimes called yolk-sac fry), hatch and lie protected under the gravel. An orange **yolk sac** attached to the bellies of the tiny fish carry a food supply consisting of a balanced diet of protein, sugars, vitamins and minerals. As the fish grows, the yolk sac gets smaller. They will not leave the protection of the gravel until the yolk is used up, which can be twelve weeks or more. A flow of water is critical to alevin survival.

3. JUVENILE STAGE

In late spring and summer, with yolk sacs buttoned up, or absorbed, and eyes still protruding, small fish called **fry** emerge upward through the gravel and and begin to forage for food. They are about the length of a fir needle and stay in shallow pools near the edge where the current is slow.

When the young fish reach about two inches in length, they are known as **parr** (sometimes called fingerlings) and become intense feeders on plankton, small insects, worms, mussels and snails. The parr growth phase is best recognized by the development of dark bars aligned vertically along each side of the fish. The parr phase is the most vulnerable time in a salmon's life. From sculpins to raccoons, from kingfishers to large trout, parr are the morsel of choice. **Juvenile** (fry and parr) salmon will remain in the river four months to two years before moving downstream to the estuary.



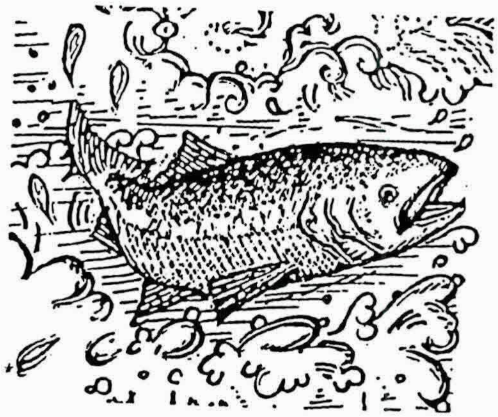
4. SMOLT STAGE

At four to six inches in length, salmon are known as **smolts**. As the parr marks disappear, most young salmon begin a physical change that triggers their downstream migration and adaptation to saltwater environment. Smolts let the current carry them downstream, tail first. Much of their travelling is done at night to avoid predators.

Estuaries occur where coastal rivers enter the ocean, creating a mix of fresh- and saltwater habitats. For salmon, the estuary represents the drastic transition from the river to the sea. Nutrient-rich sediment in estuaries produces nurseries for thousands of tiny organisms, upon which salmon feed. The inner waters of eelgrass beds and salt marshes provide habitat for the fish as they transition from fresh to salt water. This transformation involves amazingly complex body-chemistry changes. In addition, other physical changes occur during smolting: scales become larger, color turns silvery, and tails lengthen and become more deeply forked. Depending upon the species, salmon spend from a few days to a few months in an estuary.

Water flow is again a critical factor during downstream smolt migration. High flows mean higher survival rates. Decreased flows can increase the amount of time it takes smolts to reach the ocean and affect their ability to adjust to saltwater conditions. A delay can also increase their susceptibility to predators and disease.

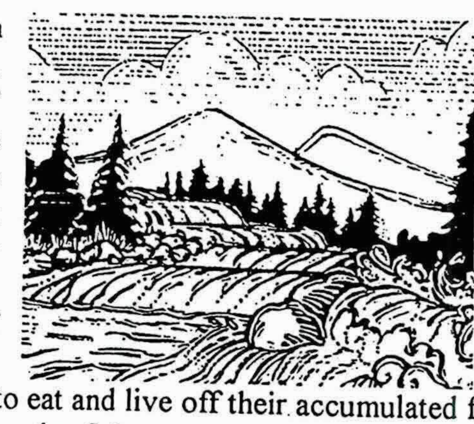
5. OCEAN-FARING ADULT STAGE



Some theories suggest that salmon follow a life cycle of going to the ocean in order to overcome the limits of food and space in freshwater habitats. Upon entering the ocean, salmon will turn toward their **hereditary** feeding grounds. For some it is north to Alaska. Others will feed in the deeper waters off of the California coast. To avoid predators like seals they will remain in large schools. Their two-tone coloring helps conceal them from enemies. Seen from above, they blend with the dark ocean waters; from below, they blend with lighter sky. They feed heavily on such prey as crab larvae, barnacles, herrings, sand lance, rockfish, anchovies and squid. Time spent at sea varies according to species ranging from one to five years.

6. UPSTREAM MIGRATION STAGE

The salmon's return to the estuary is remarkable. For a fish to travel thousands of miles in the open ocean, up to thirty miles a day, and then locate and return to the estuary of its origin seems to defy all odds. This is called **homing**. Although still a mystery, scientists hypothesize that salmon navigate at sea with the aid of an inner magnetic map and a strong sense of day length, thus a salmon knows approximately where it is in relation to its home stream. As changing day length signals the advance of the season, the fish moves more or less directly toward the river mouth. As the salmon gets closer to the river the salmon's keen sense of smell comes into play, drawing it toward water smells encountered during the juvenile phases of life. Salmon can pick up the scent of their home river with noses so sensitive that they can detect dissolved substances in parts per 3,000,000,000,000,000,000! Arrival occurs during all seasons depending on the species.

