94-E-06

Final Report

Cooperative Agreement #14-48-0001-94-610

For Development of the K-3rd Grade Portion
of the Klamath River Educational Program

Submitted to
U.S. Fish and Wildlife Service
Klamath Fisheries Resource Office

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ABSTRACT

The Klamath River Educational Program (KREP) has been developed for public schools as part of the Klamath River Basin Fisheries Restoration Program. The goals of the program are to increase awareness of and knowledge about salmon habitat requirements, habitat restoration, and harvest management. To help facilitate the inclusion of these topics in school curriculums, the KREP has provided teaching units, research materials, videos, slide shows and equipment to interested teachers. Training sessions for teachers and high school students have also been provided. The program is being used by schools in Del Norte, Humboldt, Trinity and Siskiyou Counties in California; and in the upper Klamath River Basin, in Oregon. Curriculum guides have been developed for grades K-3, 4-12, 7-8, and 9-12. This report covers the development of the K-3rd grade curriculum guide and the 1994 summer institute for Eureka High School students.

INTRODUCTION

In 1986, the U.S. Congress enacted the Klamath River Basin Fishery Resources Restoration Act (PL 99-552), setting in action a twenty year program for restoring the anadromous fish populations within the Klamath River Basin. The Act established the Klamath River Basin Fisheries Task Force (Task Force) to assist the Secretary of the Interior in formulating, coordinating and implementing the program. Recognizing the fundamental role education can play in bringing about change, the Task Force made education one of the Restoration Program goals. Funding has been provided for public information and education, and for education in public schools. Public information and education is being coordinated by the U.S. Fish and Wildlife Service staff in the Klamath River Fishery Resource Office. Education in public schools is being addressed through the Klamath River Educational Program (KREP), which is being developed under contract with the U.S. Fish and Wildlife Service.

The goal of the KREP is to help citizens within the Klamath River Basin appreciate the value of the fishery, know what constitutes healthy habitat and understand that human activities are closely linked to the state of the fishery resource. To achieve this goal, the program is developing curriculum materials about the life history habitat needs and harvest management of the Klamath River anadromous fish, and is working with individual teachers or school districts that are using these materials.

The objectives of this cooperative agreement were to create the final portion of the KREP curriculum guides, for kindergarten through third grades, and to conduct a summer institute for Eureka High School students.

DESCRIPTION OF STUDY AREA

The KREP has been designed for schools within, or near the Klamath River Basin. This includes Humboldt, Siskiyou, Del Norte and Trinity Counties, in California, and Klamath and Lake Counties in Oregon. Many of the schools are rural, some are quite remote. The largest towns are Eureka, Arcata, Yreka and Klamath Falls. Many of the schools are close enough to a stream or river to allow field studies.

METHODS AND MATERIALS

Task 1 - Story Development

It was decided that for these grade levels, a story about a salmon would be the best vehicle for teaching children about rivers and the salmon resource. The story was written by a retired elementary school teacher who had previously written several children's stories.

The contractor made a list of concepts to be included in the story, which are included in this report as Appendix A. She also wrote a rough story line, which included location, possible characters, and events. The contractor and the author traveled to the Salmon, Scott and Klamath Rivers, to help the author better describe these areas. We also dove in the Salmon River to observe salmon, steelhead and river habitats.

The author wrote six drafts, beginning with one that was 34 chapters, and eventually paring down to 16 chapters. We had two meetings with a professional manuscript consultant for children's literature, which proved to be very helpful. These consultations dealt with methods for linking chapters, developing characters, keeping the story line strong, including suspense, conflict and resolution, keeping point of view consistent, avoiding confusing flashbacks, and writing descriptive passages.

The contractor edited most of the drafts to be sure the information was correct and that the concepts were being developed. The author also benefited from editorial comments made by members of her writers' group. A near-final draft of the story was also read to a group of children at the Trinity County Library, and to a class at Hayfork Elementary School. Several fisheries biologists, a former commercial fisherman, and a member of the Karuk Tribe were consulted for technical information.

Every chapter has a full page illustration. These were first sketched out by the contractor, then pencil drafts were made by the artist. The drafts were reviewed by the contractor and author, and were revised. The story is included in this report as the first part of *Klamath River Studies for Grades K-3*, Appendix B.

Task 2 Write lessons to be used with the story
The contractor wrote a teachers' guide, which includes a summary of major concepts for each chapter, and suggestions for activities to reinforce these concepts. The contractor also developed lessons and teaching aids which may be used in conjunction with, or independently from the story. These include writing exercises to develop vocabulary, puzzles, puppets, and model building. A glossary was written and lessons were illustrated. The lessons are included in this report as the second part of *Klamath River Studies for Grades K-3*, Appendix B.

Task 3 Print and disseminate K-3 curriculum guide
The guide has been delivered to schools in the Klamath-Trinity School District, to Somes Bar and Forks of Salmon schools, and to several schools in McKinleyville, Arcata and Eureka where the contractor knew interested teachers. Twenty copies were sent to other Siskiyou County schools via the Siskiyou County Office of Education. Nina Gee has distributed copies to teachers in Trinity County. The contractor has also sent a one-page announcement about the curriculum to teachers in Humboldt and Del Norte counties.

Task 4 Conduct a one-week summer institute for Eureka High School students
An educational field trip to the upper Klamath River Basin for Eureka High School students was conducted from June 20 - 25 by Paula Yoon. Nine students and three adults went on the trip. The other adults included Weldon Benzinger, Eureka High School chemistry teacher, and Bob Wunner, botanist and restoration specialist. Some of the students had also attended the 1993 summer field trip to the lower Klamath River Basin.

The field trip was part of the students' study of the Klamath River , and was designed to help them understand the ecology of the Upper Klamath River Basin and how the Upper Basin influences the health of the entire river system. Participants learned about the importance of agriculture to the region, and also about the water quality problems that can arise from agriculture. They visited healthy and impared water bodies, and heard about the issues from the perspective of ranchers and conservationists.

The students have produced a slide show about the restoration of the Klamath River, which they have presented to other students and to the Klamath River Task Force. The new information and pictures they gathered during this year's trip was incorporated into the slide show. Six of the students wrote a 54 page report titled The Klamath River Basin, Interconnections Within a Watershed Ecosystem. Appendix C contains the agenda for the summer institute, a list of participants, and the cover, table of contents and forward to the student report. Copies of this report may be purchased by contacting Bill Schaser at Eureka High School, (707) 441-2508.

RESULTS AND DISCUSSION
The results of the cooperative agreement were the creation of K-3rd grade portion of the Klamath River Educational Program and a week-long educational field trip to the Upper Klamath River Basin region for high school students.

SUMMARY AND CONCLUSIONS

The Klamath River Educational Program has provided accurate and timely curriculum materials about river ecosystems, restoration and protection of river habitats, anadromous fishes and harvest management. Teaching materials are now available for grades K-12, and these are being used in schools throughout the study area. Summer institutes provided by the KREP have significantly increased interest and level of knowledge for those teachers who participated, as evidenced by the on-going Klamath River studies at Eureka High School and by the number of schools that are currently including fisheries topics in their regular curriculums. The KREP curriculum materials have been incorporated into the Siskiyou County Science and Math Education Program and the Adopt-A-Watershed Program. The K-3 KREP curriculum will reach young children, at the time in their lives when they are forming attitudes towards natural resources.

SUMMARY OF EXPENDITURES

Salaries	$20,000
Contract Services Paula Yoon for conducting summer institute, Nina Gee for writing Springer's Quest, Gary Bloomfield for illustrations. (Printer will be included here in final report)	$10,750
Travel & Transportation Transportation for Summer Institute Travel through Klamath River Basin for story writing Travel for Nina and Diane for meetings Travel to deliver curriculums to schools	$ 1,700
Expendable Equipment & Materials Food and supplies for summer institute Materials for piloting activities Xeroxes of story drafts and illustrations Copies of curriculum for distriabution	$ 1,250
Overhead	$ 2,359
TOTAL EXPENDITURES	**$36,059**

APPENDIX A

CONCEPTS INCLUDED IN KLAMATH RIVER STUDIES FOR GRADES K-3

Concepts to Include in story for KREP Grade K-3 Curriculum

The story will be comprised of short chapters or sections that can be easily read to young children in one sitting. There will be several main characters: one (or more) steelhead from the Salmon River, coho from the Scott River and chinook from the Shasta River. Minor characters will include other fish and animals, and several humans. The plot will involve the experiences of these fish over a four year period. It will include their interactions with their environment and its other inhabitants, including people.

There will be minor story lines about people - their dependance on natural resources of the river basin and their relationships with the fish. The Hupa, Yurok and Karuk Tribes, the agricultural community and the ocean fishermen should be included in these story lines. The concepts that should be conveyed in the story should include the following.

Fish as organisms

Body form and function - fins & torpedo shape for easy movement, scales to protect skin, gills for breathing

Senses & how they help fish survive-

sight: eyes can see in water and out at same time, very good eyesight lets them catch food and avoid predators

smell: very acute sense of smell that is sensitive to soil, plants, animals in the watershed

imprinting & homing involves the keen sense of smell that is remembered even after 3-4 years at sea, the lateral line that senses earth's magnetic fields, and a strong, genetically dictated urge to return home for spawning.

hearing - fish hear very well using a combination of ears (with no exterior openings) and the lateral line, which senses vibrations.

Fish Life Cycle

The story will take several fish through the complete life cycle and end with the new generation of fish. Each chapter of the story will be about a new life stage, including:

eggs - hatching -

alevin - the developing fins, scales, etc.- emerging from the gravel

small fry - the need to find food and not get eaten , protective coloring

older fry - dominance hierarchy, imprinting, growth and learning,

smolts - the urge to migrate to the ocean - arrival at the estuary - changes in gills and protective coloring to adapt to salt water and ocean environment

adults - life in the ocean - schooling - new predators, the abundance of food, fast growth, patterns of movement in ocean

spawning migration - the navigation back to northern California coastline, smelling the right stream, battle to get upstream

spawning and death - pairing of fish - building redds - males chasing off others, depositing and fertilizing eggs, burying eggs, guarding the nest, death and decomposition

Fish Behavior/Genetics

There are different types of salmonids. They behave differently (migrate at different times, use different habitats, etc.) as a way to reduce competition and increase chances of survival.

Fish have ancient "memories" (genetically determined behaviors) that have developed as adaptations to conditions of their particular stream. Parent fish pass these memories on to their young, so that each fish is equipped with the "inner knowledge" of what to do to survive.

Habitats

They story will describe the various habitats the fish use during their life. The ideas to stress for each environment are::

Gravel: provides protection to vulnerable eggs and alevin. It must be free of silt so water can flow through it and bring the fish oxygen and carry away wastes. If gravel bed shifts a lot during high flows, fish can be buried too deeply to emerge.

The rearing stream has different environments - pools and riffles, undercut banks, spaces in or under submerged logs, rocks and boulders and deep holes under cascades. The water is cold. There are many trees that shade it from the sun. The stream provides food for fish in the form of insects, snails, etc. Many of these organisms live down in the gravel. The stream is a place where predators come to seek food - birds, otters, raccoons, bears, etc. The water tumbles over rocks and has lots of oxygen for fish to breathe.

We'll describe different types streams ie. steep, large boulder stream like Salmon River and flatter, slower moving river like the Shasta. The differences in the way the steelhead, coho and chinook use stream will be described, too. (Coho preferring pools, steelhead the faster water, chinook leaving soon after swim-up.)

Estuary - Where fresh & salt water mix. Different substrate and flows. The organisms of the estuary (sea otters & seals, seabirds, etc.) A place where fish adjust to salt water and change coloration.

Ocean - cold ocean currents cause upwelling of nutrients - thus food resources are great. Fish grow large quickly. Often don't have to migrate far away, but some go to Columbia River and steelhead may go north to Alaska.

Spawning stream - the search for the right gravel size and flow conditions.

The Watershed - the stream and estuary are fed by water from an area of land called the watershed. Things that happen in the watershed can affect conditions in a stream. Fish in story will experience several types of conditions that are linked to the watershed.

Fishes' role in the ecosystem

Fish are good food. They are caught and eaten by different types of predators, including humans.

Fish populations start out large, but most do not survive to spawn. Most of the fish in a given population will become part of the food chain. This is a natural part of life.

Fish face other threats besides predators, such as floods, freezing water, land slides and siltation, lack of water, high water temperatures, pollution and diseases. People may cause some of these problems.

Some runs of fish in the Klamath River Basin have become very small recently, because of habitat problems and over predation. People are trying to save these fish.

People Depend on Natural Resources of the Klamath River Basin

People have always depended on salmon for food. People fish for salmon in the ocean and in the river.

Native Americans have an ancient relationship with the fish, and practice ceremonies and rituals involving the salmon.

European settlers who came here in the 1800's thrived on the abundance of salmon. They have also developed ways of life that depend of the fish.

People use water from the rivers to irrigate crops that feed people and livestock. The fish also need water in the streams to survive.

Trees are cut for wood products and byproducts. Trees are also an important part of the salmon's ecosystem: the watershed.

People are an integral part of a watershed ecosystem. They have the ability to harm and to help those ecosystems and fish.

People care about the fish and often do things to help them. Sometimes people's actions hurt fish, however. Knowing as much as you can about the fish and the river and watershed we all share can help save the salmon and steelhead.

APPENDIX B

KLAMATH RIVER STUDIES FOR GRADES K-3

Klamath River Studies for Grades K-3

Klamath River Educational Program

Written by Diane Higgins

Illustrated by Gary Bloomfield

Featuring
Springer's Quest, A Chinook Salmon Story
By Nina Foran Gee

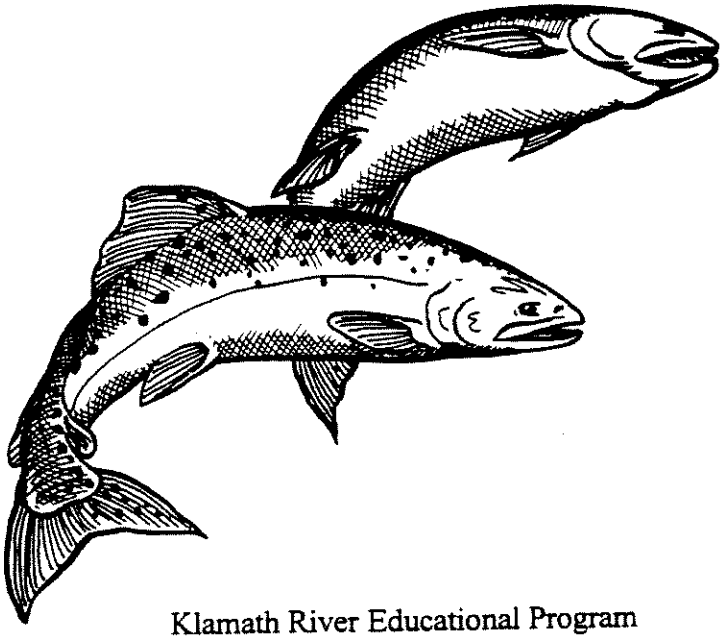
These materials were developed for the
U.S. Fish and Wildlife Service under
Cooperative Agreement Number 14-48-0001-94610

Introduction

This curriculum guide was developed for primary school children, so they may come to appreciate the beauty and value of salmon. The unit is structured around a sixteen-chapter story, *Springer's Quest*, which the teacher should read to students daily.

The teacher's guide, beginning on page 66, provides additional information about main concepts developed in each chapter, and a few suggestions for discussions, demonstrations, and other activities. Materials for students, including pages to color, puzzles and puppets, follow the teacher's guide.

Klamath River Studies for Grades K-3 is one component of the K-12th grade Klamath River Educational Program. Klamath River Studies guides are also available for Grades 4-6 and Grades 7-8. High School materials include a *Fisheries and Watersheds Unit*, a *Chemistry Unit*, and a Social Studies Unit: *California Geography and Water Use*. The Klamath River Educational Program maintains a loaning library of videos, slide shows, books, posters, displays, and field equipment. For information about obtaining any of these materials, contact the program coordinator.



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KLAMATH RIVER STUDIES FOR GRADES K - 3

Klamath River Educational Program

KLAMATH RIVER STUDIES FOR GRADE K-3

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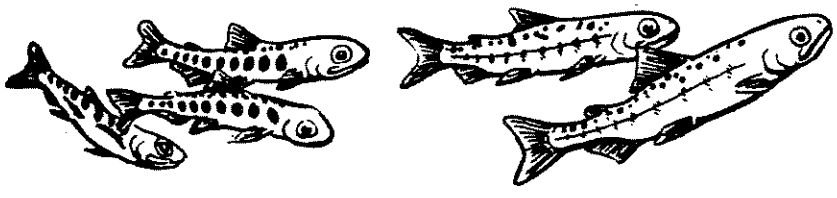

Springer's Quest

A Chinook Salmon Story

Written by Nina Foran Gee

Illustrated by Gary Bloomfield

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Acknowledgments

Thanks for invaluable help with this story must go to:

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Carolyn Polese, Children's Literature Specialist, for providing expert help with fictional aspects of the story.

Patrick Higgins, Consulting Fisheries Biologist, for a wealth of technical advice.

Michael Dean, California Department of Fish and Game Biologist, for teaching and demonstrating about salmonids.

Mike Wallace, California Department of Fish and Game Biologist, for information about migrating salmon and the Klamath River estuary.

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Sue Maurer, Siskiyou County Office of Education, for assistance with diving to observe the fish and their habitats.

Leaf Hillman, Karuk Tribal Member, for information about the Karuk First Salmon Ceremony.

Patricia Washburn, Retired Teacher, for reading and commenting on each evolution of the story.

Springer's Quest

A Chinook Salmon Story

By Nina Foran Gee

Illustrated by Gary Bloomfield

Chapter 1 A Secret Nest

High in the Klamath Mountains of Northern California begins a cold water stream called the Salmon River. The stream becomes rough and wild as it flows far away through national forests into the Klamath River and finally into the Pacific Ocean. Few people live on its rugged banks, so the river is naturally pure and fresh. This story begins in a new year near a town called Forks of Salmon. White snow decorates the bare branches in trees. Water freezes to ice at the quiet edges of the river.

On this cold morning in January, a boy named Arthur played along the banks of the Salmon River. The water was clear as glass, and he could easily see the rocky bottom. Safely standing at a distance from the frozen edges of the river, the seven-year-old boy poked and turned rocks with a long stick. He hoped to find a salamander, or a water snake hiding in a hole. He never dreamed what lay hidden in the bottom of the river just beyond his reach, until something very strange caught his eyes. Arthur stood straight up to look carefully at a clean patch of gravel that shined like a light. Most of the rocks were plastered with a green and brown film of old **algae** and dust, but these rocks were different from the others! Arthur wondered what made them so bright. Curious and wondering, Arthur raced home to pester his mother with questions before he was off to school.

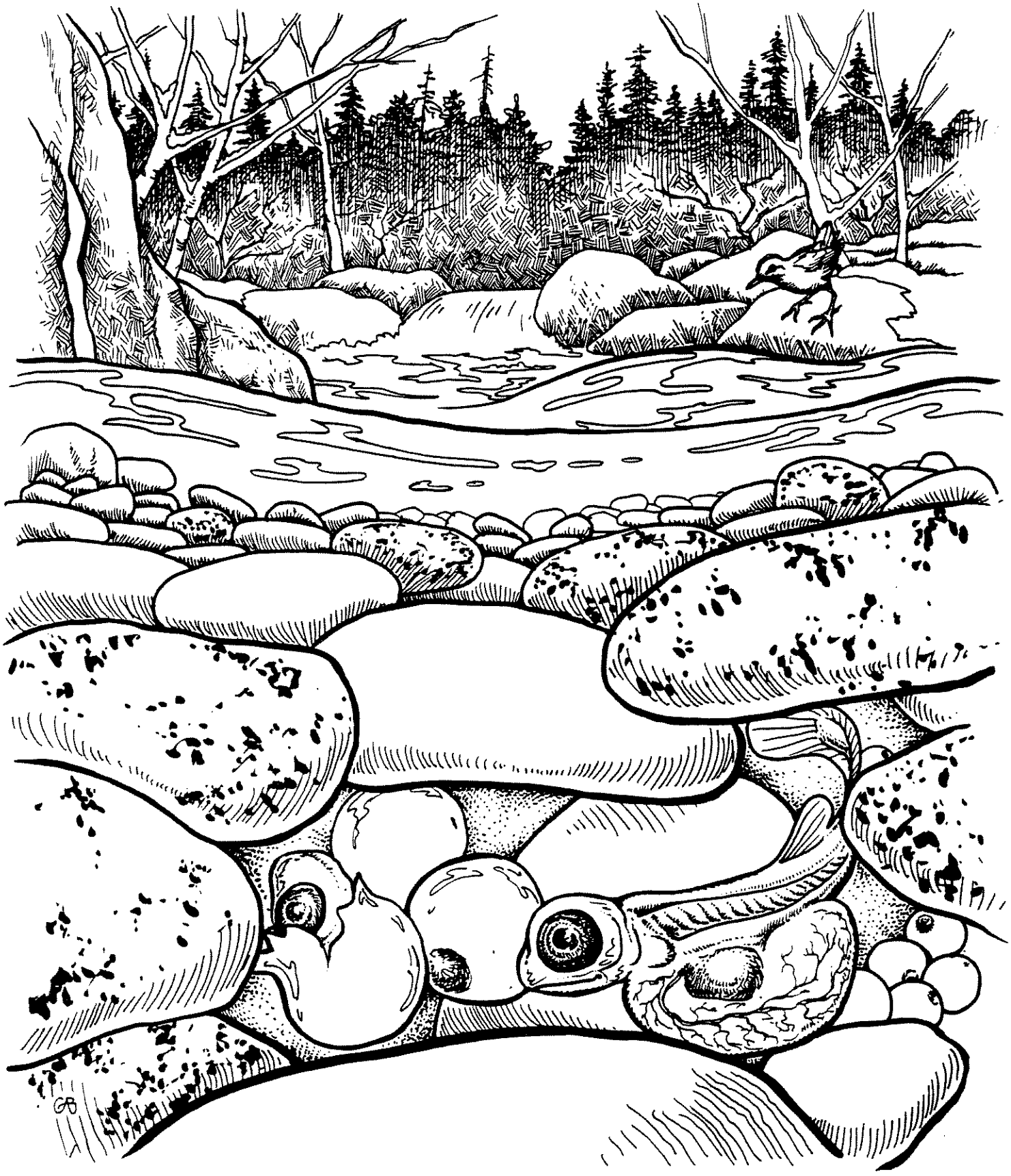
Arthur had discovered a secret. The Salmon River's icy blue water slid over a nest; a secret nest hidden deep under the rocks last fall. The shiny rocks Arthur saw with his sharp eyes were the only sign of the secret nest where thousands and thousands of eggs rested. The tiny, pink eggs, each the size of a pea, might fill three wagons! This special nest built in the

stones was a **redd**. The redd was a secret nest of Chinook salmon eggs.

Big, black and white spotted boulders stood near the redd. The boulders broke the water to make bubbles of air carrying oxygen to the eggs. One egg at the foot of the nest, close to the boulders and the bubbles of air, shivered and stirred for a moment. Then it grew quiet and snuggled again in its home of stones. The egg was a female **eyed-egg**, a new member in the great family of **salmonids**. A clear, soft covering over the egg showed a strange, alien-looking baby inside. Her big, black, unblinking, baby eyes stared out through the thin walls surrounding her. She also had fine, brown-freckled fins and a tail connected delicately to a pearly white back bone. Every egg has a yolk, and the eyed-egg did too. The baby's big yellow **yolk sac** crowded her eyes, her fins, her tail, and her back bone into a circle around the sac. Each of the egg's tiny parts attached by a vein to the yolk sac. The red veins formed a web around the yolk sac. All day and all night the yolk sac fed the baby special oil for its meals.

The eyed egg had grown big and strong in three months in the river. She was ready to explode from her shell because she needed more room and more oxygen--*now!* The tiny egg started to boogie and bounce. Inside, she made a tremendous struggle to punch the tough shell with her body. She pushed with her back bone to stretch the tight walls. She shoved her tail again and again into the shell. As small as she was, as teensy her muscles, she never gave up. After awhile she wore out the shell. It tore in two. The tough little fighter was free!

Oxygen from the water flooded into the fish's **gills.** She uncurled her body from around the yolk sac and stretched out her tail behind her. No longer an eyed-egg, she had become an **alevin.** The new alevin wriggled about.



She bumped and thumped the other salmon eggs with her funny yolk sac that hung below her little belly like a rudder on a boat. Soon, the nest jumped with thousands of eyed eggs, all struggling to become salmon alevin, too. They *all* wanted to be free from their shells.

The new little female alevin never wandered from her nest. She easily hugged the floor of the redd, for she was heavier than water. She fed on the oils of her yellow yolk sac and scooted around, like all babies do. Hidden so well under the rocks, she had no worries in the world just yet. Enemy eyes could not see her and enemy mouths could not eat her. The salmon redd was the best kept secret in the river!

Chapter 2 Swim-Up Fry

Time passed, and the little alevin grew. Then a strange thing happened one afternoon in March. For the first time, the baby fish suddenly felt really hungry! The alevin ran out of food just as the sun slipped down low in the sky over the Salmon River and the night was about to begin. Her yolk sac was gone! The sac had fed her for more than four months, and now she was on her own to find food. Where would she go? How would she get there? She cannot swim yet.

Without her yolk sac, the little fish became a **fry**. From head to tail, the fry looked different. Where the big yellow sac once hung, her stomach zipped up, in a way. All that remained was a faint crisscross pattern. She was as long as a child's small finger and her back fin and deeply forked tail had turned brown. Her other six fins were clear, without any color, so they nearly disappeared. Only a dim outline showed a bone that supported the fins. Funny, crooked circles and triangles, along with other irregular spots, decorated the top of the fry's body. Her belly, all but the part that looked like a zipper, was white. The small fry would blend well with sand, and rocks, and moving water in the river now. The free flowing river above her nest was where she must go to find food!

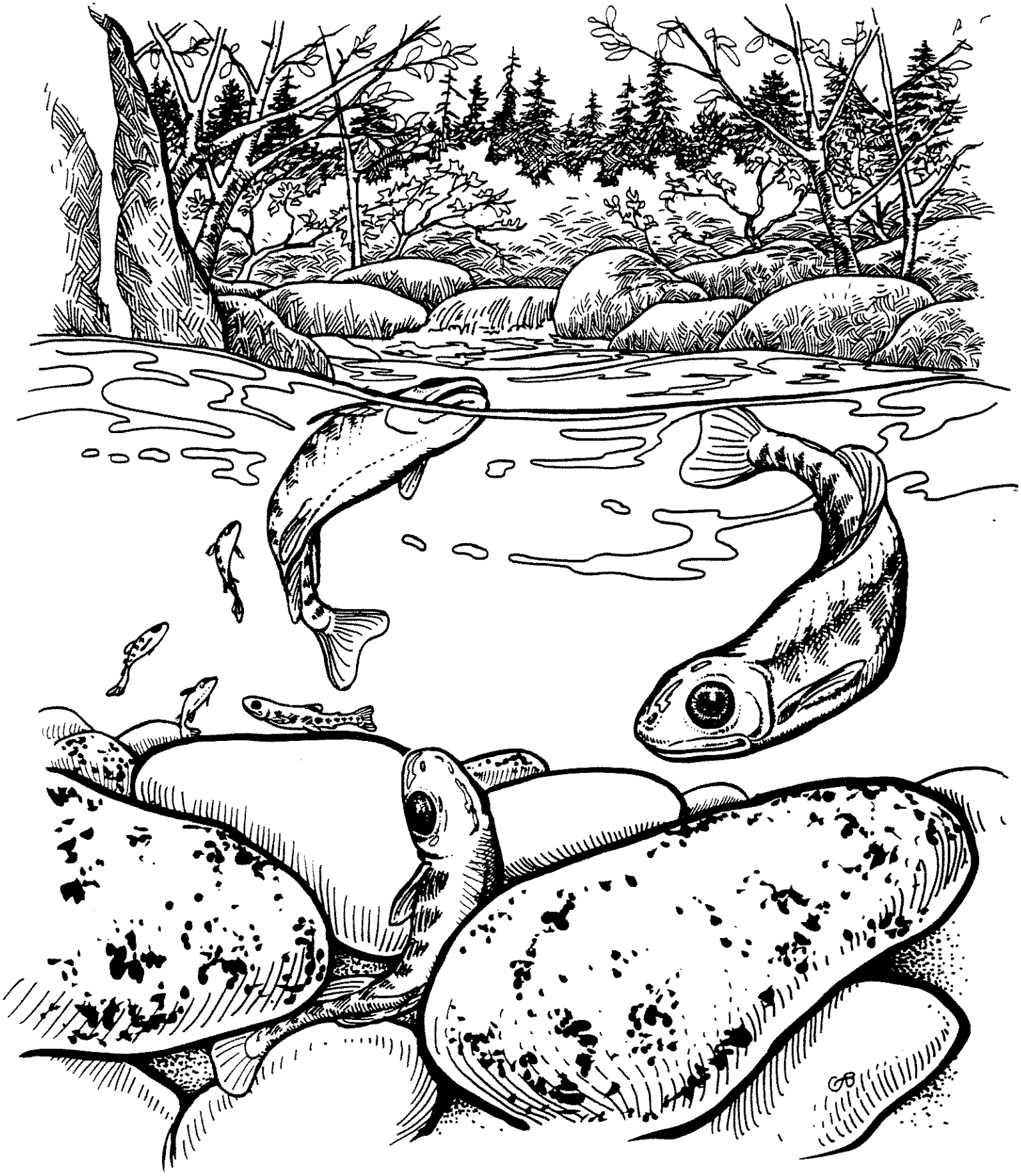
To eat, the tiny salmon must swim. But to swim she must fill her **air bladder**, somehow. She faced two fantastic tasks: she must find a way out of the rock pile in her redd, and then she must get to the surface of the river for air. All this she must do before she could swim. All this she must do to eat! A powerful urge took over the fry. Like a cat always chases a mouse, the little fish always followed an urge, or drive, to move on. Now she wanted to be free from the nest, and to be out in the river. She no longer

liked to live buried, one-foot deep under gravel in the river bed.

Tiny **scales**, covered with **mucous**, made the fry slippery and slick like a worm. Already good at slithering around, she began to move out between the stones surrounding her home. She slid over the rocks when she could, and squeezed through walls she could not creep over. She sometimes burrowed in mountainous drifts of sand. She strained every muscle as she pressed upward. Nothing came along to interfere with her drive away from the nest and the fry would not stop what she started to do. Finally she bulldozed her way by an old, rotting branch, and was free of the redd. She lay under nothing but water, at last. Hooray!

Now she must swim. The fry tried her tail, tried her fins, tried every muscle in her body, attempting to swim. Something was wrong. Her head pointed up when she wanted to go forward. There was nothing she could do but face up like a rocket ready to launch from its pad. She was a very slow rocket in this heavy water! Inching her way to the surface by whipping and vibrating her tail, in stages, she forced her way up through the water. The fry stopped to rest, but never for long. When she rested she drifted further downstream in the river, for she was helpless in the strange current until she could swim. With her tail, working as hard as she could, she pushed up, and up, and up. The first silver sheen from the moon reflected like a mirror on the river when the fry finally popped through the top of the water. Oops! What a shock and a surprise she felt in the cold, dry air!

Quick as a wink, the fry snapped her head sideways, and gulped the cold air through her mouth. Then she dropped back in the water. With her mouth and **gill covers** tightly closed, she forced the air to her bladder.



She took several more snatches of air, turned upside down, and dove from the surface. With a fine, baby burp, she quickly released two extra bubbles of air, so she had the correct amount in her bladder. The extra bubbles trailed from her mouth and up through the water behind her. She did not look back, because she wasted no time. She was swimming!

The fry's swim bladder worked like a balloon, so the fish no longer felt the terrible weight of the water. The swim bladder lifted her body, keeping it floating just right for swimming. She tested her new, level position. She climbed up and zoomed down in the river. Then she forced her way forward and pedaled back. The fry stood on her head and stood on her tail. Safe in the night, by the light of the moon, the swim-up fry floated and swam like a salmon! She will swim for the rest of her life on an incredible **quest**, but first she must find things to eat.

Chapter 3 "Springer!"

The night of the swim-up passed safely for most of the new fry. They learned to swim in that one moonlit night. The next morning the sun appeared earlier, getting ready for spring. It shone brightly on the stream filled with fry. Terribly hungry, the young fish milled about anxiously. They had been a day and a night without food.

The first little fry scoured the river, searching for something she could eat. Using the muscles of her sides as a whip to help her tail, she dodged this way and that, exploring her new home from one end to the other. What would she find to eat? Too young to know where danger lurked in the water, she swam freely like a small arrow sprung from a bow. Now, a **school** of strong fry followed her.

White spears of sunlight pierced the water from above and shined to the floor of the river. Beneath the fry, the sharp rays of sunshine shone on some spotted white and black rocks. Sunlight on these speckled rocks glowed like signs along a road. The fry felt strangely drawn toward these gleaming stones. She smelled the hard things, rubbing her snout and her lips over them. She tasted these small **cobbles** broken from big boulders and rounded in the water over time. She let her belly slide over moss and prickly patches of plants that grew on the rocks. The new feelings sent exciting messages to her brain. Suddenly, she charged all the way up to the surface as if she were a swim-up fry once again. Tickled by water torn by sharp wind, she dove to the river bottom once more. While the rising sunlight waved over her like a radiant flag, the fry was still for a moment. Then, restless again, she began poking everywhere looking for food. She searched without luck. Nothing tasted good enough to eat.

The fish, hardly longer than a pin, turned upstream, against the current. She tried different places in her search, choosing the quieter edge of the river. To swim, she had to push with all of her strength. She barely got started when a great roar in the distance sent her darting under a rock. The young fish's wildly beating heart hurt inside her. She now knew the feeling of fear. She looked up at the head of the pool and saw an explosion of white bubbles. She struggled forward again, coolly drawn to the **bubble curtain** ahead as if she were a big pin made of steel and the bubbles a magnet. Maybe the bubbles were food? Boldly the fry and her school swam into the tumbling **riffles** of water before the curtain. But the water flowed too fast for them all.

In the furious seconds that followed, the first fry struggled as hard as she could. But, light as a leaf, she was soon out of control. She gave in to the river's force. The fierce current sucked the little fry toward the deep water and the ribbon-rock wall at the far side of the river. In a flash, the water smashed into the ribbon of white **quartz** and rebounded again in a powerful **back eddy**. The small fish swirled along for the ride! She spun like a frisbee in a dizzying spiral. When she finally stopped whirling, she lay fluttering her tail slowly at the surface of a quiet **backwater pool**. Almost unconscious, she floated behind a boulder at the edge of the stream. Three little bodies, resembling her limp form, drifted by the boulder, and on down the river.

Arthur, the boy who lived nearby, watched the stunned fry bobbing by the boulder where he stood. He gently netted the fish, calling to his younger brother: "Come here, Mikie! Want to see this little fish? I have to keep her in the water."

"What kind of fish is she, Arthur? How do you know she's a girl?" asked five-year-old Mikie.

"I don't know, but I think she's a baby fry from the redd that I found! Remember, Mikie, the clean rocks at the river I showed you and Mom? I know all about salmon. She's a spring Chinook. *She's* called a King! Isn't that funny? She's the same kind of salmon as that humongous one Dad caught last year in the ocean! Do you think she will go to the sea?" he asked, turning to his mom.

"I think so, if she lives long enough. What did your library book say? Arthur, be sure you don't handle her unless your hands are wet."

"I know, Mom. I'm not going to touch her. There you go, little fish!" Arthur tipped the net sideways, and the fry sprang away in the water.

"Let's call her Springer!" Arthur said, jumping up from the rock to see where the fish went.

Chapter 4 Giant Foes

Springer was starving when she darted away from Arthur's net! She immediately swam to the quiet water behind the boulder, but all she wanted was food. Just then, in the calm of the backwater pool, a ribbon of **crayfish** eggs floated by. Springer scooped the creatures into her mouth without even thinking. Ah Ha! At last, she found something good to eat, and she stuffed herself with the tiny specks of eggs. Other fry joined in the feast. The eggs saved the day for them all.

While Springer gulped her lunch, Arthur and Mikie discovered dangerous enemies in the river near her. Mikie yelled: "What's that red thing, Arthur? It looks like a little lobster. Wow! There's a bunch of them!"

Arthur saw them, too. He came close to Mikie and said softly: "Don't yell, Mikie, you'll scare Springer away. She can hear you, you know. They're crayfish. Let's see what they do." The boys sat on the boulder and watched.

A regular army of adult, red crayfish surrounded the backwater pool where Springer ate. The crayfish hid in caves in the rocks. Their bulging eyes peered out patiently. The **crustaceans'** big claws waved about in the water, ready to catch little fry.

Springer saw the crayfish. She froze to the river floor. She lay very still with her full belly on the bottom of the backwater pool. The fry wore a perfect camouflage outfit. The dark spots on her back, the color of her tail and new **parr marks** along her sides was her disguise. Like a miracle, she merged with the flickering sunlight striking the river floor.

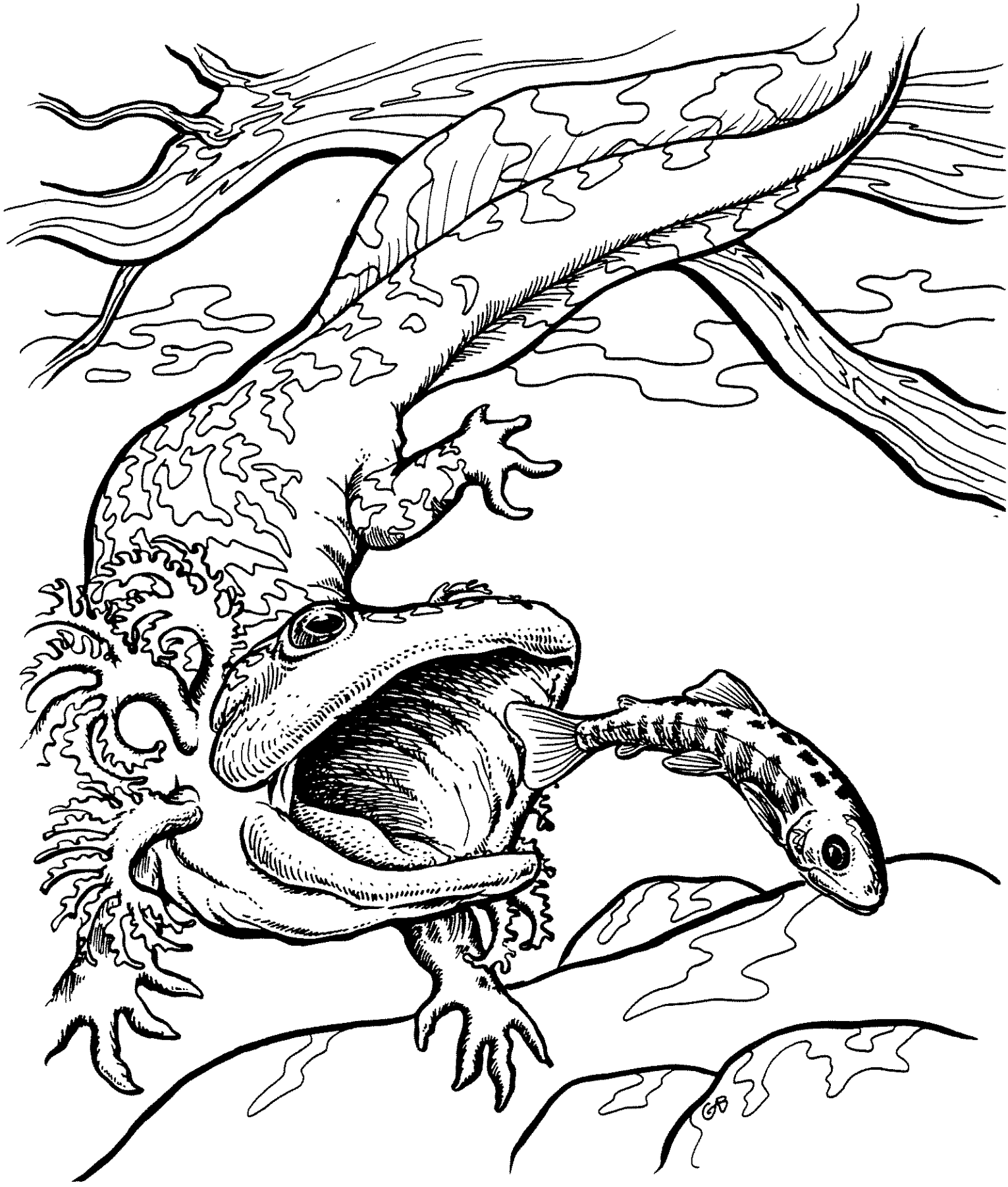
Springer balanced herself by barely moving her fins. Each of her

delicate, transparent fins moved in different ways. Two fins that stood like ships' sails, one on top of her back and another on her belly, helped her stay upright. Two more fins on her sides helped her move backwards or forwards. Only a tiny fin close to her tail seemed to do nothing at all. The most powerful fin she had, her tail, was ready to push her quickly through the water if she chose.

For now Springer stayed still, digesting her meal and looking out on the army of crayfish anchored in the rocky caverns. They showed great patience. Springer was patient, too, but other fry, full of new energy from larvae lunches, carelessly poked about. Some never stopped to look out. One fry searched the rocks for more food. A crayfish pulled back in his cave. Suddenly two red claws snatched the fish in a steely grip. With one gulp, the fry's life ended. While Springer watched from the river floor, the crayfish ate dozens of fry for lunch. Those salmon would never grow up.

Moss-coated rocks and skeleton leaves covered the river bed where Springer turned next. She, too, must search for more food. Avoiding the crayfish, she swam to the bank where a root wad held the earth tight in its curve around the water's edge. She poked into green, mossy stuff stuck to the bank. Tiny animals shook loose from the plants. Yum! Yum! More food! Other fry charged onto the scene. Frantic fry tugged and tore at the side of the stream. An exciting banquet on **stone fly nymphs** followed. The shallow bank shivered, shaking an awesome fellow perched there.

Springer sensed something wrong. She looked up. A strange creature in the water clung to the bank overhead. Its body was mottled brown like the earth. Its eyes stared out from an awesome face wearing huge purple gills.



Its four, long-toed feet clung to the knotted root in the bank. Eerily, it stood under water as still as a stone!

Springer darted backwards. She turned ninety degrees in a blink, trimmed her fins flat to her body, and sprang forward toward deeper water. The Pacific Giant **Salamander** shoved off from the root just when Springer streaked from the spot. The salamander was too slow in the water to catch her. It gave up and turned back toward the bank. The animal climbed up again on the root knot. Silent and still as a statue it stood, waiting again for a fry.