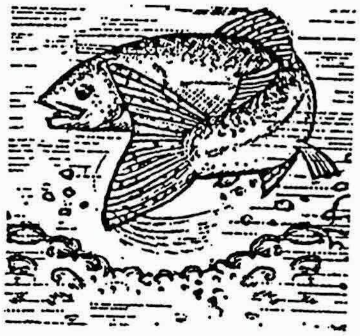


A unique feature of the life cycle is that salmon migrate and spawn in mass groups called stocks or runs. The fish within each stock or run has a unique "map" with special genetic codes that instruct and direct the fish's behavior specifically to when and where to migrate and spawn. For example, the Sandy River Fall Chinook is a stock or run of salmon that migrate up the Sandy River in the fall to spawn.

The struggling, leaping salmon against the torrent of the stream is one of nature's most incredible feats. Upon re-entering fresh water to spawn, salmon lose their desire to eat and live off their accumulated fat reserves. In proceeding toward their spawning grounds, the fish move quickly upstream in groups. They make their way by stages upstream, pausing for days at a time to rest in **pools**, often waiting for improved water flows. They tend to move as long strands, hugging the deeper channels and shaded areas of the stream. At shallow **riffles**, where the river steps down a gravel ramp, running fish raise rooster tails of water as they speed over the rocks.

7. COURTSHIP STAGE

Once they come to their home gravel, females search for suitable egg-laying territories to build nests, called **redds**. As the sac around the eggs loosen, the urge to **spawn** quickens. Aggressive displays between the fish occur at this time. Males chase, bite and attack to ward off competitors. Females butt other females that appear to threaten their redd.

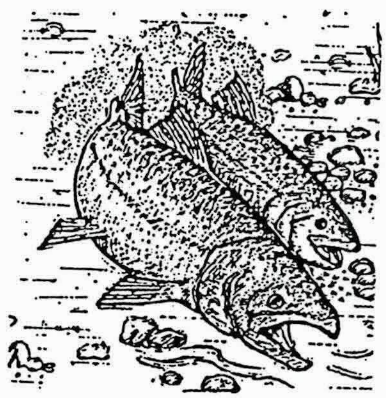


At this stage, the final days of the salmon are near, with many changes in color and body apparent. The males of some species get humped backs, hooked jaws, and sharp canine teeth. With muscles softening, skin thickening and body chemistry changing, white fungus may grow over sores or the eyes of the fish. The fins and tail fray from pounding against rocks and wounds from the journey may mark the body.

8. SPAWNING STAGE

Spawning is the process of reproduction for salmon. When a female salmon arrives at her home stream, she chooses a nesting site with just the right combination of clean gravel, adequate depth, and good flow to provide oxygen for her eggs. Once the female has selected the general location for laying eggs, she turns on her side and uses sweeping or **undulating** movements of her tail to dig the nest in the gravel. Every so often she checks the depth of the nest by "**crouching**" or lowering herself into the nest. In time, she eventually produces a cone-shaped nest up to 16 inches deep. Within that site, she may dig several nests and deposit eggs in them over a period of several days.

The digging of redds attracts males. As a male manages to ward off competitors, he joins the female in the nest in a series of courting movements. Eventually, he will move alongside the female and move his body against hers slightly. Frequently he will open his mouth in a "**gape.**" When the female is ready to deposit her eggs, she too will open her mouth to resist the current and help her deeper into the nest. Finally, as both rapidly vibrate their tails, the eggs and sperm, or **milt**, are released. A female may lay up to 7,000 in a series of redds.



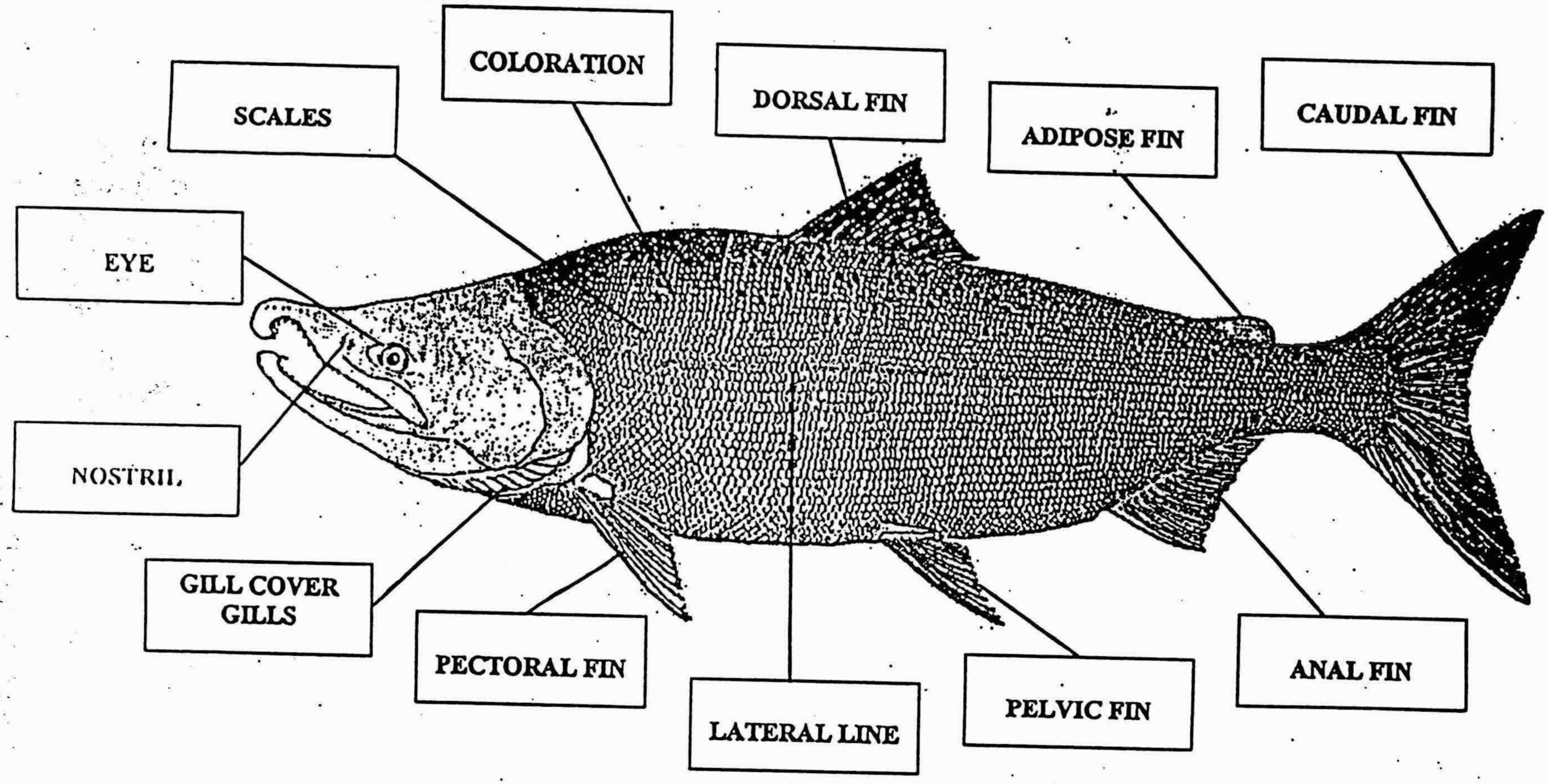
9. KELT STAGE

As the female has released her eggs, she instinctively covers them by moving upstream slightly and repeating her digging motions. This lifts gravel just above the nest, so that the current carries it into the depression. Females will defend their redds until they die, which may be a few hours or a week. Males can spawn more than once and often will leave the female, in search of another that is preparing a nest. Salmon that have spawned are called **kelts**.

10. CARCASS STAGE

Most salmon spawn only once during their lifetime (**semelparous**), although steelhead have the ability to spawn more than once (**iteroparous**). Both the male and female salmon die within a week after spawning. Their **carcasses** float downstream, get caught in roots and limbs, line beaches and sink to the bottom of the river. Opportunists like bears, gulls, crows, and eagles dine on the dead salmon.

The death of the salmon serves the next generation. As decaying salmon add nutrients to the rivers, they feed aquatic life that will in turn feed young salmon already growing in the gravel in the streambed. In Cascade streams, as much as 40 percent of the nitrogen and carbon in young fish and 20 percent of the nitrogen in streamside plants come from dead salmon.


COLORATION
SCALES
DORSAL FIN
ADIPOSE FIN
CAUDAL FIN
EYE
NOSTRIL
GILL COVER
GILLS
PECTORAL FIN
LATERAL LINE
PELVIC FIN
ANAL FIN

FUNCTION OF EXTERNAL CHARACTERISTICS OF SALMONIDS

FINS help a fish swim. Salmonid fins are supported by branched, flexible rays rather than stiff sharp spines. Thus, they are placed in the "soft rayed" family of fish.

DORSAL & ANAL FINS help keep the fish balanced so its body won't tip from side to side. One function of the anal fin may be to sense the size and texture of the gravel that is best suited for spawning.

PECTORAL & PELVIC FINS are found on each side of the body, like arms and legs in animals. These fins are used for turning, backing up and stopping, in addition to balancing.

CAUDAL OR TAIL FINS sweep from side to side and push the fish forward.

ADIPOSE FIN is small and fleshy and has no apparent use.

BODY SHAPE: The shape of a salmonid fish is highly efficient and streamlined for movement and stability in swift water. Salmon can move at an estimated speed of 14 mph and have been observed to jump to a height of 10 feet.

MUCOUS COVERING: A mucous coating covers the skin of the fish and protects it from fungal and bacterial attack. The slippery texture of the mucous also allows the fish to swim more easily through the water. To prevent damage to its mucous protection, it is important to wet your hands before handling live fish.

EYES: A fish has eyes which can see in all directions. Each eye works by itself, so the fish can see to the front and back at the same time. Eyelids and tear glands are not needed. Water keeps the eyes we and clean. It is important to note that most fish are nearsighted, using other senses to detect food at a distance then moving closer to visually identify it. Their eyes are large and pupils do not contract in response to light. Consequently, they are more likely to remain in shaded areas.

NOSTRILS: A fish uses its nostrils for smelling, but not for breathing. Salmon have an extremely sensitive sense of smell. They return to the spawning area by following the faint scent of the stream in which they were reared.

HEARING: Although the salmonid lacks external ear opening, the inner ear and swim bladder sense can detect sounds in the water.