It never took long. A steady supply of fry swam to the bank for more food. Fast and furiously the deadly **amphibian** dove from its perch, opened its mouth, clamped down with its teeth. Back to the bank, where its motionless, marbled body blended with the colors of the earth, the creature, always waiting, went for another small fry. Three young salmon in a row wriggled briefly in their **predator's** mouth and then became dinner. The earth bank was a good place to fish. Like its cousin the frog, the salamander did well. It found a fine meal for the day.

For now, Springer was safe. In the next weeks things went well for the fry. She found plenty of food, and grew fast. And spring came in like a lamb to the river this year, at first bringing only gentle signs of what was to come.

Chapter 5 Over the Divide

While Springer was fine, things suddenly turned to worms for Arthur. After weeks of fine weather, thunder rolled upon the first night of school vacation in April. Arthur awakened with boom-BOOM in his ears, in time to see white crackles of lightening in the window over his bed. He remembered the story that thunder was the noise made by giants bowling in Heaven. This did not seem very funny to him now. He covered his ears with his pillow, wishing the storm would go away!

A storm meant rock slides on the road over the mountain **divide**. Rock slides meant Arthur's family could not go to get his new puppy. The road could be blocked for days, leaving no time for a trip to cousin Claire's. What a way to start a vacation! It was time to get his puppy, he thought.

Rain began to pour down. Arthur sat up and stared out the window over his bed. He felt awful, totally depressed. Then thoughts of his puppy popped into his head. Arthur looked at his picture of the small, black-and-tan ball of a pup. He liked the puppy's look, with one white ear flopping over his eye. But wait, . . . he'll be bigger now! Arthur counted the weeks from his birthday when Claire gave him the puppy. By now, the puppy was six weeks old and running around. Why can't we just go and get him? Arthur thought sadly.

He pressed his nose to the cold window to stop his tears of disappointment. He watched the rain run down the window, and drip off the fir and oak trees, and the **ceanothus** bush. The water drops landed on the ground and soaked into the soil, but Arthur knew the rain traveled secretly underground, too. Arthur forgot his puppy for a moment, thinking about the underground passages of the water. It ran, like it did on the

surface of the earth, from **rivulets** into **gulches** to **bedrock** in the river. When the raindrops reached the river they had touched granite rocks, and tree roots, and everything else in the earth. The rain carried tiny pieces of these things with it, so it was not just rain anymore. Arthur opened the window to see better and got a sudden spicy whiff of the woods in the air. He smelled the manzanita's sweet flowers and the piney perfume of last year's dry needles. They mingled in the raindrops running to the river. He decided the Salmon River must taste cool to Springer. . . .

He was hungry! Arthur jumped up from bed and ran from his room to the kitchen.

"Can we go get my puppy in the storm? I want to take him to the river to meet Springer when we get back!" he announced excitedly. He crossed his fingers, hoping his parents would say yes.

"We were just talking about that!" said his dad with a laugh. "The storm is passing over already. How long before you'll be ready?"

"I'm ready!" Arthur shouted, doing jumping jacks around the kitchen table. After eating his cereal he ran to his room, dressed in a flash, put his toothbrush in his knapsack, and waited at the door for everyone else. Mom had already packed food for their trip, so soon they were ready to go.

Mikie was still asleep when Dad lifted him into the bed in the car. Then they drove away over the bridge crossing the **north fork** of the Salmon River. The rain let up as the trusty, blue four-wheel-drive began the climb up the narrow road along the river's **south fork**. Arthur's dad stopped to move a rock once in a while, but the road was passable. The rain finally stopped. On the long way up toward the **summit**, Arthur watched out the window as the river dropped away deeper into the rocky,

grey **canyon** below him. The edge of the road was so close it scared him. He looked away to see white clouds and a patch of blue sky over the high ridge ahead. On the other side of the mountain, his puppy was probably playing in sunshine.

"Look at the sky. I think it may be clear in Scott Valley!" Arthur's dad said. "I'm going to stop on the other side of the divide. Does anyone want to stop with me?" He laughed. He liked joking.

"I do!" Arthur's mom laughed, weakly. She was pregnant, and did not like riding in cars.

Further up in the woods, they came to a sign that said "Summit." In a few minutes they stopped at a pullout to look down at Scott Valley on the other side of the mountain.

"Look!" Arthur said. "I think I see Claire's red barn! Is that the Salmon River down there?"

"That's the Scott River by Claire's. Okay, Eagle Eye, can you see a black-and-tan puppy?" joked Dad.

"I think *I* do!" Mikie said sleepily, climbing out of the car.

It took another hour to travel down from the summit to the broad Scott Valley floor. Arthur began counting tiny calves in the pastures they passed because he could barely sit still. They crossed over the Scott River and they were in front of Claire's house.

There stood Claire and two pups! Arthur spotted a white, floppy ear in a flash. He jumped from the car and ran for his puppy, feeling this was the happiest day of his life!

Chapter 6 The Fish Screen

Arthur was at his cousin Claire's, at last! Before anyone else in his family was out of the car, Arthur was rolling around on the ground with two fluffy puppies licking his face.

"You're my puppy!" Arthur said jubilantly, looking into the eyes of the friendly, floppy-eared critter he caught in his arms. It was sunny and warm here in the Scott Valley, and the puppy smelled of dry earth and sage. Arthur thought of the difference between Claire's ranch and the sweet smells at home, and he said to the puppy: "Wait till you see where we live, little pup, it's way different from here."

Auntie Alice came through the farmhouse door to greet everyone. The parents hugged, and kissed, and talked about the trip over the mountains. Then Auntie Alice asked; "What do you think of your puppy, Arthur?"

"I love him!" Arthur said, and it was plain to see. "Thanks everyone for my present!"

Arthur's dad asked then, "Where's Bill?"

"Daddy's down at the ditch." answered Claire. "Do you want to go see what he's doing, Mikie? We can see the new baby calves. Okay?" Claire and Mikie were good friends. Claire was in first grade, but she and Mikie were born only a few months apart and they always played together.

"Okay!" shouted Mikie, standing by the grownups because he had nothing else to do.

"Let's *all* go down and see how well Bill's doing repairing the **fish screen**," said Auntie Alice. "We'll see the calves on the way."

Calves were everywhere. They stood at their mothers' side like little

shadows. At the stand of leafy, green trees by the ditch, Claire's dad was bent over a big, metal paddle wheel. He was pulling on a broken branch jammed in one paddle, so the paddle wheel could not turn and clean the fish screen across the ditch. Dead leaves and algae covered the screen, causing the ditch water to spill over instead of through it. The spilled water made puddles at the sides of the ditch where Claire's dad stood. His faithful shepherd dog looked on from the bank--until the puppies arrived. The puppies, begging milk from their mother, jumped on her and she gave in. She flopped on the grass and allowed them to nurse, but only for a minute or two. Impatient with the pups, she quickly stood up and walked away from them. When they tried to follow, she growled.

Arthur laughed at the mother dog's impatience. His uncle laughed, too, and said, "She's ready to wean them, as you can see. I'm mighty glad you came for your puppy, Arthur. It's time those pups are weaned."

"Bill, let me give you a hand with that branch," Arthur's dad said.

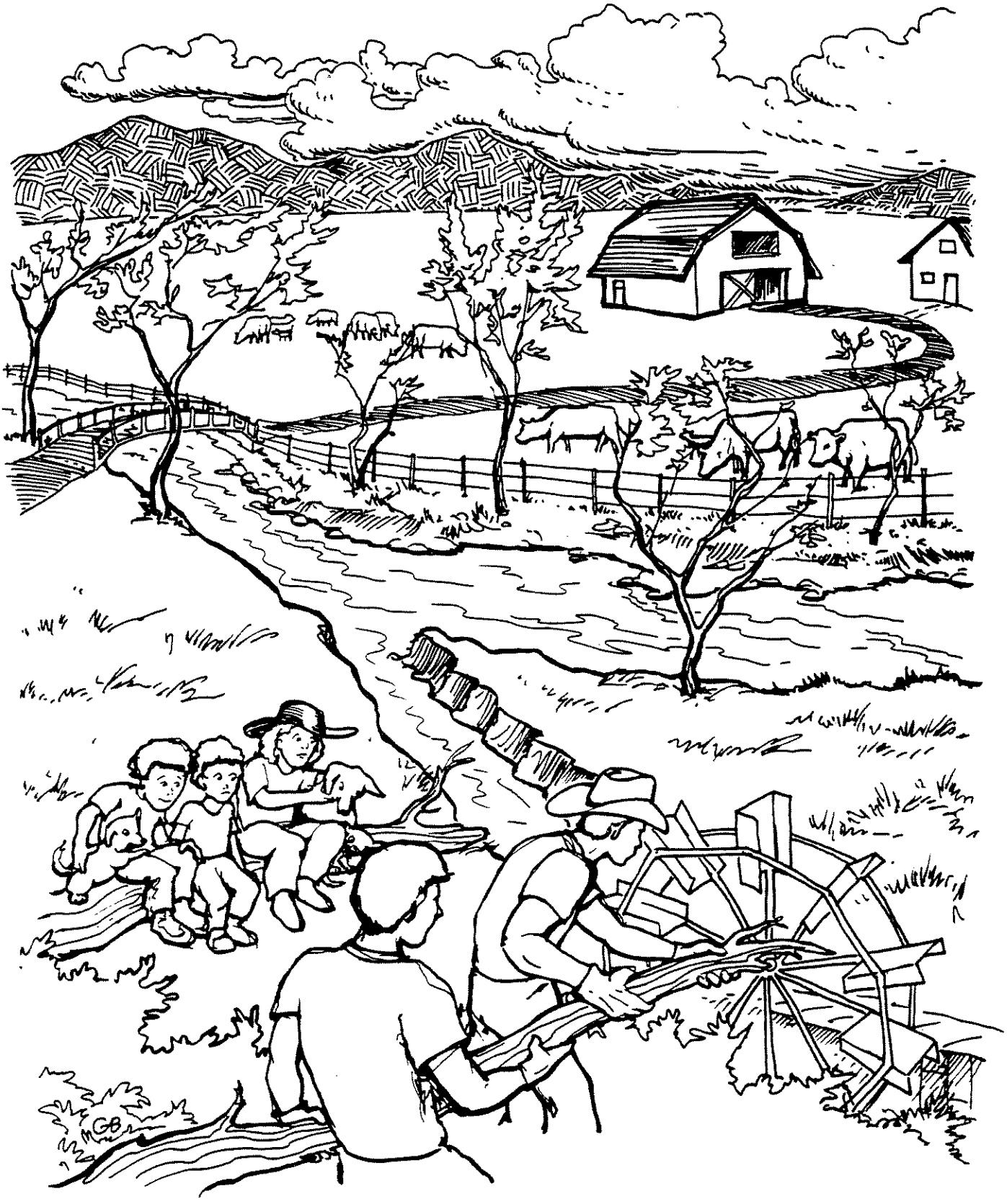
"Great! I think I need some help." said Uncle Bill. Together they had the jammed branch out in a minute. Instantly the paddle wheel turned in the water, moving a scraper back and forth across the screen. It began to clean the green algae and leaves from the clogged screen.

"What is the fish screen for?" Arthur asked his uncle.

"It keeps our irrigation water clean for the hay fields, but it's also important protection for salmon and steelhead. It keeps them from getting trapped in the ditch," explained Uncle Bill.

"Look! I see a fry in that little puddle. It looks just like Springer!" Arthur exclaimed.

"I see more over there!" shouted Claire.



"They must have spilled with the overflow water. I'll get a pail from the barn and you guys can rescue them," said Uncle Bill.

The kids gently scooped each fry into the pail and carried it over to the river. It took a long time to get all of the fry. They rescued a dozen little fish altogether.

When they finished, Uncle Bill said proudly, "I would give you all awards, if I had some."

His dad patted Arthur on the shoulder. He shook hands with Mikie and Claire to congratulate them. Then he said: "You children did a great thing; you freed the salmon so they can go to sea."

"To sea?" Claire said. She sounded like an echo.

"Oh yes, I read about that, Dad. The salmon all go to the ocean." Arthur said.

"Is that where rivers go, too, Arthur?" asked Mikie.

"Yup. I think all rivers go to the ocean," answered Arthur. Other thoughts jumped into his head, before he could finish his answer. He wondered when Springer would go to the sea? Would she meet these Scott River fish on her way? Would they swim together in the Pacific Ocean?

Chapter 7 "Springer's Gone!"

"Thor" was the name Arthur gave to his puppy. On the way home from sunny Scott Valley, up and over the divide, Arthur explained to his family: "My puppy came with the thunder and Thor was the old god of thunder." The name satisfied everyone.

When they arrived home in Forks of Salmon, Arthur whispered into Thor's ear: "Let's go to the river. Alone. Okay?" Thor wagged his tail to say, *yes!* Together Arthur and Thor snuck out the door while everyone else unpacked.

The ground was soaked from rain that fell while the family was gone to Scott Valley. Arthur's tracks oozed muddy water, and the curly hair around the puppy's feet turned brown. The air was thick with smells of flowers, and leaves, and decay that rose from the earth with each step that they took. The strong scents filled Arthur's brain. It was hard to *think* of anything else!

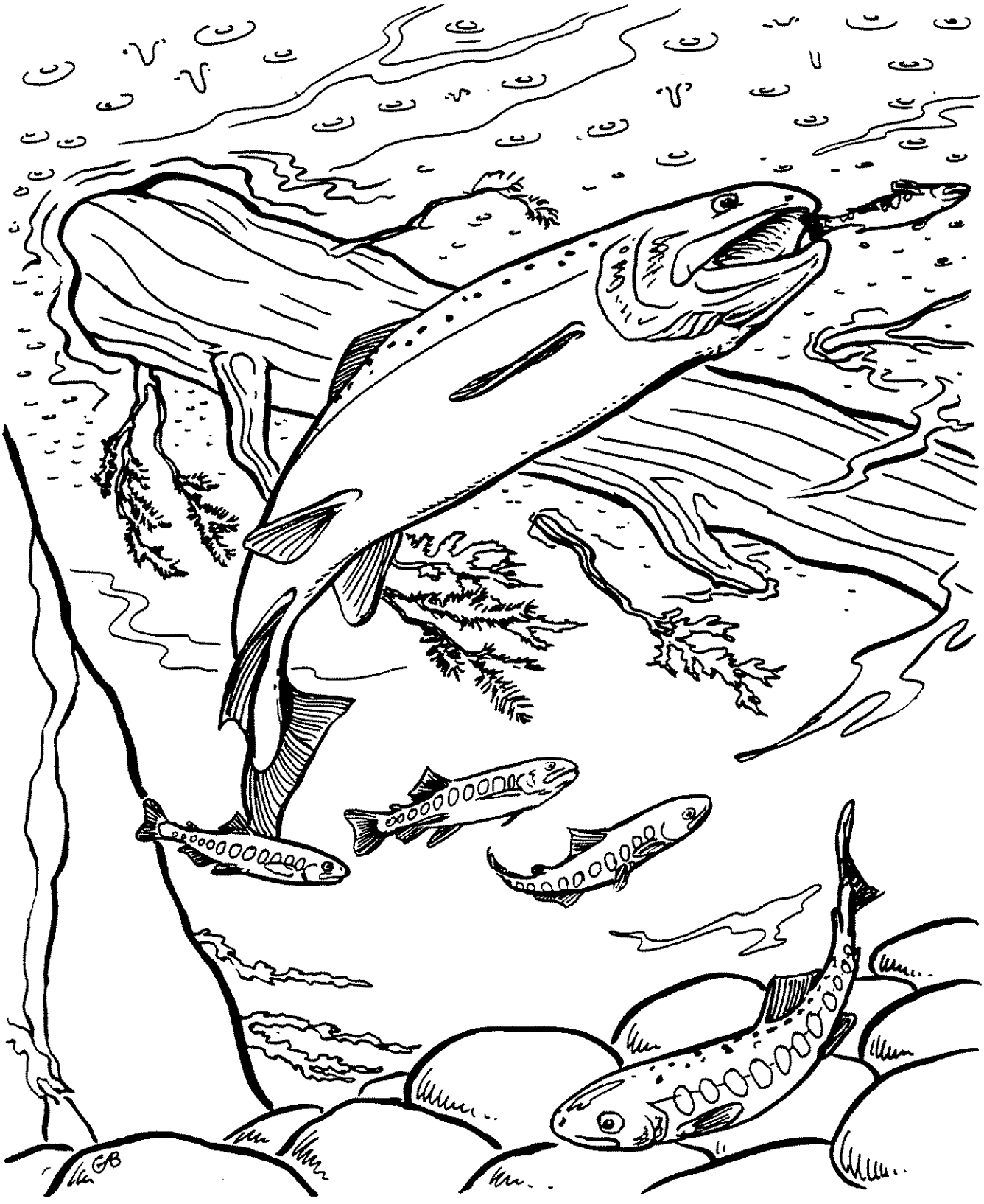
Then a terrible noise from the river began to pound into Arthur and Thor's ears. The river roared like a lion now! It drowned out all other sounds with its voice. When they got close to Springer's ribbon-rock pool, Thor began to shiver. Arthur picked the puppy up in his arms and carried him the rest of the way to the white marbled rock. They trembled together for a moment, watching the awesome river. Arthur thought the river was like a monster in a cage. Terribly swollen with rain and melting snow, it leapt in the air and clawed over the banks. Where once-shallow riffles hummed, sliding like silk over rocks, the river spit foam in its rush to move on.

"Let's look for Springer!" Arthur said loudly, trying to hear himself talk to his puppy over the noise of the angry river. Careful so he did not stumble, Arthur traveled slowly along the bank. The rocks were slippery and

treacherous, but Arthur wanted to find the fry. He hoped to show Thor what Springer looked like. Arthur tried to see into the dark and forbidding water, with no success. The river was **turbid**, dirty with debris from the storms. Arthur could not see a thing. A spooky feeling crept up on him. He wanted to get home. Thor whimpered a little, and Arthur immediately turned toward home. When Arthur and Thor were back in the quiet house, the puppy stopped shaking. Both felt much better!

Back in the noisy and turbid river, Springer had problems, too. She tried to stay close to the new, shallow **margins** at the water's edge. Here the river moved slower. It was clearer and safer. She tried to avoid the deep, dirty water, those spooky places where she could not see well. Now she was finding little to eat! She tasted and smelled everything anyway. The sweet perfume of fresh rain water added to the memories of home already stored in her brain. Each odor and taste that washed over her imprinted itself in a special place in her brain. She would never forget the smell and taste of this place in the Salmon River. She would never get lost from her home. The memories she stored with the help of these senses were all very important, but they were not finding food for her.

Another powerful sense guided Springer, a sense that people do not have. Could it help her to find her next meal? She was almost as big as a fingerling now. Her scales, grown tough like finger and toe nails, covered her back and her sides. Special holes in her scales made openings for two **lateral lines**, one down each side. The lateral lines ran directly to her brain, they were the forces that triggered her fast escapes. So sensitive to sound were the nerves from these lines, they warned her of the danger and caused her to run, all at the same time. At *every* strange sound Springer darted from her



bank and swam in the opposite direction. All of the noises the river made now pounded into her brain from her lateral lines. While the river roared like a lion, she lived in constant commotion. Like Arthur and Thor, Springer became edgy and restless from the noise. There was no time to look for food! Something must change. Something must save Springer!

Then, without warning, there was a thunderous crack. The ground shook like the jolt of an earthquake. A huge fir tree, released from soaked soil, fell across the ribbon-rock pool. The crash jarred everything in the river. The great tree that stood for seventy-five years and grew one hundred feet tall was uprooted at last by the wind and rain. Vibrations from the crash struck Springer's lateral lines as strong as lightening bolts. She spooked! Filled with terror, she thrust herself into the deep water where the river raced in every direction. She tried to hide behind a big rock, but her muscles ached with the effort to stay there. She did not know where to go.

Suddenly a dark, shadowy form approached Springer. A steelhead, as long as a child's arm, moved up the slope coming toward her! Springer fled! She turned her head downstream and pointed her nose with the current. If the driving current caught her broadside, it could dash her on boulders. She flew over the great fallen tree that forced steep mountains of water near the tail of the pool. Her heart pounded painfully. Her brain became numb. She let the dark, terrible water swallow her. The river took her away, and she did not look back. Her quest from her home had begun!

The next day, when the river was quiet, Arthur and Thor stood at the ribbon-rock pool. They found the big tree lying over the river. They saw a steelhead swim by. But Springer was not swimming around! Arthur ran home with the puppy close at his heels. At the house Arthur cried out: "Hey Mom! Springer's gone--*I know she's gone!*"

Chapter 8 Wooley Creek Hideout

More than a month passed after Springer escaped from the steelhead and the flood waters at the ribbon-rock pool. On a warm, sunny day in May, the small Forks of Salmon school bus rolled over the road that followed the river downstream to Wooley Creek. Arthur sat near the back of the bus, wishing he had stayed home! While they traveled down the narrow road, his brother, Mikie, and his friends, ganged up on him. The entire miserable group sat at the back of the bus chanting under their breaths: *"teacher's pet, teacher's pet, teacher's pet . . . "* Arthur was sick of them! It was tough in a school where he was the only person in third grade, the second grade was all girls, and the rest of the students was this swarm of kindergarten and first grade kids. The upper grades, with their own teacher and their own room, did not count for Arthur, he had no friends his age. Besides, the teacher would not let him bring his puppy on the field trip. He was disgusted!

When the bus arrived at the bridge over the mouth of Wooley Creek, all the kids gathered around the teachers and their biologist guest. The biologist told them the Wooley Creek **convergence** with the Salmon River was a great **refuge** for fish traveling up and downstream. For one thing, the turquoise green water was colder and felt better than the **main stem** at this time of year, when many fish traveled. Another attraction for fish was lots of good things to eat in the creek! Insect larvae floated down the creek from faraway, wilderness places, like Man Eaten Lake, the **biologist** said. Also, fish liked the deep mouth of the creek, gouged from water falling hard onto the floor of the river. From where Arthur stood looking over the rail from the tall bridge, he could not see the bottom of the mouth of Wooley Creek.

He decided that fish may like it for swimming, but it looked very scary to him.

Would Springer like this hideout, he wondered? Was she swimming here now? A shout interrupted Arthur's thoughts: "Look! What are those birds? What are they doing?" As a flock of **mergansers** swooped down on the water, the biologist said: "Those are *fish-ducks*. Guess what they're doing?" The birds, with a flurry of green and white feathers, and flashes of red, began diving below the surface of the water. Emerging again with fish hooked in their mouths, their crested heads bobbed with each gulp of the fish. Of course everyone guessed that fish-ducks ate fish. "Other birds eat fish, too," said the biologist. "I know where there's an osprey nest near here. Who wants to take a hike and see it?" he asked.

"Me!" everyone shouted, except Arthur. He wanted to be alone more than anything else. He wanted to try to see Springer. Arthur did not move when the others left. He stood still watching everyone cross the bridge. His teacher looked back for a moment, smiled and winked, and then hurried on.

They left Arthur behind. Soon he could not hear their voices over the noise of the water. He looked down on giant boulders lining the **gorge**. The grey boulders surrounded the creek that splashed into the pool. Arthur felt dizzy watching the water swirling so far below him. He decided to sit on the bridge. Looking into the water was like seeing through a glass window into a hole thirty feet deep in the river. He was disappointed not to see any small fish from his height on the bridge, but he began to imagine that Springer was there. He wondered what it would be like to be a fish? Does she sleep? Does she think? Does she know about humans? Why does she want to go to sea? What is she seeking? What is her quest?... Arthur was lost in thought.

While Arthur was thinking so hard about Springer, she hovered under a log waiting for the mergansers to leave. She enjoyed the cold water and good food of Wooley Creek. She just did not like the mergansers! Tattered and torn by her five-week trip down the swollen river, she had stopped at the mouth of each creek she passed. But Wooley Creek, with its cold water and the great, rocky depths of its pool, free of **sediment**, was the best hideout she found. Her body had healed in the Wooley Creek refuge.

There were many other fry here with Springer. They swarmed at the place where the creek tumbled into the gorge carrying all kinds of good bugs to eat. Like little pigs, the fish fought over food, some swimming too near the surface for safety. When the flock of fish ducks, the mighty mergansers swooped in, they attacked those fry at the surface. A burst of color, a rush of feathers and life ended for a dozen or more small fry.

Chapter 9 Strangers Together

The day after the children's visit, Springer left the mouth of Wooley Creek. She bristled with new energy and strength from the food she gobbled there for days, and she was ready to return to her journey down the river; to continue on her quest.

In two days she reached the strange tea-colored waters of the wild Klamath River. Springer came around the last bend of the Salmon River at Somes Bar, in a broad canyon flooded with sunlight. The Salmon River painted bright streaks of blue upon the dull-colored water of the Klamath River, before it disappeared from sight. Springer moved at an angle through the new water, looking for a comfortable edge. She came close to the Klamath River's shallow edge, where spring flowers grew in bright colors of red, yellow, and purple. The flowers' reflections danced over ripples from the wind on the water. In these new places Springer found food. She needed all the energy and strength that she had for the next few weeks in this river.

Everything here was different. Springer smelled new scents from faraway creeks that joined the Klamath River. She got a whiff of a baby calf from Scott Valley. She noticed wild animal smells that floated down streams from lakes in the mountains. She sampled the perfumes of exotic rocks, and minerals, and plants mingling in the great river. The Klamath River was a brew, like tea.

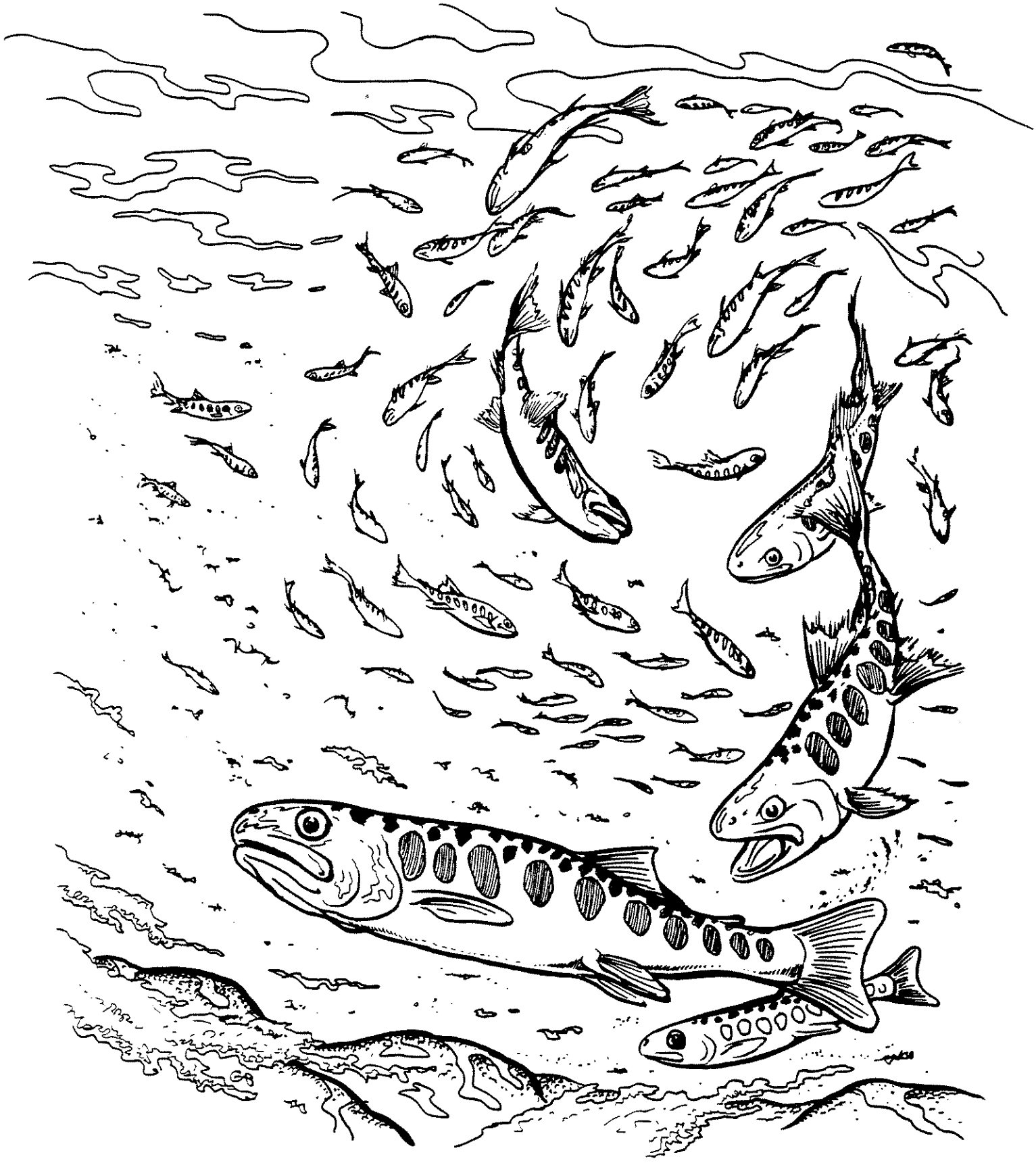
Strangers with dark stripes and spots like Springer's joined her now. Among the new fish were the fall Chinook rescued on the ranch in Scott Valley. Most of the fry she met were salmon cousins from dozens of wild rivers, like hers. The fish formed schools when they met. They swam together for safety from predators; but when crowded they fought over food.

The middle of the river flowed fast and deep. Springer and the other fry stayed away from the center as long as they could. Mysterious, big fish swam by Springer going up the river now. The river was like a super highway for fish **migrating** upstream and downstream. She avoided these strange, large fish, and other monsters that lurked in the river. The oldest and largest fish in the Klamath patrolled below Ishi Pishi Falls. These giant **Green Sturgeon** looked like they would eat almost anything, and everything stayed out of their way.

Springer headed down the Klamath River. It was summer now. The water grew shallower and spread out like a bolt of cloth over the broad bottom of the river. Some days the sun on the rocks at the river's edges heated the water too much for Springer. She found it hard to breathe. Forced to the center of the stream with the big fish, she spent these days making fast getaways. She had no time to eat. In the cool night, she wove along the edge of the river again, eating with a great appetite.

The river continued to change. Every mile added more scents from new streams for Springer to grow used to. Each mile also added more fish. Springer tolerated new tastes and smells better than the fever heat developing with each passing day into summer. The river became so warm in places that towering clouds of green algae grew freely. These floating plants took oxygen from the river at night, giving back only some of it by day. Springer suffered without plenty of oxygen. Sometimes she felt slow and numb. She could suffocate in the heat.

To get away from the sun and find fresh supplies of food, Springer joined other fry swarming where small streams joined the river. The mouths of the streams brought cooler water. When they became overcrowded with cousins, Springer moved on with the current, letting it carry her downstream, again. She always continued down the river on her journey as if she had somewhere special to go. Where was she going? Did she know?



Springer followed the river as it made a wide turn, bending to the right. Above her was the ancient village of Weitchpec. She felt a rush of water entering the Klamath River from the left. Ahead of her was the strangest new experience of all. She was about to run into odd relatives from the Trinity River.

Springer saw the first sign of trouble when a cloud of thick silt rose ahead of her. It seemed to travel up the river, coming right for her. The swirling volcano of silt and sand revealed a mass of living creatures. They traveled like a mob, writhing and wriggling forward in confusion. A horde of **hatchery** salmon from the Trinity River in the south met the wild fry from the north! The weird hatchery fish were the strangest of Springer's cousins. They were hungry and extremely aggressive, always fighting and biting each other! Their fins, frayed from crowded **cement raceways** where they grew up, made them look feathered. One fin on each back was clipped off.

Two hatchery fish charged Springer with strange jerky and menacing motions. Springer dodged. Her movements only attracted more fish. They chased and bit her from every side. She was desperate to get away, but there seemed to be no escape.

Then a thread of fresh water made a faint trail to Springer's nose. Quickly she followed the cool water, ignoring the fish that attacked her. She easily out-swam the hatchery fry, and found the source of the water at the mouth of Blue Creek. Here she rested and feasted on insects with other wild fry who knew a good place when they found it!

The Trinity fish swam on their crooked and crazy way without stopping by Blue Creek to eat, or to rest. The poor, hungry, hatchery fish, hand-fed in their crowded homes of cement, did not know any better. They did not know what they missed!

Chapter 10 Into a New World

After she tangled with the hatchery fish, life in the Klamath River was better for Springer. From the mouth of Blue Creek the river flowed into a steep canyon. The water became deeper and cooler. It was clear and looked bluer because it reflected the summer sky. Springer swam hard with the current, feeling pulled now toward something mysterious ahead. Hints of something new in the river drew her forward. Traces of **brackish** water reached her sensitive snout. The scent of the salt traveling up the river tempted her to taste the water she swam in. Always before, Springer absorbed water she needed. Now, she began to drink the wonderfully tangy liquid.

Springer discovered another exciting sensation. Against the downstream flow of the river came a powerful, pulsating push upstream! The river sometimes seemed to flow backwards! She charged forward toward this awesome perception, feeling an urge to find out what was going on.

She swam headlong, barely noticing two great blue herons on the bank at the quiet Klamath fish camp. Standing still as trees and tall as eight-year-old children, the birds took their dinners out of the masses of fish that drove recklessly by, too close to shore. Safely out of the reach of the birds' lightning-fast bills, Springer swam on to some place she sensed was important to her.

She arrived at the **estuary,** where the Pacific Ocean enters the river and the river flows into the sea. This huge mouth of the river was the place Springer looked for. The pulse of the sea every few minutes, the perfect swell and taste of the tide at the estuary, satisfied her. She searched for

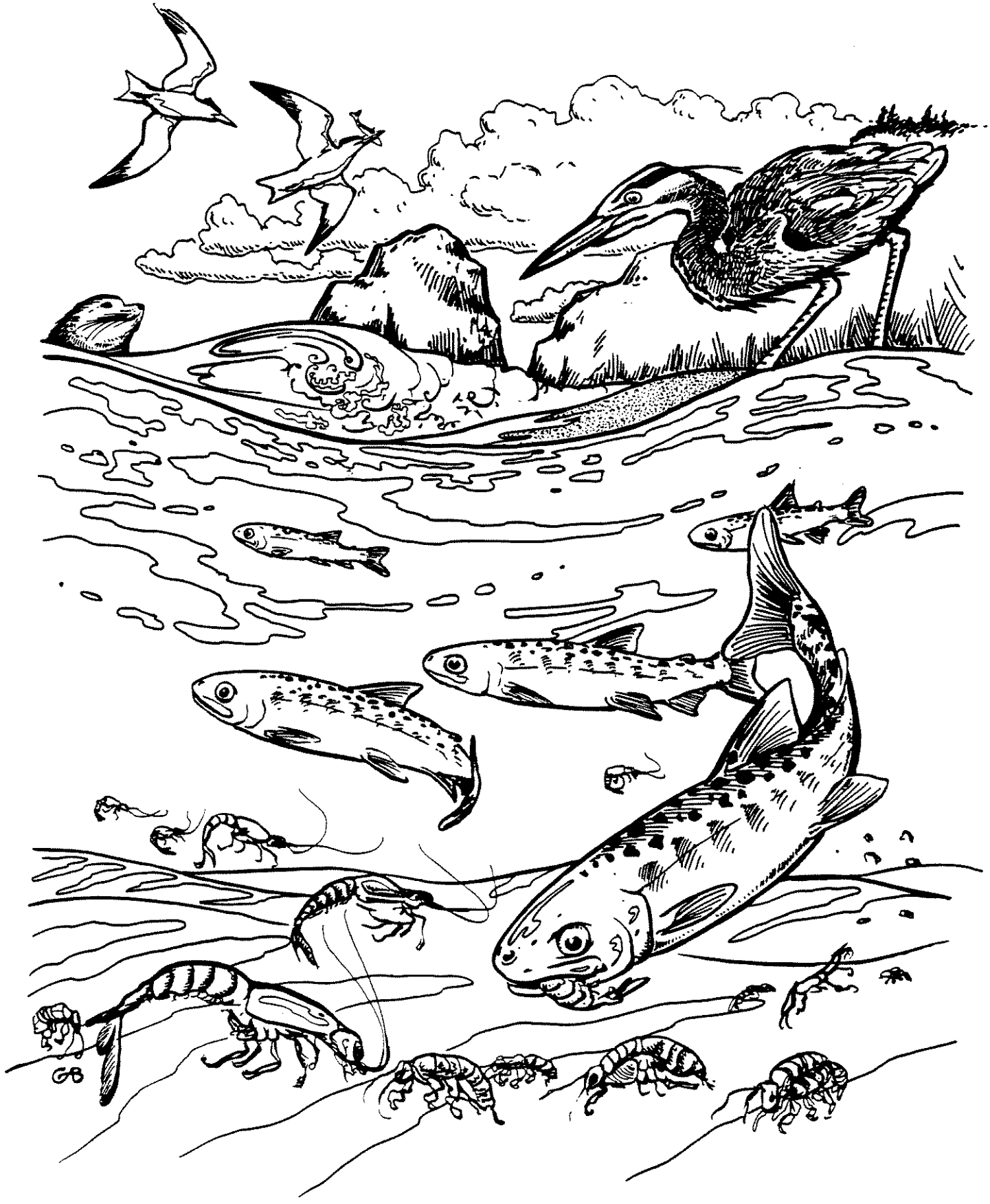
food. The brackish water widened out, like a flat bowl of soup. It brimmed with familiar things to eat from the river plus fresh, tasty creatures from the sea. Springer gulped a rich stew of insect nymphs, squid, shrimp, seaweed, and crab larvae. She drank the sharp, salty water when she wanted. Her gills worked to squeezed out extra salt from her body with no trouble.

In this place next to the sea, water braided its way by many banks, and carved deep channels at the center. Surging waves from the ocean rolled regularly through the estuary. When it receded, it tugged whatever it could back out to the ocean. The noise was like an engine driving the many, wonderful mysteries here.

Springer had plenty of places to roam. She rode and dove in the estuary waves and ate like a fast-growing teenager. In the next two months, she grew two inches longer. She changed color to match the salt water. Shiny silver covered her sides. Each day her scales grew thicker and tougher, until they nearly hid her parr marks. She was becoming a **smolt**, getting ready for the sea.

One day a hunter skimmed through the blue sky. It was a bird with a harsh nasal call. A shining fish body in the estuary below flashed in the noon day sun. The hunter interrupted its flight and its call in a twinkling, and dove from the air to the water. The black-capped arctic tern that flew on strong, slim wings in the winds over the sea, caught a smolt just like Springer. The smolt became dinner for the ocean bird.

By fall, thousands of smolts roamed the rich waters in the mouth of the Klamath River, and food began to be scarce. Springer's growing appetite became a problem. She always felt hungry, and never free of danger from hunting birds. She needed deeper water for protection for her



bright, six-inch-long body, and she needed a greater diet. It was time to move out to sea.

To get out to sea Springer had to pass by a dangerous place on the **sand bar**. Sea lions picnicked there. They lolled about at the end of the barrier between the estuary and the ocean every September. They liked to eat Springer's fall Chinook cousins that returned to **spawn** in the river. The adult salmon were fat from their years at sea, and they made a fine sea lion picnic. The lions caught the salmon as they swam through the narrow neck between the sand bar and steep side of the estuary. Springer must swim the curving neck of the estuary, too. She was a smaller and more difficult target for a sea lion. Still, she could be part of the picnic, in a pinch.

Springer and the mass of other smolts ready to go to sea, waited for a surging high tide to help them move quickly by the sea lions. Then with careful timing and the right tide, the smolts rushed together into the inlet. The powerful tug of the ebb tide snatched Springer's body into the ocean. A rolling breaker seized her and sent her spinning in seething, white foam at the surface. She righted herself and plunged beneath the bubbly foam. In minutes she found a current, like a river in the sea, and followed it. She went in a northerly direction in the great Pacific Ocean, with other first year salmon smolt following her lead. Now, Springer faced new adventures in her quest.

Chapter 11 Shark Attack

Springer swam north along the California coast from the moment she righted herself in the ocean. She was light! She was buoyant! She was as fast as a six-inch torpedo in salt water. Each push of her rippling muscles carried her rapidly forward. Her tail, like a fanning silver blade at the end of her spine, waved after each sideways flex of her body to drive her faster ahead. She could drift at sea almost as fast as she could swim in the river. In the first minutes they bounded into the ocean, she and the other smolts covered a mile. When Springer was hungry, she simply opened her mouth and gulped in small creatures she overtook. Springer and her school of salmon ate without slowing down. The Pacific Ocean was a fine place for Springer to be, but a fine place for Springer is good for other creatures, too. The smolt faced new enemies in her quest, far from home.

Strange messages came from everywhere. Mysterious sounds of the sea came on cross currents to Springer's lateral lines. They came from the great reaches of the deepest parts of the ocean--maybe a hundred miles away. These were voices that rumbled and boomed like cannons from whales and fish the size of a house. Springer ignored the noises for now. She had something to take care of first. She searched for a depth that suited her best by swimming to the surface of the sea and then down to its floor. She discovered how good it felt in a current where it was warmer and less salty. In awhile, she stuck to the top thirty feet of the water.

While exploring the sea around her, she sensed many differences from the rivers. There were no sides to the sea; no walls of rock rose through the surface, no dirt banks packed with roots at the edges, no bushes.

There were no reflections; no tall shadows from trees, no wild flower colors, no lights at night. Instead, muddy green **kelp** plants reached from the floor of the ocean. The kelp, with bladders of air to lift them, waved and stretched out for miles in the current Springer followed. The seaweeds made good telltale signs to keep her close to shore. They provided her, also, with shelter. She often hid in the branches of kelp. After a quick getaway from predator fish--that were bigger and bigger in the sea--she swam into the tough arms of kelp that grew steadfastly here.

Winter months passed. Springer grew fast, adding plenty of **herring** and small shellfish to her diet of larvae and **plankton**. She was strong. She put on bursts of speed, like a biker peddling down a steep hill, to catch quick fish on the run. She turned faster than most fish. Because her bladder was below her center of gravity, she rolled naturally sideways and upwards. After a meal, she made a half turn in less than a second to grab her dessert. Nothing her size or smaller got by her. A deadly hunter, an athlete as well, her skills helped her eat and escape.

Something bothered her now. Sea lice stole her attention. The lice were parasites who lived on her blood. They attached themselves between the scales on her side. There they ate, they slept, and they raised families. Springer was their home. Irritated by these pests, Springer shot for the surface, jumped from the water, and came down on her side very hard. She knocked some lice off, but not all of them. They clung like fleas on a dog. Still Springer tried to get rid of the lice by jumping again and again. Tiny trickles of dark, red blood shown in the water when she dove.