GILLS: Just like people, fish must breathe oxygen in order to live. While we get oxygen from breathing the air around us, fish get the oxygen they need from the water which flows through their mouths and passes by their gills. Gills are found under a flap just behind the head. They have many folds and pieces of thin skin which take oxygen from the water.

COLORATION: The dorsal or top surface of salmonids is dark colored and the ventral or bottom surface is a silvery white. A predator viewing the fish above sees a dark back which blends in with the color of deep water or stream bottom. If viewed from below, the white belly blends with the lighter color of the water surface.

LATERAL LINE: Most fish have a line running along each side of their body. The lateral line has a series of pores that detect low frequency vibrations and pressure changes near the fish's body.

SCALES: The bodies of most fish are usually covered with thin overlapping scales. Just like the cross section of a tree trunk, the oval scales of the salmon show annual growth rings. And just like a tree, annual rings can be used to learn the age. During the summer or other times when growing conditions are good, the fish grows quickly and the rings are far apart. In the winter when living conditions are not as good, the fish grows slowly so the rings are closer together.

STEELHEAD

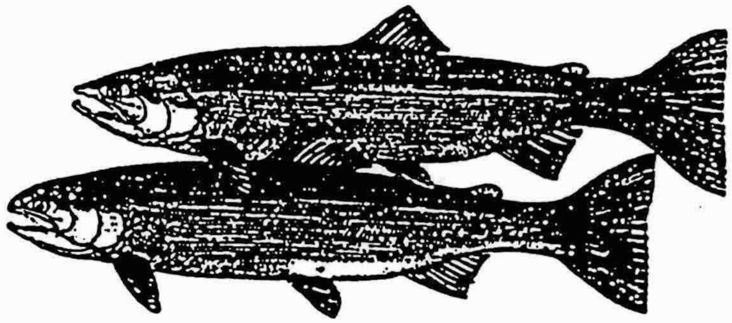


Illustration Courtesy of NOAA

DID YOU KNOW? Unlike salmon which die after spawning, steelhead may spawn several times.

SCIENTIFIC NAME: Oncorhynchus mykiss, 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. Unlike salmon, steelhead migrate individually rather than in schools. Steelhead spend 1 to 5 years at sea before returning to natal streams or rivers. At least two specific 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, but will again migrate through estuaries to the ocean.

California. They will remain in large schools and feed heavily on baitfish, like anchovies and herring.

Time spent at sea is variable according to species, ranging from one or two years for coho to four or five for chinook. When the time comes, a little-understood combination of genetic memory and sense of smell brings them back to their **natal** streams.

Arrival occurs during both spring and fall. Salmon returning in the spring, primarily chinook, tend to enter the freshwater rivers and streams immediately upon their arrival offshore. After proceeding upstream toward the spawning grounds, they will enter deep pools to rest until fall. Then they come out of their lethargy to spawn.

Fall fish, both chinook and coho, will typically concentrate in ocean waters outside their native streams during the summer. There they will feed and mature while waiting to begin their inland journey in the autumn months.

Upon re-entering fresh water to spawn, both spring and fall salmon lose their desire to eat and live off their accumulated fat reserves. They make their way by stages upstream, pausing for days at a time to rest and wait for improved water flows.

On reaching the spawning grounds, males stand guard while the females clear a series of nests or **redds** with vertical sweeps of their tails. The females then lay their eggs and the males deposit clouds of sperm or **milt** over them. They repeat the process in separate redds until all eggs have been laid. Salmon die within days of spawning.

STEELHEAD

Steelhead, or sea-run rainbow trout, parallel salmon in much of their life-cycle but differ in several significant ways. First, unlike the salmon, steelhead do not migrate in schools, but seek their own way at sea. Although the migratory picture is not clear, tagging studies have shown that steelhead travel far and wide. Oregon steelhead have been caught in the waters off Japan, a 2,000 mile journey from their home streams.

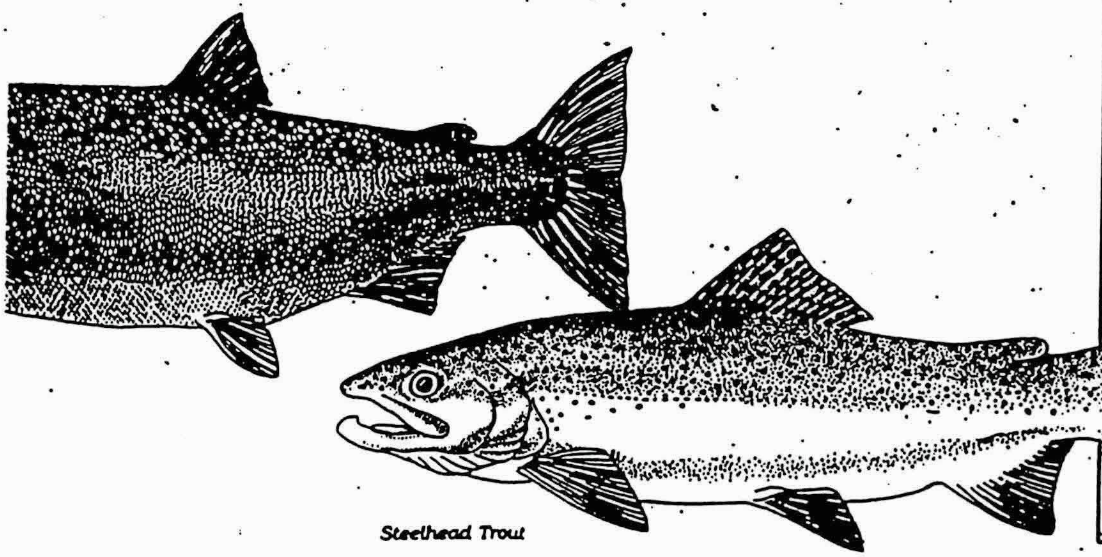
Steelhead also stop eating upon entering fresh water; although they maintain an aggressive bite response which is a never-ending source of joy to sport anglers. Unlike salmon, not all steelhead die following their spawning cycle. Although survival percentage is low, some steelhead survive to spawn twice or even more. Another trait that endears steelhead to anglers is their spawning schedule: Unlike salmon, which return primarily in spring or fall, steelhead have both winter and summer runs, with considerable overlap. Some rivers enjoy both. The end result is that steelhead can be found somewhere in Oregon waters 12 months a year.

The Lateral Line

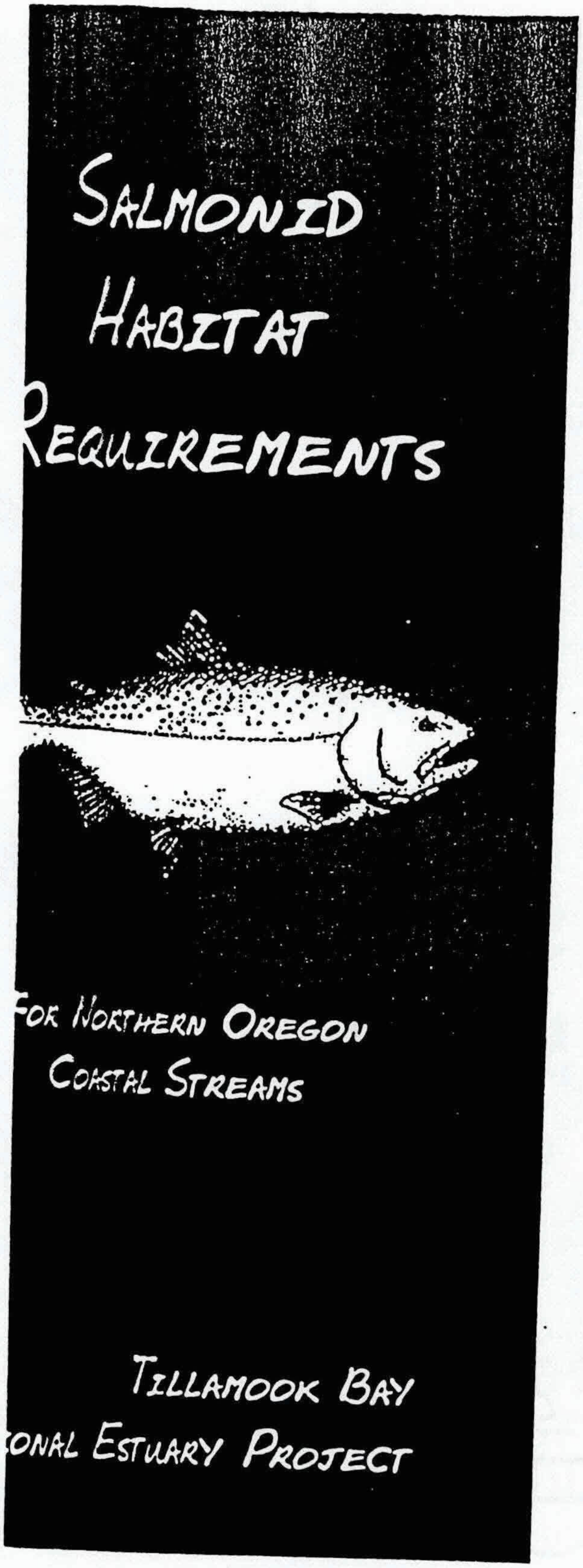
In addition to their senses of sight and smell, most fish have developed a highly sensitive sense o touch through their lat- eral lines. Lateral lin are a series of micro scopically small ski openings to sensory o gans arranged in line from head to tail on eith side of the fish.

Lateral lines enab fish to feel and accurat estimate the size, di tance and direction disturbances in the wat around them throu small changes in wat pressure. This well-de veloped sense of touc allows fish to respon quickly to potent predators or prey, eve without adequate visu contact.

Although the pro esses are not comple understood, lateral lin may also improve th sense of smell and hel fish to avoid unseen, mo tionless obstacles.



Steelhead Trout



Habitat

Salmonid populations in the Pacific Northwest have been in decline for many decades. As a result some populations are listed as threatened or endangered species. One of the reasons for their decline is a lack of suitable habitat.

Studies show that salmon require a range of conditions in which to migrate upstream, spawn, and grow. This chart outlines some of those conditions and represents best professional judgement compiled from scientific reports and studies. It is designed to be a reference chart.