From behind, a movement and sound stopped her suddenly. She quit battling the lice. Springer felt scared by spooky waves in the sea that she sensed through her lateral lines. A shark on coastal patrol made the eerie

motion she felt. The shark has a keen sense of smell. It finds anything wounded and bleeding for miles by the scent of blood.

The shark attacked her as she dashed into the kelp. The creature got a mouthful of seaweed and only scratched Springer's flesh. The small, grey shark became easily discouraged by its very poor eyesight. It lost track of Springer. The shark went to look for another meal. Frightened and dazed, Springer poked her tail between branches of seaweed to anchor herself. She became almost motionless to seal the scratch from the shark. Healed in a day, Springer left her lair and joined a new school of salmon. The school turned east with the ocean current sweeping by icy lands now. From these lands, fresh rivers and estuaries brought new food, new scents, and new salmon to the sea. Springer's school of salmon grew in numbers. They followed herring and the herring followed rich layers of plankton that floated in a circle called the **gyre** of the sea. The thick blankets of food Springer followed, sank by day and rose by night, so she swam always in darkness to eat. In the next year Springer turned south, then west, then north again in her invisible stream in the sea.

She never ignored the weird moves of a shark again, or any of the sounds of the sea. Still, there were more adventures and lessons to come in Springer's quest in the sea.

Chapter 12 Fishermen

Thick, white fog hung over the ocean this late summer morning off the shores where Springer swam. Two children watched the fog closely. They looked out at the sea from an upstairs, bedroom window in their home.

"It's lifting, Dad!" called a girl of eleven. "I can see the **breakwater** and the red **buoy** now!"

"Okay, let's go!" answered her dad.

The children's parents were ready. Bait and lunches were packed in the car, rain gear was on the back porch. All other salmon fishing stuff was already on the boat. They would put on ice at the dock.

Summer vacations were cool. The kids always were glad to be on their way to the harbor, and to the *Lorlee*. The small green fishing boat was the family's pride and joy. It was a small **troller** that fit their family just right. For many years, their dad had a crewman and fished every season to make a living for the family. Now their father worked on land in the winter, and the family fished for the love of being on the ocean, working together.

The girl and her twelve-year-old brother knew what to do as deck hands on the boat. They had important jobs. First, they helped their mother load equipment and supplies on board, while their dad cranked up the engine and prepared to cast off from the dock. Next the kids helped sharpen hooks. As their mother made **bait** on top of the **hatch** box--running the long "**crowbars**" through the silvery **herring**--the kids attached the herring to snaps on long **leaders**. The five **fathom** leaders could reach five times the length of their dad's arms stretched wide.

The whole family thrilled at the feel of the boat rocking beneath them as it took to the open sea. Fog still floated in places. The thinning wet clouds touched the kids' cheeks as it lifted, whispering things in their ears, they thought. Excited, the children had lots of questions about where they were going, but they knew they must not distract their dad. He was at the **helm**, keeping a close watch for other fishing boats that poured out of the harbor in the small, "mosquito" **fleet**. He listened to his friends on the radio to help locate them. The water was calm today, so the outgoing tide at the harbor entrance was not dangerous.

"Mom, you want me to help you with the bait? I've finished all the spreads on my side" said the boy.

"No, thanks. Help your sister on her side. I'm doing okay."

The kids finished baiting the **spreads** for the other trolling pole and then listened for the sound of the engine shifting down. When the engine shifted down it was a signal they were near the fishing grounds.

"Do you want to watch the video screen?" asked their dad. Quickly he added: "Oh! There they are! Come and see the fish on the **depth finder**. Looks like a big school of salmon close to the surface."

The kids' dad cut the boat engine to **trolling** speed. He put on auto pilot heading northwest with the fleet. He said: "We'll send down the deep lines as well as the shallow ones, just in case these guys on the screen are too small. Honey, will you watch for other boats while I set the gear?"

The two children went to work, too. They took turns helping their dad throw out the spreads, putting the lightest leads out first. Then they watched the hydraulic gurdies roll the wire lines off the **spool**, through **pulley blocks** and into the dark green sea.


Lorlee

They handled the spreads carefully. **Leaders** were snapped on at every stop and the trolling wire sprouted with herring that could get tangled going over the side of the boat.

After the floating line was out far enough to keep from tangling, the deeps were set. Six lines in all, with ten hooks each, went over the side of the *Lorlee*. Everyone watched for a tug on the lines. They did not wait long. The **starboard** float began bouncing, rocking back and forth. "Looks like a **splitter**!" cried the young girl. Their dad hauled in the line to find two king salmon.

"That smaller one's a **shaker**," said the children's father, quickly shaking the salmon free.

"We'll catch it next year," said the boy. "It's too small."

"Did you see its back fin, son?" That was a wild fish. New rule: we keep only **fin-clipped** hatchery fish. No matter what size they are, wild fish must go free!"

And so Springer, the shaker, was set free to continue her quest in the sea.

Chapter 13 Homing

Until that late summer day swimming north in the Pacific Ocean, Springer never had a hook in her mouth. In more than a year at sea she never stumbled on the fisherman's tricks. A thousand times, or more, she had grabbed a herring, crushed it easily between her tongue and the roof of her rough mouth, and gulped it down. A simple job, to catch and eat herring. She could almost do it in her sleep, if she slept, or with her eyes closed, if she had eyelids.

Then it happened. The innocent looking herring that dangled from a line off the *Lorlee* offered an immediate tug. She felt a hook pricking the corner of her mouth. She shook her head violently and tried to get rid of the sharp point of the hook, but instead drove it further into the hard **gristle** in her mouth. Springer panicked as she was dragged and then hoisted out of the water. She had no way to breathe in the air. She charged sideways, her tail batting the air in a frantic effort to be free. The wound in her mouth only grew larger.

Springer survived because she quickly was set free. She was back in the sea in time to gulp water into her gills with the oxygen she needed. Still, shock overcame her and tight cramps grabbed her sides when she swam from the boat. Her muscles had taken too much oxygen from the rest of her body when she strained to get rid of the hook. She sank to the cold depths of the sea, needing time to recover.

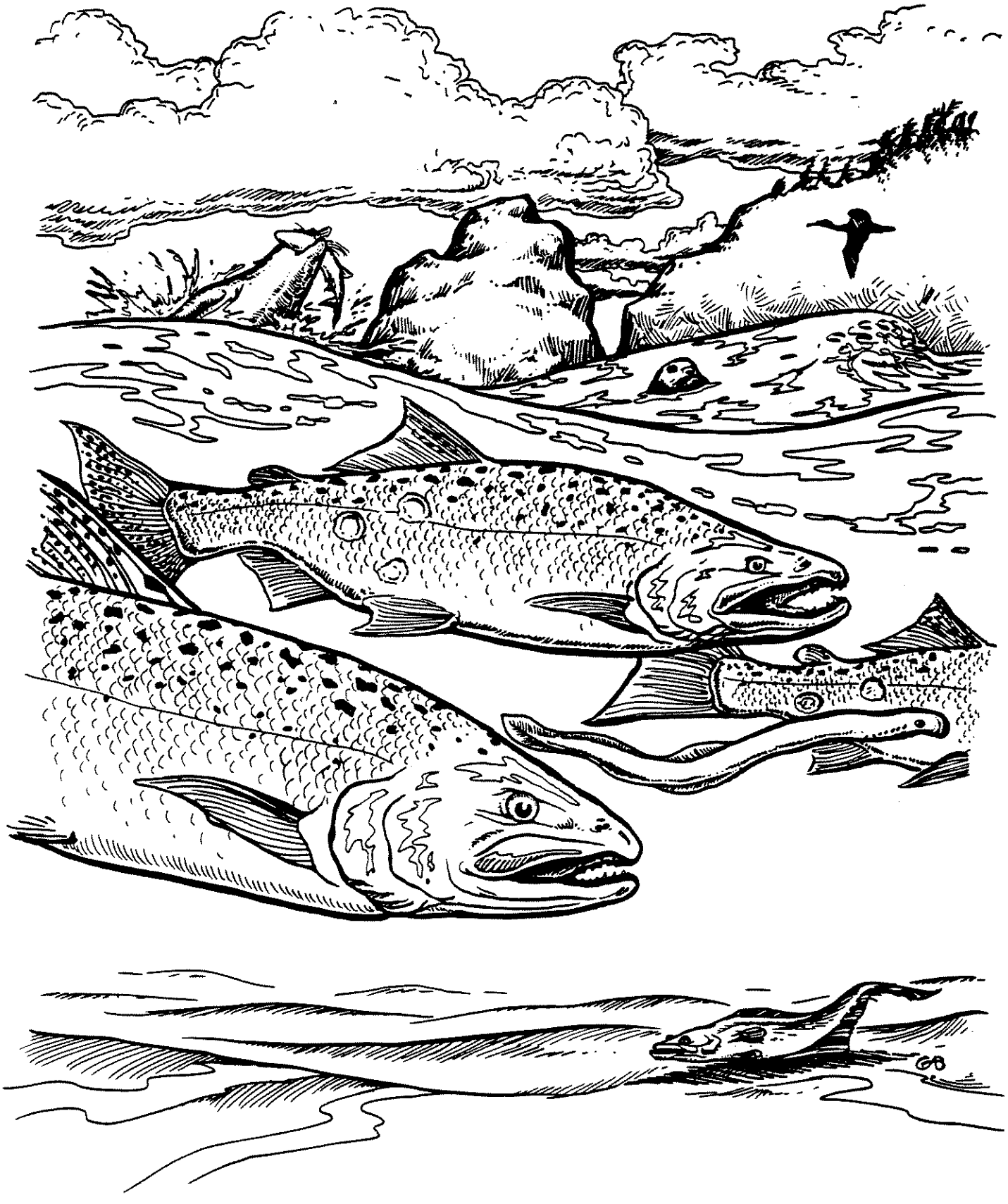
Flattened against the ocean floor, Springer was motionless for a moment. She was deeper than she normally went and there was no seaweed here to hide her. She made herself invisible to predators by remaining very still. Satisfied she was safe, she then threw her head back

and forth, testing the damage to her mouth. Her mouth and snout were tough, but she could not ignore the tear from the hook. She remained in this cold spot for hours, occasionally throwing her head to check on the condition of her wound. Finally the rip in her mouth sealed shut and oxygen flowed in her muscles again. She swam to find a new school of salmon. Hungry for herring, but wise about bait, she would hunt carefully during her second year in the ocean.

Springer began another complete circle of the sea in her third year. She remained in the counterclockwise gyre and in the familiar current. She was immense for a salmon and weighed over 20 pounds, more than a six-month-old baby. Hard muscles rippled under the silvery scales of her sides. Few predators in the ocean could capture her now. She and others who survived swam safely in their stream in the sea. Her dark back, shining with iridescent blue and green colors, made Springer look like the water she swam in by day and by night.

She was making her final journey in the gyre. Her astonishing quest would now send her back to the river where she was born. This change came over Springer far out at sea. When she felt a powerful need to go home to the ribbon-rock pool, she was hundreds of miles from the mouth of the Klamath River, even farther from Forks of Salmon. How could she find her way?

Springer used a special sensory part of her body, like birds and butterflies do when traveling many miles over the earth. She could feel a special force from the earth, something like gravity, and it drew her in the direction for home. Guided by forces from the earth and compelled by her quest, she swam faster than ever in her life. She lost interest in the sea and swam days and nights without eating. Like an express train, she was



making no stops.

One day in April all the smells, tastes, touch, sights and sounds of the sea faded away. Springer tasted and smelled her river. She was at the mouth of the Klamath River, by the estuary. Crowds of salmon were there, so were sea lions. They sprawled about on the sand bar, waiting this time for a spring picnic of fish. Springer joined the throng of big Chinook cousins waiting for the push of a rising tide. The fish were ready when the tide rolled in, and the crowd of huge bodies charged for the narrow neck of the estuary. They tried to stay far from the sand bar and the lions, but the fish next to Springer did not make it. Slowed down by a **lamprey** hanging from his side, the salmon became dinner in the jaws of a sea lion.

Springer stayed a few days in the estuary while her body adjusted to fresh water again. Her scales and her back lost the shades of the ocean. They turned brown, black and cream, like the river. Her sides took on tints of pink and red. Then it was time to go on.

When Springer left the estuary, she stopped drinking and eating, forever. She began steadily swimming up the Klamath River, against the current. She had no trouble at first; she felt strong. Traveling upstream was not easy, however. The water was high from melting snow in the mountains, and it was swift. After some miles, she stopped to rest in Blue Creek. The deep mouth of the creek held many huge salmon in the **spring run** up the river. Springer swam lazy circles in the water with the others. She waited for the time to leave on the final journey of her quest.

Chapter 14 The Spring Run

While Springer waited at Blue Creek a few miles up the Klamath River, a very old ceremony began. In an ancient place called Amekaram was a priest of the **Karuk** people. The priest made a fire in a sacred, sweat house. He burned the first salmon caught in the river and then he sent a message in the smoke--the spirit of the fish--to any who followed. The message for the spring run was sent down the river to Springer and the other fish waiting. The message was sent all the way to the sea while salmon still searched for the mouth of the river.

The message of the spirit of the first salmon was simple. The message told how well-treated the salmon was and how great an honor it was to feed The People. The priest also prayed, asking for return of the salmon and that the fish might swim up the river quickly.

At Blue Creek, Springer moved quickly. More fish crowded into Blue Creek's clear water, so Springer went on up the river. Each day became longer, moving into summer. Fish swarmed at the mouth of every stream, where they rested before continuing their long swim upriver. The big salmon also packed into dark, backwater pools wherever they found them. Sometimes, Springer felt tired, but the drive to get home pushed her on. She continued to ignore all the food drifting around her and depended for energy on the fat she had stored at sea.

Again, Springer changed in appearance. Her belly began to swell and her head took a new shape. Her snout grew a small hook over her mouth. She grew darker every day in the river until she looked like a black shadow. Only white scars from the sea lice shone on her sides. The male fish that swam up the river with Springer changed, too. They glowed with flashing bright red

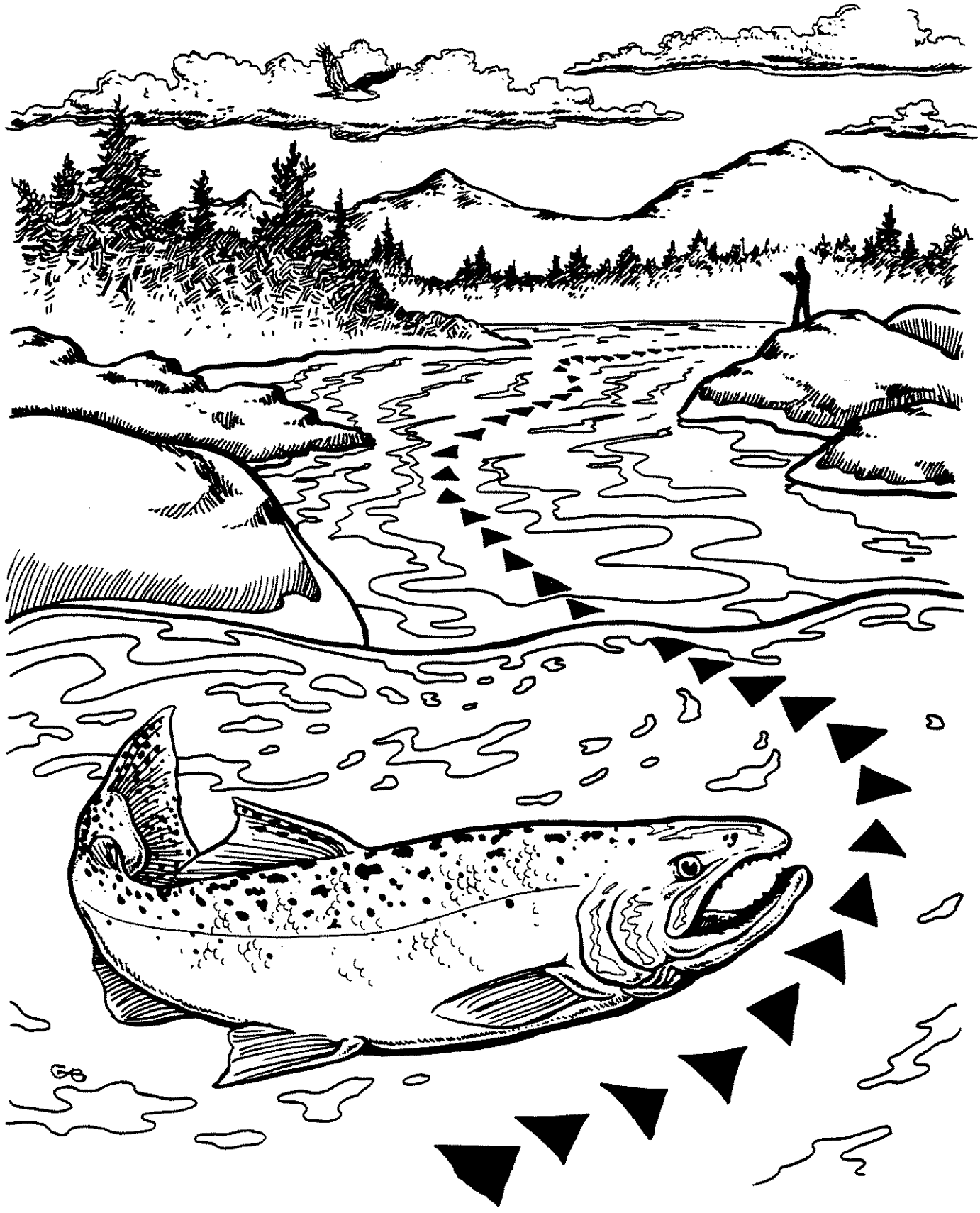
colors and sharp hooked snouts that made them look fierce.

For two weeks, Springer pushed forward against the current. The warm, spring days had melted snow high in the mountains, and the Klamath River was swollen and muddy. Springer could not see in this muddy water, and it was impossible to fight the strong, main current. But Springer was determined to continue, so she swam in the gentle water at the river's edge, and let her lateral line guide her.

Then came a break one day. At the sweeping turn of the Klamath River by Somes Bar, Springer found crystalline clear water that reflected blue sky. This was the mouth of the Salmon River. Springer wasted no time. She split off from most of the fish that swam with her, and left the Klamath with relief. The clear waters of the Salmon River saved her. Her curious quest could continue.

Springer had one other advantage. She had few worries with predators at this time in her life. She was safe from most birds and animals now. While she felt well, she was too big, and too strong, and too clever for fish-ducks, herons, osprey, even bear. Now she felt better in familiar water again, and she put on speed. She knew where she needed to go and she had only one drive--to get there. She was close! She could smell the ribbon-rock everywhere.

New difficulties faced Springer, however. The water in the Salmon River showed all the signs of old storms. Trees and logs laced the river, creating small waterfalls and dreaded **plunge pools** in places. In these pools where waterfalls fell, Springer rested before jumping. Sometimes she must leap six feet high over the falls. It may take several tries and much energy. Some pools held the bodies of salmon who died making a great effort to hurdle the falls. The plunge pools were good hunting spots for bears.



Springer swam under many fallen trees and jumped over many waterfalls until finally she reached Wooley Creek. The cold, turquoise water under the towering bridge was deep with the spring rains and melting snow. Springer and other salmon of the spring run rested there.

Three of these salmon waited to climb the steep channel of Wooley Creek to their birthplace. Springer and the others were still many miles from home. Not all the fish could go on. Some, too exhausted to leave Wooley Creek, floated at the bottom of the pool, their lives ended.

The towering bridge over Wooley Creek, of course, was the very same place where Arthur sat two and a half years earlier and looked for the fry he named Springer. Arthur was now a tall fifth grader. Thor was a full-grown dog. Mikie was eight, and for his birthday this year had received his own puppy from Claire. Cousin Claire's puppy had grown up to have puppies of her own. The boys' little sister, named June for the month she was born, was two years old today.

Chapter 15 "Springer is Home!"

Springer stayed at the Wooley Creek junction for the whole month of June. She moved little, deep in the pool, and often drifted into a sleep-like trance. Then, one day in early July, Springer snapped awake. The river was flowing just right--it was time to move on. As Springer swam upriver, the scents of Wooley Creek fell behind her. Each time Springer passed a large **tributary** or a tiny rivulet running from a spring in a mountain, she recognized special smells. The Salmon River became more familiar each day on her way toward home.

Springer was going home if she could, but her body was wearing out. It had been seven weeks since the day in May when she stopped eating and left the estuary. She had used much of her fat swimming against the current for so long; she had very little energy left for any more obstacles in her path. Now, the rugged Salmon River was the greatest challenge of all. Each riffle of swift water over boulders and **cobbles**, each steep **cascade** over bedrock, each channel, backwater, **scour** and plunge pool challenged Springer to succeed. She swam slower and slower. She stopped more often to rest in little pockets of water behind rocks. She even squeezed into shallow corner pools where she had to remain close to the surface. This was against her nature. Exposed in this way, a bear could catch her.

She flattened her frayed fins next to her body to streamline her shape and increase her efficiency as she steered slowly toward her goal. Still, Springer lost more strength with each passing day. She often saw dead salmon. These members of her spring run from the sea had survived as fry in their trip down the river; had survived the estuary and two years at sea;

had survived the birds, and the sharks, and the hooks; but they did not make it to their homes. These salmon making a quest, like Springer's, were finished.

As Springer inched her way along, July and August passed. The river grew shallow and thin, and warm. It was not easy to find cool places to rest in. Springer laid up a week in a pool with four tired fish like herself. The nights turned cooler. Finally one September day, it rained. Refreshed, Springer moved up the river again. She was nearing her destination, painfully working her way through one more riffle, when a sound from the past greeted her. Children played by the river.

"Look, here comes a salmon!" shouted a small girl. The preschool children, dressed in colorful fall clothes, stopped their search for bugs on the bank of the river.

"Ooey, what's that funny looking white spot on the fish?" asked one child, making a face.

"What's the fish doing?" asked someone else.

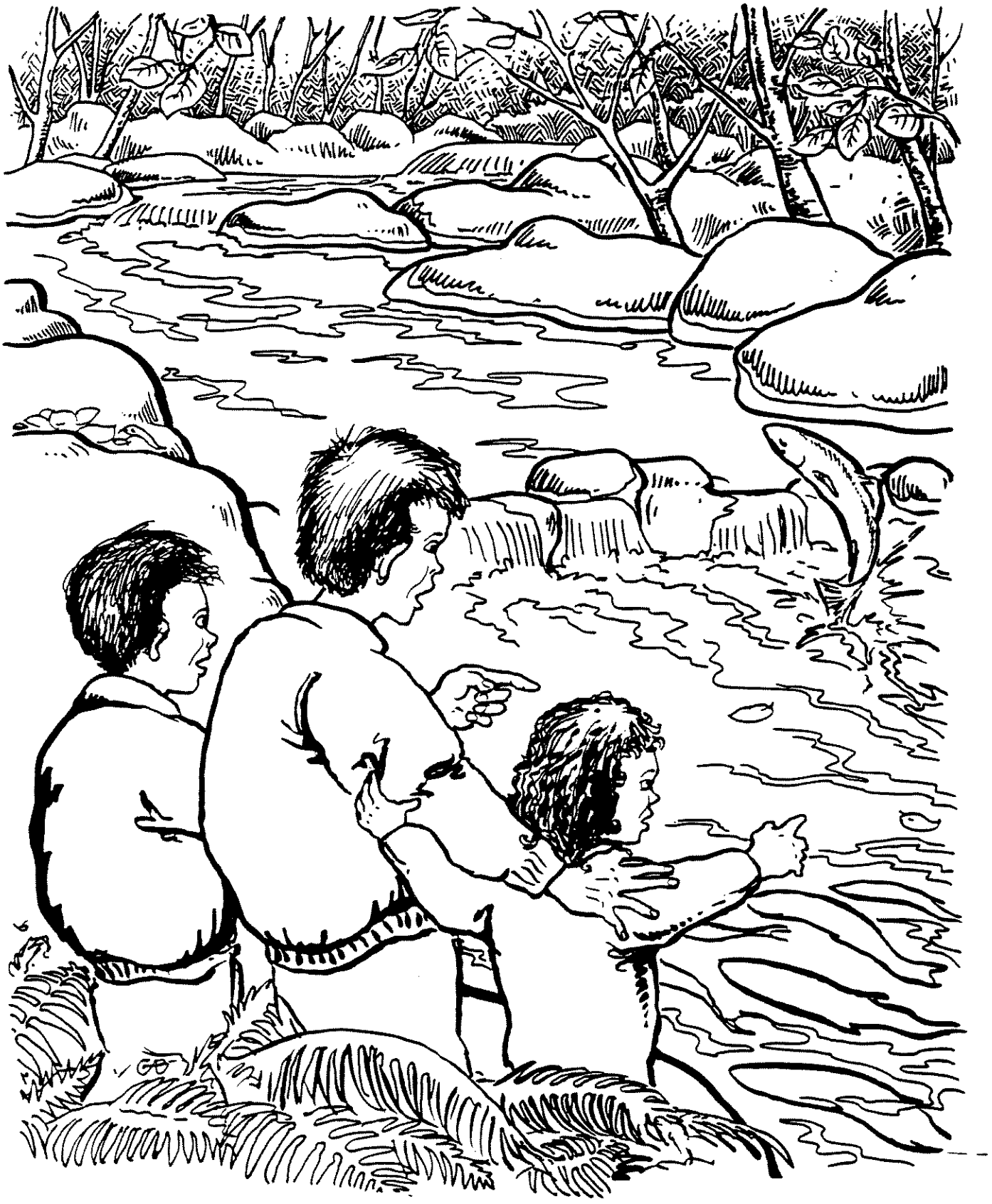
"Where's it going?" "Does it have friends?" "What do they eat?" "How do they sleep?" "Does it eat bugs?" "Where has it been?" . . . The questions did not stop.

The little girl who spotted the fish ran to her teacher. "Mommy, can we go and get Arthur and Mikie?"

"Yes, June. I know they'll want to see this salmon," her mother said.

Arthur, Mikie, and the other kids in Forks of Salmon School came running down to the river with June and her mother. Other teachers were close behind.

"Wow, maybe it's Springer!" yelled Arthur. He was excited. He stood next to his mother, almost as tall as she was now.



Mom! Look! She's going upstream! I think she's on her way to the campground."

"Yes, Arthur. We'll check the **spawning area** by the campground every day. If it's Springer we'll see her." said his mother.

"I hope Springer is home!" added Mike, with a whoop and holler, "Yippee-Yeah!"

Chapter 16 Spawning

Springer reached the ribbon-rock pool shortly after the children saw her swim by. She stopped her migration upstream and rested one final time. In the familiar pool where she was born, she waited through days and nights as still as a statue. The nights began to grow cooler. The river flow went up. The water dropped degrees in temperature. Surely her quest was nearly over. What was she going to do now?

In the second week of October Springer stirred from her trance. She began looking over the foot of the pool. She swam above layers of cobbles that once-upon-a-time hid her safely in a redd. She traveled along the bank where the salamander stood. She moved up to the bubble curtain at the head of the stream where young steelhead trout still swam. Finally she turned to the deep corner pool by the shining, white ribbon-rock where the water had tossed her about as a fry. Her survey was done.

She returned to the cobbles. She tested them with her fins, and her snout, and her tail. She found some just the right size. Her movements then became strangely mechanical. As if controlled by the push of a button, she began to clear the coarse gravel for a nest. Back and forth, back and forth, back and forth she went. She pushed a rock here and she pushed a rock there. Attracted by what Springer did, a bright, red male salmon came close to her. He chased off another male that followed.

Springer never stopped her work for a moment. She rolled on her side now, and crisscrossed the area she had cleared. She slapped her tail on the cobbles. Dust and dirt billowed in the water around her. She kept on working. Repeatedly she pounded her tail on the rocks, sweeping away clouds of silt. Next she fanned her tail over the cleaned rocks pushing them

downstream. She began to create a large bowl.

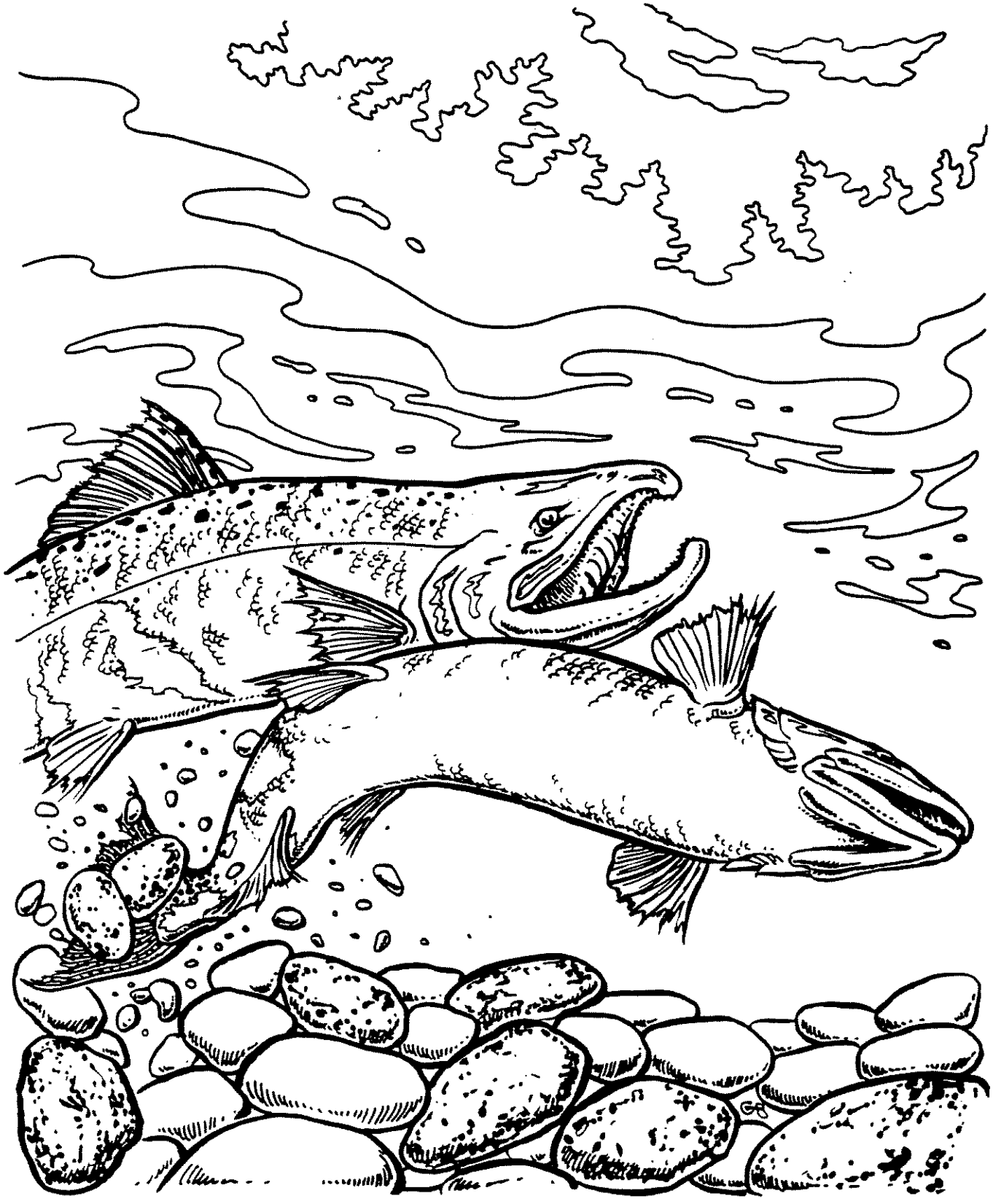
Hours and hours she worked. Night time came and then the next day. The bright red male never left her side. When she was done, she moved slowly to hover over her nest. She waited. Suddenly she moved to the tail of the redd, shook herself slightly, and released a thousand eggs from her body. They looked like small, pink peas. They settled into the clean, gravel nest because they were heavier than water, Her faithful partner moved over the eggs, releasing a cloud of milky white **milt**. This fertilized Springer's little pink eggs.

Then Springer started all over. She moved upstream a little and built another nest. She slapped the stones and fanned her tail. She pushed the cobbles to send them rolling gently over the eggs in the first nest, covering them safe from harm. Then she laid more eggs that were covered by the milt of the male. With her tail worn and frazzled like an old cleaning rag, she repeated the slapping and fanning treatment for another, final time. The male drifted away to die, after his part in creating new life was completed. Alone, Springer covered the last of the eggs in her redd.

Sunshine sparkled like silver glitter early the next morning. Frost coated rocks, and bushes, and pine needles in the trees. Thor barked urgently down at the river and Arthur ran to see what his dog had found. He barked while Springer still flopped over her redd.

"C'mon! This may be the last time we see Springer!" Arthur yelled when he went to get Mikie. "She's made her redd. Y'gotta see it! She's almost dead. She's finished her quest."

"What do you mean, Arthur? I don't understand, . . ." asked Mikie. Arthur was already gone back down to the river. Mikie pulled on his



clothes, and ran.

At the river Arthur stood quietly watching Springer. She was finally limp in the water. Her tail was frayed, and she was faded. The white scars on her sides stood out. She lay over the redd she had carefully covered with shining cobbles.

"Why did she go to the sea and come back?" Mikie asked.

"I think she went to the sea to find out what it was like, and she came back because this was her home. She liked it better, here." Arthur said seriously. He watched Springer's body with awe.

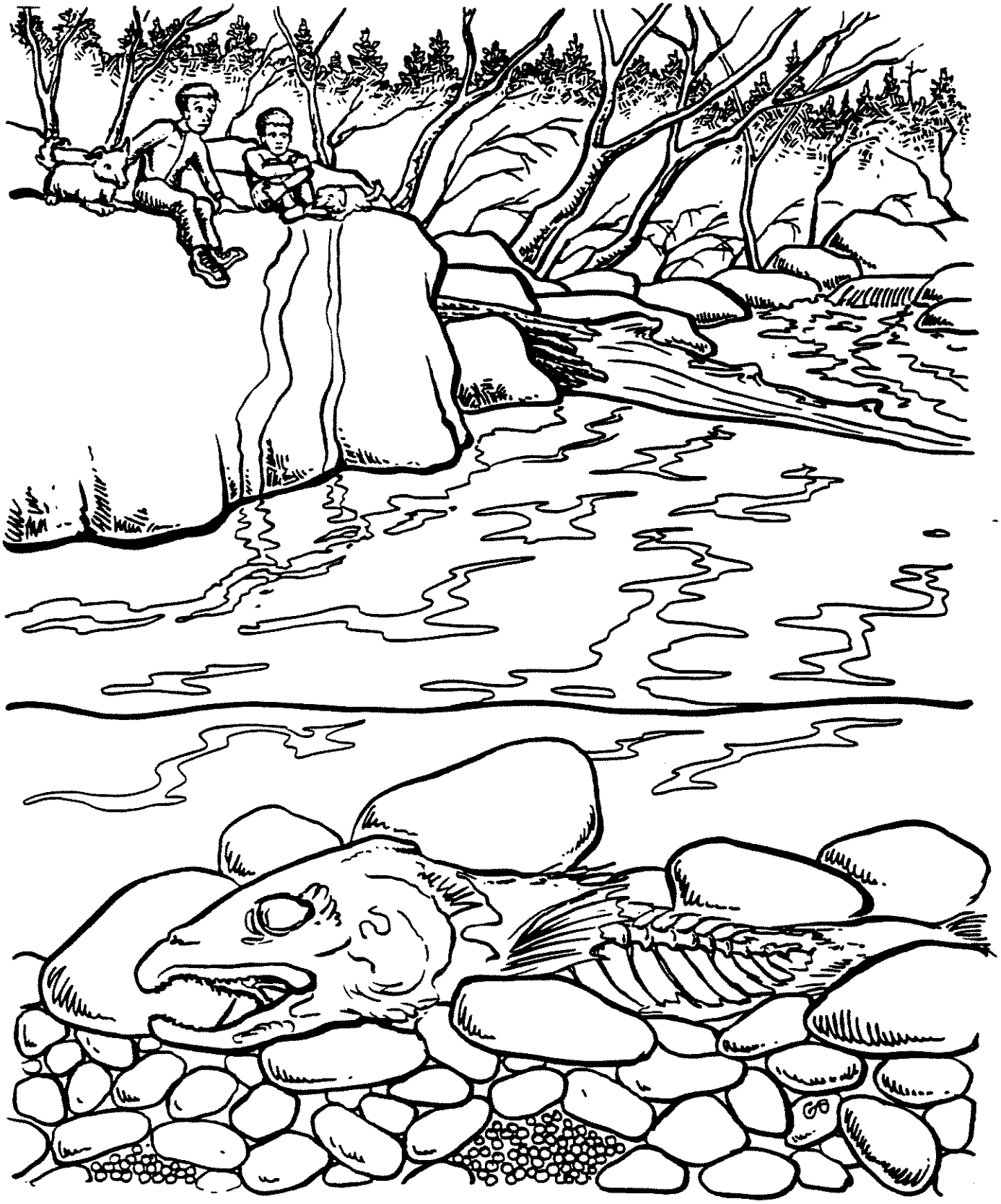
Mikie thought for a minute.

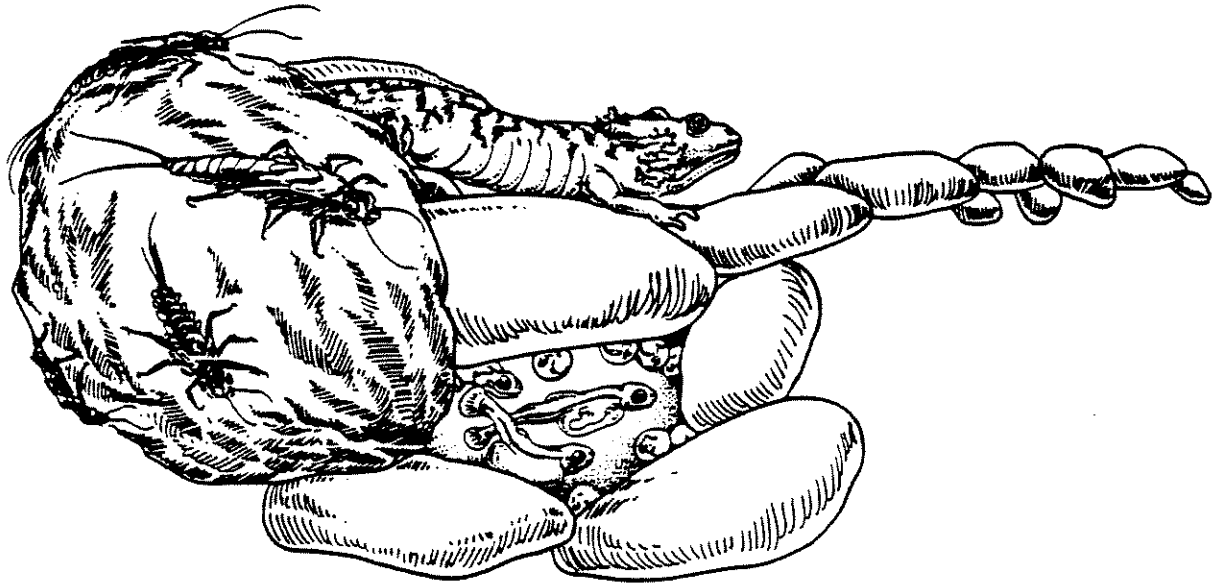
"Y'know what, Arthur?"

"What?"

"I think Springer went to the sea to grow up. I'd like to go to the sea, too!"

More than three months went by. Thanksgiving and Christmas holidays passed and a new year began. When a snowy day in February dawned on the white, ribbon-rock, and cold, mountain stream, Springer's redd still lay safely hidden under smooth, speckled cobbles. Among the thousands of eggs in the nest, one bounced. Then the egg, with a perfect embryo inside, began to shudder and shake. After hours of work, the embryo-egg broke its shell. The first alevin to emerge wiggled and squirmed. It disrupted the nest, so other eyed-eggs joined the ruckus in the river. Soon, thousands of baby salmon bounced in the nest. For redd and rocks, for river and mountains, two more months would pass while the wriggling alevin grew ready to become swim-up fry. Only a stately stack of white bones returned minerals to the river and marked the secret salmon nest with its place of new life. Many were the gifts from Springer's quest to the sea.





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Lessons and Student Materials

Chapter 1- A Secret Nest

Cold water rivers and streams are often habitat for salmon. Salmon and trout need cold, clean water flowing over and through gravel and cobble river beds. There should not be too much fine sediment in the river bed.

Salmon nests are called redds. The adult female salmon makes a redd by turning sideways and fanning her tail to make a hole in the gravel stream bed. Eggs are deposited in this hole and covered with gravel. This fanning and digging is what cleans the gravel of algae and silt. A redd stands out from the surrounding, undisturbed gravel.

The eggs and alevin are buried up to two feet deep and live in the spaces between the rocks. Water flows through these spaces too, bringing the eggs and tiny alevin oxygen and carrying away wastes.

When the salmon embryo inside the egg shell develops eyes, it is called an eyed egg. The eyes are dark spots that clearly show through the egg shell.

As the embryo develops, the nutrients inside the egg (mostly rich oils) become encased in a large sac on the embryo's stomach. After hatching, this sac provides food for the young fish, which is called an alevin as long as the sac remains. (The salmon's mother provided a sac lunch.)

The alevin remains under the gravel while it continues to grow. It is very small, and can wiggle around in the spaces between the rocks. It avoids light at this stage - an instinct that helps it survive. If the alevin swam toward light and out of the gravel, it would become easy prey.

Fish breathe with gills. Water enters the gills through slits on the side of the fish's head. It flows over folds of membranes that absorb oxygen from the water.

Difficult Pronunciations

alevin ('**al** e vin) rhymes with pal e fin
salmonids (sal '**mon** ids) stress **on**

What is an egg?

Materials:

Picture of egg life stage picture, 1 for each student
Pictures of other types of eggs, including birds, amphibians, reptiles, insects, crustaceans and other types of fish.
Crayons

Procedure

Discuss the parts of an egg. Eggs contain a protective shell, nutrients (yolk) and a developing embryo. Ask children to think about a chicken's egg. Compare the chicken egg to the salmon egg. They both have a shell, but the shells of bird eggs are hard and brittle. The shell of a salmon egg is soft and not brittle. Both contain yolk material that feeds the developing animal inside.

Show children pictures of other types of eggs and discuss what kinds of animals they are from. Make a list of types of animals that lay eggs. Discuss where the eggs are laid and how the parents care for them. Birds usually sit on their eggs and guard them. Some reptiles and fish also stay close to their eggs until they hatch. Other animals, like salmon, frogs and salamanders do not protect their eggs. (Salmon do stay close to the redd, until they die.)

Children can color the egg picture and label the parts: egg shell, embryo, eye, yolk.

What is an alevin?

Materials

1 Copy of alevin life stage picture for each student.
Pictures of other larval forms, such as tadpoles and insect larvae.
Crayons

Children will probably be most familiar with tadpoles. Discuss how the tadpole hatches from an egg, like the salmon. It does not look just like the adult frog, and the alevin does not look just like a salmon. They must go through changes. Discuss these changes.

Children should color the picture of the alevin. They may also label the parts - eyes, fins, gills, yolk sac.

Build a redd

Materials (for each group of students)

- A paper plate
- Blue paint
- Pink or orange clay
- Gravel from a stream Should be smooth and about 1 inch in diameter. Each group should have enough to cover the bottom of the plate

Directions

1. Paint the plate blue.
2. Put the gravel in the center of the plate. Some gravel may be placed on top of the bottom layer.
3. Notice the spaces between the gravel. This is where eggs live.
4. Make eggs from the clay. Eggs should be about 1/4 to 1/2 inch in diameter.
5. Place the eggs in the spaces between the gravel.

Chapter 2 Swim-Up Fry

As nutrients are used, the alevin's sac shrinks, until it finally is gone. The hole where the sac attached to the stomach closes over, or buttons up. At this point, the alevin becomes a fry. It must now find food, and begins its journey out of the gravel.

Sometimes, as many as 90% of the eggs in the redd never emerge from the gravel. Mortality is caused by a number of factors, including shifting stream beds during high flows. A redd may be scoured away and the eggs dislodged. Or, the redd may be buried under many feet of gravel and debris, trapping the tiny fry. If the water is carrying too much fine sediment, it gets deposited in the spaces between the gravel. When the gravel gets filled with silt, water cannot flow over the eggs, and they suffocate. Sediment can also form an impenetrable layer, like cement, over the gravel surface. With all these potential problems, successful emergence from the gravel is a big event.

A swim-up fry is about an inch long. It must find its way through a maze that is 10 to 20 times the length of its own body.

Fish have air bladders that must be filled before they can swim. The bladders act a little like floatation devices - they help the fish float in a level position. Fish can adjust the amount of air in their bladder as needed in various water conditions.

Salmon, like all animals, have instinctive behaviors that help them survive. Avoiding light as alevin, swimming out of the gravel to find food, gulping air into their bladders, and swimming are all instincts, not learned behaviors.

Fish are covered with scales that protect their skin. The scales are covered with slime, which helps the fish resist diseases.

Silt in gravel - Demonstration and discussion

Materials

- Quart sized canning jars
- Gravel - enough to fill both jars
- Clay
- Sand or silt
- Water

Preparation

1. Make several alevin shaped figures from the clay.
2. Place some "alevin" in the bottom of each jar.
3. Fill both jars with gravel.
4. Pour sand or silt into one of the jars until most of the spaces between gravel are filled in.
5. Fill jars with water.

Discuss the events of chapter 2 with students. The tiny fish had to swim out of the gravel, where they were buried. Was this dangerous? What might have stopped them?

Look at the model redds the children made, or at the jar with no silt. Try to map a route that the fry might take to get out of the gravel.

Now ask, what if the spaces were plugged? Show children the jar with silt. How could the fish get out of the gravel in conditions like this?

Discuss how gravel can get plugged with silt. When the land has been disturbed or when there is a landslide, the soil erodes and washes into streams. The finer particles are deposited in the gravel. What can people do to prevent this kind of erosion?

Why live in gravel? Discussion

Ask students why salmon bury their eggs in the gravel. What are the advantages? (Protection from most predators) What are the disadvantages? (All the problems discussed in the teacher's summary.)

A long way to go - Math

Swimming out of the gravel is a lot of work. How high would students have to climb, to make a comparable journey?

Materials Yard sticks or measuring tapes
newsprint or scrap paper
pencils

Preparation

Students will use the paper to mark heights of their partners. Tape several sheets of paper to a wall 3-4 feet from the floor.

Look around the school yard for an object that is about 50 feet high, such as a tree or building.

Procedure

You may have students do their own calculations, or you may solve the problem as a class. Students should work in pairs to measure their heights.

Ask students to imagine that they are buried in large rocks. If they were to climb out, like Springer must, how far would they climb?

Working in pairs, students should mark their partner's height on the paper, then measure the distance from the floor to the mark. The heights should be rounded to the nearest foot.

Assume the emerging fry is 1 inch long and swims 1 foot up through the gravel. How many times its own length must the fish swim? (12 times its own height.)

If students had to climb a distance that was 12 times their height, how far would that be? (For a height of 4 feet, it would be 4 X 12 = 48 feet.)

Go outside and look at something that is about 48 feet high. Discuss what this journey might be like. Is this an easy journey for the swim-up fry?

Chapter 3 - Springer!

Streams have riffles, pools and glides. Riffles are areas of higher velocity, where rocks break the surface of the water. Water flows quickly through glides, too, but the surface is not broken, either because the area is deeper or the stream bottom is smooth. In pools, the water flows slowly. Pools are often deep areas along the margins of the stream or on the downstream side of boulders or logs, where water has scoured out a hole.

Flowing water makes currents and eddies. When water hits a big surface, like a stream bank or boulder, it is pushed backwards, making a back eddy. Something floating in a back eddy is actually carried upstream. Often, a backwater pool is also formed where there are back eddies.

Bubble curtains are areas of white water - where the water tumbles over rocks. Larger fish often hide under bubble curtains. These areas are high in oxygen, often carry insects and other food items, and provide visual cover from predators.

Small fry are not strong enough to hold a position in swift water. They usually stay in the margins of the stream and in pools, where the water is gentle.

Granite rocks often have veins of white quartz in them. The ribbon rock in this story is a large boulder with a big vein of quartz, that looks like a ribbon against the dark granite.

Fish slime can be rubbed off if they are touched with dry hands. Biologists and people who practice catch and release fishing always wet their hands before handling fish.

Stream visit - A field trip

If it is possible, take your class to a nearby stream. While you are there, observe some of its characteristics. Streams have parts that move quickly and other parts that are still. Fast moving water where the surface is broken is a riffle. Slow deeper areas are pools. Observe how the water moves as it

flows. Throw in twigs or leaves and watch the course they take. Try to find a back eddy, and see what the twig does in this area.

Look at the stream bed. Is it made of gravel? Could salmon make redds here? Where are the places where fish might hide? Look for logs, big rocks or boulders, undercut banks, bubble curtains, etc. Look for aquatic insects in the gravel and other small organisms that fry might eat.

Video or slide show

If you can not visit a stream, show part of a video or slide show to give students an idea of how a stream looks. *The Way of the Trout*, and *Miracle of the Scarlet Salmon* both contain good footage of flowing streams, salmon or trout under water, and feeding behavior. Both are available from the KREP loaning library. You should preview videos and choose segments that are appropriate.

What do salmon eat? Observation and Discussion

This activity may be done at the stream if you take a field trip.

Materials A Kick net (optional) available on loan from KREP
A pan, at least 9" X 12" to dump insects into
A container with a tight fitting lid, a small cooler and ice to transport insects back to classroom .
Hip boots, waders or old shoes
Magnifying glass or two-way viewers
Several shallow pans or plates to hold samples in classroom

Preparation

Try to collect the insects the same day you will observe them in the classroom, since the predators will eat the other insects and none will live more than a few hours without lots of oxygen. Or, you may preserve insects in a jar of alcohol (rubbing alcohol is all right for short-term preservation.)

To collect insects, place the kick net against the stream bed so the water flows through it. Use your foot to disturb the gravel,

which will dislodge insects. They will flow into the net along with dead leaves and other material. Very small insects often cling to the leaves.
To collect insects without a net, simply pick up rocks and look for them clinging to the underside. Also, pick up leaves and sticks, and check them. You will not find as many types of insects using this method.

Procedure
Tell students they will be looking at aquatic insects, which are a major food source for salmon and steelhead fry in streams. Explain that many insects are very small and are the same color as the leaves and sticks, so they should look very carefully.

Students should work in small groups. Give each group a portion of the insect sample in a pan. Let them look for insects with the magnifying glasses. They may count them, draw them, and describe them. Optional - Use the insect keys in Klamath River Studies for grades 4-6 and for grades 7-8 to identify the insects.

What is a bubble curtain? Demonstration

Bubble curtains are best observed in streams, but you can simulate one in the classroom.

Materials: A sink
Dish soap
Small objects that will sink, like marbles or clay fish

Procedure
Fill the sink with several inches of water. Place the objects, which stand for fish, in several places on the sink bottom Put a small amount of dish soap in the water and use your hand to keep the bubbles on one half of the sink. Keep water running. Let children see how those objects underneath the bubbles cannot be easily seen, while those in the area with no bubbles can be easily seen. Explain that streams do not have detergent in them, but bubbles still occur where water spills over rocks. Ask students why fish would like these areas.

Chapter 4 Giant Foes

Salmon eat insect larvae and nymphs that live in the gravel stream bed, terrestrial insects that fall into the water, larvae of other animals, and other items. They are considered opportunistic feeders - that is, their diet is flexible and they will eat whatever they find. However, salmon and trout can also be quite selective about what they eat. This is why people who fly fish must take along a variety of tied flies if they hope to entice the fish to bite. Often, the fish will only eat the particular insect that is hatching at the time.

Salmon fry have protective coloration that allows them to blend into their surroundings. They have spots on their fins and back, and round parr marks on their sides. These markings mimic the mottled colors of the stream bed. Fry raised in hatcheries or aquariums often take on the color of their surroundings, too. Those raised in light colored containers will be very light colored, and those in dark containers will be dark.

Salmon fins are designed for different functions. The shape, range of motion and placement on the body are all finely tuned to allow the fish maximum speed and flexibility. The adipose fin, the one with no apparent function, is unique to salmonids (salmon, trout and char) and is one of the distinguishing characteristics of this family of fish.

Pacific Giant Salamanders live in the stream during the larvae stage, and can be voracious predators. They have large, external gills on the sides of their head. Sometimes, if there is plenty of food to be found, the salamanders never leave the stream at all, and become sexually mature as larvae. Those that do leave the stream lose their gills and live in damp places in the forest, like under fallen logs.

Salmon fry are an important part of the food web. Many animals consider them delicious meals. This is one reason why salmon must lay so may eggs. Most of them will not survive to maturity.

Predators and Prey

Materials Pictures of various plants and animals that live in or near streams
Drawing paper
Colored pens or crayons

Procedure

Discuss the events in chapter 4. Recall that the fish were eating larvae, and that they in turn were eaten by a crayfish, and by a salamander. Draw this relationship on the board with arrows connecting predators and prey. The tip of the arrow should point to the predator. Example: larvae ⟶ fish. Discuss the meanings of predator and prey.

Display pictures of the various stream animals. Ask students which are predators and which are prey. Which animals might the predators eat? Is it possible for a predator to also be prey?

Students should draw a picture that shows some predators and some prey. They should then connect the predators to the prey with arrows. There may be more than one arrow for each animal, that is, each animal may eat (or be eaten by) more than one type of animal. Be sure to include salmon in the picture.

Fish Parts

Materials 1 or more trout, or salmon, whole if possible
(Check fish markets or a local hatchery)
A pan for each fish
Dissecting scissors and probe
Tweezers
Newspapers and paper towels
Magnifying lenses
Fish Parts worksheet - 1 per student
Student scissors - 1 per student
Paste
Crayon and pencils

Preparation

Sometimes, hatcheries will save fish that die for teachers to use for dissections. If you live near a hatchery, call them to discuss this possibility. Otherwise, call or visit a local fish market and ask about getting trout or salmon with heads still intact. Most likely, the fish will be gutted, but if you are not planning a dissection, this won't matter. You will be observing the external features of the fish

Procedure

Choose a location where all the students can see clearly. Make allowances for those students who may feel uneasy about dissection.

Cover the work surface with newspaper and paper towels. Keep sharp tool out of children's' reach.

SKIN Let students feel the fish's skin. Discuss the purpose of slime. *(It protects against growth of fungus and it helps fish slide through the water).*

SCALES Use a magnifying glass to see how the scales are arranged in an overlapping pattern. Why do fish have scales? *(They protect the skin from constant exposures to water and from abrasions.)* Optional: Remove several scales from the fish's side and observe them with a magnifying lens or microscope. You will see concentric circles, which are growth rings. Just like a tree, a fish's age can be determined by counting these rings.

MARKINGS Look at the color pattern. Discuss the advantage of being dark on top and light on the belly. *(It blends with the dark below when viewed by predator from above, and when viewed from below, it blends in with light sky.)* Why does the fish have spots? *(So they blend in with surroundings.)*

LATERAL LINE Observe the lateral line. Discuss what it is used for and the way it works. *(The line is a mucous-filled canal in the skin. It is very sensitive to vibrations caused by animals on the land or in the water, which help the fish avoid predators. It can also sense vibrations reflected back from*

surfaces, like sonar. This probably helps fish in the coordination of schooling. The lateral line may also sense Earth's magnetic field, which may help the fish navigate in the ocean.)

SHAPE Discuss the overall shape of the fish and how this is an advantage. (The torpedo shape, streamlined and tapered, helps the fish glide with minimum resistance and to swim fast. In the stream, they can hold position with little effort.

FINS Look at placement of the fins and ask students to imagine a fish swimming in the water. How does it move? How are the fins used? Note the range of movement of each fin. Pectorals can rotate 180 degrees, other fins are less flexible.

Feel the bony rays that support the fins. Count the number of rays on the anal fin. This is one of the distinguishing characteristics among salmonids.

EYES Note the size of the eye. Its relatively large size, and the large pupil tell us how important vision is for this animal. Look for eyelids (there are none). Observe the tough, clear membrane that covers the eye. Rotate the eye in its socket with your finger.

NOSTRILS Locate the nostrils. Describe the large olfactory lobes that are located in the brain. Why are salmonid's smell receptors so highly developed? *(Salmon imprint on the smell of their stream and use their sense of smell to guide them back to that stream from the ocean. Smell may also help them detect predators and food items.)*

MOUTH Open the mouth and look at the color of the gums and surrounding area (another distinguishing characteristic, rainbow and steelhead trout gums will be light). Feel the teeth along the gum margins and on the roof of the mouth. Do fish chew? *(No, but teeth are used for grasping and holding prey.)* Find the teeth on the tongue. Does the tongue feel like a human tongue? See how wide the mouth can open. Why is this? *(It opens very wide so fish can eat large food items.)*

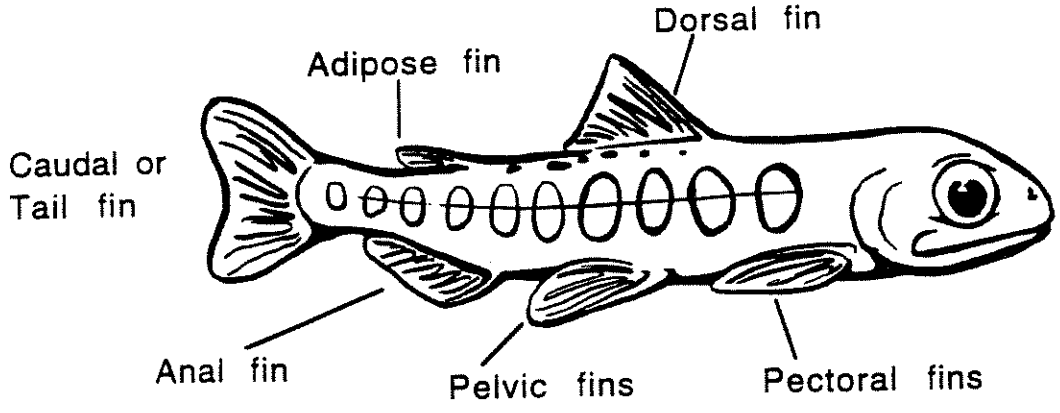
The mouth is also used for breathing. In low oxygen conditions, fish can actively pump water over gills by opening and closing mouth. Try this, relating it to the action of a pump.

GILL ARCHES The gills arches can be seen by looking down the fish's mouth. Use a probe to separate the arches and explore how they are arranged.

Place fish on its side and look at the operculum, the bony plates which protect the gills. Lift the operculum and look at the gills. Now cut the operculum away at its base, exposing the gills.

GILLS Remove the gills by cutting the upper and lower attachments of the arch. Look at the gill rakers, the bony projections along the inside curve of the arches. *(These filter out debris which would damage the gill tissue.)* Observe the large surface area provided by the gill filaments, and the thin tissue which allows blood vessels to come into contact with the oxygen in the water. Compare and contrast gills with lungs.

After looking at the fish, give students the worksheet to complete. They should cut out the scales and paste them on the fish, beginning at the tail and overlapping scales. The fins may be labeled by writing in names or pasting on names.



Chapter 5 Over the Divide

This chapter is about where rain and melting snow goes. It introduces the idea of watersheds and divides between watersheds.

A watershed is sometimes called a river basin. It is the land that drains into a particular stream, river or river system. Different watersheds are separated by divides. On one side of a divide, all the water flows into one river system, and on the other side, all the water flows into a different system. When you stand on a divide, if your view is unobstructed, you can see two river systems below, one on each side.

Some water flows over the surface of the land in sheets, but most water above ground finds it way into a defined water way, such as a rivulet or stream, which flow ever downward, towards larger water ways.

Water also percolates through the soil and flows in underground water ways. It can become trapped in great underground reservoirs, too. Water that flows underground eventually finds its way into streams. It seeps in through the stream bed or banks.

Every watershed has a unique combination of plants, animals and minerals in the soil and rocks which impart their odors to the water. All these odors end up in the stream, where salmon smell them. This is called imprinting, an idea that is developed more in chapter 7.

What is a watershed? - Demonstration and Discussion

Materials A sheet of aluminum foil about 1 foot square that has previously been used and washed or that has been crinkled and then roughly smoothed out
Two pans at least 1 foot long
Food colors - 2 colors
Watering can
Klamath River Basin Map, 1 for each student

Procedure

To develop the concept of watershed, have children face a partner and lock their hands together as shown in the illustration below. The tips of their fingers are like the ridge and each hand represents a different watershed.

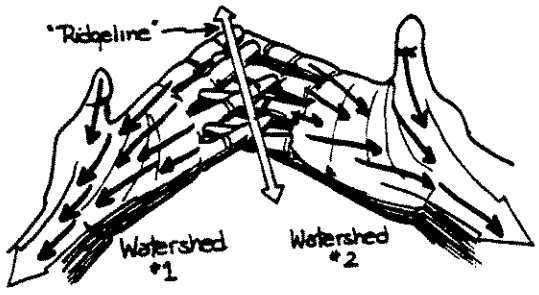


Illustration from *Project Wild Aquatic.*

To demonstrate how water flows from two adjacent watershed into different rivers, set up a simulated watershed with the aluminum foil and pans.

Bend the foil into an inverted V shape. Put the two pans side by side and place one edge of the foil into each pan. Put a few drops of food coloring into the crinkles. Use different colors on the two sides. Now use the watering can to make it "rain" on the ridge and both watersheds. The water will drain over each watershed, and will end up in the pans (which are like the rivers). Each pan will receive only one color. The two colors will not mix, because the water is taking two separated courses, just as water in adjacent watershed takes different courses.

Go outside and look for obvious ridges. Ask students to describe how rain or melting snow would flow.

Look at the Klamath River Basin map. Point out the ridges that are formed by the mountain ranges, and the different river systems.

Students should make a black line along the ridges, following the lines of mountain ranges. There is a different watershed on each side of each ridge. These should be colored differently. The streams should be colored blue.

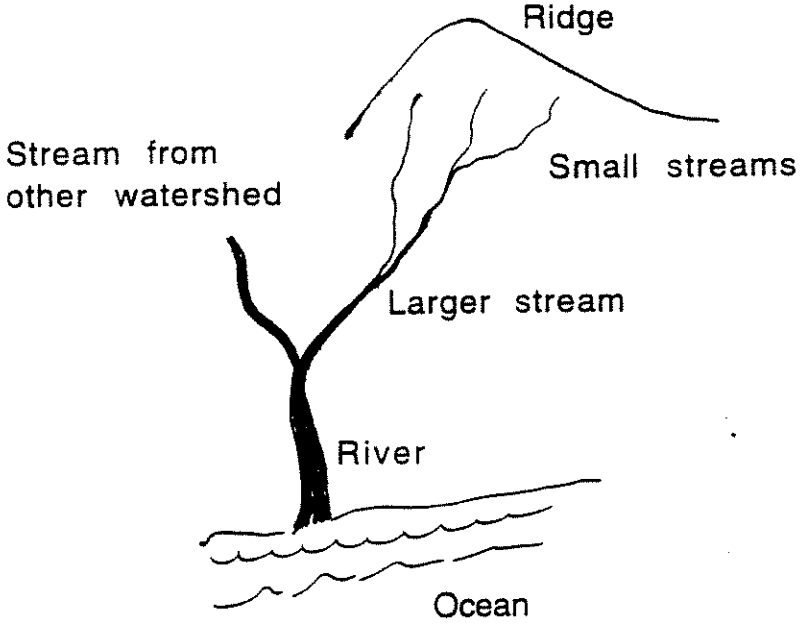
What are the parts of a river system and where do rivers go?

Materials Raised relief map of your region or a detailed map that shows river systems
Paper & crayons

Ask students to think about their experience with streams and rivers. Are they all the same size? Why are they not?

Discuss how a watershed drains water. At the top of the watershed, the water collects in small streams and rivulets. These flow downhill, and eventually join other small streams. The result is a larger stream. This continues throughout the watershed. As the streams continue to merge they grow larger until they are big enough to call a river. The river eventually flows into the ocean. (Small streams and rivulets near the coast may flow directly into the ocean.)

Students should draw a river network. They should use different shades of blue and making line thicker as they progress "downstream". Finally, their river should flow into the ocean. They may label the parts of the picture. An example is given below.



Chapter 6 The Fish Screen

A large part of the Klamath River Basin is used for agriculture. Cattle and crops require water, which is taken from wells and rivers. Usually, the water is diverted into a ditch, which leads to smaller irrigation ditches.

To prevent salmon and steelhead from swimming into the ditches by mistake, a fish screen is installed near the intake. The screen spans the width of the ditch, and is often cleaned by a scraper that is attached to a paddle wheel. The flowing water turns the paddle wheel, which pushes the scraper. Without this cleaning action, the screen soon becomes clogged with algae and other debris, and the water spills over and around the screen, defeating its purpose.

The children find salmon fry stranded near the fish screen. Most of the rivers and streams in the Klamath River system have salmon and/or steelhead. They all go to sea, and eventually return to their home stream to spawn. Although the fish are the same species (all chinook salmon, for instance, are the species *Oncorhynchus tshawytscha*) they are considered distinct races, because they are geographically isolated from each other and do not interbreed. Thus we have different "runs" of fish, such as the Scott River fall chinook run, and the Salmon River fall chinook run. Run times often vary according to seasonal rainfall patterns in each river basin.

In this chapter, the mother dog briefly nurses her puppies. Dogs have only a few offspring at a time, and care for them for several weeks after birth, so mortality is low. Salmon, however, die shortly after spawning and do not care for their babies. The offspring are on their own right from the start, and their mortality is high. This is one reason why salmon lay thousands of eggs while dogs have only several puppies at once. Also, a dog can have several litters in her life time, while a salmon gets only one chance to spawn.

How do different animals care for their babies?

Make a list of the animals that have been in the story so far: salmon, crayfish, salamander, birds, dogs, cattle, people. Ask students how these animals cares for their young. How long do the young stay with the parents? Students may not be very familiar with some of these animals, but they probably know about birds, dogs and people. Compare and contrast the type of care each young animal receives. The salmon and salamanders never know their parents. They are left to fend for themselves. Crayfish eggs adhere to the mother's tail, where they stay briefly after hatching, until they have grown their own shells. Birds feed their young until they are ready to fly away. Mammal babies stay with parents longer.

Now discuss the number of offspring each of these animals bears. Those that give no care, or minimal care, often have many offspring, often in the thousands. But those that care for their young intensively usually only bear a few (or one) offspring at a time. Ask children to explain why this is so. Discuss mortality rates for the different animals, and the amount of energy it takes from the parents to care for their young. You might also talk about animals that live in colonies or groups, like insects, herding animals, wolves, etc. In these cases, the young remain with the group after growing up.

What is irrigation for and what is a fish screen?

Discuss what plants need to live. All living things need water. Plants get water from rain and snow in the wild, and from garden hoses and watering cans in home gardens.

Ask children how farmers get water to their crops if it does not rain enough. Farmers must water their plants, just like home gardeners must. They do this by taking water from streams and underground wells, and sending it through ditches or pipes to the growing plants. Livestock need water too.

What would happen if a salmon swam into these ditches? In most cases, they do not survive. Like a window screen keeps insects from flying into a house, a fish screen keeps fish from swimming into ditches .

Chapter 7 Springer's Gone!

Heavy rain and melting snow swell rivers and streams to raging torrents. Places that were once safe for small fry become dangerous.

Fast moving water can carry more (and larger) particles than slow water. Often, during high flows, the water is turbid. Turbidity is a measure of the amount of material suspended in the water. Turbid water is not clear, and visibility is poor for the fish, which rely on their sight to find food and escape from predators.

Salmon have a special row of cells on each side of their bodies called the lateral lines. These cells are extremely sensitive to vibrations of all frequencies. Fish can detect another animal walking on the stream bank through the vibrations of its footsteps. The lateral lines can also detect vibrations made by something moving through the water, and they are sensitive to the Earth's magnetic fields, too.

The many scents that are in the water are detected by salmon and steelhead because they have an extremely well developed sense of smell. The smells register in the fish's brain and are never forgotten. This is called imprinting, and it is the mechanism by which the fish finds its home stream when returning from the sea to spawn. Since each watershed has its own unique combination of elements that all impart their smells to the stream, the fish can identify its own stream from others that smell slightly different. Imprinting is responsible for salmon's remarkable homing behavior.

Chinook salmon fry usually spend only a few months in the stream before they begin their downstream migration. It is likely that they leave while flows are still high. If they wait too long, the river can drop, and in very dry years, some reaches may actually dry up. Fish in different river systems have evolved migration patterns that match the flow patterns of their own rivers. This is one reason why attempts to move fish from one river basin to another, very different one, are

often unsuccessful. The transplanted fish may have behaviors patterns that do not match the conditions of the new stream.

Steelhead may spend several years in the stream before migrating to sea. They grow large enough to prey on small, young-of-the-year chinook. It's a fish-eat-fish world.

How does rain affect rivers? Demonstration

Ask students to recall how watersheds work. Rain flows over the watershed and ends up in streams and rivers. What happens to those streams when there is a lot of rain or snow melt?

To demonstrate, simply go to the sink, put in the plug, and begin to run the water. What happens to the level of water in the sink? The sink is like the stream, because it is collecting the water. Ask students how the sink is different than a stream. (The water in the sink just stays there, but the water in the streams flows downhill, and is constantly moving.

Now partially unplug the sink, so some water is draining out. Adjust the water flow so it equals the outflow down the drain. This is more like a stream. Now increase the water flow, so the water level rises. Ask students what will happen if the water kept flowing in at this rate. (It will overflow and spill onto the floor.) Can this happen to streams, too? (Yes, during flooding.)

Discuss how water levels and flows increase and decrease in streams, depending on the amount of precipitation falling on the watershed.

What is turbulence? A Demonstration

Materials 2 jars, filled with water
Some very fine dirt (silt) that will stay suspended in the water
2 small objects tied to a string

Procedure
Turbulence is a measure of suspended matter in water. Visibility is lower in turbulent water than in clear water. Show the children both jars of clear water. Then pour some of the silt into one jar and shake it well. Ask children to describe each jar. Now lower the objects into each jar and ask children which jar has the best visibility. Discuss how lowered visibility would affect an animal that depends on sight to find its way around. What does Springer have that helps her in these conditions? (Her lateral line, which can sense vibrations and acts like sonar.)

How does the lateral line help fish?

Materials 1 Piece of string, about 4-5 feet long, for each pair of students

Procedure
Students should face each other and each hold one end of the string. Or they may tie one end of the string to a desk leg and take turns holding the free end. The string should be stretched tightly. One student should close her eyes and lightly touch the string. The other student should touch or lightly hit the string, which will make it vibrate. The student with closed eyes will feel the string vibrating. Students should experiment with different ways of disturbing the string, and seeing whether it can be felt. They should take turns in the two roles.

Discuss how the string is similar to the lateral line. Although similar, the string is not nearly as sensitive as the lateral line, which can sense direct vibrations and even reflected vibrations of many frequencies. (Sound occurs when molecules vibrate.) The lateral line is also sensitive to Earth's magnetic fields. Ask students to explain how the lateral line helps fish survive.

What is imprinting? A simulation activity

Materials •6 jars with tight fitting lids
•6 scented oils, like mint, almond, orange, etc.

Some scents are hard to tell apart. Try to choose very dissimilar scents.
•6 pieces of paper - number them, 1,2,3, etc. or write the name of a different river on each, then tape one to the bottom of each jar.
•6 cotton balls or paper towels

Preparation
Soak each cotton ball in a different scent. Some oils will leave a color. In this case, use brown paper towels to disguise colors, which would be a visual clue. Put one cotton ball into each jar. Spread the jars out on a counter or table.

Procedure
Discuss the fact that streams have unique scents, which come from the rocks, animals, and plants that are in the stream and watershed. The salmon imprint on these scents, and remember them for their entire lives. They use this scent memory to locate their stream as they migrate back from the ocean to spawn.

Tell children they will now "imprint" a scent, and then see if they can find that scent later, like the fish do. They should choose only one jar, and smell the scent it contains. This is their "home stream". They should look at the number or name on the bottom and not tell it to anyone else.

Now tell children that they will migrate away from home, like the salmon do, and when they return from their travels, they will try to find their home stream. Children should go to recess or lunch, or do another activity. Meanwhile, mix up the positions of the jars.

When children return, they should try to find their home stream by smelling all the scents. They should not look at the number or name! They must rely on their sense of smell only. When they think they have found their stream, they can check the bottom of the jar to see if they are correct.

River systems are networks of waterways. The network begins in the headwaters, which in the Klamath system is often mountainous. Headwater streams sometimes flow from mountain lakes, or they may originate from underground springs. These small streams flow into other streams, which eventually flow into the Klamath River.

Streams that flow out of wilderness areas are typically cold and relatively free of sediment. There are usually fewer harmful human activities that can degrade stream habitat occurring in wilderness areas. Also, mountainous topography produces swift, high gradient streams that flush out fine sediments and are high in oxygen. These streams are usually very cold because they are fed by snow melt, high mountain lakes and ground water. Often, they flow through deep gorges and forests, which shades the water.

Migrating fish congregate at the mouths of cold tributaries. Salmon like cold water, and they find refuge from warm water at the convergence of cold streams. Often, there is a deep pool below a convergence, and a bubble curtain to hide under. These cold water streams may be rich in food, too.

How far is it from Salmon River to the ocean?

Materials An accurate map of northern California
Rulers
String in about 6" segments

Procedure
If you have enough maps, children may work in pairs or small groups. Otherwise, pairs of students can take turns using a map.

Introduce students to the scale of the map. Explain what the scale means. Find the Salmon and Klamath Rivers, Forks of Salmon, and the ocean.

Tell students they will measure the distance that Springer and other salmon must swim to get to the ocean.
Use the ruler to mark 1 inch segments on the string with a pen. The string should then be carefully laid on top of the line representing the river on the map, beginning at Forks of Salmon. Students should be careful to make the string exactly follow the river line.

Small segments should be measured at one time, using the marks on the string to determine inches. The map should be lightly marked with a pencil to mark the end of each segment, which will be the beginning of the next segment. (If you don't want marks on the map, use small strips of removable correction tape.) Students should keep a careful tally of inches measured, until they reach the ocean.

Add up all the inches, then use the scale to convert to actual distance.

Ask students how long it would take them to walk that distance. How long to drive, or ride a bike. Help them with the calculations, using miles per hour, and then converting to days.

Chapter 9 Strangers Together

The Klamath is a very large river which is fed by many streams and other major river systems. The Upper Klamath River Basin, above the dams, is a huge, agricultural area. Once, salmon migrated into this portion of the river system, but since the dams were build, their passage is blocked.

The Shasta, Scott, Salmon and Trinity Rivers, major river systems in themselves, all flow into the Klamath River. Each river and stream that feeds the Klamath contributes it own fish runs and unique scents.

Water quality in the Klamath River is affected by the activities in the watershed. Agriculture can add extra nutrients to the water, in the form of livestock wastes and fertilizers. This causes large blooms of algae, which make the water look dark and murky. Some of the tributaries are quite warm when they flow into the Klamath River, which causes the temperature of the Klamath to also be warm - often uncomfortably warm for salmonids.

The Klamath is like the interstate highway of fish migration. All salmon and steelhead in the river system swim in the Klamath on their way to sea, and then again when they return to their home streams. Salmonids also live and spawn in the Klamath River.

Among the many fish species that live in this river, the sturgeon is probably the largest and the oldest species. In spite of its large size, the sturgeon is a docile fish that eats plants and small animals on the stream bottom.

The Trinity River supports several wild runs of salmonids. It also has a large fish hatchery. Hatchery fish are raised in cement raceways until they are released to swim down river to the ocean. Studies of hatchery fish behavior have found that they tend to be more aggressive than wild fish. One study of hatchery brown trout in the wild showed that the hatchery fish drove the wild fish away from feeding areas, but then failed to take advantage of the food themselves. Since they have always

been fed by humans, they may not know how to forage for food in the wild. Certainly, some of the fish do learn survival behaviors, since they return to the hatchery after spending several years in the ocean. But some scientists are concerned about competition between the hatchery and wild fish for limited food and space in the river.

Comfortable, uncomfortable, and deadly temperatures for salmon

Materials 3 buckets or dish pans
Ice cubes or gallon jugs and a refrigerator
Warm water from the tap
Thermometer
Index cards or paper and felt pen

Preparation

Fill the containers with water of three different temperatures. One should be about 50 degrees, another about 70 degrees and another about 85 degrees. Make signs that say:
50 degrees: Springer is happy
70 degrees: Springer is not comfortable
85 degrees: Springer will die
Put the signs in front of the appropriate containers.

Procedure

Ask children what happened in chapter 9. How did Springer feel? What made her uncomfortable? Discuss the fact that salmon and steelhead must have cold water to survive.

Children should put their hands into each container. (You may have to check the temperature and make adjustments with ice cubes or warm water, as needed.) Ask children how each water sample feels to them. They may be surprised that the one that is most comfortable to them (85 degrees) is lethal to salmon, and the one that is most uncomfortable to them is best for salmon.

You may also discuss the difference between warm blooded animals, like humans, and cold blooded animals, like fish.

What is competition? A simulation

Materials

Several work areas that will comfortably accommodate 6-8 students.
Crayons for 6-8 students at each area
Drawing paper

Procedures

First have children work at separate areas in small groups. They should use the crayons and work space to create a picture. Let them work for several minutes.

Now, have all children crowd around one work space and continue to work on their pictures . They must all share the crayons at that area, they may not bring crayons from other areas. They should all try to squeeze into the one work area. Make believe there are invisible boundaries they can not cross.

After a while, have children return to their desks and discuss what happened. How did they feel in each situation? Were there enough crayons to go around when they were all in one work space? Was it easy to move? Were there any conflicts over space or crayons?

Ask children to define competition. What if they were competing for food and living space instead of crayons? Would they all survive? Why?

Chapter 10 Into a New World

The river meets the sea at the estuary, where fresh water mingles with salt water. During high tides, the salt water may push its way some distance up the river. The estuary supports different life than the fresh water river. Many ocean animals use the estuary as rearing grounds, and the larval forms of these species are food for salmon.

Salmon fry may spend several months in the estuary, growing larger. This is an important phase of their life. The bigger they get before entering the ocean, the better their chance of survival.

Salmon become smolts while they are in the estuary. This involves several changes in their physiology and appearance. A salmon must adjust to the salt water before entering the ocean. In fresh water, the fish must keep salts from leaving its body, into the less salty water. But in the ocean, salt concentrations are higher outside the fish's body, and the gills must extract excess salt from the water the fish takes into its body.

The fish's appearance also changes. The protective coloration that worked in the stream environment does not work in the ocean. The fish lose the parr marks and their sides become silvery. Their backs become dark, and their stomachs very light. This is so that a predator, looking down on the fish, will see the dark back, which will blend into the dark depths below the fish. A predator looking up at the salmon will see the white belly, which blends with the light ocean surface.

Predators congregate at estuaries. Birds, sea lions, seals, otters, other fish and humans all take advantage of the hunting opportunities in the estuary.

What is an estuary? Demonstration

Materials Gallon jar or large glass bowl
Quart jar
1/2 cup of salt
Food coloring, 10 drops

Procedure

Discuss the sensations Springer felt when she entered the estuary. The water here was brackish, or salty. Talk about difference in salinity of river (fresh) water and ocean water. You might let children taste a little fresh tap water and tap water mixed with salt.

Explain that salt water is heavier that fresh water, so when the two meet, the salt water sinks. To demonstrate, slowly pour the salt water into the jar or bowl containing the fresh water. The colored salt water will sink to the bottom. This must be viewed from the side of the jar, not the top, since the color will reflect off the surface of the water. If you observe closely, you will see "currents" of salt water.

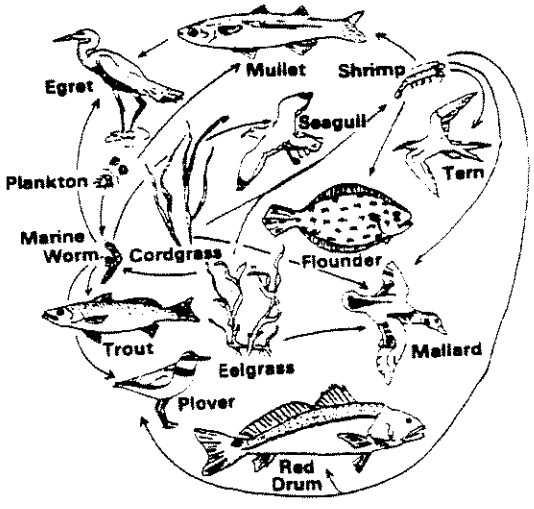
Estuary Food Webs

Materials Pictures of various animals found in estuaries
Crayons or colored pens
Paper

Procedure

Review the concepts of a food web. Look at the river food webs the were constructed earlier. Discuss the fact that estuaries and oceans have different communities of animals than rivers. List some of the animals that are found in estuaries, such as sea birds, sea lions, crabs, etc.

Children should design a food web, using arrows to indicate predator and prey relationships. Be sure to include salmon.



Chapter 11 Shark Attack

Little is known about how salmon behave in the ocean. Some studies have attempted to determine the range of different stocks of salmon, but it is very difficult to conclude with any certainty just where they go. Migration patterns are probably influenced by ocean currents, temperatures and availability of food - all factors that are interrelated.

There is a deep trough just off the California coastline which causes an upwelling of cold water. This area is very rich in food, and the salmon grow large quickly. In the streams, their growth is measured in inches. In the ocean, it is measured in pounds.

Salmon are very powerful swimmers. They may swim thousands of miles during their two or three years in the ocean. As the fish grow larger, they become prey to fewer types of fish. Sharks are one predator that can kill salmon.

Salmon swim in schools in the ocean. There are several advantages to being in a school. If a predator attacks, they are likely to be confused by many fish and may not be able to single out just one to catch. Also, a school of fish may look like a very large animal and may scare off predators. Swimming with a school may help inexperienced fish find food, too.

Gyres are circular ocean currents that are set in motion by temperature gradients and the rotation of the earth.

Activities

For activities on oceans, use *The Ocean Book, Aquarium and Seaside Activities and Ideas for All Ages*, Center for Marine Conservation, 1989 John Wiley & Sons, Inc.

This book contains many simple lessons and coloring pages related to currents, tides and waves, animals in the ocean, food webs and ecosystems. It is available from your local bookstore for about $12.95, or it may be borrowed from the KREP library.

Chapter 12 Fishermen

Until recently, commercial fishing for salmon in the ocean was a thriving industry. However, for the last decade, fishing has been severely curtailed in the Klamath Management Zone to protect endangered stocks of Klamath River salmon. This has caused hardships for many families that once made their livelihood from the fish.

Sport fishing is still allowed in the ocean and in the river, although the number of fish allocated to these fishing groups has also been reduced. The Native American tribes of the Klamath River, who fish commercially and for subsistence, have had their allocations of fish reduced, too.

Salmon fishing in the ocean is done with barbless hooks on lines. Most fishing boats have depth finders which can detect the presence of schools of fish swimming below the boat.

There are size restrictions of fish that are caught. Fish that are too small must be released. Also, some biologists would like to see regulations the prohibit keeping wild fish, since these stocks are so depleted. To implement such a rule, all hatchery fish would have to be fin clipped - their adipose fin is removed. This is how fishers would distinguish between wild and hatchery fish. In the story, the hatchery fish is fin clipped. In actuality, most hatchery fish are not yet fin clipped.

Parts of a Salmon Troller

To help children understand the special terms of salmon fishing, give each a copy of the picture titled A Salmon Troller before reading the chapter, and discuss the new words.

Children will probably have some knowledge of fishing with a hook and bait. A salmon troller is a boat specially equipped for fishing in the ocean with a lines, hooks and bait. It has two very long poles that can be raised and lowered. They are attached to the mast with wires. These poles have lines that attach to the fishing wires, and keep the wires suspended away from the boat.

The fishing wire is kept wound around spools. When the wire is released, it is guided around the pulley blocks, which are held by the gurdys. The wire has stoppers spaced at regular intervals. The leaders are attached to the fishing wire with line snaps, and the stoppers keep the leaders from bunching together on the line. Large hooks, which resemble crowbars, are baited with herring or other small fish, and are attached to the leaders. The leader, line snap and crowbar together are call the spread. Each fishing wire may have four or six spreads, and each side of the boat may have three spools of wire. The troller may have twenty four hooks in the water at once.

The picture shows three views, at different scales. Talk about the function of all the parts and then ask students to draw their own fishing boat.

Draw a Fishing Boat

Materials Can You Draw a Salmon Troller? 1 for each student
and/or Drawing paper
Crayons or colored pencils

Use the page provided, or another type of paper and ask students to draw a fishing boat. Encourage them to include some of the equipment they have learned about.