Dissolved Oxygen - The oxygen carried in the water is called dissolved oxygen and is required by fish. The amount of dissolved oxygen in the water varies with water temperature. Salmonids, in general, tend to require high levels of dissolved oxygen.

Temperature - In general, colder temperatures are preferred by salmon. Colder water carries more dissolved oxygen and also slows fish metabolism, which allows fish to gain weight more easily and grow to larger sizes.

Velocity - Water velocity needs to be great enough to provide continuous oxygen supply, but slow enough not to wash away eggs and juvenile salmon.

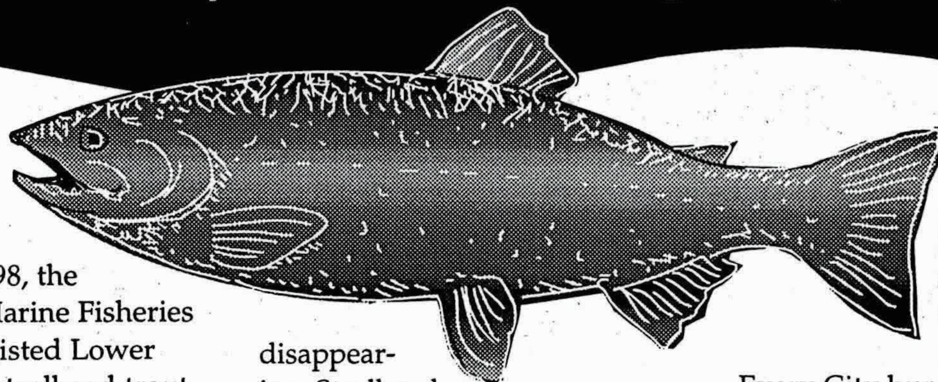
Percent Fines - "Fines" refer to the very small sediments carried by the water. Too much sediment in streams can stop migrations and kill fish by clogging gills and suffocating eggs. Fines prevent fish from getting essential dissolved oxygen.

Depth and Substrate - Salmonids seek good places to make their redds, or nests. Appropriate conditions depend on the size of the gravel in the nest and the depth of water.

For more information about salmon, water quality, or other related topics, contact the National Estuary Project at (503) 322-2222 or visit our web site at:
http://osu.orst.edu/dept/tbaynep/nephome.html

Steelhead Listing

Portland's Response To The Endangered Species Act



March 13, 1998, the National Marine Fisheries Service (NMFS) listed Lower Columbia River steelhead trout as a threatened species under the federal Endangered Species Act (ESA). Since the Columbia River system includes rivers and streams in the Portland area, the listing means the City of Portland must take steps to protect steelhead.

The ESA does not allow the listing agency (NMFS) to consider economic impacts when it determines a species is threatened. The listing agency relies on available commercial and scientific data to make that decision. The time for considering economic impacts is when the listing agency determines what habitat is critical to the survival of the species.

NMFS is in the process now of determining what habitat is critical to the conservation and eventual recovery of steelhead trout. Although the agency hasn't yet made that determination, it's anticipated that the critical habitat will include the mainstream Willamette River, the Lower Bull Run River, and Johnson and Tryon Creeks.

Why Were Steelhead Listed?

NMFS listed steelhead as threatened because natural habitat is disappearing. Steelhead populations in this area have declined 90 percent in just the last ten years. The population decline is most likely due to loss of habitat caused by passage barriers development, erosion, and activities that pollute water.

NMFS listed Columbia River steelhead trout as threatened, not endangered. An endangered species is on the verge of extinction, while a threatened species is at risk of becoming endangered. The threatened designation gives the City more time to formulate its response.

What Happens Now?

The City is working with NMFS to develop a program to help restore steelhead habitat. The first step is assessing all City programs to determine what impact, if any, each program has on steelhead habitat. The listing could affect programs in all City bureaus.

Environmental Services, for example, will assess everything from the quality of treatment plant effluent to sewer pipe maintenance in riparian areas. Every City bureau is represented on a steering committee that is coordinating Portland's response to the listing.

One immediate impact is that all Federal agencies must consult with NMFS about any project that might have an impact on steelhead. That will affect any City projects for which federal money is used, including projects that require federal permits.

The listing also means that NMFS will review any activity, Federal and non-Federal alike, that could impact steelhead trout. The ESA prohibits any "take" of a listed species. A "take" is defined not only as physical harm to a species, but also as any significant modification of its habitat. Take prohibitions are automatic with an endangered species. In the case of a threatened species, take prohibitions are established by special rules called 4(d) rules, which have not yet been established for Lower Columbia River steelhead.

Questions?
Call Mary Abrams,
Environmental Services,
823-7032

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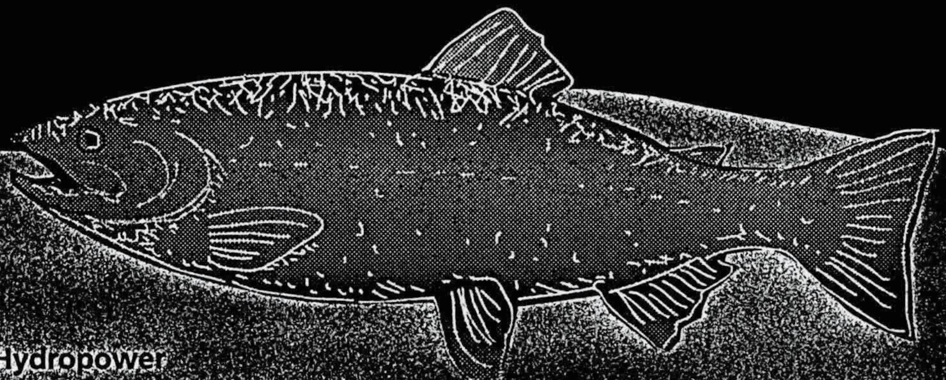
Threats To Steelhead



Steelhead are very sensitive to changes in the stream environment. Any human activity that degrades water quality in stream and riparian habitat, or affects natural patterns of flow in rivers and streams is a potential threat to steelhead.