Fish Tales

Materials Pictures of fishing boats and gear
Pencils and paper

Procedure

Discuss fishing with children. Some may be familiar with river fishing, but most will probably have little or no experience with ocean fishing. Talk about why people catch fish. Some fish for food, others for sport. Most people who fish like to share their fishing experiences, or fish tales. Ask students to write a story or draw a picture about fishing. They may take the point of view of the fisher or the fish. You may want to give students a list of words that will help them.

Chapter 13 Homing

The ocean just off California's shore is very rich in food. A deep trough, and an upwelling of cold water provide excellent conditions for the salmon to feed and grow large. In years with good ocean conditions, California's salmon may not migrate farther that the Columbia River.

Salmon usually stay in the ocean for two or three years. A small percentage of male fish, called jacks, return to spawn after only one year at sea. Occasionally, salmon will stay in the ocean four years.

When salmon become sexually mature, they return to their river of birth to spawn. Salmon, like migrating birds, probably use celestial cues, especially the sun, and their sensitivity to Earth's magnetic field to navigate. Scientists have found magnetized crystals in salmon brains, which could act as a compass. The lateral line could detect the electrical currents that are generated when the salty ocean water (a conductor) moves through Earth's magnetic field. During the day, salmon also navigate by the sun. These abilities get them back to the shoreline near their river. At that point, their sense of smell and familiar landmarks probably guide them to their home river.

Entering the estuary can be dangerous for salmon. Predators, including people, know the salmon are coming and wait for them. Once again, the fish must adjust to different salt concentrations in the water.

Once the fish enter fresh water again, they stop eating. Spring chinook have a high percentage of body fat, which sustains them for several months, until they spawn.

Activities:

Which Way Is Home? See Lessons and Student Materials.

Chapter 14 The Spring Run

The Native American peoples of the Klamath River have always depended on the salmon runs for food. During the First Salmon Ceremony, thanks are given to the spirit of the salmon. In the past, the Karuk First Salmon Ceremony was always performed before any fishing was done by the Karuk, Hupa or Yurok.

When fish of a the same species (chinook, coho, steelhead) return to a river from the ocean at the same time, they are called a run. There is a fall chinook run, a spring chinook run, a steelhead run and a summer steelhead run in the Salmon River. Other rivers have their own runs of fish.

Spring chinook enter the Klamath River in the spring, when the river is high with spring rain and melting snow. The Klamath and some of its tributaries get turbid, or muddy, when the flows are high. The fish may find it difficult to fight the current in the main channel of the river, so they swim along the edge of the river. The lateral line is used like sonar, to guide them when visibility is low.

Once the spring chinook enter the Salmon River, they swim towards their spawning grounds. As spring turns to summer, the river level drops, the water warms up, and the fish seek deep, cold pools. They reduce their energy needs by moving very little. They do not eat.

As fish get ready to spawn, their appearance changes. The male fish grow hooks on the their mouths, called kypes. These are used to battle other males that compete with them during spawning. Both male and females turn reddish, and their backs become much darker. Often, the fish have large areas on their bodies covered with fungus.

When the weather turns cold in the fall, the river becomes colder. This is the cue for the fish to begin their spawning.

Activity:
Do the *Fish Run Calendar* lesson. See Lessons and Student Materials.

Chapter 15 Springer Is Home

Salmon are relentless in the journey home. They must jump water falls, dodge predators and often must endure poor water quality. All. this takes a great toll on their bodies. Wounds usually become covered with fungus, and fins are often frayed. Since the fish do not eat, their flesh begins to waste away. At this stage, the fish are not good for eating, and people should not attempt to catch them. It is best to let them complete their mission - to spawn a new generation of fish.

Review of life cycle - spawning

Ask children to recall how the story began. Springer was an egg, buried deep in the gravel. Discuss the salmon's journey to the sea, and back to their home. This wondrous event, the return of salmon to their home stream is why people are so intrigued by these fish. Talk about how people have anticipated, and benefited from the salmon runs over thousands of years.

How we change

Materials Pictures of students
Pictures of other animals and plants at different life stages

Ask students to bring pictures of themselves as a baby, as a toddler. and as they are now.

Have children put pictures in order, and as them to consider how they have changed over time. How have they stayed the same. Let them share and discuss their pictures with classmates.

Discuss the changes Springer went through, during the course of the story, and her life. How is the cycle of Springer's life similar to the human life cycle? How is it different?

Talk about life cycles of other living things, such as trees, flowering plants, insects, frogs, etc.

Chapter 16 Spawning

Cold temperatures and sometimes fall rains bring on spawning. The females seek out good spawning gravel. For chinook, this is gravel about the size of an adult fist. The best spawning areas are at the very end of pools, where the water begins to flow into a riffle.

The fish tests the size of the gravel with her tail and begins to dig a redd. Meanwhile, males begin to surround her. Usually, one male will chase away all intruders and will stand guard while the female makes the nest.

Turning on her side and using her tail as a fan, the female digs a hole in the gravel one to two feet deep. Fine sediment is cleaned from the area. She deposits some of her eggs in the hole, and the male releases his milt, which contains the sperm, to fertilize the eggs. Sometimes, more than one male fish will fertilize the eggs.

The female then moves upstream and digs another hole. The gravel from this hole covers the one where she just laid eggs. Again, she deposits eggs and the male fertilizes them. This process is repeated until all the eggs have been buried.

The fish often stand guard over the redd for several days after spawning. However, the exhausted fish are close to death, and eventually they drift away and die.

The salmon bodies do not go to waste. They are eaten by scavengers and they release nutrients which enrich the stream for plants and animals, including their own offspring.

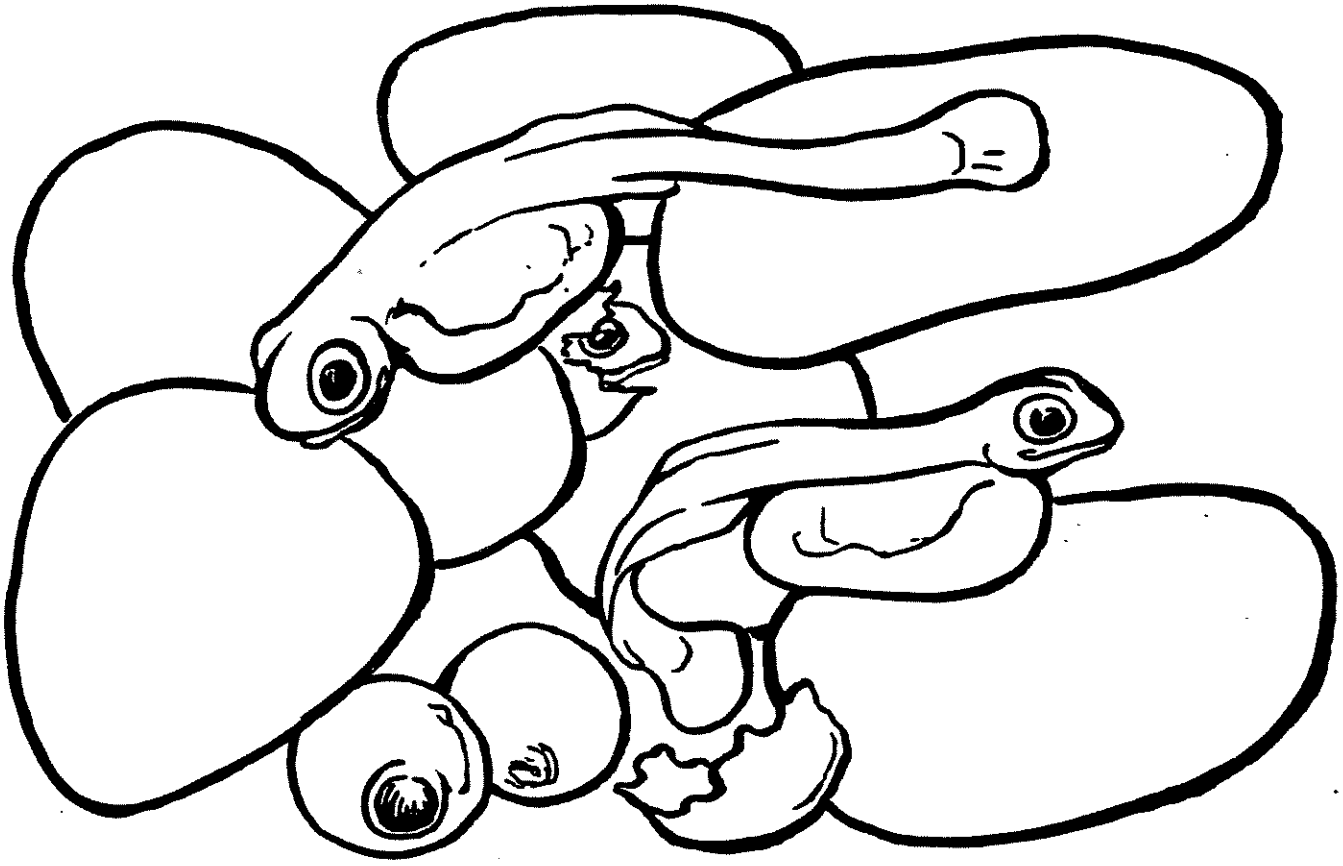
Rivers flow out to sea, constantly carrying nutrients away, but salmon reverse the direction of the nutrient flow. Salmon harvest of the ocean's rich resources and bring them back to the river, in the form of their own bodies.

Video

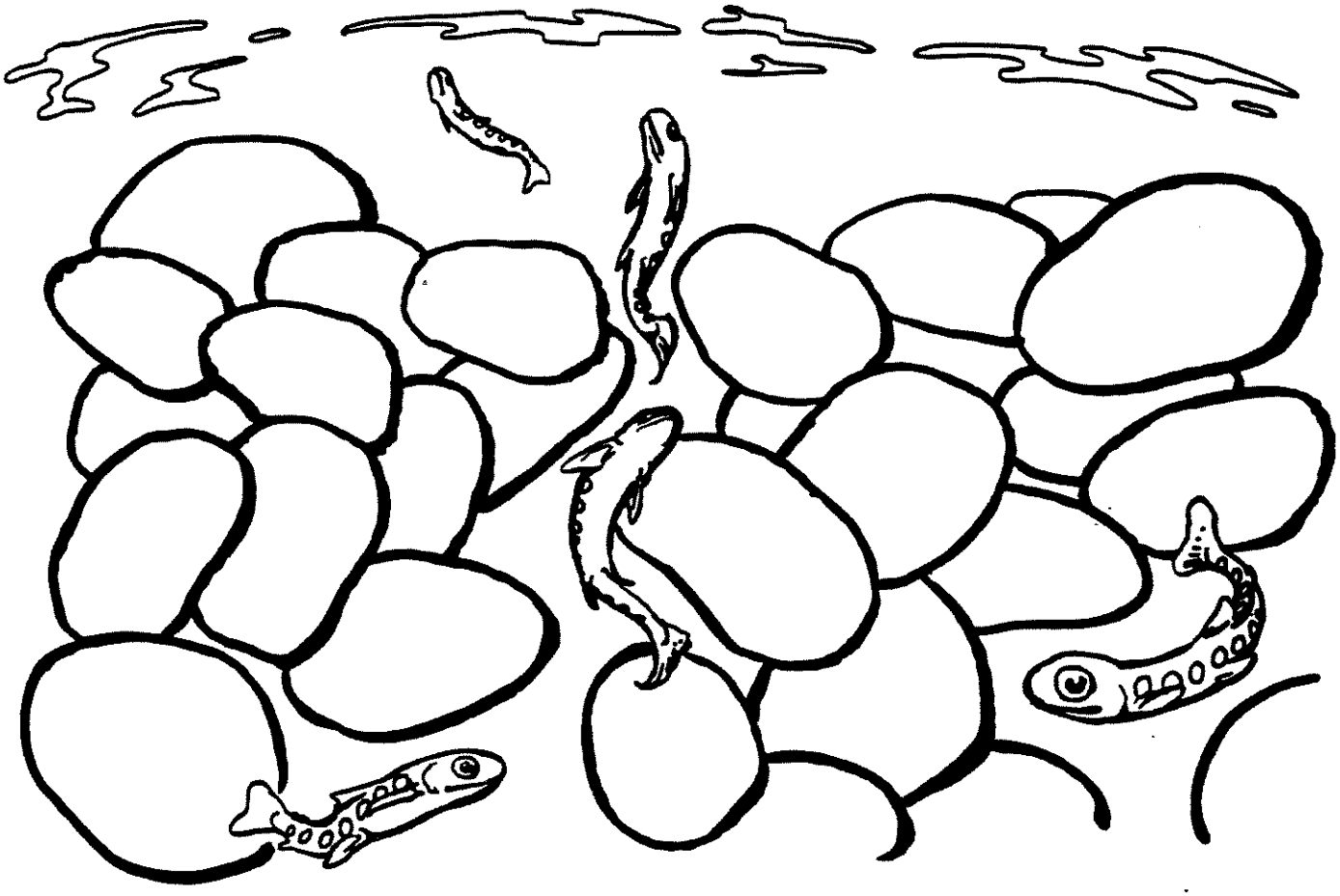
Watch the sections in *Miracle of the Scarlet Salmon* about spawning. It is available from the KREP loaning library.

Talk with the children about why Springer dies. How does her death help the ecosystem and ultimately nourish her offspring.

What is her quest, in their view? Let children discuss their feelings about the story, and share their own story books.



What is happening in this picture? Please write a story.
Words to use: egg, fish, salmon, river, gravel, redd, hatch, alevin



Tell a story about this picture. Here are words to help you:

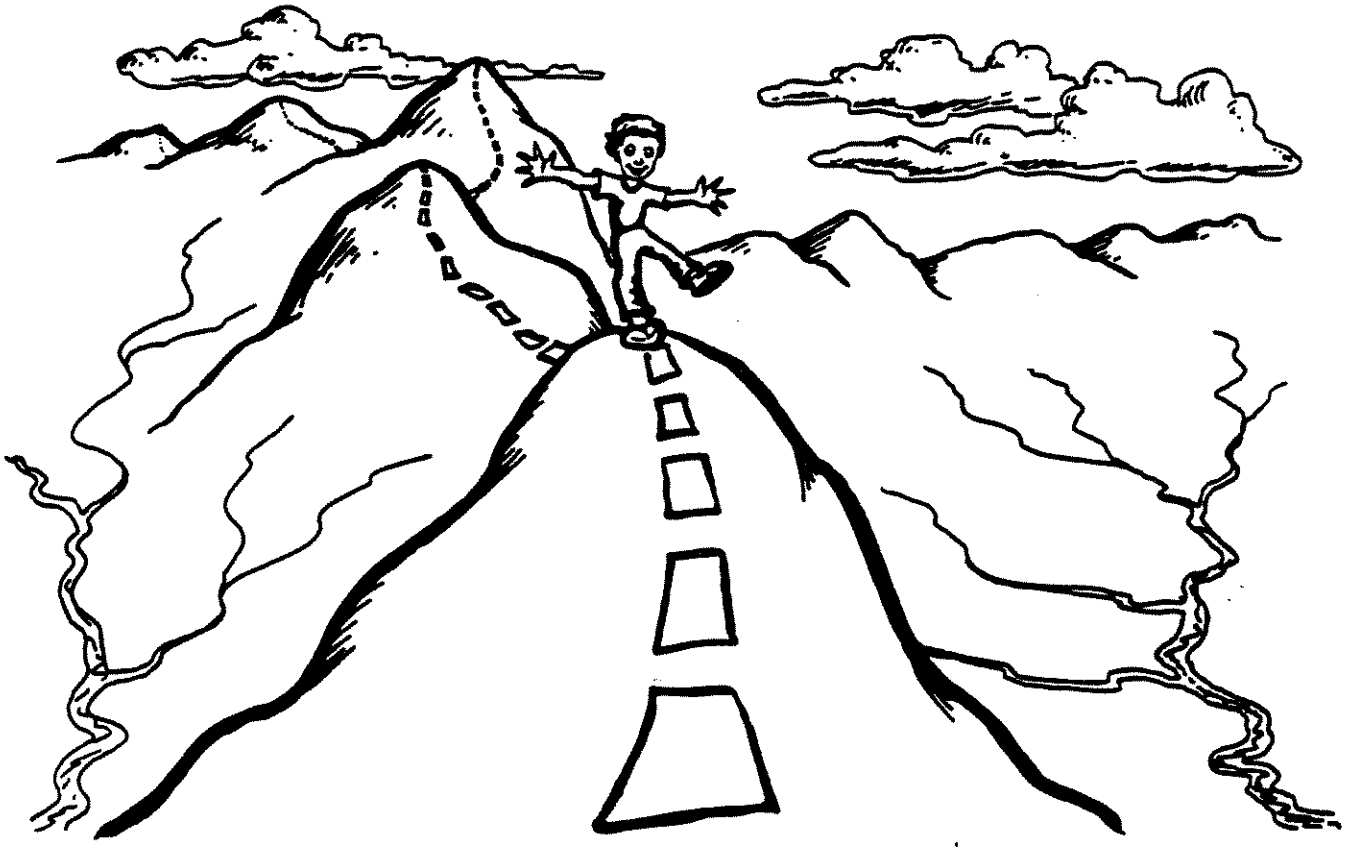
air, bladder, gills, hungry, salmon fry, stones, swim, yolk sac

Write a story that tells what is happening here. You may use some of these words, and other words you know.

fish, scoop, net, water, look, swimming

Write a story about the picture. Here are some words you can use.

crayfish larvae, salmon fry, claws, pool, cave, swim, tree roots, stream bank



Where is Arthur? What can he see?

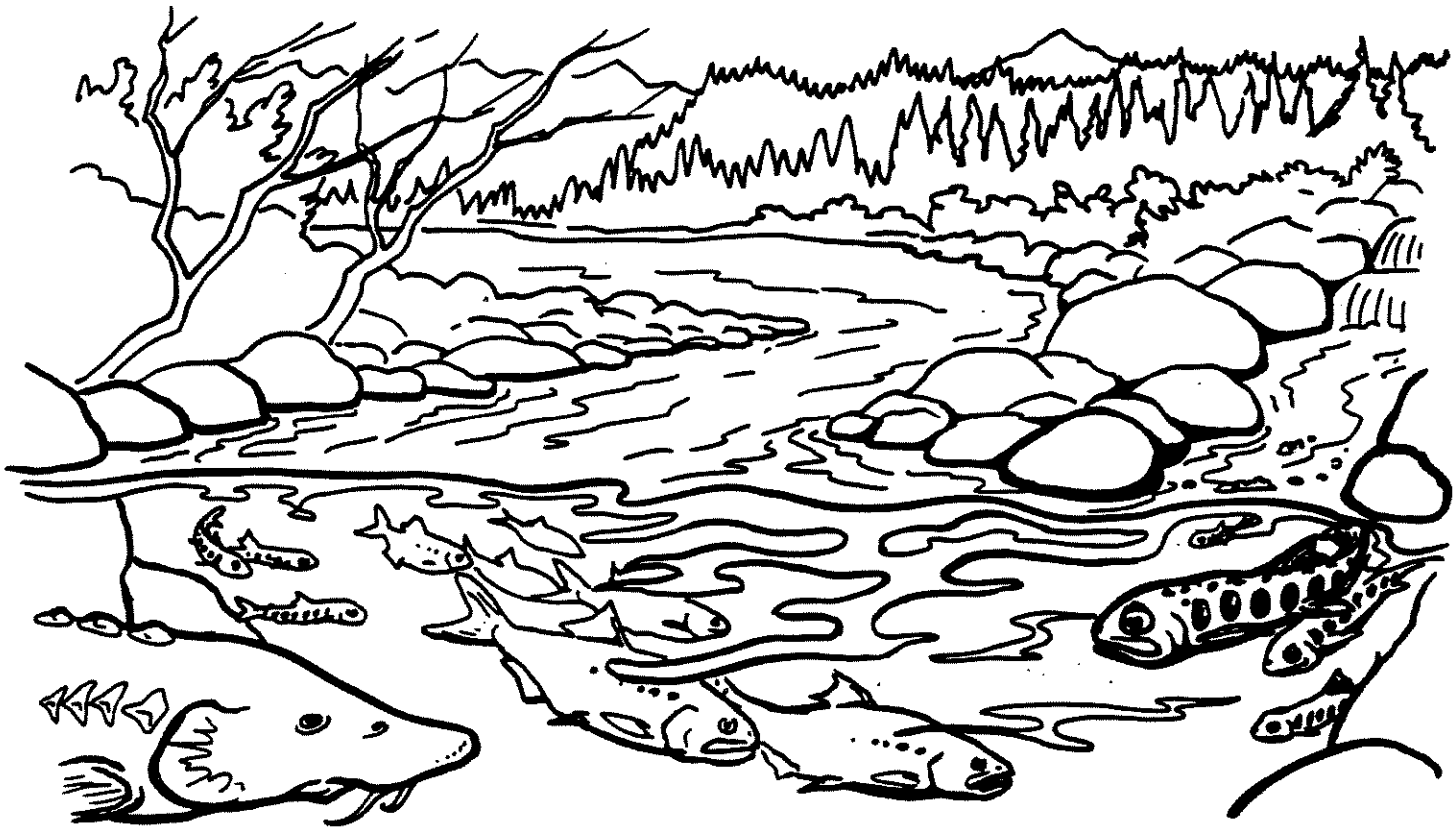
divide, mountain, watersheds, rivers, streams, up, over

What are the children doing in this picture?

salmon fry, ditch, save, pail, river, rescue, sea

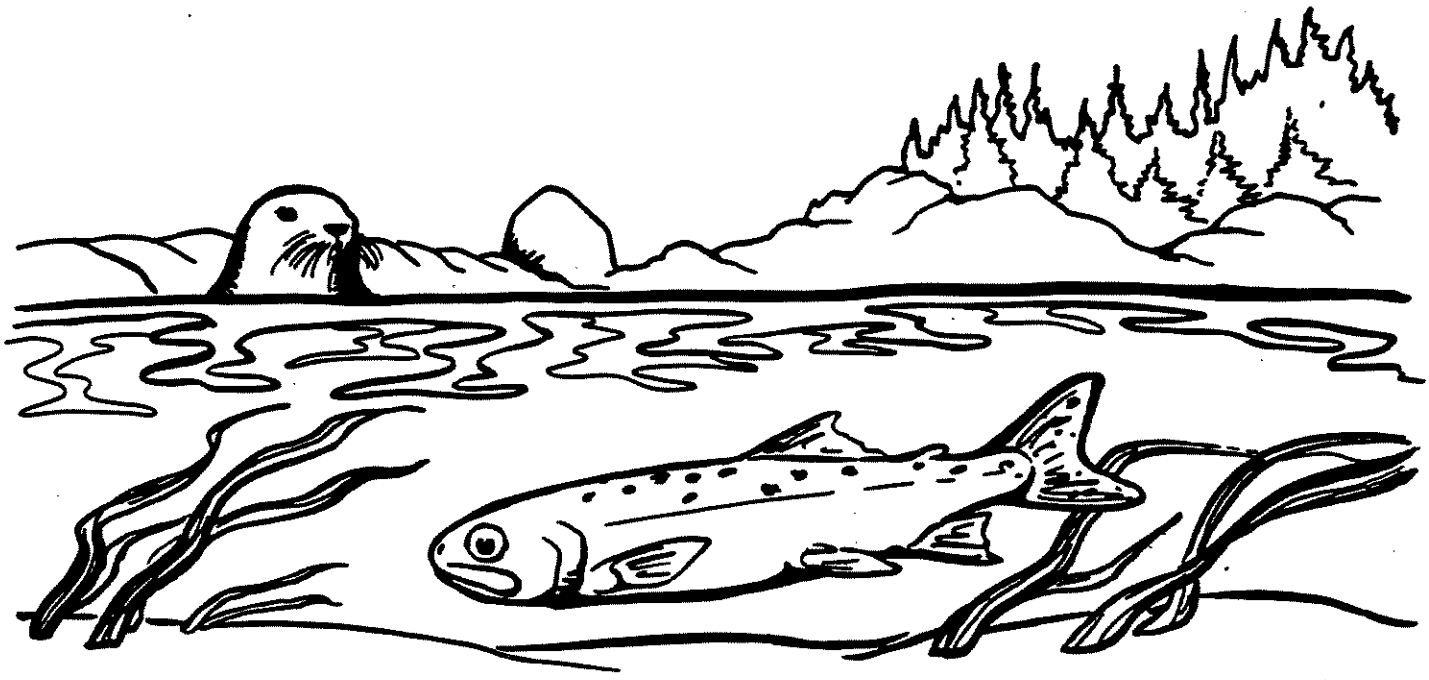
Pretend you are Springer and tell what is happening. What will you do?

ducks, beaks, log, hide, still, eat,



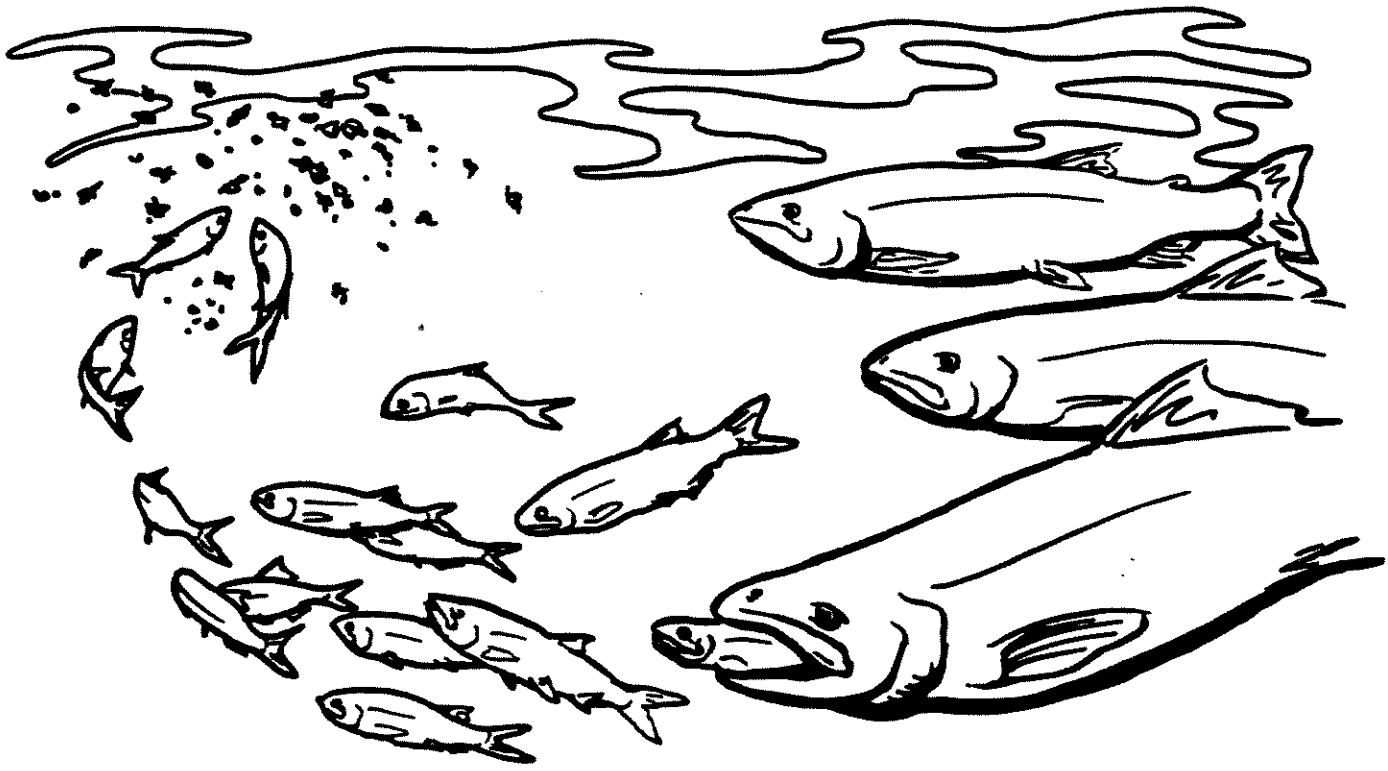
Where is springer going? Where is she now? Who is she with?

migrating, Pacific Ocean, Klamath River, salmon fry, sturgeon, down river,



Springer is in a new place. She has changed. Tell a story about it.

estuary, Pacific Ocean, salt water, smolt, silver, gills
parr marks, tide, waves, sea otters

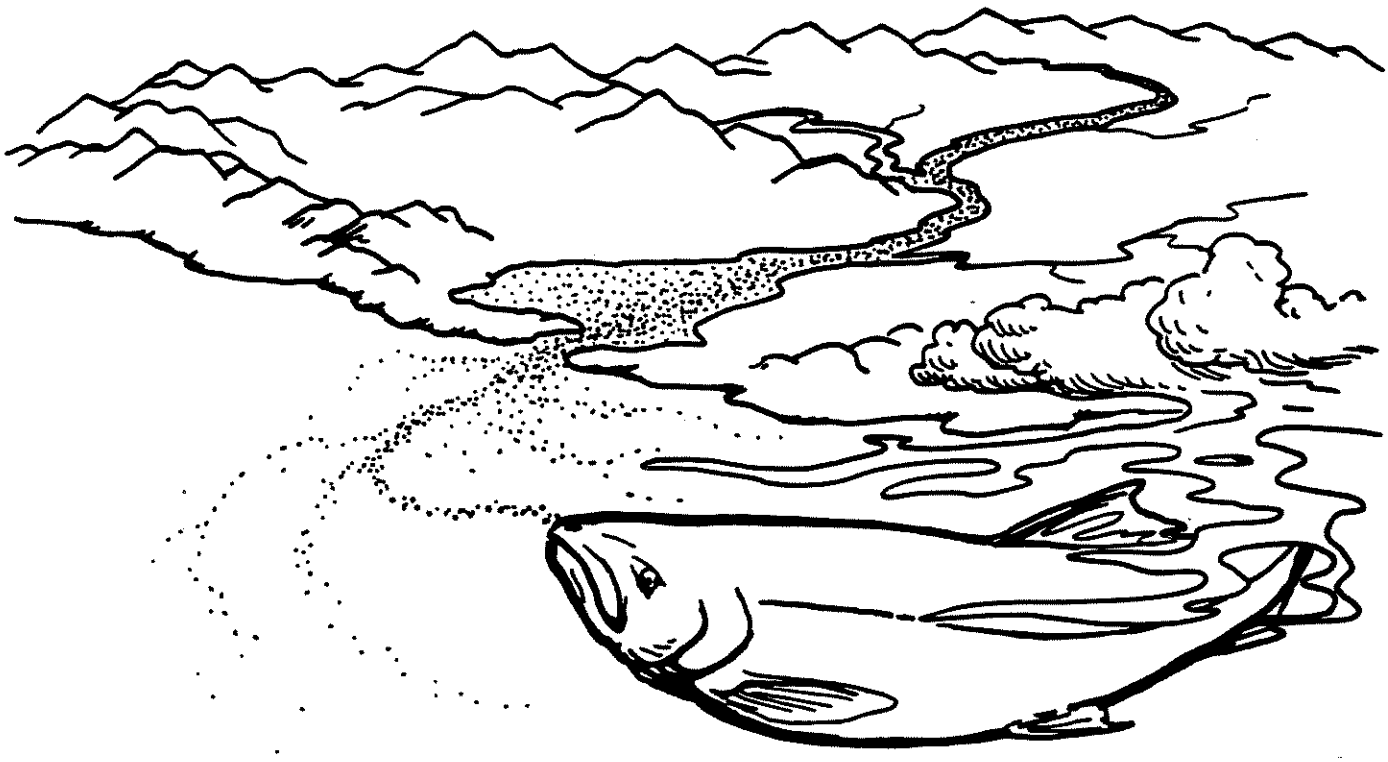


Tell a story about Springer's life in the ocean.

food, herring, plankton, school, swim, thousands, miles, grow, large, eat

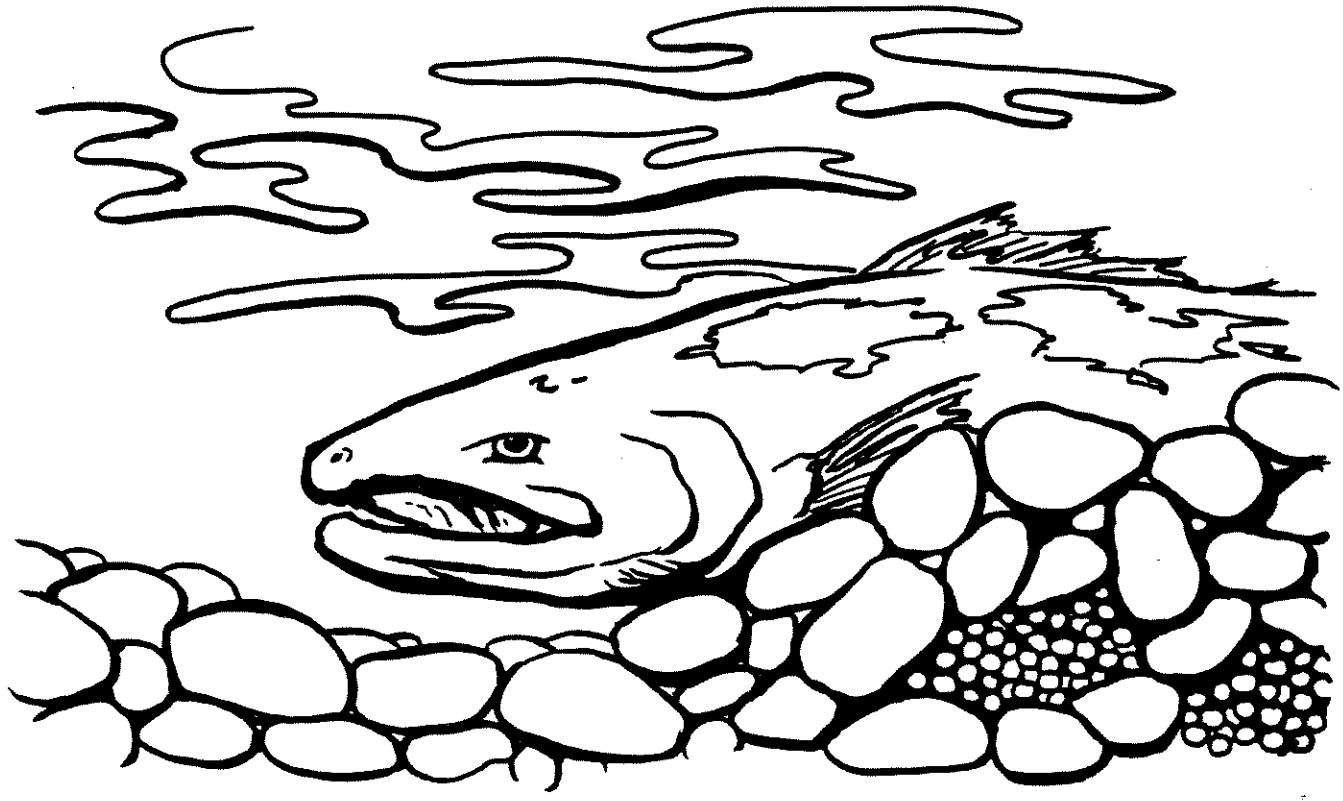
Tell a fish tale. You may use some of these words.

boat, bait, people, catch, salmon, eat, fishing line, hook



Springer wants to go home. How can she find her way?

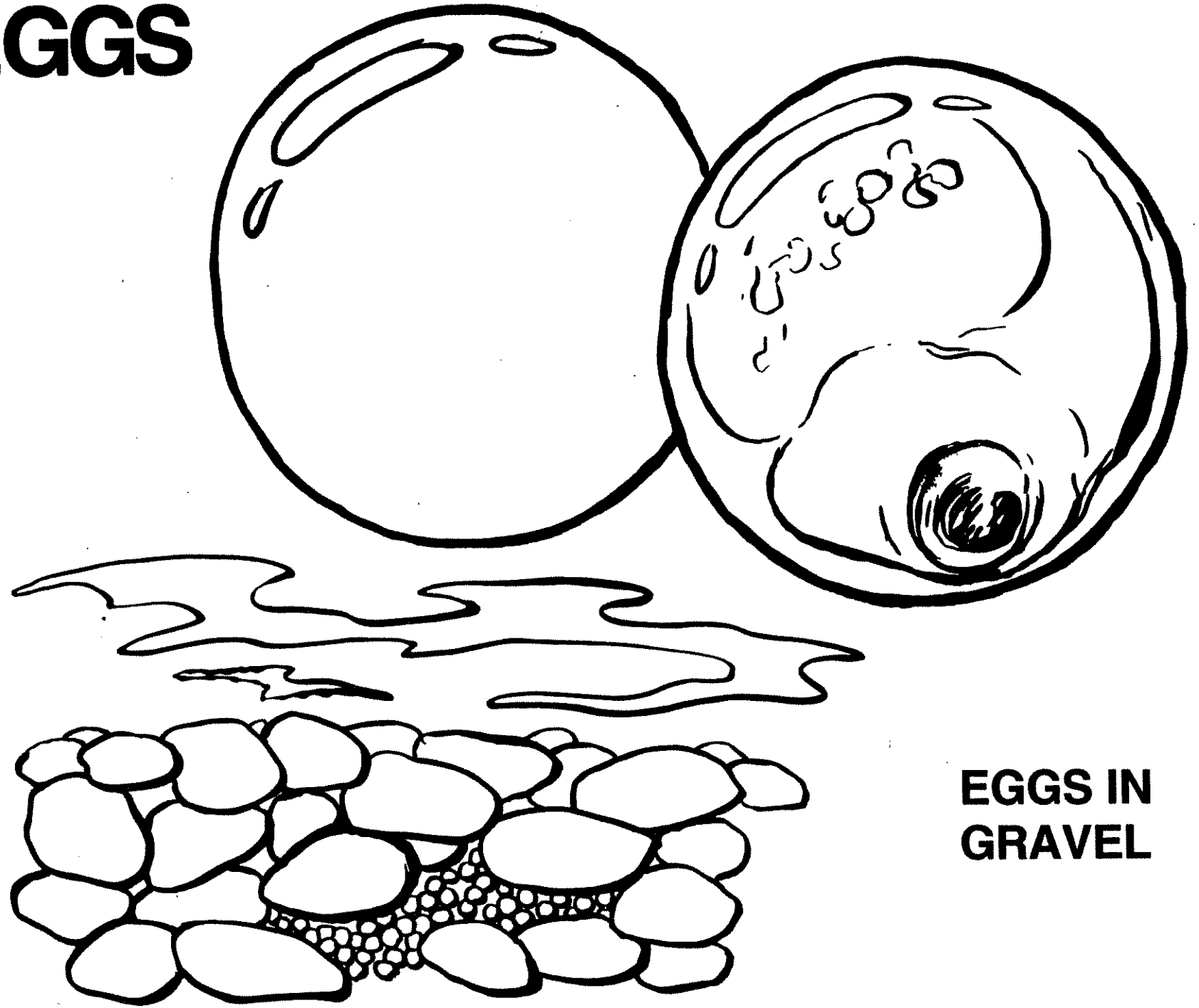
smell, imprint, lateral line, direction, river mouth



Springer's quest is almost over. Write a story about it.

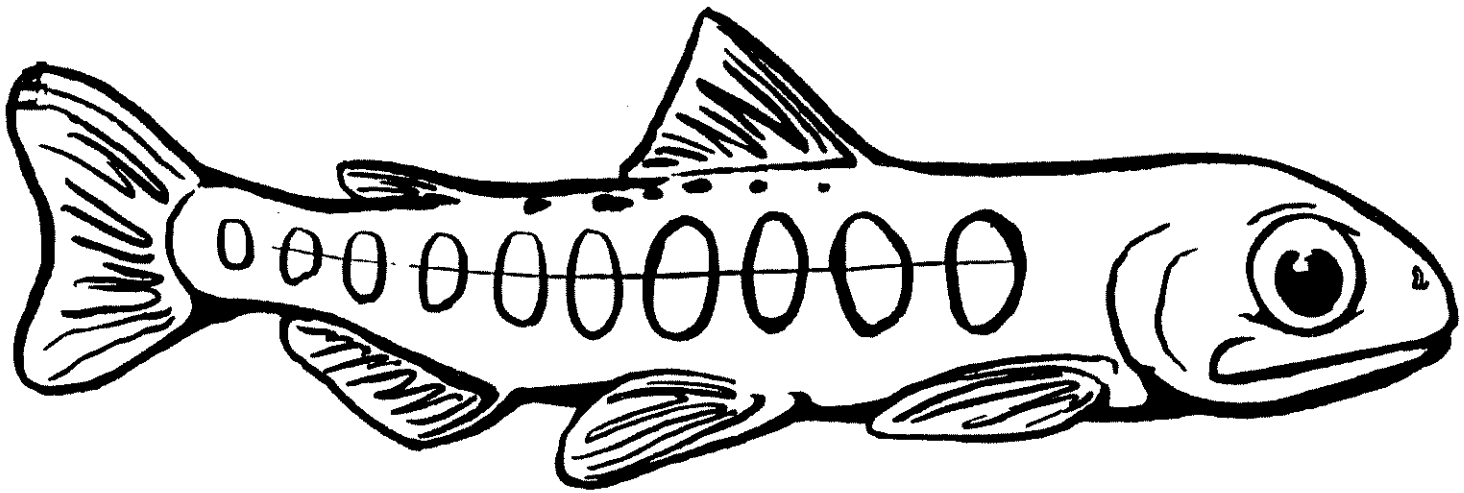
spawn, redd, eggs, gravel, new life

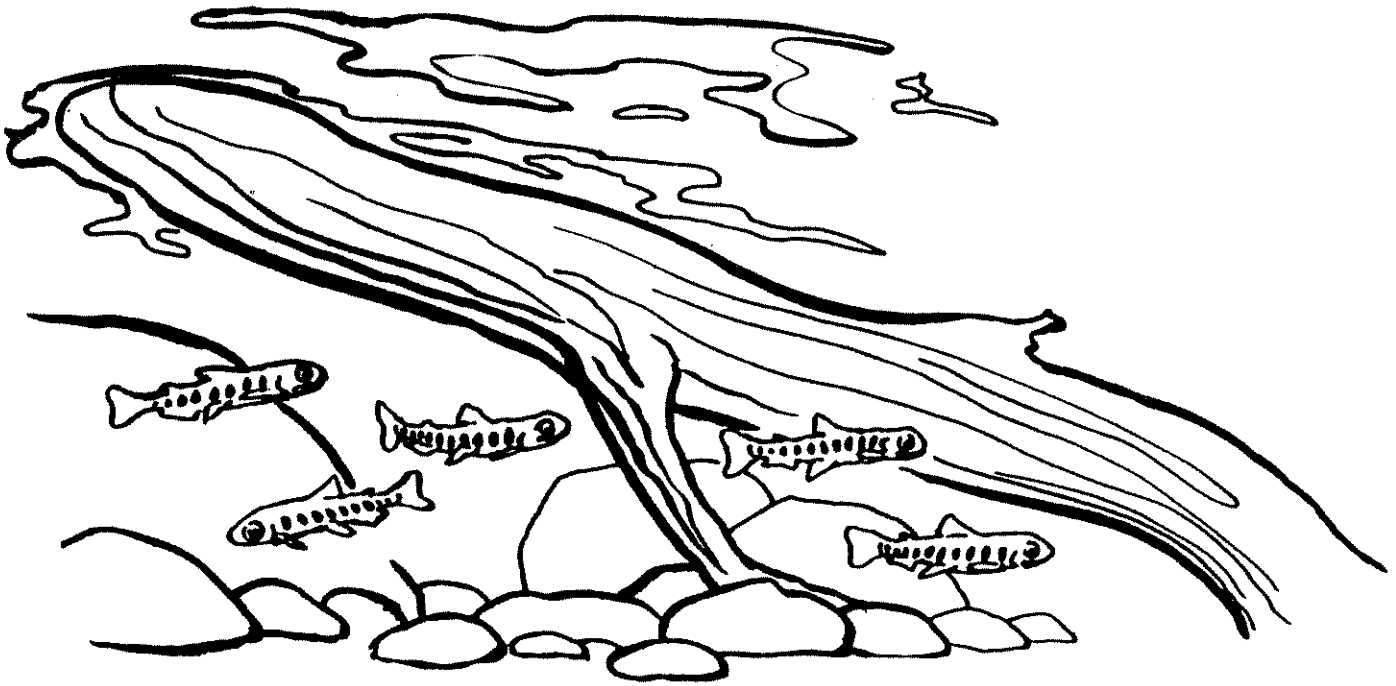
EGGS



EGGS IN GRAVEL

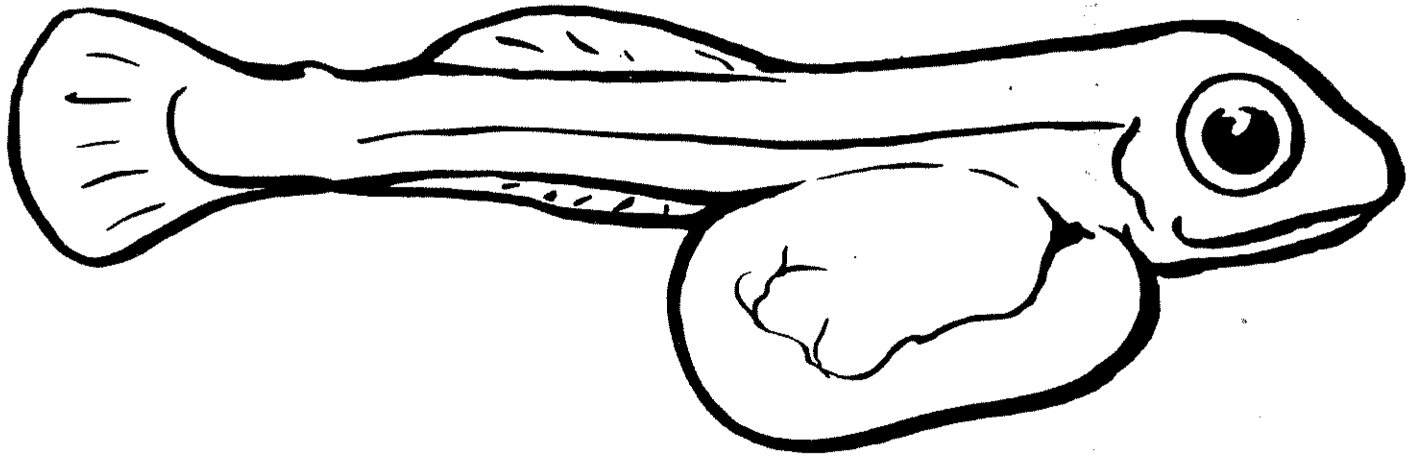
FRY

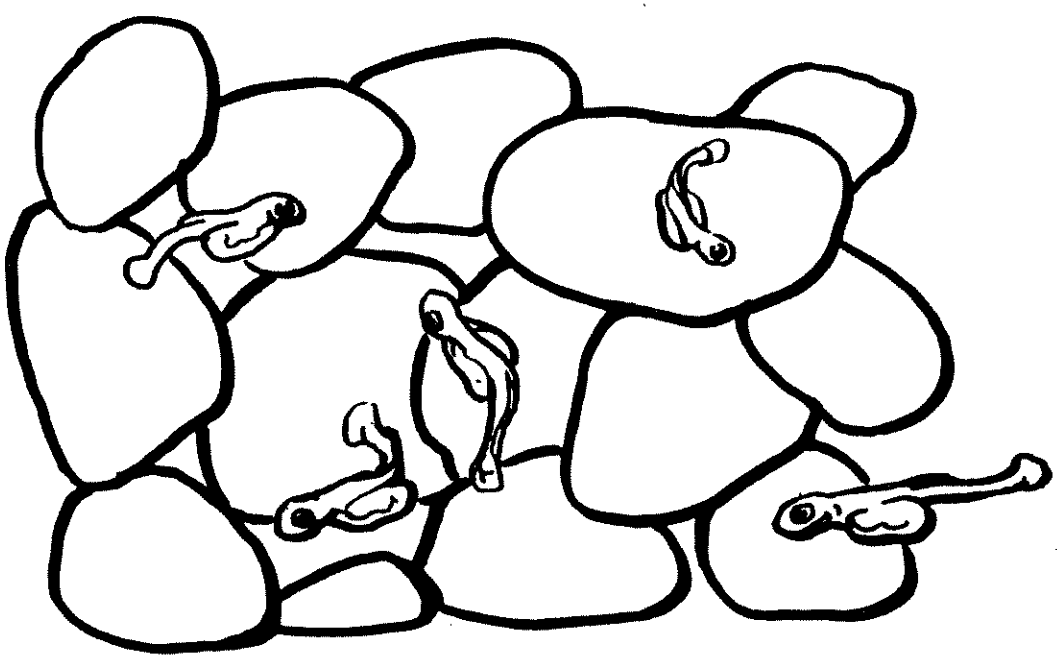




FRY IN STREAM

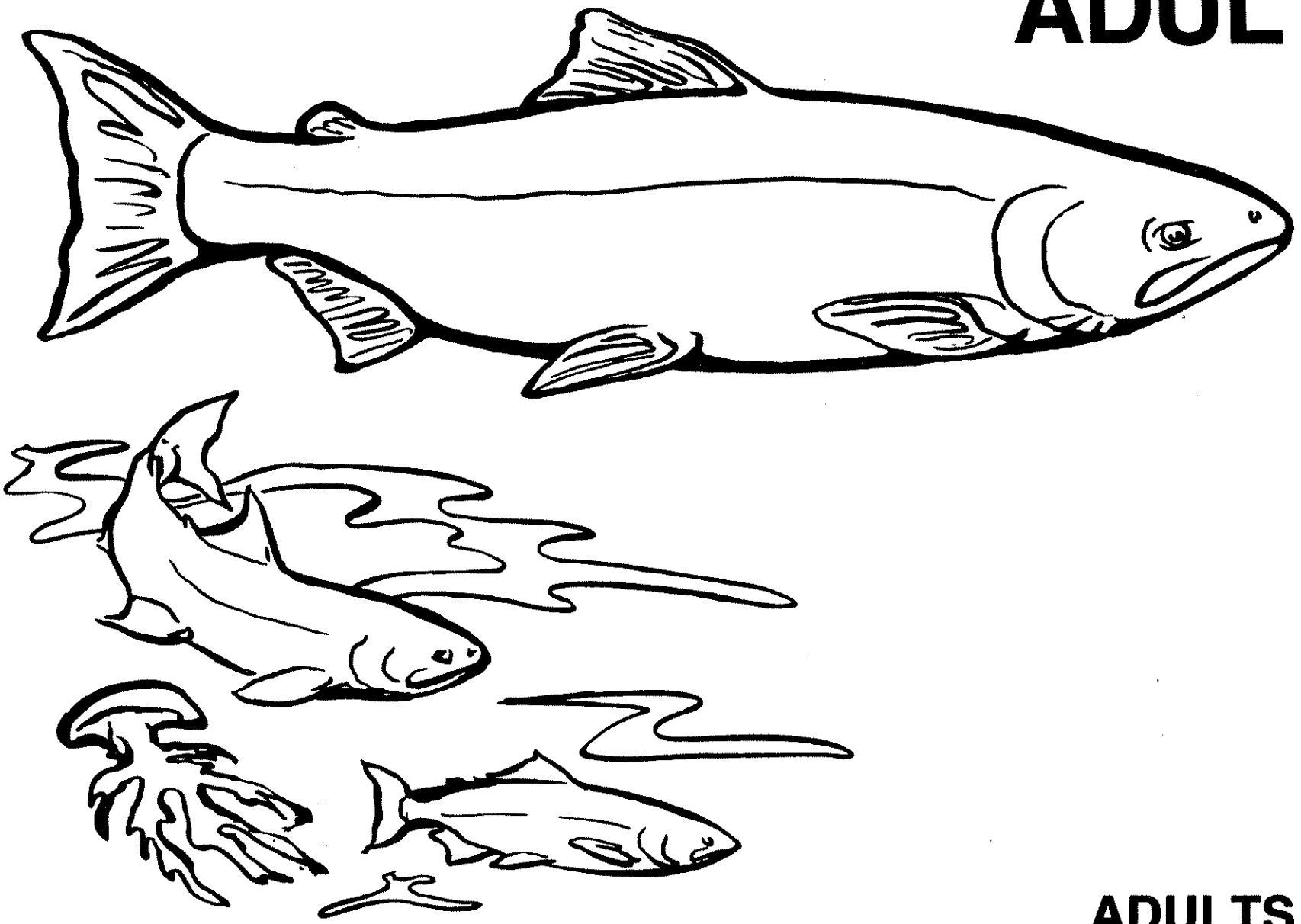
ALEVIN





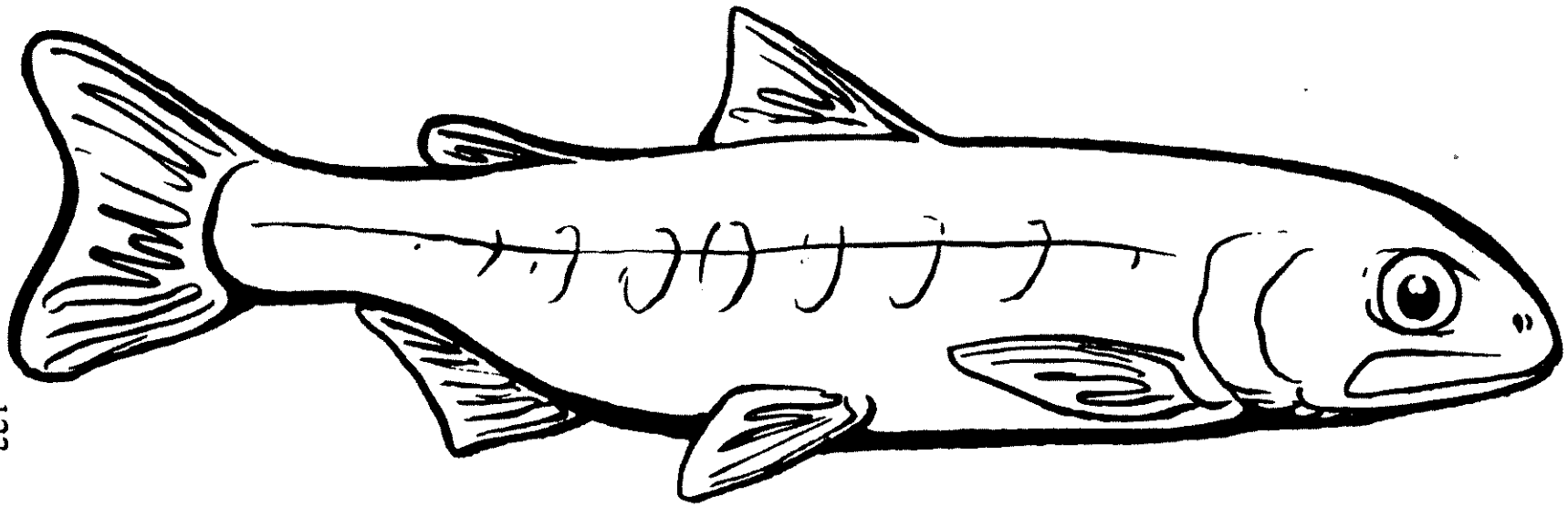
ALEVIN IN GRAVEL

ADULT



ADULTS
IN OCEAN

SMOLT



SMOLTS IN ESTUARY

SALMON AND TROUT ENVIRONMENTAL NEEDS

SPAWNING FISH NEED: _____

_____

_____

EGGS NEED

_____

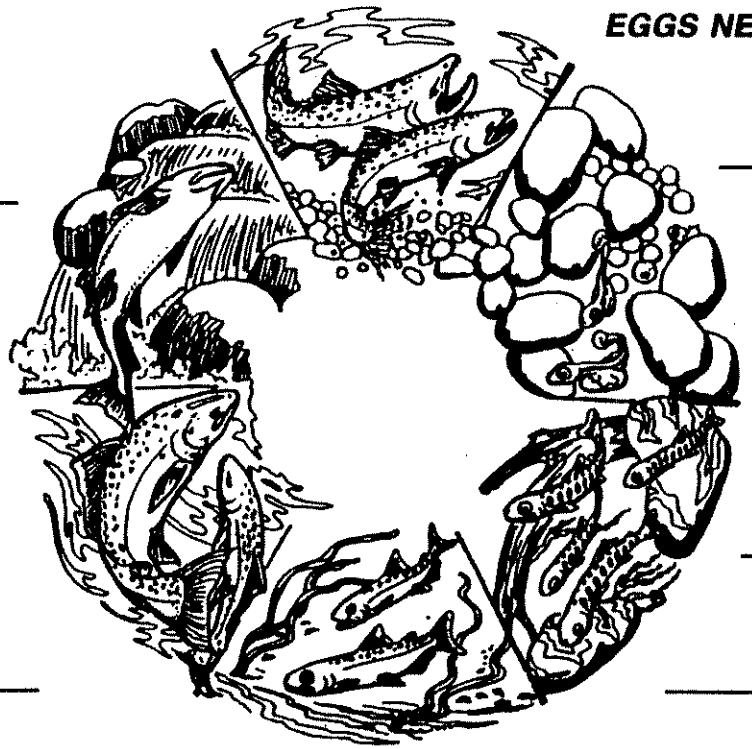
_____

_____

RETURNING ADULTS NEED:

_____

_____



FRY NEED:

_____

_____

_____

ADULTS NEED:

_____

_____

_____

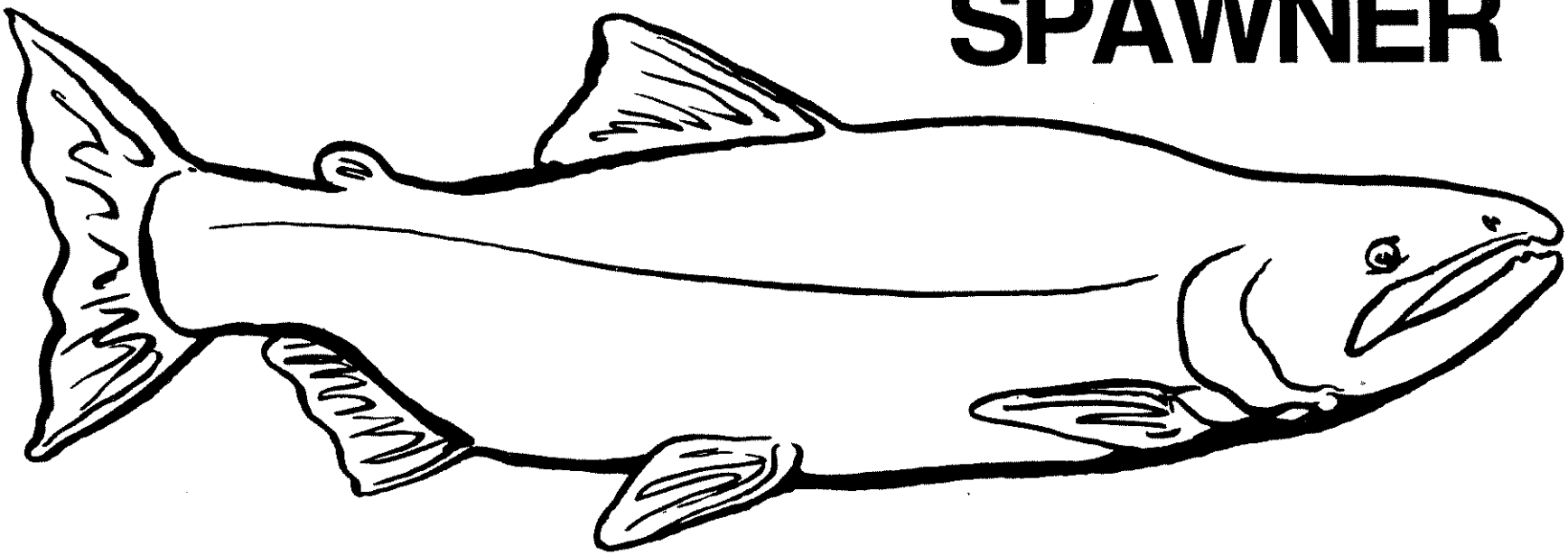
_____

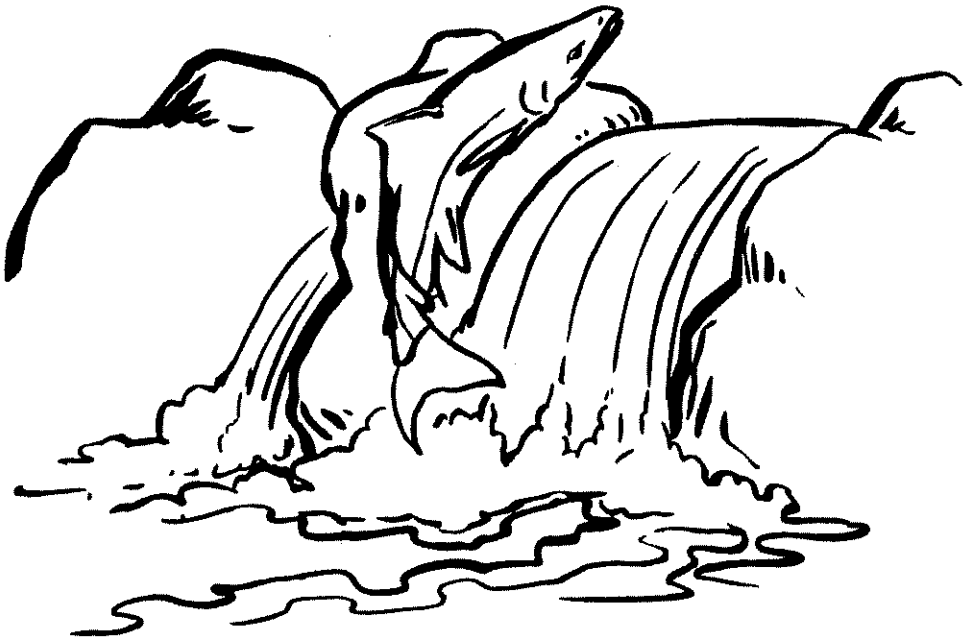
SMOLTS NEED:

_____

_____

SPAWNER





SPAWNER SWIMMING UPSTREAM

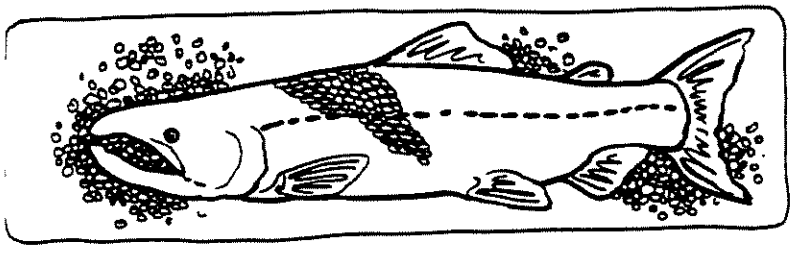
Mosaic Fish

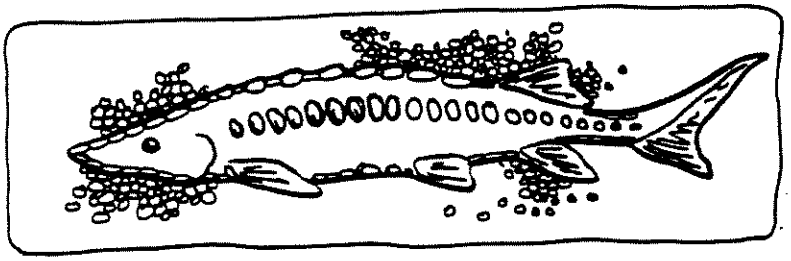
Make a mosaic with seed and beans

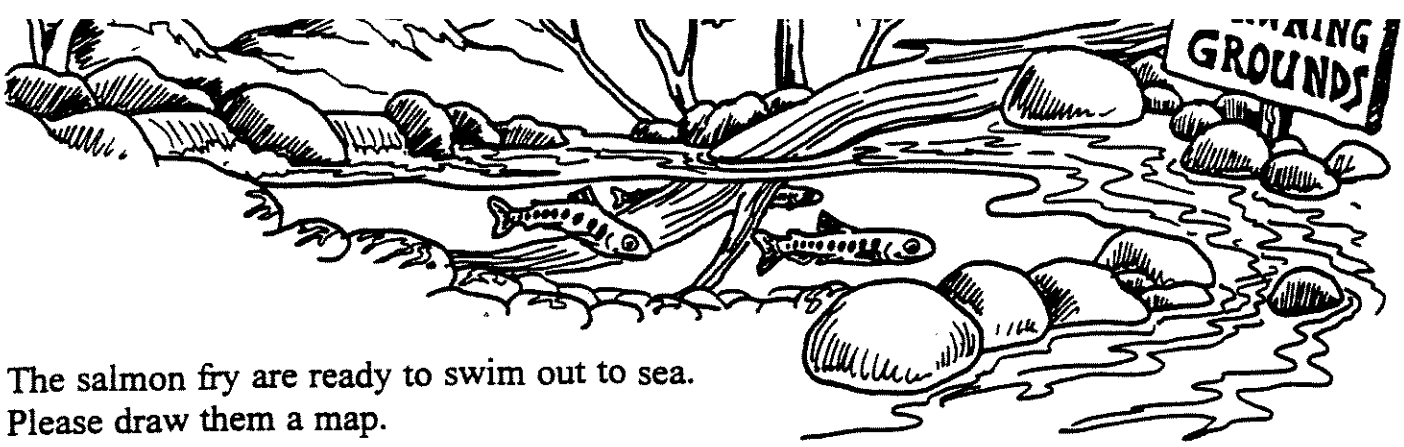
Materials
tagboard, posterboard or cardboard
variety of seeds and beans
glue
crayons or paint
pencils
pictures of fish

Procedure

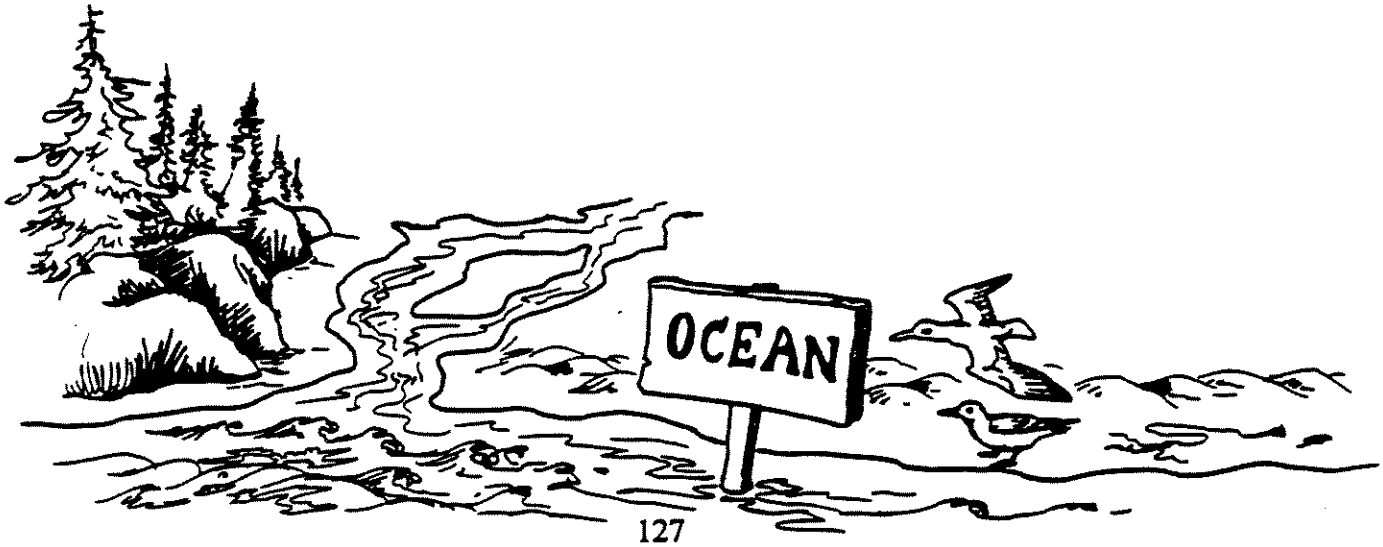
1. Draw fish shape on tagboard. Include fins, eyes and gills.
2. color the area outside the fish outline with crayons or paint
3. Experiment with arrangements of beans and seeds to decorate the fish.
4. Glue seeds and beans down.
5. You may decorate the area outside fish with only one type of seed or bean instead of coloring.





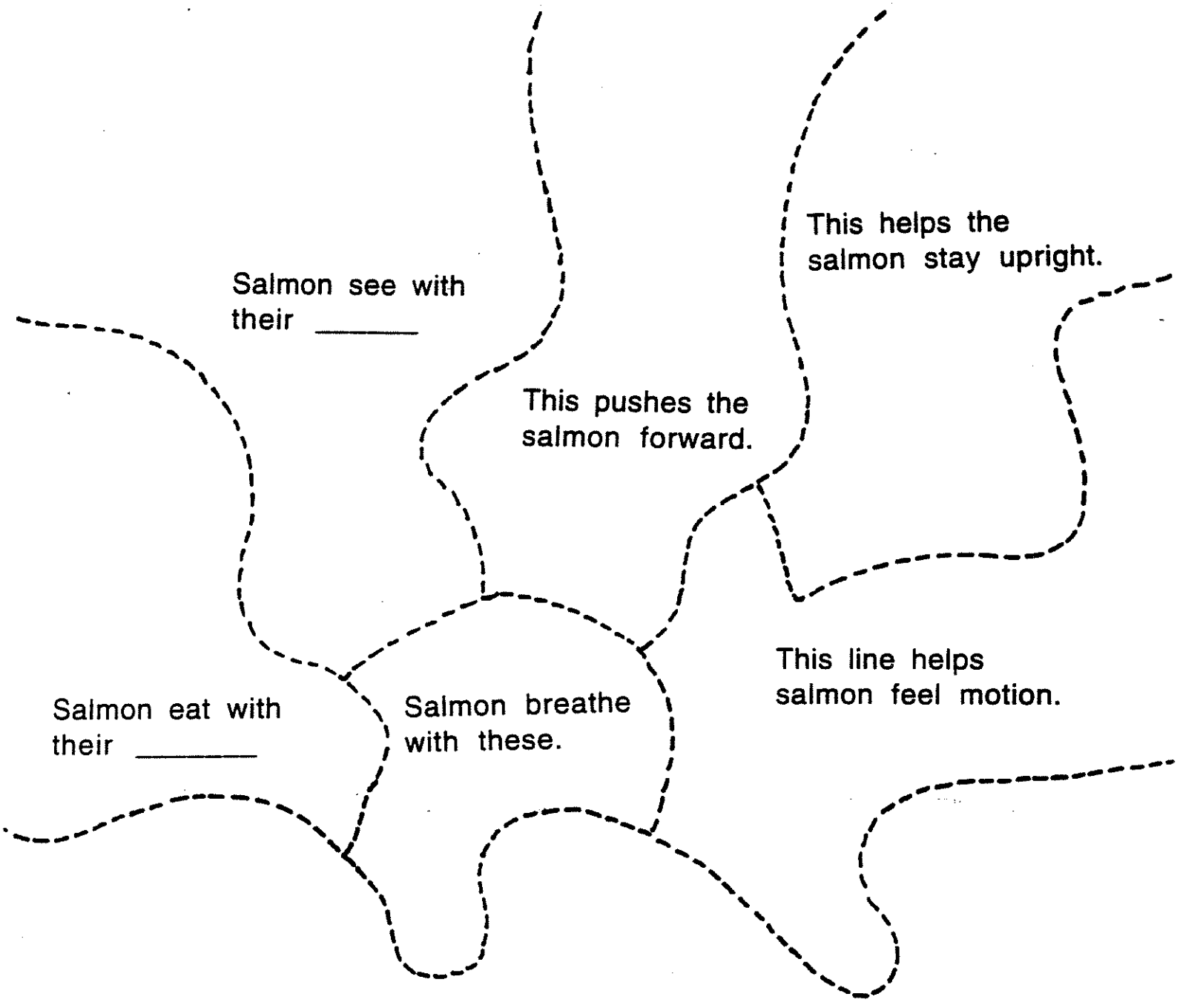


The salmon fry are ready to swim out to sea.
Please draw them a map.



Salmon Puzzle Name _____

Cut out the 7 salmon parts and glue them onto the puzzle below.
Use the clues to help you.

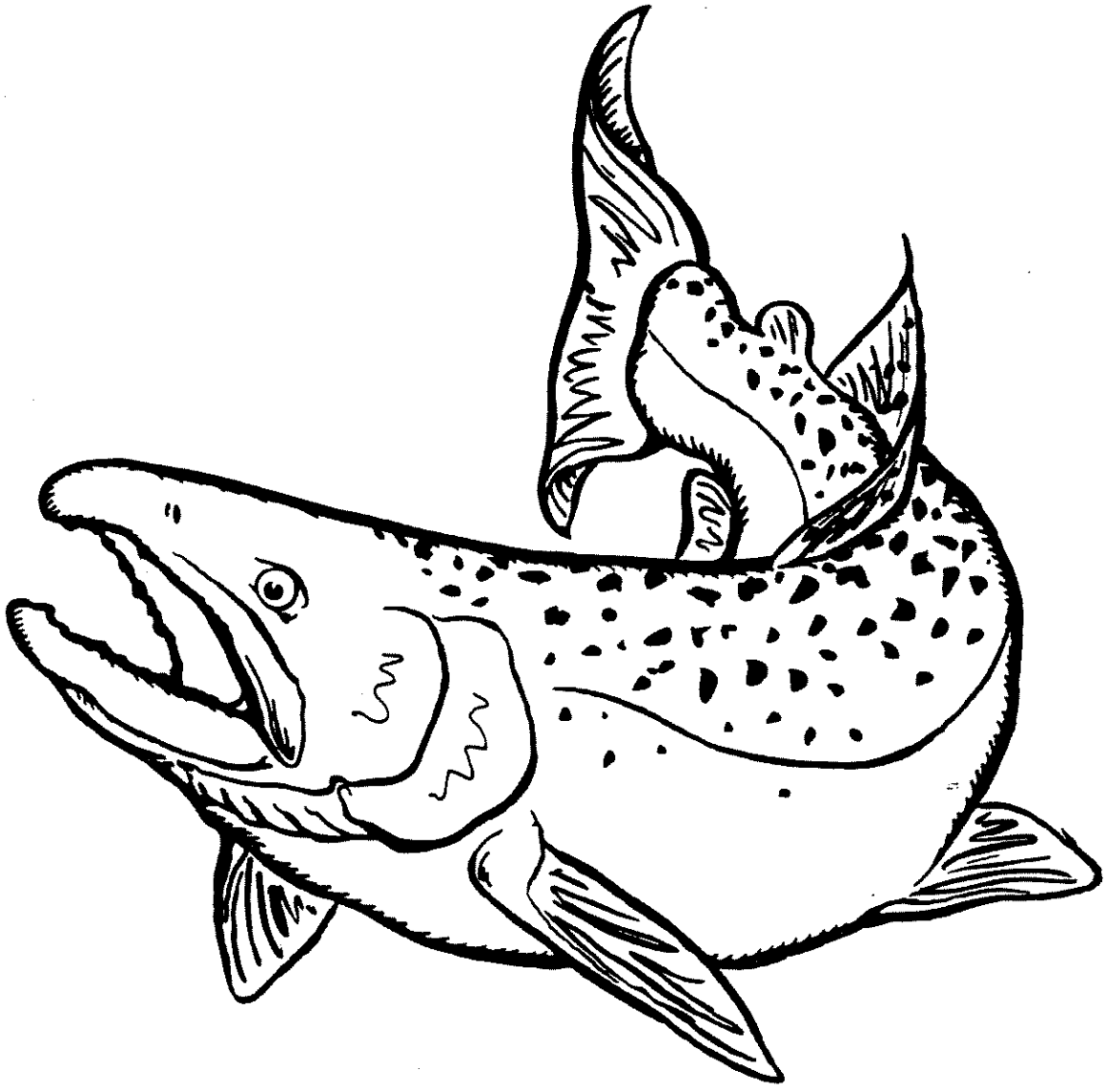


Salmon Puzzle Directions

Cut out the 7 puzzle pieces. Older students may do this themselves. Younger children may need some assistance. The pieces include all of the white areas and the line drawings. The parts with the lined-pattern should be discarded.

Children should lay down pieces to see how they fit before pasting them .

The salmon may be colored with crayons or colored pens.



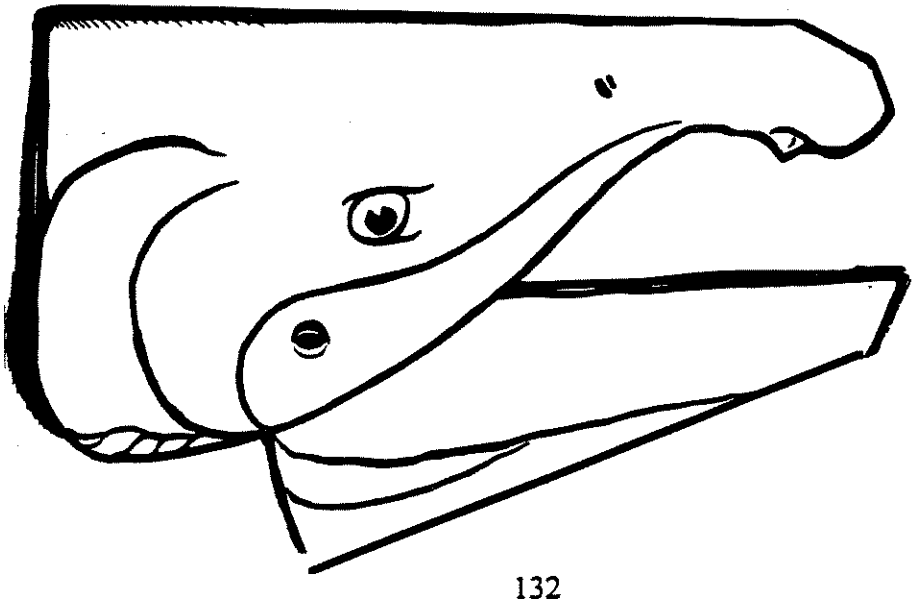
Salmon Puppet

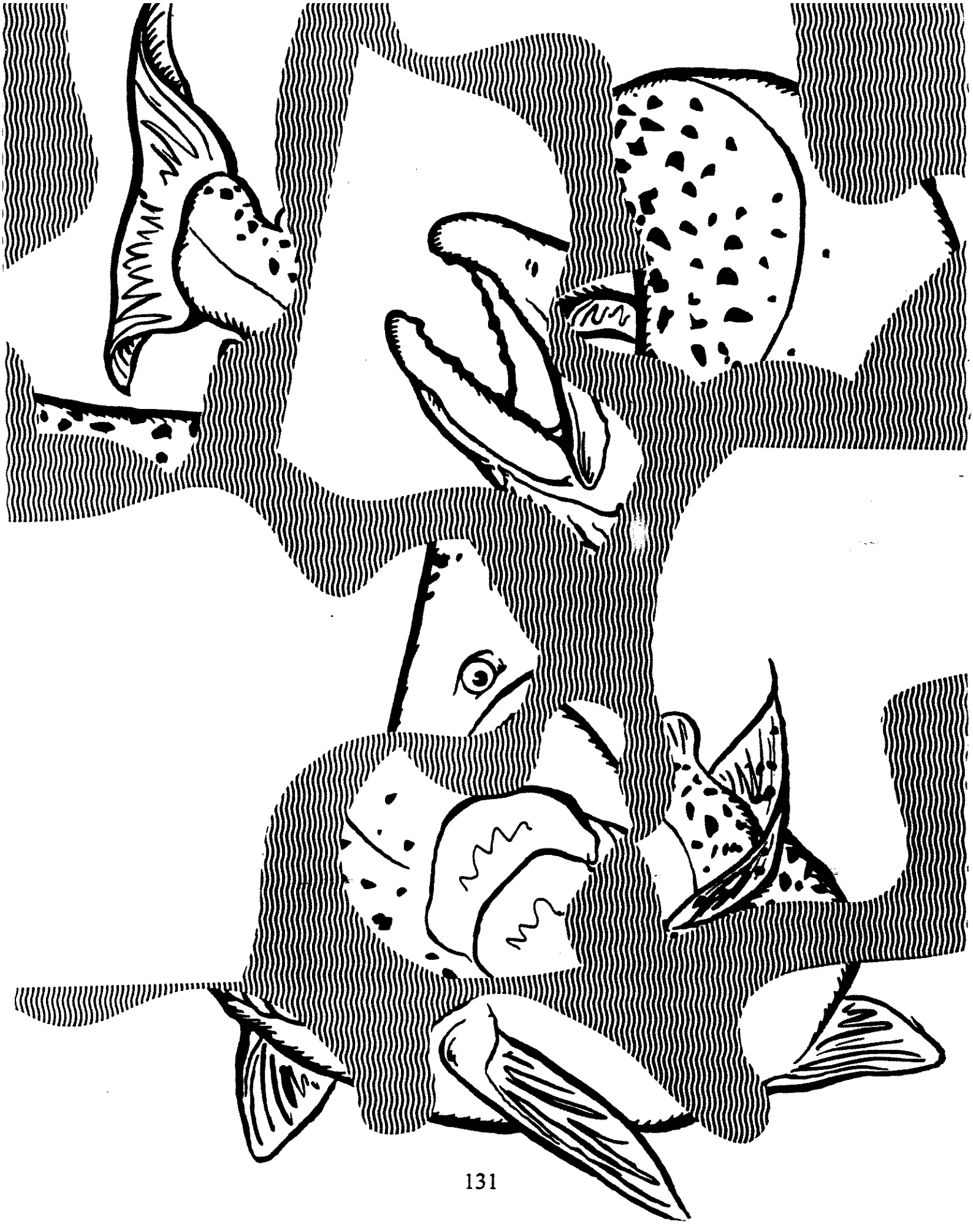
This puppet may be used for a variety of language arts activities.

Materials
salmon puppet template
light weight card stock paper
package of brass fasteners (2 per puppet)
scissors
tape
rubber bands or string
colored pens or crayons (optional

Preparation
Xerox the puppet on cardstock paper. For young children, cut out the puppet .

Directions for construction
1. Cut out the two pieces, the head and the lower jaw.
2. Color if desired.
3. Punch 4 holes where indicated for connecting lower to upper jaw.
4. Lightly sold both pieced along the lines.
5. Tape sides together al front of mouth.
6. Put brass fasteners through holes and connect upper and lower parts.
7. Connect fasteners with rubber band or string.
8. Another rubber band or string may be placed mid way down lower jaw. The thumb will fit under this and allow movement of lower jaw.
9. You may have to bend and crease the lower jaw so it will fit into the upper mouth.





Where is the salmon?

Salmon live in both fresh water and salt water. Print "s" for salt water and "f" for fresh water or "b" for both.

_____Eggs lie deep in the redd.

_____Salmon may be eaten by predators.

_____Salmon eat small insects.

_____A whale could eat the salmon.

_____Parr marks help salmon hide.

_____People might catch salmon to eat.

_____Salmon migrate far from California.

_____Salmon spawn in the place they were born.

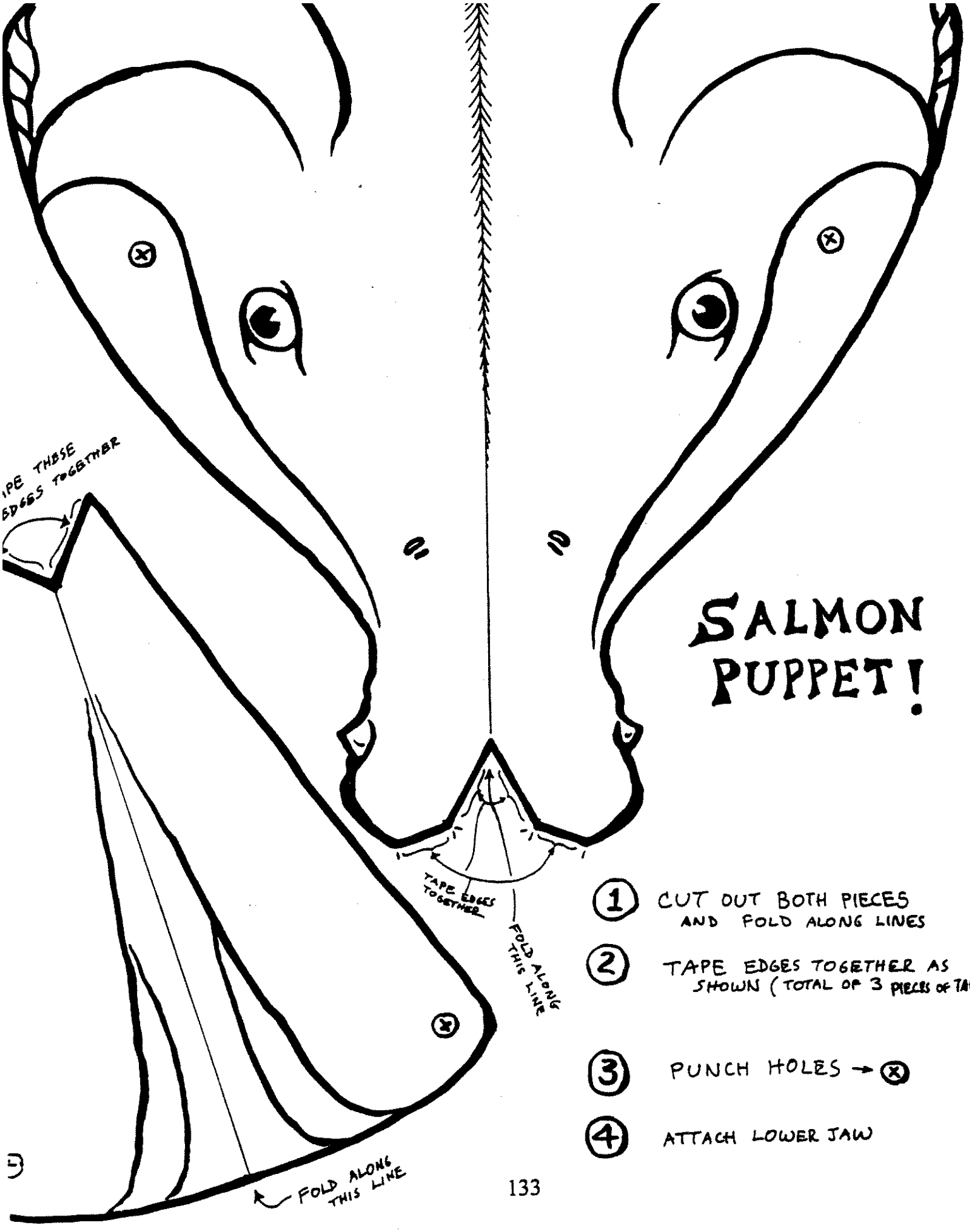
_____Salmon need clean water.