Threats to steelhead can be grouped into four categories, sometimes referred to as the 4 "H's"— habitat, hydropower (dams), harvest, and hatcheries.

Habitat

Streamside vegetation is extremely important to steelhead. Trees shade and cool the water. Branches fall into the stream to provide the woody debris that is such an important part of steelhead habitat. Streamside vegetation also provides habitat for the insects that are an important food source for steelhead.

Human development in stream corridors often removes this critical riparian vegetation. Development can also cause erosion, which dumps sediment into streams. Sediment covers the gravel required for spawning and rearing, and can harm the aquatic insects steelhead eat. Activities like channelization, dredging, and bank stabilization also harm steelhead because they alter streambeds and change flow patterns.

Hydropower

Dams can block adult steelhead migrating up river to spawn and juveniles migrating down river to rear in the ocean. Dams that do not allow fish passage have caused the extinction of some salmon and steelhead runs. Dams that provide some type of passage, such as fish ladders, improve the survival chances of migrating fish, but are still potentially harmful.

Steelhead passing through fish ladders and other artificial structures may become disoriented, stressed, or injured, and are more susceptible to predation. In urban areas we also have other barriers to fish passage such as flood control levies, improperly designed culverts and utilities that cross stream channels.

Harvest

Fishing obviously reduces the number of steelhead that survive to spawn. Many forms of fishing selectively harvest larger fish, leaving the smaller, less productive fish to spawn.

By itself, harvest is unlikely to decimate steelhead populations, but it becomes more important in conjunction with other threats. Harvest is also used as a short term management tool. It is easier to control harvest rates than to stop habitat destruction. So reducing harvest rates is often used to maintain spawning populations of adults in declining steelhead populations. This results in only short term protection.

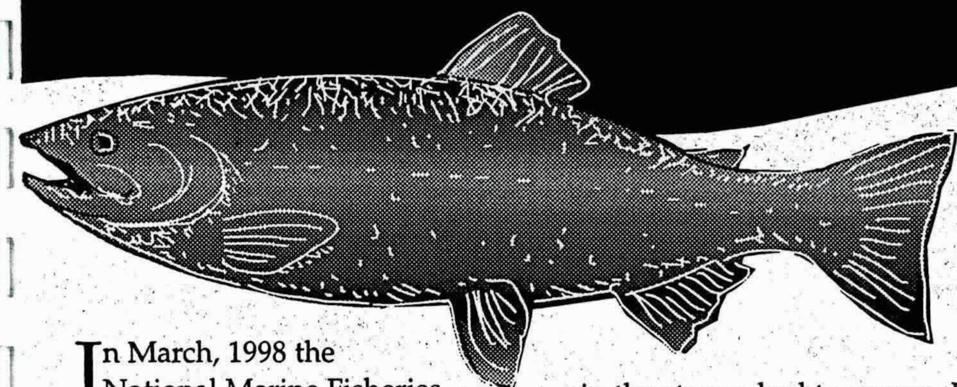
Hatcheries

Steelhead have remarkable homing abilities. After migrating for thousands of miles, they return to spawn in the stream in which they were born. Over time, this means that each salmon population becomes highly adapted to the streams in which they live.

Hatcheries introduce non-resident fish that are not adapted to local stream conditions. If they interbreed with wild, non-hatchery fish, they may reduce the fitness of wild fish, decrease survival rates, and introduce diseases into wild populations. In addition, the introduction of large numbers of hatchery fish can make it harder to detect drastic declines in the population of wild fish.

Continued

Steelhead Facts



In March, 1998 the National Marine Fisheries Service (NMFS) listed Columbia River steelhead trout as a threatened species. That means the City of Portland must act to protect steelhead, because the Columbia River system includes rivers and streams in the Portland area.

One important reason for the declining number of steelhead is the steady loss of their natural habitat. Development, erosion, and activities that pollute water all have all helped destroy steelhead habitat.

What Are Steelhead?

Steelhead are "anadromous" fish, which means they are born in freshwater, migrate to the ocean, then return to freshwater to spawn. Anadromous fish benefit from both freshwater and marine habitats. Freshwater streams have fewer predators and are safer for the development of young fish. Marine habitats have more abundant food and support rapid growth and larger fish.

Habitat Requirements

Steelhead, like all salmon, need clean, cool water with plenty of oxygen and low amounts of suspended solids and contaminants. They also need gravel and rocks in the stream bed to spawn. Fine sediment is lethal to steelhead. It clogs the spaces between the rocks and gravel, buries the eggs, and prevents oxygen and flowing water from reaching the eggs. Sediment can also damage the gills of adult steelhead.