_____Salmon may live in the esturay for months.

Where is the water salty?_____

Where is the water fresh?_____

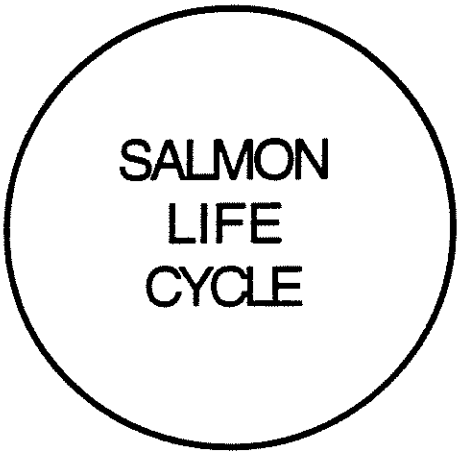
Where do fresh and salt water mix together?



SALMON PUPPET!

1. CUT OUT BOTH PIECES AND FOLD ALONG LINES
2. TAPE EDGES TOGETHER AS SHOWN (TOTAL OF 3 PIECES OF TAPE)
3. PUNCH HOLES → ⊗
4. ATTACH LOWER JAW

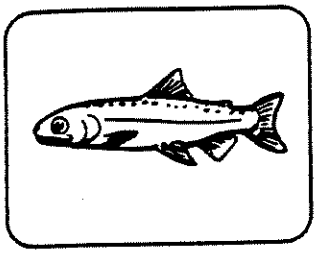
Salmon Life Cycle By_____



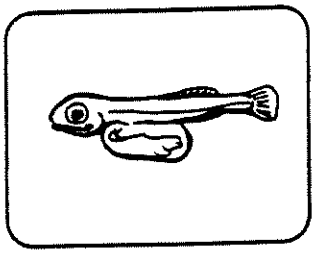
Where is Springer? Name_____

Draw a line from Springer at each life stage to the habitat that is her home.

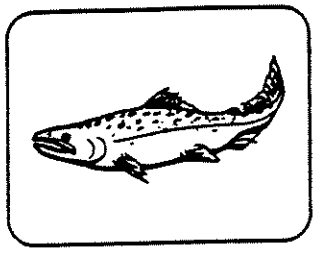
SMOLT



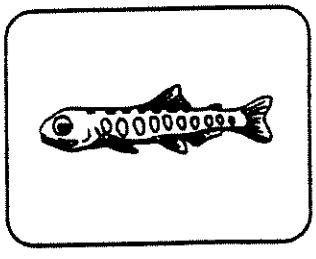
ALEVIN



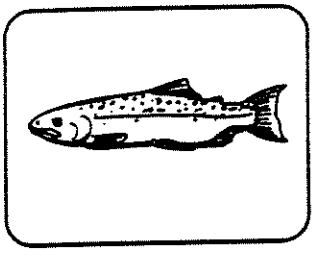
SPAWNER



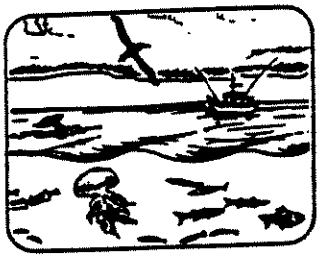
FRY



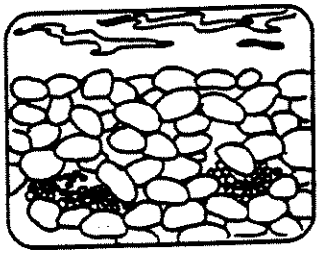
ADULT



STREAM



OCEAN



GRAVEL IN STREAM

RETURN TO STREAM

ESTUARY

From Mountains to the Sea

Students make a pull through that shows the different regions of a river and some of the animals that live there.

Objectives: Children will describe the course of a river including mountain streams, larger streams, big rivers, estuary and ocean.

Subjects: Science and Language Arts

Background:

River systems have different sections that can vary greatly in characteristics such as water flow, gradient, riparian vegetation, and stream bottom. A river, from its headwaters to the ocean, provides many types of habitat that supports a variety of animals and plants.

Most rivers begin in mountains and eventually flow to the sea. Some rivers or streams may flow into lakes that have no outlets, and occasionally a river will simply disappear into the ground before reaching the sea. But most rivers do reach the sea.

River headwaters are often in the mountains. These streams my be ephemeral, and because the gradient is steep, salmon and steelhead may be absent. Many tiny tributaries combine to form larger streams, which have wider stream channels and carry more water. These steams are often good rearing habitat for salmon. There are riffles, cascades, pools and glides in most streams.

Streams and rivers may combine with larger streams and rivers many times before finally flowing into the ocean. The Klamath River receives all the water from several other major river systems, like the Trinity, Salmon and Scott and Shasta Rivers. As flows increase, the streams channel and stream bed change. The types of animals living in the river change, too.

When the river reaches the sea, it combines with the salty area in the estuary. Estuaries may look calm from above, but beneath the surface they often team with life. This is because they are so nutrient rich. The river captures nutrients from the watershed (decaying organic matter and minerals from the soil and rocks) and delivers them to the estuary. The ocean, which surges into the estuary, also contributes nutrients.

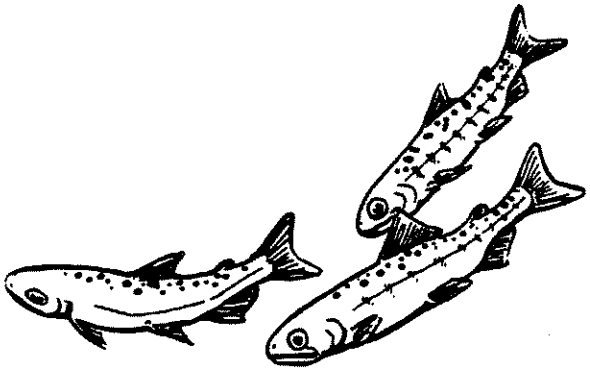
The topography of ocean floor just off California and Oregon causes upwelling, which makes the waters very rich in nutrients and food.

Materials

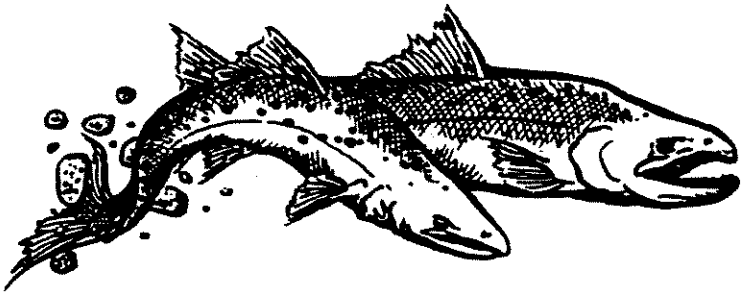
copies of the Mountain to the Sea panels (1 per student)
copy of cover for each student
construction paper cut into strips 3 1/2 inches wide and 24 inches long.
glue
scissors
crayons or colored pens or pencils
stapler
tape

Salmon Life Cycle Picture

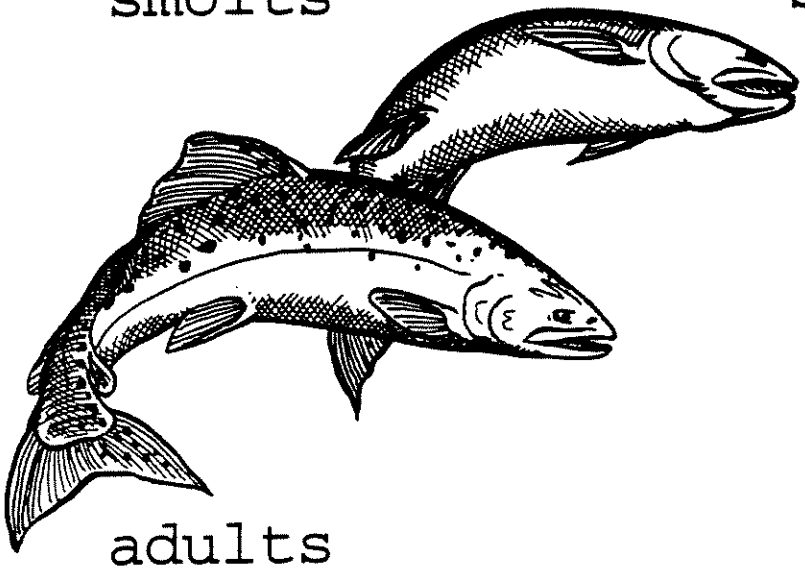
Cut out the pictures and the words. Put them in order of life stages. Paste the pictures and words on the circle.



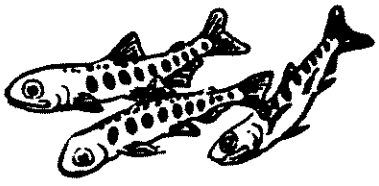
smolts



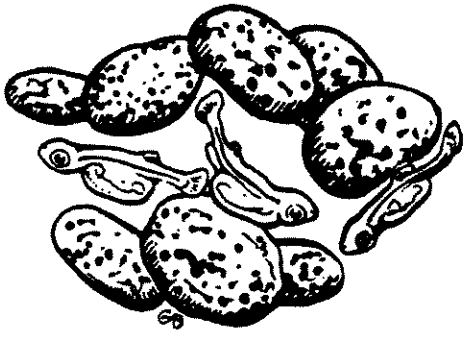
spawning adults



adults



fry



alevin

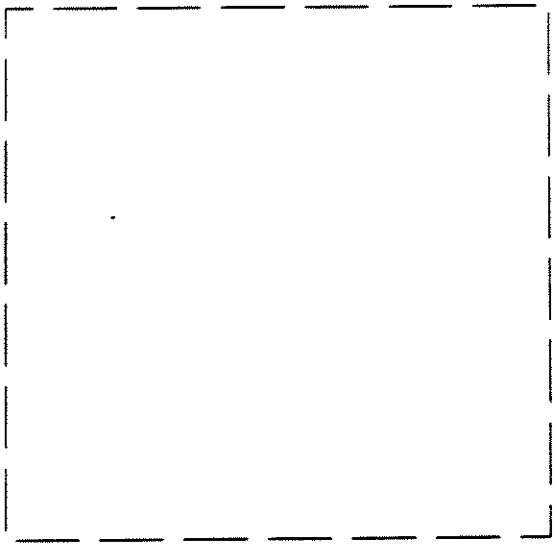
eggs

Making the Pull-Through

1. Color the 4 panels (optional)
2. Cut out panels along dotted lines. The left sides of panels 2 and 4 should be cut right to the picture. The right sides of panes 1 and 3 should not be cut. They will overlap with the other panels.
3. Match the small squares on the panels. ■ ■
4. Glue and/or tape the panels together. The four panels may be put in a series, or, panels 3 and 4 may be glued to the back of panels1 and 2.

Making the Cover

1. Use the template below to cut cover out of construction paper, or xerox onto heavy paper.
2. Cut two pieces. For one continuous panel, cut the square out of only one piece. For back-to-back panels, cut square out of both pieces.
3. Glue the two side of cover together. Glue the short edges of the cover only. Leave the sides (long edges) open. When the glue has dried, insert the pull-through into the cover so that the square is centered over the picture.
4. Staple the cover to keep the panel in position. (see diagram)



Procedures

Begin with a discussion of rivers, estuaries and the ocean. Show slides, video, or show pictures. Let children share personal experiences with streams and rivers and explain what they are like. Can they jump across the stream? Can they swim in it? Do they know places where the river is to big for swimming?

Discuss how different animals like to live in different habitats. The river provides different kinds of habitats from the mountains to the sea.

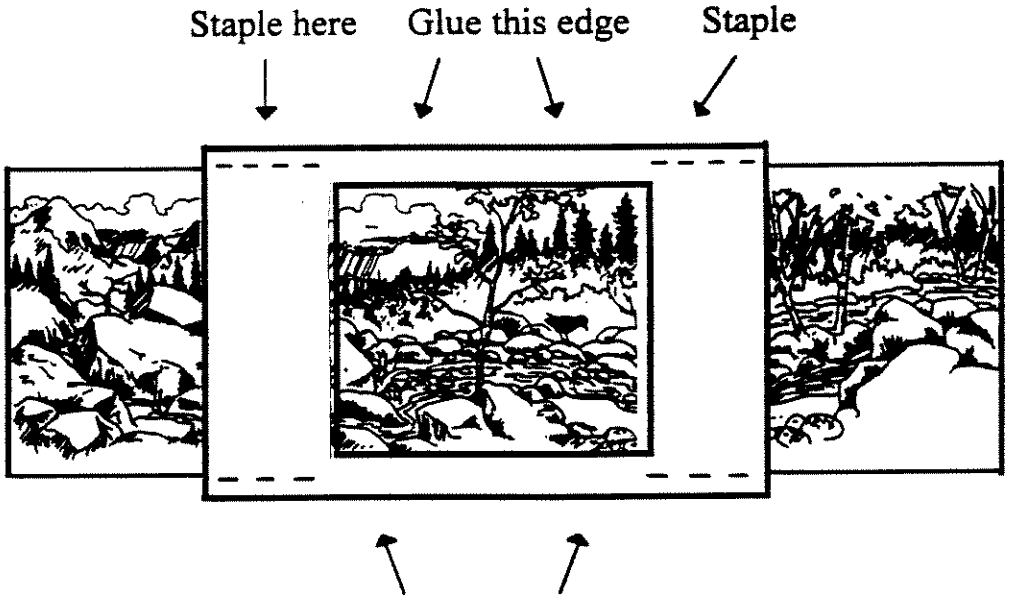
Make a list of words students can use while using the pull throughs. Include: mountains, rain, watershed, tributary, rivulets, stream, river, cascade, pool, riffle, boulders, water falls, logs, salmon, fry, bear, sturgeon, ducks, .otter, sea lion, egret, heron, trees, riparian, stream bank, water flow, substrate, estuary, salt water, ocean, coastline, seashore, waves,tide, seaweed, kelp. anenomies, shark, schools of fish, jellyfish, seagulls, fishing boat.

Activities:

Use the pull-throughs to tell stories about Springer's adventures. Or, students can describe parts of the river system, and tell about the animals the live there. Have them work in pairs or small groups and take turns telling their stories.

Older students can write captions under each picture to describe what it shows or to tell a story. Modify the template for the cover to make the window larger, to show the writing.

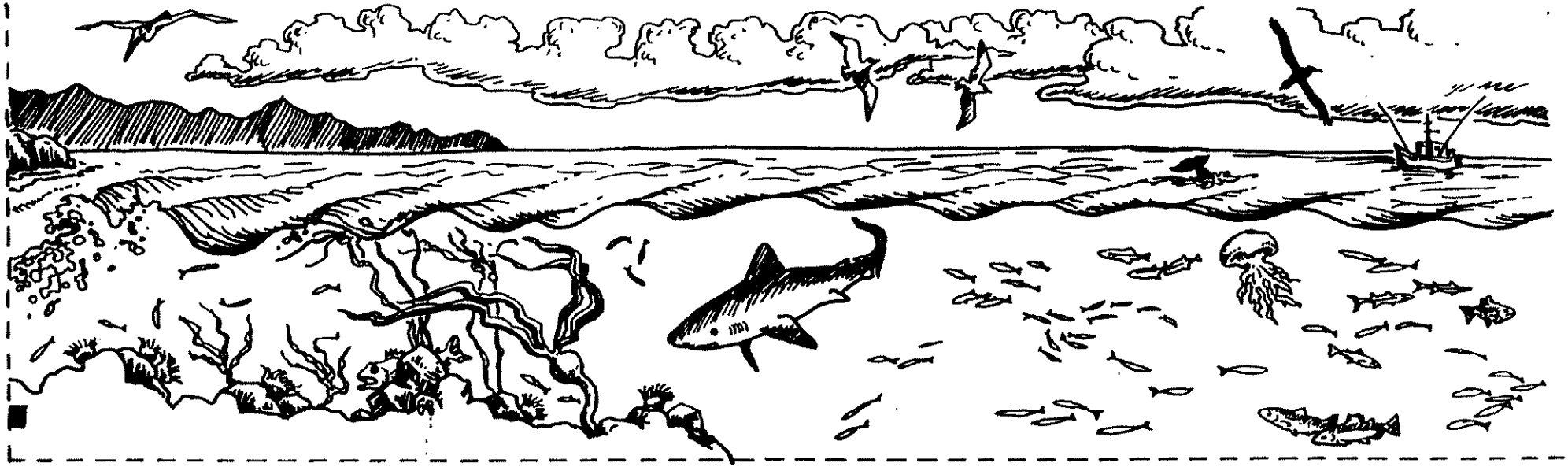
Students can also design a pull-through that tells a story.



do not cut this end

3.

4.



do not cut this end

1

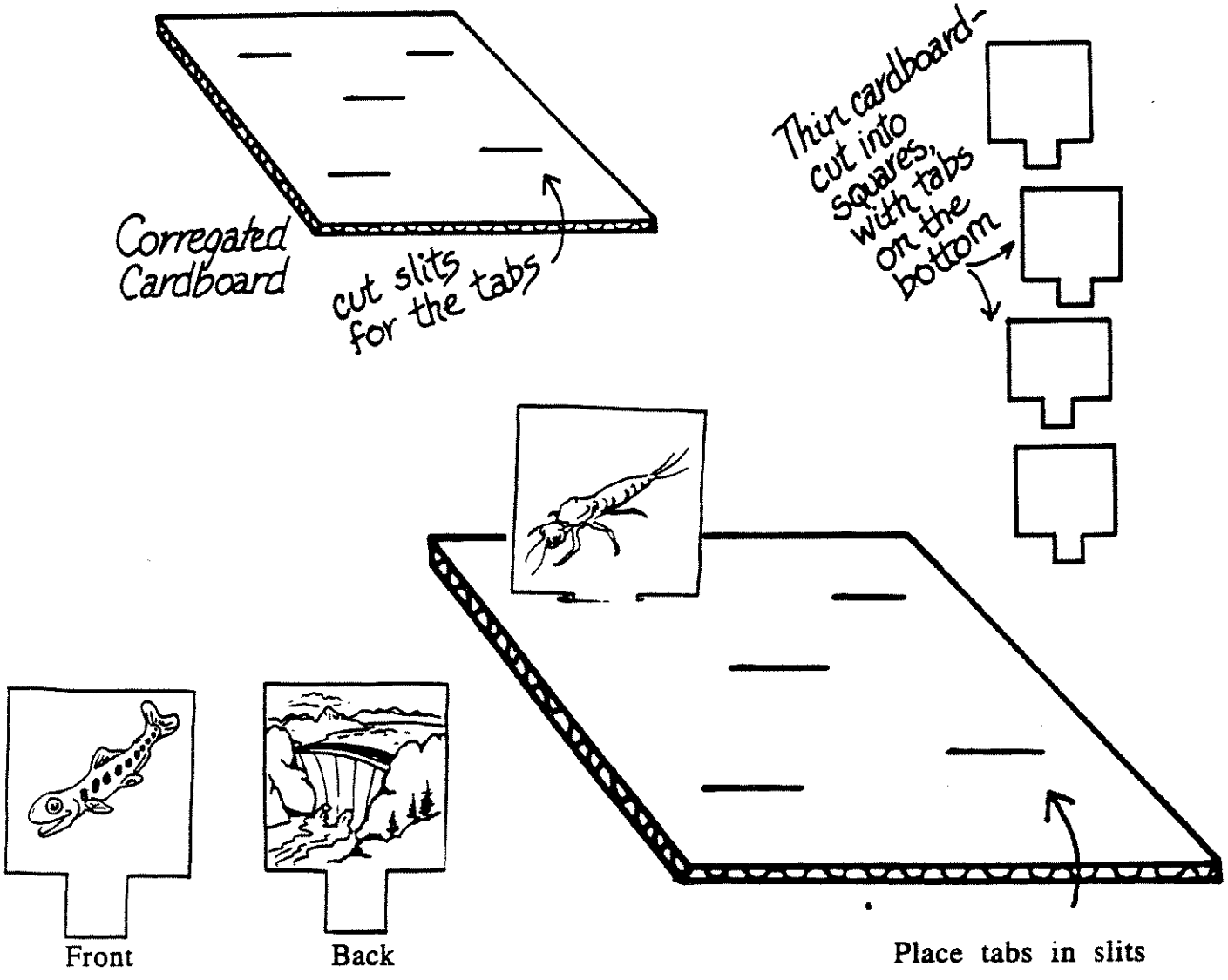
2.

when turned around, it will show conditions or activities that hurt the ecosystem.

Demonstrate how to put the board together. Pictures may be drawn or cut from magazines.

Give each student a baseboard and the cardboard pieces. Students may draw the scenes on a separate piece of paper and then glue them onto the cardboard, or they may draw directly on the cardboard tabs.

Have each student show his or her board and discuss them as a class.



Adapted from "Estuary Environmental Board", Smithsonian Environmental Research Center

River Habitat Environmental Board

Design and make a 3-D display showing elements of a healthy stream, including animals, and man-made disturbances that hurt the stream environment.

Objectives

Students will be able to identify several components of a stream and ways that humans can harm them.

Background

Humans sometimes create problems for salmon. People have always relied on salmon for food, and when habitat is healthy enough to support plenty of fish, fishing can be done with no harmful effects to salmon populations. But too much fishing, or fishing at the wrong time (when fish are fry or during spawning) can hurt fish populations.

People also hurt salmon habitat sometimes. Dams have eliminated many miles of former salmon habitat and have changed river conditions. Activities like logging, road building, construction, and agriculture can cause erosion. If erosion is high, streambeds may become buried in silt. Pollution with various chemicals that find their way into streams also hurts salmon and trout habitats.

Materials

corrugated cardboard, about 1 square foot or larger (cut slits in the cardboard with a sharp knife) 1 per person.
thin cardboard pieces usable on both sides (10 per person)
crayons, colored pens or paints
scissors
glue
white drawing paper
magazines with pictures of streams

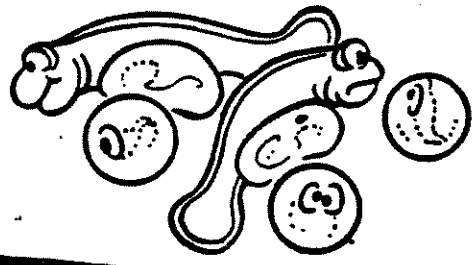
Procedure

This activity should follow a discussion, video or slide presentation about salmon habitat and its restoration.

Explain to students that they will design a display that will show others how humans can upset the balance of a healthy stream environment. Viewed from one direction, the board will show a healthy ecosystem, and

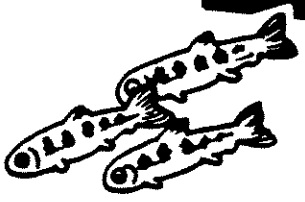
Help Springer

name _____



6+3=__ 3+4=__ 9+3=__ 7+2=__ 8+6=__

$\begin{array}{r} 6 \\ +\,6 \\ \hline \end{array}$



0+9=__ 3+7=__ 5+5=__ 9+4=__

$\begin{array}{r} 7 \\ +\,6 \\ \hline \end{array}$

8+2=__ 7+4=__ 10+5=__

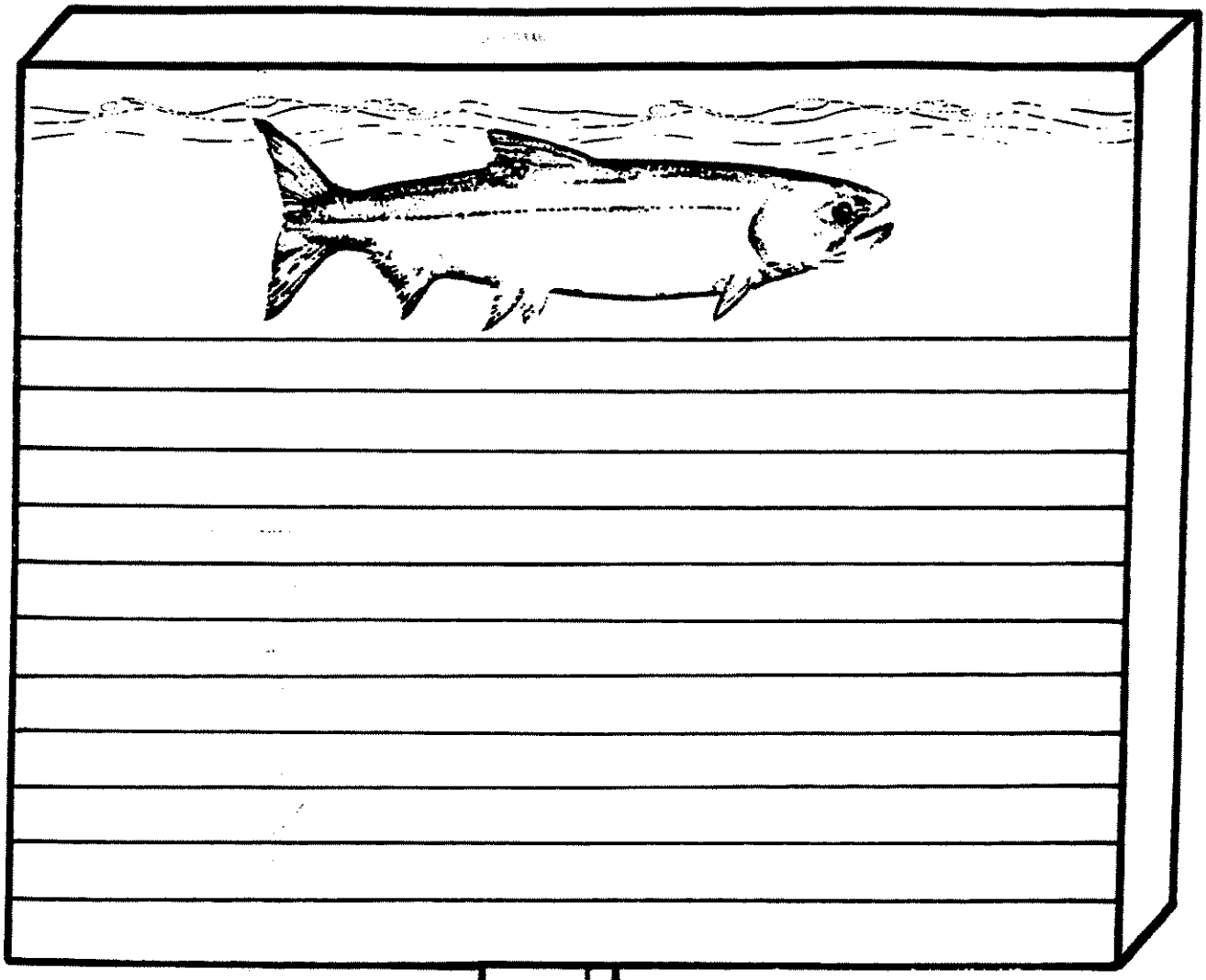
6+4=__

$\begin{array}{r} 3 \\ 2 \\ 6 \\ +\,4 \\ \hline \\ \hline \end{array}$

Help the Salmon

name _____

- Print some rules on this signpost that will help to save the salmon.

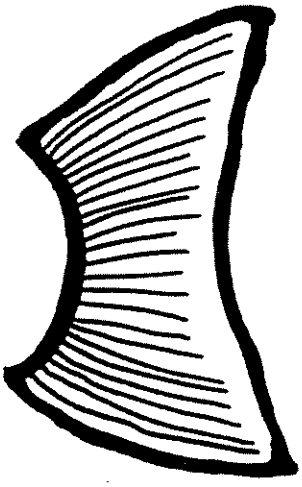


PARTS OF A SALMON

Salmon have fins to help them swim.

Pelvic fin

Dorsal fin

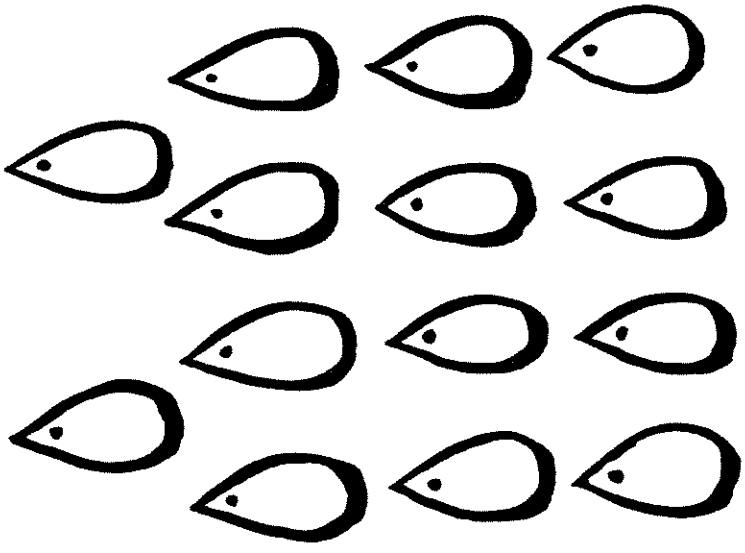


Caudal fin

Pectoral fin

Anal fin

Scales cover and protect the fish's skin.



Eyes

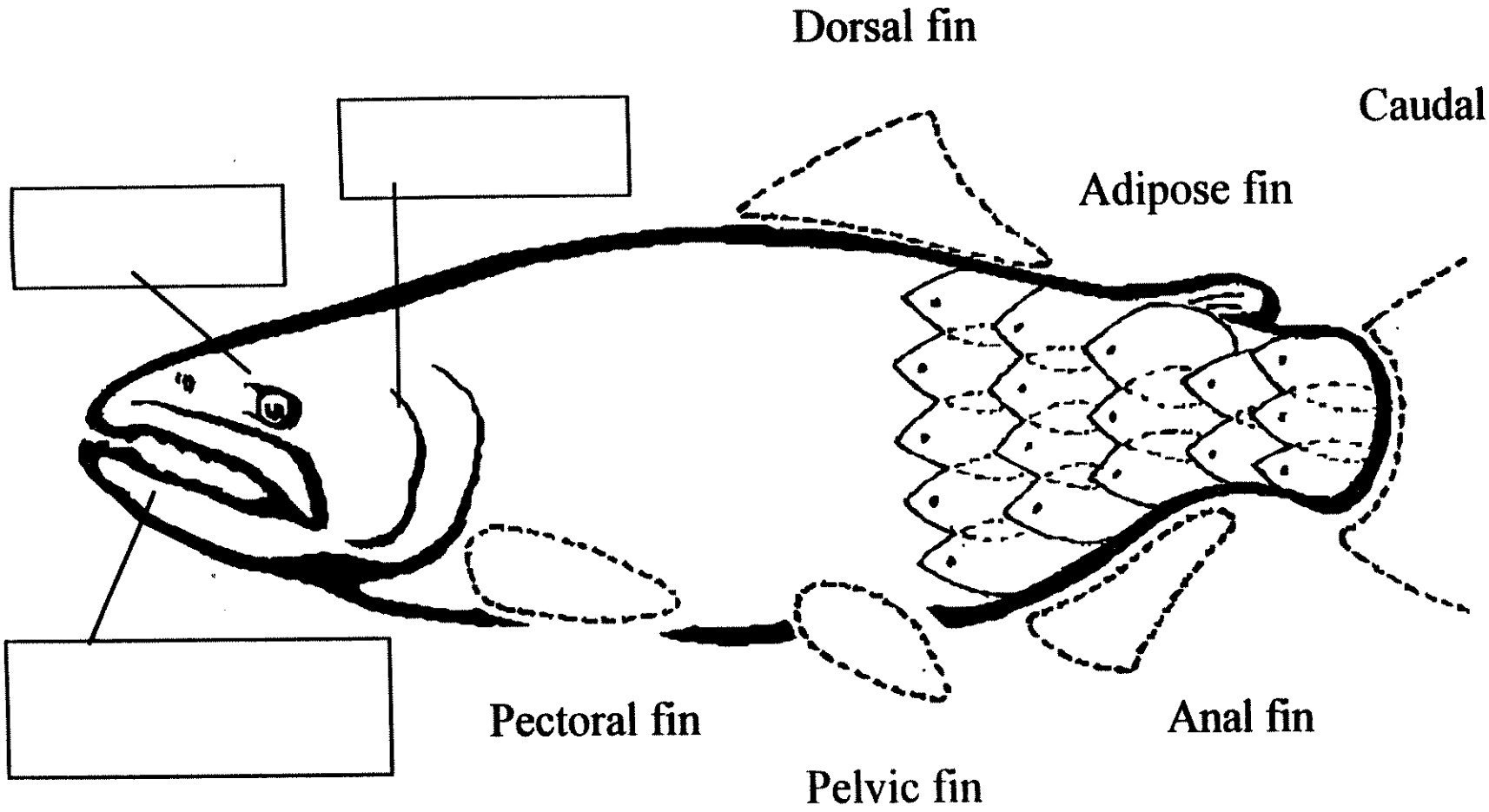
Gills

Mouth

Carefully cut out the fins, scales, and words. Then paste them on the salmon.

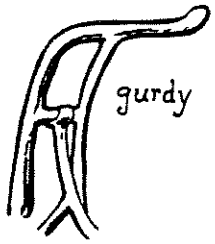
PARTS OF A SALMON

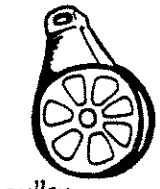
NAME_____

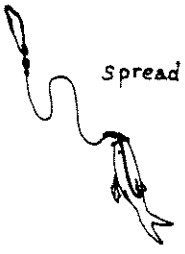


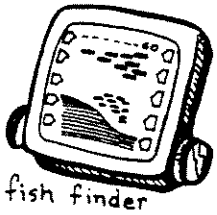
Paste the fins on the salmon. Paste the word in the boxes. Then paste on the scales. Begin with the scales near the tail and make the scales overlap. Color your salmon.

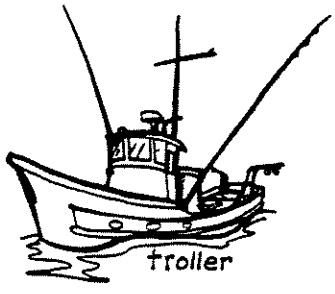
Can you draw a salmon troller?

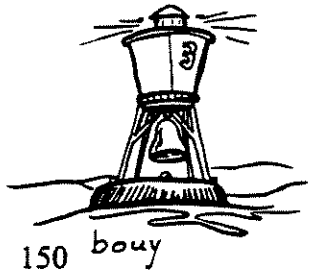


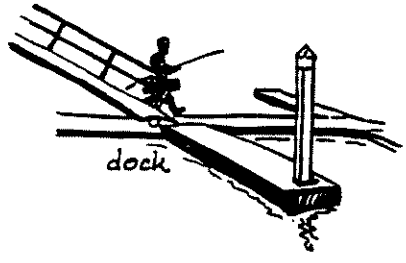




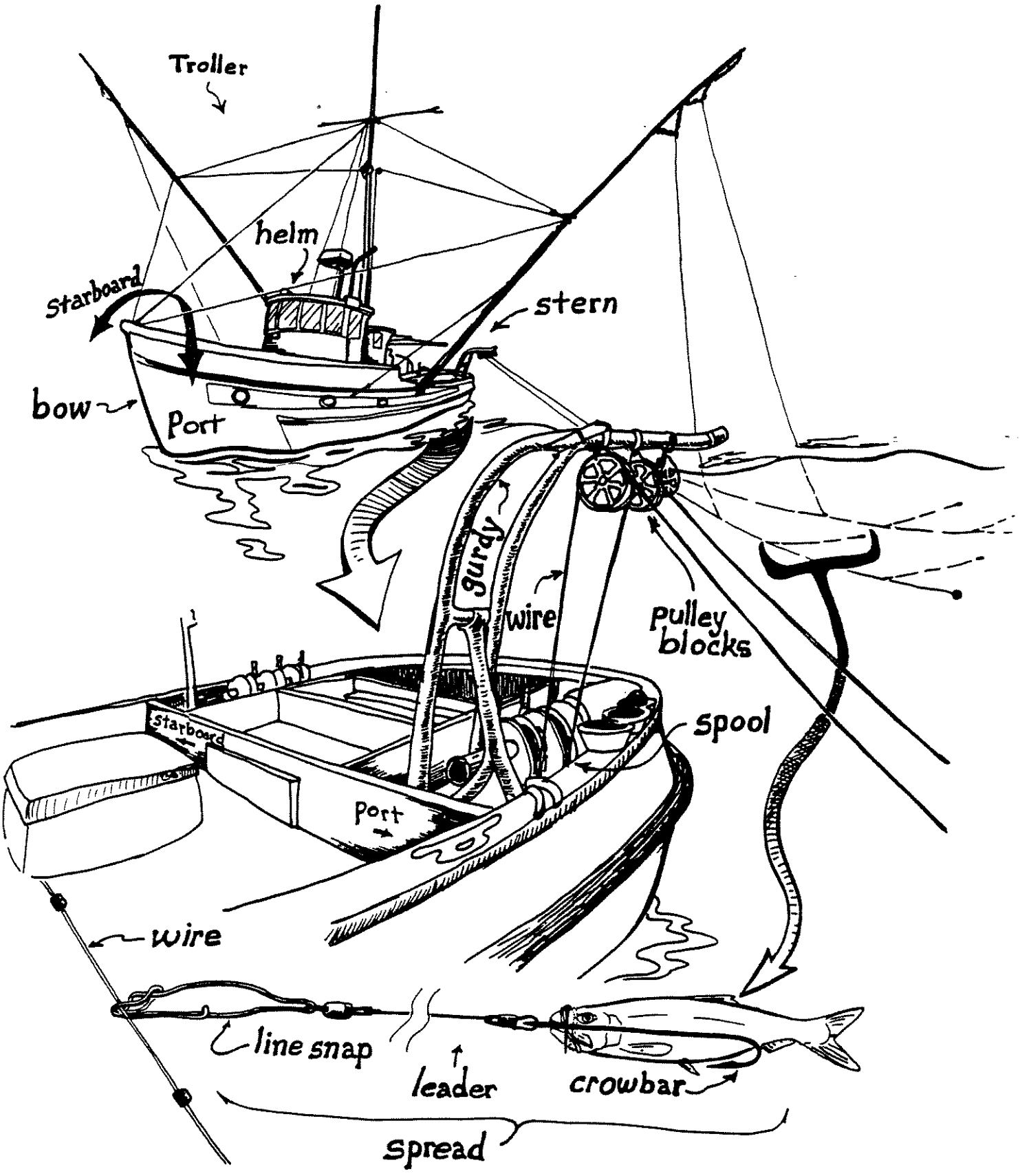








A Salmon Troller



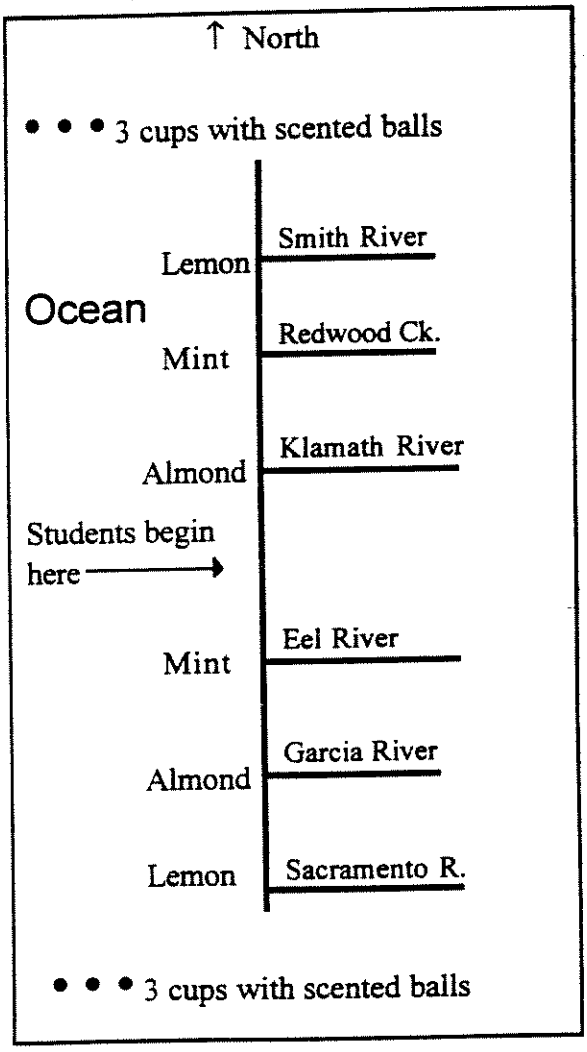
Which Way Is Home?

Students become salmon migrating home from sea. They use a compass, the sun and their sense of smell to find their home stream.