Steelhead also require large, woody debris and deep pools in their streams, which provide refuge from predators and resting places during storms. Deep pools give steelhead cool water when shallow areas warm up in the summer.

Life History

Steelhead have a summer run and a winter run. Summer run steelhead migrate from the ocean into freshwater between May and October. Winter run fish migrate from November to April.

Steelhead typically spawn in the spring, though this may range from January to June. They prefer streams in the highest reaches of the watershed, on steep slopes, and streambeds with large gravel and rock. Adult steelhead spawn between steep areas, where the water is flatter and gravel on the stream bed is small enough for fish to dig nests for egg-laying and incubation.

Eggs hatch in the summer. Young steelhead like very fast water, and move to steeper areas where water flows more quickly. They wait in the eddies behind large rocks, allowing the river to bring them insects, salmon eggs, and small fish to eat. As they grow, the young fish gradually move into deeper, but relatively swift, water with coarser stream bed gravel.

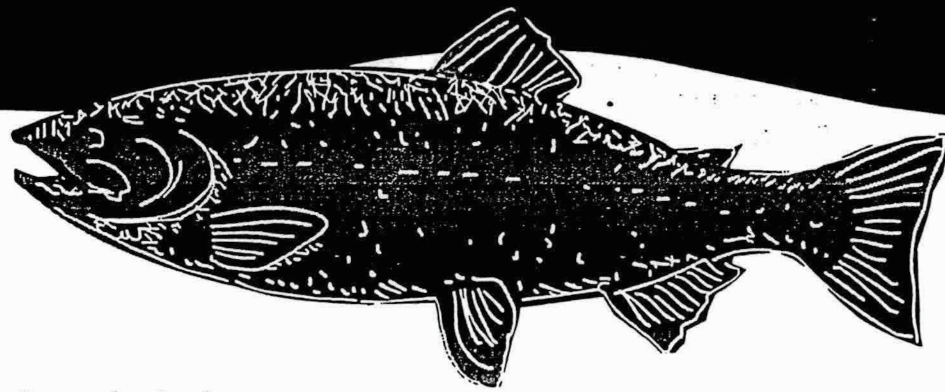
After hatching, steelhead typically spend one to three years in freshwater, then migrate to the ocean. They spend an average of one to three years in the ocean, then migrate back to freshwater to spawn. Unlike most salmon, a small percentage of steelhead may spawn more than once.

Steelhead have the most complex life history of all the salmon species. While they exhibit general patterns in the timing of migration and spawning, there is tremendous variation in these patterns. Specific steelhead stocks and individuals may show considerable variation from the patterns described above.

Questions?
Call Mary Abrams, Environmental Services, 823-7032

Urban Development

Its Effects On Salmon And Trout



In March 1998 the National Marine Fisheries Service (NMFS) listed lower Columbia River steelhead as a threatened species. The listing includes the Willamette River and its tributaries below Willamette Falls. In March 1999, NMFS listed Chinook salmon as a threatened species.

In response, the City of Portland is evaluating how all its activities and development regulations affect salmon and trout. The City is also identifying how to avoid, minimize, or mitigate activities that have a negative impact on these fish.

Three Primary Impacts

Salmon and trout are very sensitive to any change in the stream environment and urban development can alter their habitat. Development activities can pollute water, degrade instream and riparian habitat, and alter the natural flow of rivers and streams.

❶ Erosion

Erosion can put excessive amounts of sediment into rivers and streams, and can be lethal to salmon and trout. Both species need gravel and rocks to spawn and rear young. Erosion caused by construction introduces fine sediments that clog the spaces between rocks and gravel in streams, buries the eggs salmon and trout lay in these spaces, and prevents flowing water and oxygen from reaching the eggs and newly hatched fish.

Sedimentation can also fill in pools, which are an important part of fish habitat. Salmon and trout use pools for rearing and spawning, as resting areas during migration, and as a refuge to avoid temperature and flow extremes. Sediments in water can damage gills and decrease visibility, which can hamper the fish's ability to find food. Sediments also can carry and store toxic pollutants and nutrients that can poison habitat.

Portland is developing a new system to track and respond to erosion problems. The City is rewriting its erosion control regulations and design manual to improve construction site erosion control and stormwater management. And Portland is exploring methods of improving enforcement of erosion control standards and responding to complaints more effectively.

❷ Impervious Surfaces

Parking lots, roofs, roads, and other hard surfaces prevent water from soaking into the ground. As impervious surfaces increase, so do the volume and velocity of stormwater runoff into rivers and streams. Increased volume and velocity cause more erosion and sedimentation, and disturbance to spawning and resting areas.

In undeveloped areas, stormwater can soak into the ground, allowing soil and vegetation to filter out some pollution. In urban areas, the dirt, oil, chemicals, and other pollutants that collect on roads and other hard surfaces wash directly into streams without the benefit of any natural treatment. Impervious surfaces "short circuit" natural watershed cleansing processes.

Research shows that when the percentage of impervious surfaces in a watershed exceeds 10 to 15 percent, streams degrade markedly. The diversity of fish and the aquatic insects they eat begins to decline. Sensitive species, such as salmon and trout, may be replaced by fish species that are more

Continued