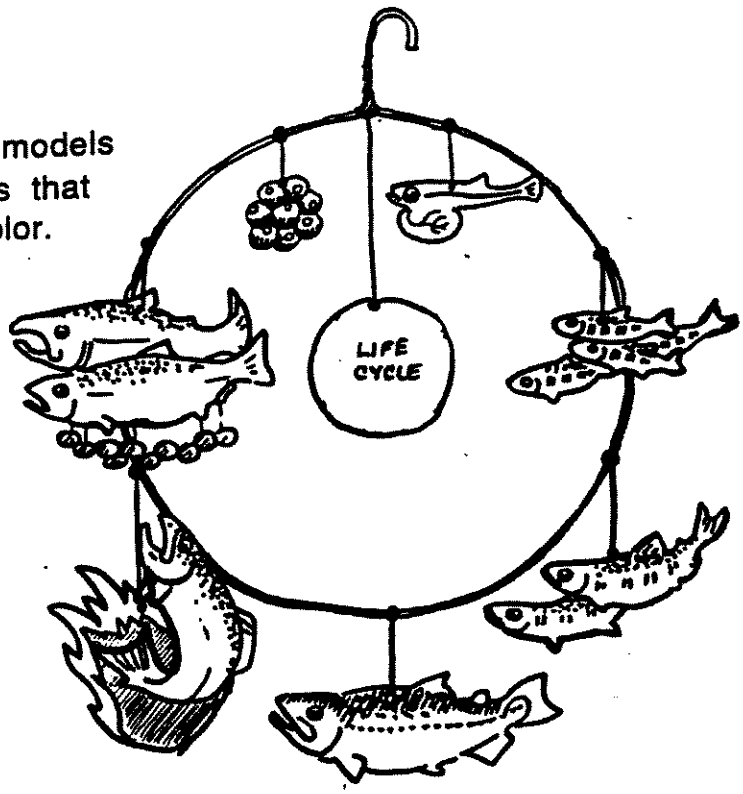
Materials Large map of California that shows the ocean
10-15 Compasses
Masking tape
Poster board or other paper for making signs and a "sun"
Felt pens
3 scented oils - choose very dissimilar ones, like lemon, almond and mint
A bag of cotton balls or paper towels
12 Paper cups or baggies to hold cotton balls

Advanced Preparation:

1. Use a large open area. If you do this outside, students can use the sun to navigate, like salmon do. Inside, you can hang a paper sun overhead, in the southern part of the room.
2. Use a compass to find magnetic north. Determine the north-south line, and mark it with masking tape. It should be at least 30 feet long. This line represents the coastline. When you face north and stand to the left of the line, you are in the Pacific Ocean. To the right of the line, you are on land.
3. Make six "rivers" with masking tape. See the diagram. You may give the rivers names.
4. Soak cotton balls with scents. Put three cups at the north and three at the south end of the "coastline", and put 4-6 cotton balls in each one. Keep scents separate. Place one scented ball at the beginning of each river.



Life Cycle Mobile



Objectives: Students will create models of salmon at the different life stages that show relative size, body shape and color.

Materials

wire hangers or flexible wire
butcher paper
bakers clay
paints - acrylic or tempera
colored pens and pencils
string
newsprint or scratch paper
glue
staples
pictures or templates of salmon

Procedures

1. Make eggs with small balls of clay. Bake them and paint them pinkish orange.. Eyes may be painted black. Glue several eggs together into a clump.

2. To make alevins, roll the clay, then shape a yolk sac. Bake and paint them. Show the eyes and the veins in the yolk sack. Blood flowing through these veins carry nutrients from the sac to the fish.

3. Make the fry and smolts from clay, too. The smolts should be bigger than the fry. The fry should have parr marks and the smolt should be silvery, with a darker back. Discuss how these markings help the fish hide in the stream environment, and then the estuary.

4. Make the adults, migrating fish and spawners by tracing the shapes from a template or from a picture, such as a poster. Cut two of each shape. Color both sides with paints, crayons or pens. Staple the sides together and stuff them with toilet paper or newspaper.

Ocean adult should have silvery sides, with a light belly and very dark (greenish brown) back. Returning fish and spawners are dark with bright red colors. Consult photographs or posters for markings and colors.

Bend coat hangers into round shapes and hang salmon with string.

Procedure.

Look at the map of California, and talk about the rivers, coastline and ocean. Springer spends three years in the ocean, often swimming in big circles with the gyres. She may be far from the mouth of the Klamath River when the urge comes to go home. How does she find her way? Discuss the senses salmon probably use to navigate - Earth's magnetic field, the position of the sun, and then visual clues and smell.

Remind children of the imprinting that occurred when Springer was in the Salmon River. She has a very good memory, and can still remember the smell of the Salmon River. But first she has to get close enough to smell her river. To do that, she uses her inner compass and the sun to navigate.

Show children the coastline and rivers you made with masking tape. Show them how to read the compass. Explain that the compass responds to Earth's magnetic field by always pointing north. Direct students' attention to the sun. The sun's position in the sky changes daily and seasonally. Use the compass to determine what part of the sky the sun is in (east, west, or south) and help children see how they can use that knowledge to navigate. If the sun is overhead (at noon during late spring or early fall day) it may not help navigation for this activity. The fish, however, swim all day, and could use the sun's east/west motion to navigate.

Explain that students will pretend to be salmon at sea who want to go home. Like the salmon, they will first use a compass and the sun (if possible) and then their sense of smell.

Divide the class in half. One half are spring run, the second are fall run fish. One by one, the spring run "fish" walk by the teacher, who will give each a compass and whisper which direction their river is - to the north, or to south. This assignment should be random. Using the compasses and the sun, students should find north or south and walk (swim) in that direction until they reach the cups with the scented balls. They should then put down the compass, and choose 1 scented ball. Using that as a reference scent, they should find the river with the same scent, and swim upstream. Those who went south will swim up one of the three southern rivers, those who went north will go to one of the three northern rivers.

Collect the compasses and let the second half of the class (later runs of fish) navigate their way home.

Fish Run Calendar

Objectives: Students will identify the months of the year when the various runs of salmonids return to the river to spawn. Students will make inferences about why different fish come back at different times.

Materials: Construction paper, scissors, paste marking pens, species readings

Background

The Klamath River supports several runs of anadromous salmonids. By returning to spawn a different times of the year, salmon maximize their use of habitat. Flow conditions vary seasonally and year to year, and with staggered fish runs, there is better likelihood of finding adequate flows at some time of the year, so some salmon, at least will spawn, even in drought years. The runs of salmon in the Klamath River System are listed below.

Chinook: Fall - Runs begin in August-September. These fish are going to the Upper Klamath, Scott, Shasta, and Salmon Rivers. Trinity River fish start returning in September and go through October.

Late runs come in November through January. They return to the Lower River (below Weitchpec) and middle River (Weitchpec to Scott River).

Spring Chinook: Wild fish enter river in March - May, going to the Salmon River, Wooley Creek and some tributaries.

Hatchery Chinook return to the Trinity River from April to late June

Steelhead There are fall, summer and winter runs of steelhead.. Winter are the most widespread.

Summer Run: From April - July
Fall Run: August - October
Winter Run: Nov. - March

Coho Hatchery (from Columbia River stocks) Sept. 15 - Oct. 20

Cutthroats - Return only to the lower river, during March through November. They stay in ocean (or estuary) for only 4-6 months. They spawn annually.

Procedure

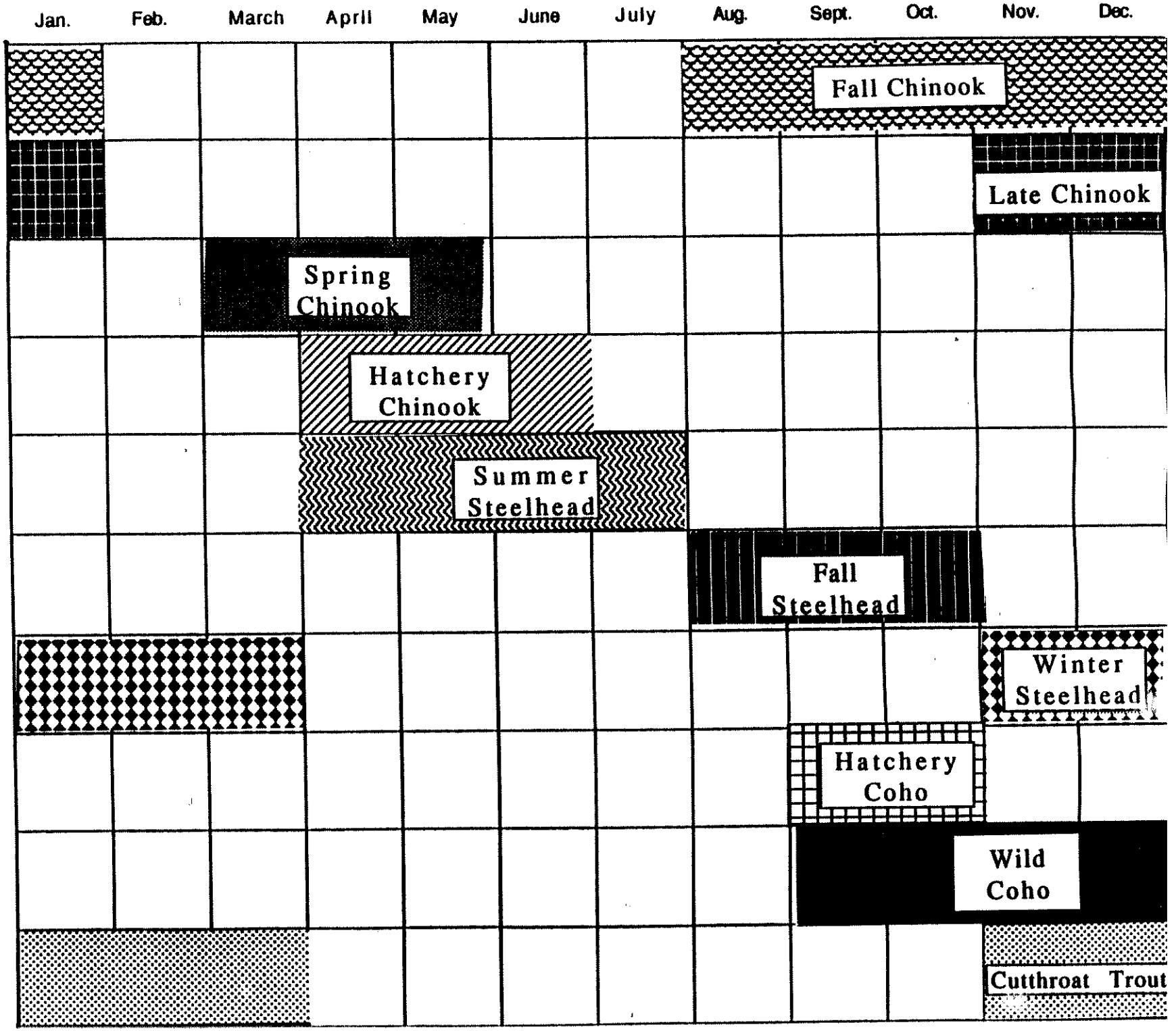
Give each student a calendar grid Anadromous Fish Runs in the Klamath River Basin and several strips of construction paper. There should be four colors, each representing a different species of fish. Make the strips of paper one unit by 12 units long (.75" by 9").

Put the table with information about fish runs where all students can see it. Using the information of the table, students will cut and paste strips of colored paper onto their grids to represent the different runs of fish.

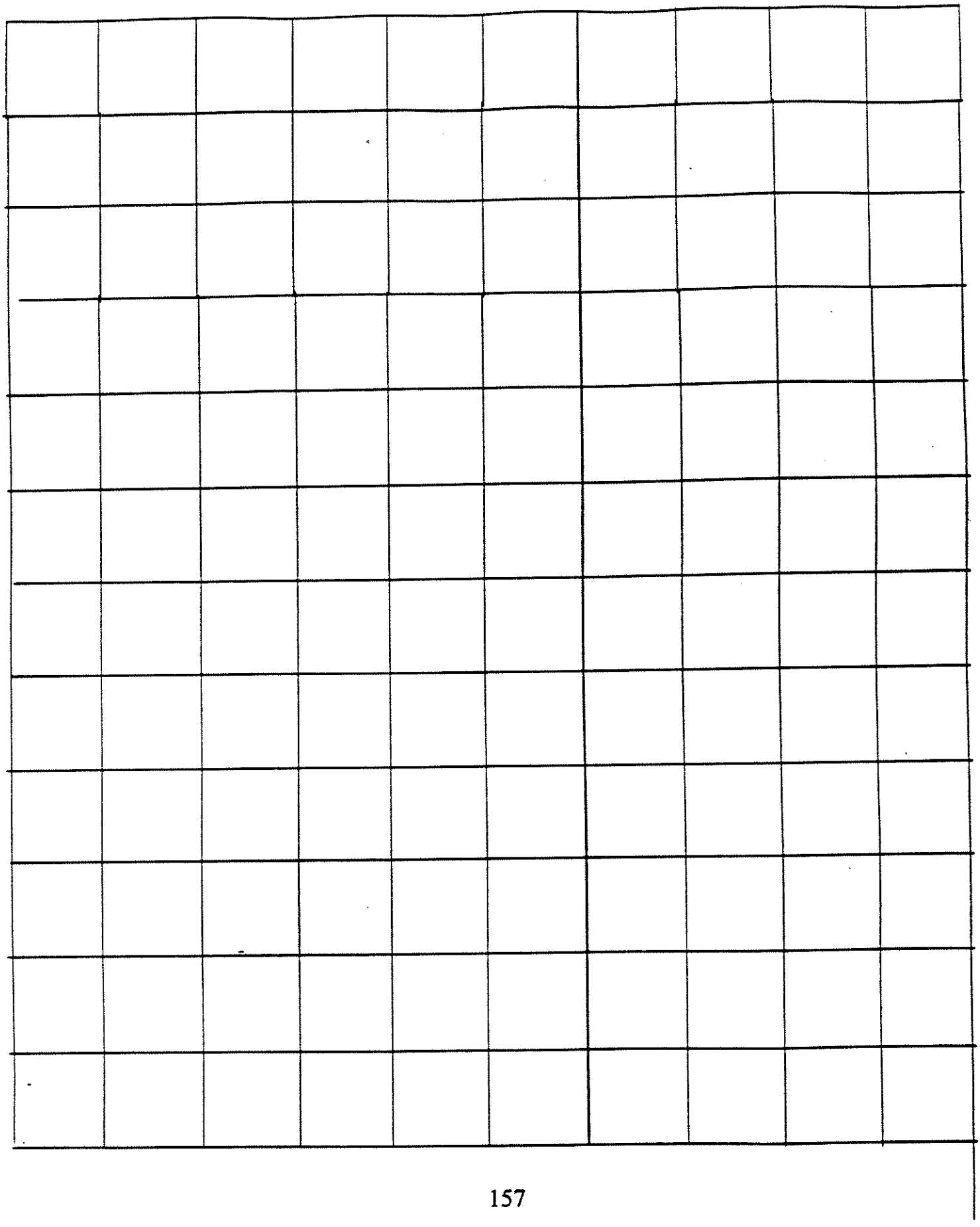
RUNS OF SALMONIDS IN THE KLAMATH RIVER BASIN

Chinook	Fall Run	August - October
	Late Fall Run	November - January
	Spring Run	March-May
	Hatchery Spring Run	April-June
Steelhead	Summer Run	April-July
	Fall Run	August-October
	Winter Run	November-March
Coho	Hatchery Run	Mid September- October
	Wild Run	September-December
Cutthroat Trout		November-March

ANADROMOUS FISH RUNS IN THE KLAMATH RIVER BASIN



FISH STOCK


ANADROMOUS FISH RUNS IN THE KLAMATH RIVER BASIN
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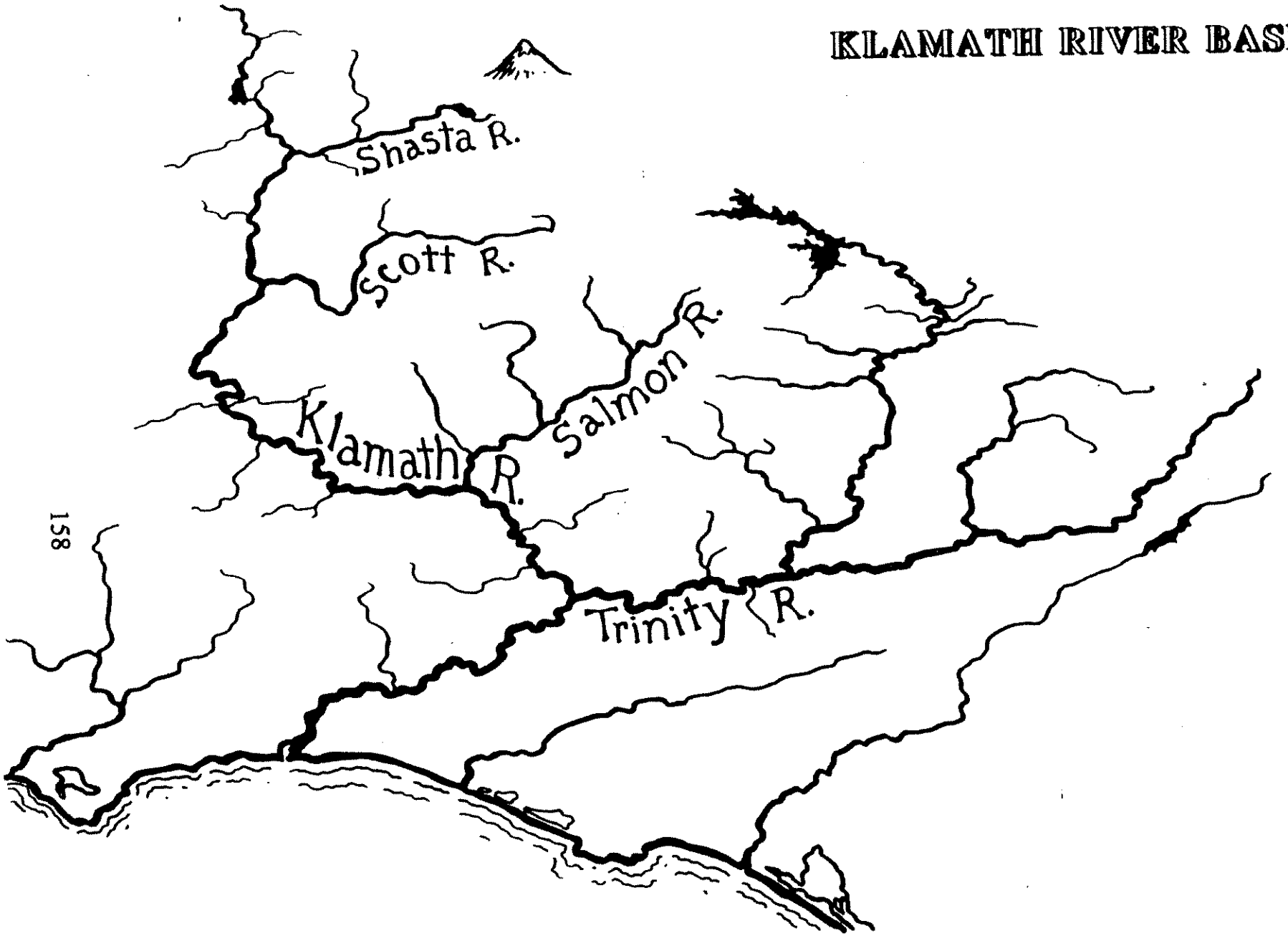
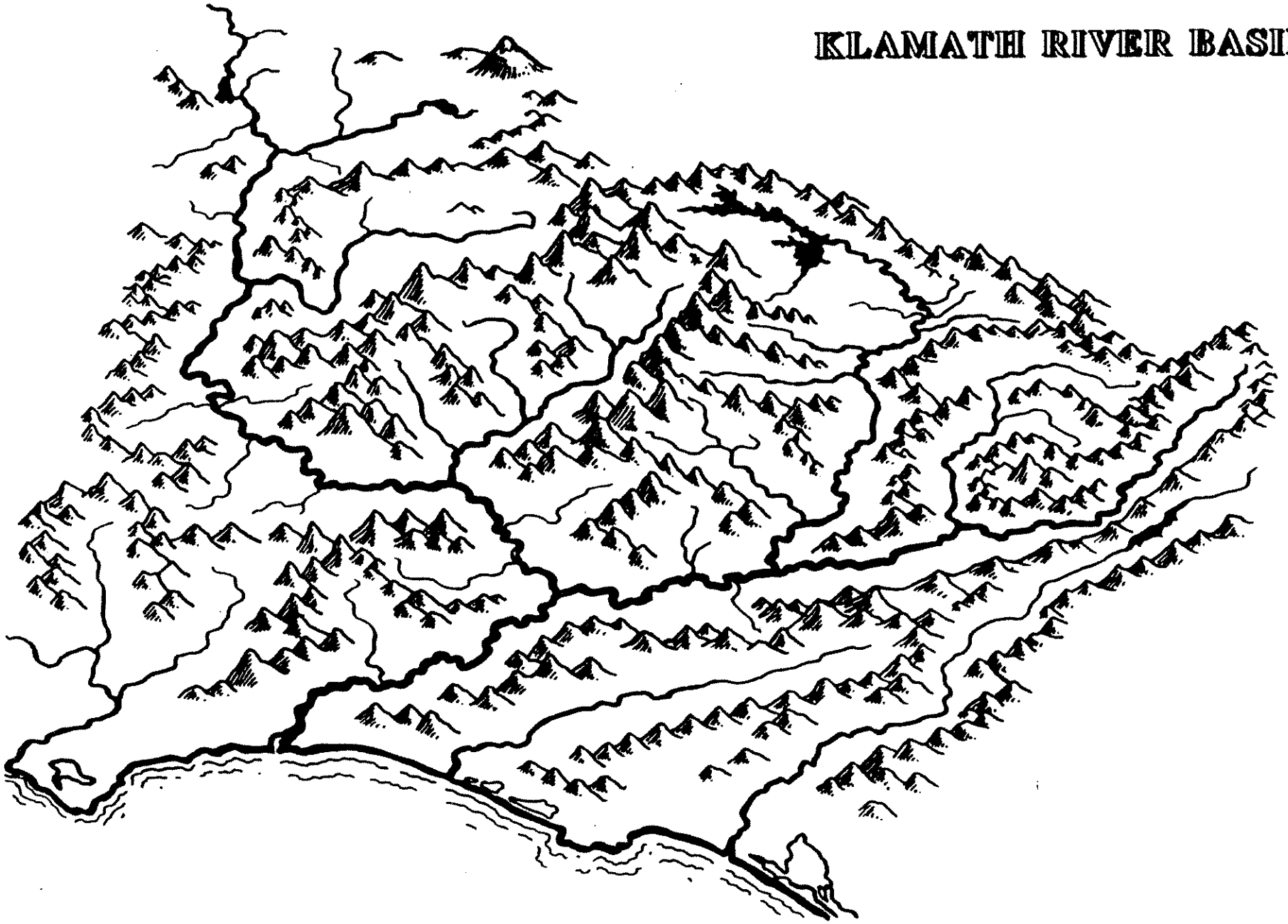
KLAMATH RIVER BASIN

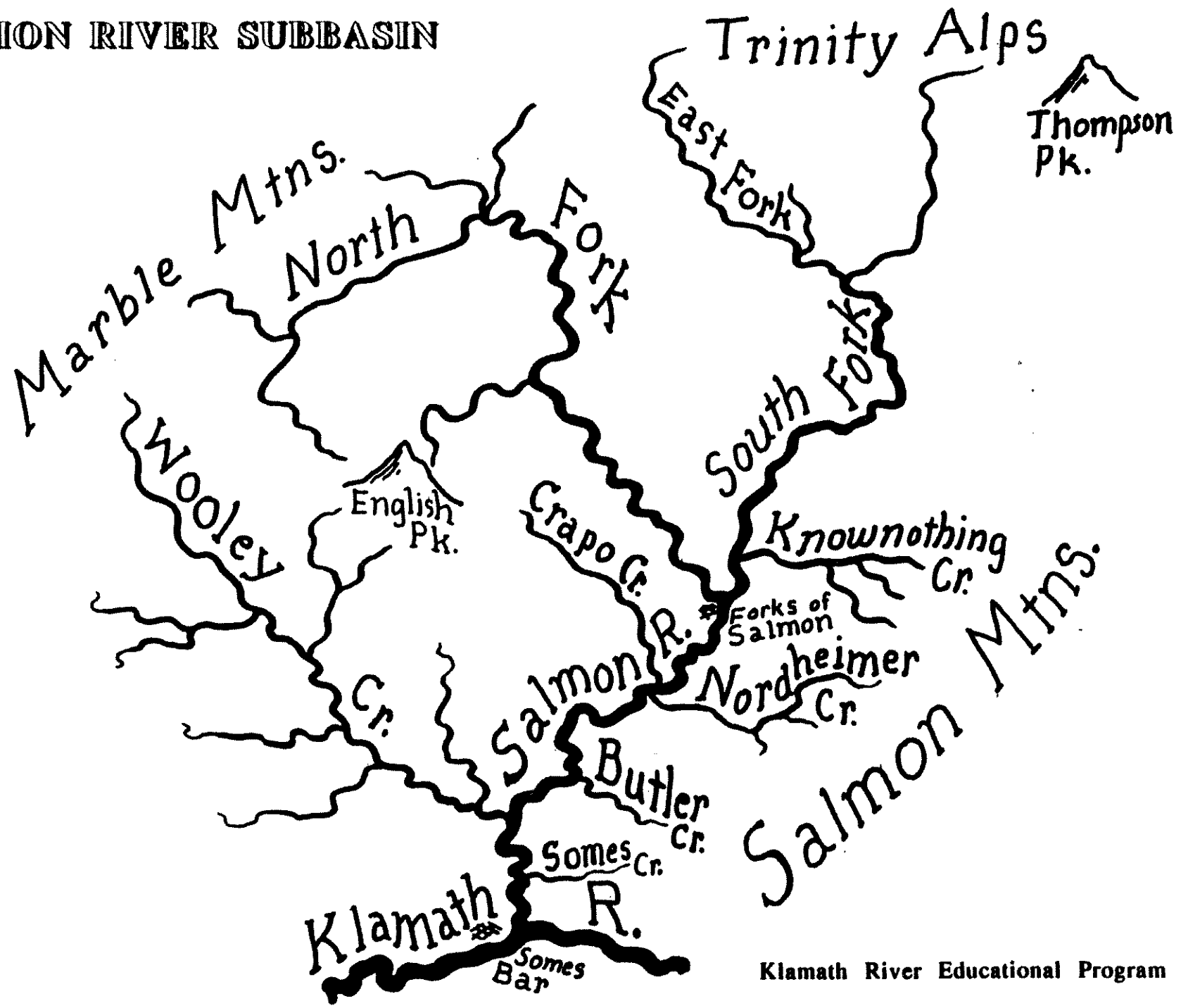


KLAMATH RIVER BASIN



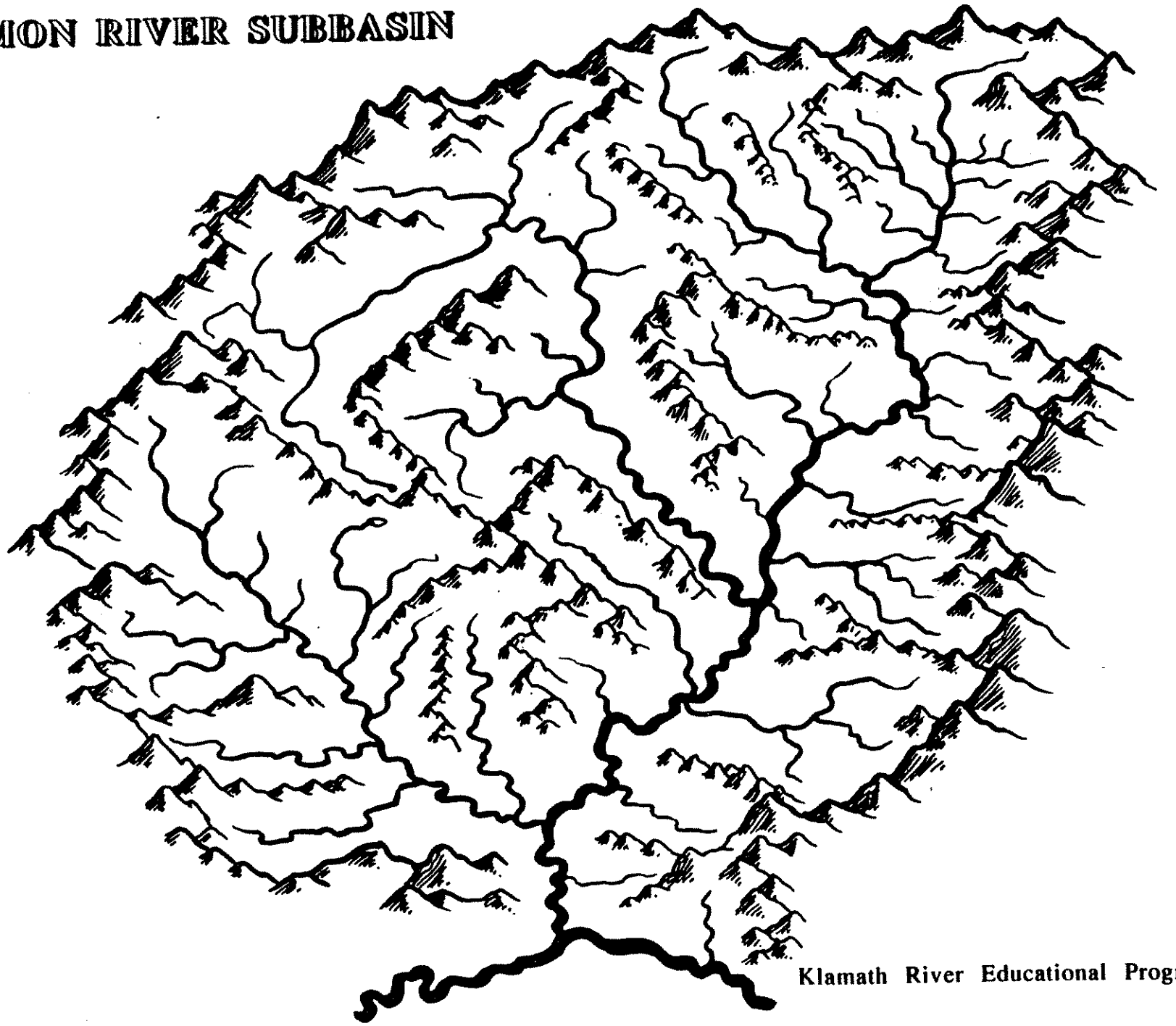
Klamath River Educational Program

SALMON RIVER SUBBASIN



Klamath River Educational Program

SALMON RIVER SUBBASIN



Klamath River Educational Program

GLOSSARY

air bladder	A sac under a fish's backbone that is filled with air
alevin	A newly hatched salmon with a yolk sac attached to its stomach. Lives in the gravel in the stream bed.
algae	Small plants that live in the water
amphibian	A class of animals that lives in water when young and on land when older. Includes frogs, toads and salamanders.
back eddy	A current of water that goes against the main flow of the stream.
backwater pool	A pool formed by a back eddy.
bait	Small animals that are put on fishing hooks. Fish get hooked when they try to eat the bait.
bedrock	The solid rock that lies under the gravel stream bed.
biologist	A scientist who studies life.
breakwater	The place in the ocean where the waves are breaking.
brackish	Water that is a little salty
bubble curtain	Where you cannot see through the water because there are lots of bubbles.
buoy	A marker that floats in the water.

canyon	A deep, narrow valley with steep sides. Often has a stream flowing through it.
cascade	Falling water
ceanothus	A native California shrub that flowers in spring. Common in parts of the Salmon River watershed.
chinook	A type of salmon. One of five species of salmon.
cobbles	Stream rocks that are 2 $\frac{1}{2}$ - 10 inches across. (From the size of a person's fist to the size of a person's head)
convergence	The place where two streams come together.
crayfish	A crustacean that lives in freshwater.
crowbar	A large fishing hook.
Crustacea	A class of animals that usually live inside shells. Includes shrimp, crayfish, lobsters and crabs.
depth finder	An instrument used on boats that measures the distance to the bottom of the ocean (or lake). It can also "see" things below the boat.
estuary	The area where the river meets the ocean and fresh water mixes with salt water
eyed eggs	Salmon eggs that have developed eyes. The eyes show as big dark spots in the egg.

fin clipped	A salmon with its adipose fin cut off so people can tell it is from a hatchery.
divide	A ridge or high point that separates the watersheds for two river systems.
fir	A type of evergreen tree that can grow very large.
fry	A young salmon that still lives in freshwater.
gill covers	The skin that covers a fish's gills.
gills	Organs on both sides of fish's head that take oxygen from the water so fish can breathe.
gorge	A deep, narrow valley. Like a canyon.
gravel	Rocks that are between $\frac{1}{10}$ inch and $2\frac{1}{2}$ inches across.
green sturgeon	A fish that lives in the Klamath River that may grow as large as 7 feet long and 350 pounds.
gristle	A tissue like bone, but a little softer. Makes up fish's mouth.
gulch	A narrow valley that often has water flowing through it.
gyre	A circular motion. Water that moves in a circle.

hatchery	A place where fish are spawned and eggs are hatched. The fry are raised and then put into streams.
herring	A small fish that lives in the ocean and swims in big schools.
homing	When salmon return to their home stream after spending years in the ocean. An instinct.
imprinting	When the smells of a river and watershed are "stamped" into a salmon's brain, making a scent memory.
Karuk	A Native American Tribe that has lived along the Klamath River for thousands of years.
kelp	A plant that lives in the ocean. A type of seaweed.
lamprey	A long, narrow fish, like an eel. They attach to larger fish and suck their blood.
lateral lines	A special line of cells on each side of a salmon's body. Used to sense motion and magnetic fields.
leaders	Fishing line that attaches to the heavier fishing wire. The hook and bait are tied to the end of the leader.
main stem	The main part of stream. The part that all the tributaries flow into.

margins	The edge of the stream, next to the stream bank.
merganser	A type of duck that likes to eat fish.
migrate	To move from one place to another, usually in a group. Salmon migrate out to sea and then back to the river where they were born.
milt	A white liquid that contains the sperm of the male fish
mucous	A slippery liquid usually in places of a body where the inside meets the outside, like in the mouth.
north fork, south fork	A branch of a stream or river that flows into the mainstem from the north (or south).
oak	A type of tree. Loses its leaves in the winter.
ocean	Very large bodies of salty water that make up most of the earth's surface. Also called the sea.
outrigger	
parr marks	Marks on the sides of a salmon fry that are almost round. Help salmon hide from predators by making it look like its surroundings.
plankton	Very small plants and animals that float in the ocean.
plunge pools	Pools that are made when water falls over a rock or log and scours out a hole.

pool	A place in the stream where the water flows very slowly and the surface is smooth. Pools are usually deeper than other areas.
port	The left side of a boat as you face forward.
predator	An animal that eats other animals.
pulley blocks	Pulleys turn and guide the wire as it unwinds from the spool and as it winds back onto the spool.
quartz	A mineral that is in some rocks. Can make white specks or streaks through the rock.
quest	A search for something.
raceway	A long, narrow container that holds water. The place where hatchery fry live.
redd	A salmon nest. Made in rocks in on the stream bed.
refuge	A place where someone goes to be safe from harm.
riffle	A place in a stream where the water flows quickly over rocks. The surface of the water is choppy.
rivulets	A tiny stream or waterway across the land.
run	A group of salmon that come back to a river together to spawn.
salamander	An animal with smooth, wet skin that lives in the water when it is young and on land when it get older.

salmonids	A family of cold water fish that includes salmon, trout and char.
sand bar	A place where sand has built up in the stream.
scales	Small, plate-like things that cover a fish's body. Made of material like fingernails.
school	A group of fish that swim together for protection.
scour	To dig out a hole.
sea lion	An animal that live in the ocean and eats fish.
sediment	Very small pieces of rock that wash into streams. Too much sediment is not good for fish.
shaker	A fish that is too small to keep and is shaken off the hook so it can get away.
silt	Very fine particles of rock, like sand.
smolt	A salmon that has lost its parr marks and is ready to go out to sea.
snout	A long nose.
spawn	Making new life. A female fish lays eggs and a male fish fertilizes them.
spawning area	A place in the stream with the right kind of gravel and the right amount of water flow where fish build their redds.

spread	
spring run	A group of salmon that return from the ocean in the spring and swim upriver. They wait in the river until fall, then they spawn.
starboard	The right side of a boat as you face forward.
summit	The top of a mountain. The highest point.
tide	The rising and falling of the surface of the ocean. The tide comes in and goes out twice each day.
tributary	A stream that flow into another stream or river.
troller	A fishing boat that uses lines and hooks to catch fish. Trolling is the only kind of ocean commercial salmon fishing allowed in California.
turbid	Water that is muddy or stirred up. Water that is hard to see through.
wilderness	An area that is not disturbed by people. A place where wild plants and animals live.
yolk sac	A "bag" of food that is connected to the stomach of a very young salmon.

APPENDIX C

SUMMER INSTITUTE FOR EUREKA HIGH SCHOOL STUDENTS

AGENDA AND LIST OF PARTICIPANTS

STUDENT REPORT ON KLAMATH RIVER BASIN COVER, TABLE OF CONTENTS AND FORWARD

FM: Paula Yoon
RE: Eureka High School - Klamath River Project
Upper Klamath Basin Educational Camping Tour
DT: 6/9/94

Tentative Agenda 6/20-25/94

mon.	Day 1	Meet at EHS 8AM, leave 9AM
	~~Mon~~	Look at convergence of Trinity and Klamath Rivers
		Bluff Creek - see where creek blasted through a mountain (beginning of Karuk ancestral territory)
	Noon	Quick lunch along the Klamath River
	3-4:30	Irongate Hatchery Tour
		Kim Rustin, Hatchery Manager
	7	Arrive Lava Bed National Monument Campground
Tues.	Day 2	Agriculture/Ranching Perspective Day
	9-4	Being coordinated by John Crawford, Klamath Basin Water Users Protective Association,
		Jim Kerns, local historian
		Marshall Stanton, Tule Lake Growers Assn. President
		Will be meeting with other HS students also
	Noon	Lunch - to be announced
	5	Return Lava Beds Campground
		Potential Lava Beds tour
		(note: Bob Wunner worked here for 3 years!)
Wed.	Day 3	Wildlife Refuge Day
	10-12	Tule Lake National Wildlife Refuge - USFWS
		Slide show and tour
		Dave Mouser, Wildlife Biologist
		Lunch at the Refuge
	2-4	Miller Island Wildlife Reserve - ODFWS
		Tour - Roger Smith/John Fortune
	5	Return to Lava Beds Campground
Thurs.	Day 4	Klamath Lake Tribe - Chilloquin
	10-12	Agency Lake Tour
		Dr. Jake Kahn, Tribal Fishery Biologist
	12-2	Lunch at Spring Creek
	4	Oregon Natural Resource Council
		Wendell Wood at Klamath Wildlife National Refuge
		Camp Klamath Wildlife National Refuge
Fri.	Day 5	Crater Lake Day
	8	Head up to Crater Lake
	9:30	Arrive
	10-1	Hike up Scott's Mountain for basin perspective
		Boat ride to island in the Lake
		Camp Mazama Campground
Sat.	Day 6	Travel Home
		Approximately 350 miles
	8PM	Arrive EHS

PARTICIPANTS IN 1994 SUMMER INSTITUTE FIELD TRIP TO UPPER BASIN

Students

Yasmin O'Brien

Yuri Camesi

Jennifer Trotts

Moss Bitner

Sara Gladding

Mary Benzinger

Charles O'Brien

Andrew Dionne

Molly Hartman

Adults

Paula Yoon

Bob Wunner

Weldon Benzinger

The Klamath River Basin

Interconnections within a watershed ecosystem

by:

Mary Benzinger
Moss Bittner
Yuri Camesi
Sara Gladding
Yasmin Lucero
Jennifer Trotts

Table of Contents

Foreword

We are a group of six Eureka High School students who have been working for three years in order to present the reasons for the declining state of the Klamath River. This paper is a summary of our three years' research. It is a comprehensive paper which deals in a holistic manner with the Klamath River Watershed and the issues surrounding it.

Three years ago, four of us were in an Advanced Biology Honors course taught by Bill Schaser. He wanted the class to earn its honors status by going beyond the general curriculum. When he learned of the Klamath River and its declining state, he decided it would be a valuable learning experience for us to research the river and proposed to our class the idea of studying for a semester. We accepted the challenge immediatly and fervently began our research, even though many of us didn't have any idea where the river was.

By the end of the year, we had met with over forty experts. Mr. Shaser, as well as students in the class, contacted people in many areas, asking them to speak to us. These experts gave presentations in their area of interest. One of these speakers was Paula Yoon, the wife of a commercial fisherman. She was personally familiar with the decline of the salmon fishery on the Klamath River, and upon meeting the class, she became very excited about our project and offered to take us on a trip to the Lower Klamath Basin in the summer. Fifteen students, Paula Yoon, restoration experts Bob Wunner, Pat and Diane Higgins took a week-long trip to the lower portion of the Klamath Basin in order to interview people, take pictures, and become familiar with the river. When we returned, we compiled a slide show from our own slides as well as ones that we gathered from other collections. The production of the slide show took the rest of the summer and part of the next year. When we finished, we presented it to several interested groups in our area, including most of the Eureka High School science classes. The following summer, we took a second trip to the Klamath Basin, but this time we traveled to the Upper Basin. Again, we spoke to residents and experts, and took pictures. We had acquired a video camera to further document our study.

The people on this trip included Paula Yoon, Bob Wunner, Weldon Benzinger, four of the original twenty-seven students, and four new students.

Since then, we have become involved in a program at our school called the Oikos Academy (pronounced ee-kose). The Oikos Academy was developed by Bill Schaser, an advisory board, Bill Crichton, and Vernon Skoglund. It was modeled after the Klamath River Project and other similar projects. The object of this program is to encourage students to learn through personal investigation and hands-on research and to give them the time and equipment to work on their project.

Our group consists of Mary Benzinger, Moss Bittner, Yuri Camesi, Yasmin O'Brien-Lucero, and Jennifer Trotts. We are all seniors and with the exception of Moss were in the original class as sophomores. Sara Gladding, a sophomore, who joined the group on the second summer trip, is our sixth member.

Because of the research we have done on the Klamath River, we have been accepted into a group exchange with some students from the Russian city of Uglich. This exchange was organized by American Field Service (AFS) in order to improve relations between our two nations as well as to share information on subjects we have researched in our areas. We hope to share our knowledge of ecology and resource management with them.

Within this paper, we want to present our research in an unbiased manner and show the connections among all of the activities in the watershed.