River Ecosystems and Salmon

San Joaquin County Office of Education
STEM Programs

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River Ecosystems and Salmon

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Next Generation Science Standards supported by this unit

K-LS1-1 Use observations to describe patterns of what plants and animals (including humans) need to survive

1LS1-2 Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

1-LS3-1 Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth reproduction, and death

3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.

3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4-LS1-2 Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

5ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.

MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structure affect the probability of successful reproduction of animals and plants respectively.

MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-2 Construct and explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-4 Construct and argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

HS-LS2-1 Use mathematical and-or computational representation to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changed conditions may result in a new ecosystem.

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Science and Engineering Practices:
Asking Questions and Defining Problems – Lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.
Planning and Carrying Out Investigations
Analyzing and Interpreting Data – Use observations (firsthand and from media) to describe patterns in the natural world in order to answer scientific questions.
Engaging in Argument from Evidence
Obtaining, Evaluating, and Communication Information
Disciplinary Core Ideas:
LS1.A Structure and function – Organisms have internal and external structures that allow for growth, survival, behavior, and reproduction.
LS1.B Growth and development of organisms – Organisms have unique and diverse life cycles. An organism’s growth is affected by both genetic and environmental factors.
LS1.C Organization for matter and energy flow in organisms
LS2.A Interdependent relationships in ecosystems
LS2.B Cycles of matter and energy transfer in ecosystems
LS2.C Ecosystem dynamics, functioning, and resilience – Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations.
LS3 Inheritance and variation of traits
LS4 Biologican evolution, natural selection and adaptation

Crosscutting Concepts:
Patterns
Cause and effect
Scale, proportion, and quantity
Systems and system models
Energy and matter
Structure and function
Stability and change
River Ecosystems and Salmon

Overview

UNDERSTANDINGS
• A river ecosystem can be characterized in terms of its living and nonliving components.
• Any change to an organism's environment will affect its ability to survive.
• For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

ESSENTIAL QUESTIONS
• How do humans impact specific species in a river ecosystem?
• What are the results of human impact on species in a river ecosystem?
• How can humans positively affect the river ecosystem to ensure survival of specific species?

KNOWLEDGE AND SKILLS
Students will know:
• The components of a habitat (living and nonliving components).
• The specific habitat needs of salmon.
• Specific habitat needs of each stage of the life cycle of salmon.
• The impact on salmon from changes in California's river systems.
• General knowledge of California local rivers.
• The place salmon occupy in the food chain.

Student will be able to:
• Compare and contrast their habitat with that of a Sacramento-San Joaquin Delta animal.
• Construct a detailed map of the California River system to include major rivers, tributaries, dams and diversions, the Sacramento-San Joaquin Delta and bay.
• Describe and present stages of the salmon life cycle through illustrations and descriptions.
• Construct and interpret graphs of yearly returning salmon populations.
• Tell the story of the salmon and its habitat through construction of a sequential accordion book.

RESOURCES
Websites
http://www.westcoast.fisheries.noaa.gov/education/salmon_activities.html NOAA Fisheries site with curricula, activities, posters to print, stewardship opportunities
http://www.earthlingenterprises.ca/earthlingenterprises/Salmon_Education.html Salmon Education site with information on salmon, games, stewardship, and other resources
https://www.calsalmon.org/resources/watershed-and-salmon-education Links to salmon and watershed education sites
Salmonids in the Classroom

Bring the salmon experience right into the classroom through the Classroom Aquarium Education Program (CAEP). After attending an training sponsored by the California Department of Fish and Wildlife, teachers will receive salmon eggs to raise in their classrooms. The training is usually in the fall and the eggs are received in January.

Information is available on the CAEP website:  https://www.wildlife.ca.gov/caep

San Joaquin and Northern Counties: teachers refer to the North Central Region, the contact Chelsea Palisoc, (916)358-1644, chelsea.palisoc@wildlife.ca.gov

Stanislaus County and South counties: teachers refer to the Central Region, the contact is Gail Hickman Davis, (209)853-2533, Gail.Davis@wildlife.ca.gov
River Ecosystems and Salmon

Story Line

Historically Chinook salmon have entered Central Valley river systems through the Sacramento-San Joaquin Delta. Recently salmon populations have declined to very low levels. As a basis for understanding the plight of the salmon in the Central Valley water systems students will first become familiar with the California river systems by completing a mapping exercise in Lesson 1, “Mapping California River Systems”.

Once students are familiar with river systems that flow into the Sacramento-San Joaquin Delta, the next aspect of the salmon problem is a look at the habitat of the river. In Lesson 2, “The Seven Components of a Habitat”, students will examine the elements of the river habitat where salmon live. Living and nonliving properties of a habitat provide the basis for the flow of energy through the river ecosystem that includes salmon. The focus of Lesson 3, “Food Chains in an Ecosystem”, is to illustrate the energy flow in the river ecosystem by observing the food chains and food webs common in Delta river systems, which involve salmon.

As anadromous species, Chinook salmon use the Delta and river ecosystems as a necessary site for accomplishing part of their life cycle before migrating into the ocean. The focus of Lesson 4, “Life Stages of a Salmon”, is to learn about the specific stages of the Chinook salmon life cycle and where in the river habitat the different life stages occur.

An understanding of environmental influences on Chinook salmon populations is illustrated through Lesson 5, “Changing Salmon Populations”. Students will look at historical salmon numbers for three rivers in the Central Valley, noting the changes in populations over a period of sixty years. Suggestions for reasons for fluctuating populations will be solicited from students. Knowledge of fluctuating salmon populations is followed by Lesson 6, “Human Impact: Problems and Solutions”, where students are asked to determine human impacts on salmon populations. By participating in a scenario involving the building of a dam on a local river, different points of view are examined to illustrate the complexity of multiple-use issues involving rivers and salmon survival.

The culminating activity is Lesson 7, “Salmon Story”, which requires the students to summarize their understanding of the river ecosystem and Chinook salmon survival by making an accordion book about Chinook salmon and the Sacramento-San Joaquin Delta system.
Phenomenon: photo of salmon that was found on the Calaveras River just east of the University of the Pacific and the Weberstown Mall in the city of Stockton. A printable or projectable color photo can be found at: https://deltastudies.weebly.com/caep-salmonids.html

The photo can be used to generate student questions – what is this big fish doing in Stockton? What are the spots on its skin? Why does the lady have a hook in its mouth? Questions will be answered as the students learn more about the salmon life cycle and migration.
Activity 1
Mapping California’s River System

OBJECTIVE
Students will become familiar with California’s water systems and human-made water diversions on these systems through a direct instruction lesson labeling a map of California.

BACKGROUND
The California’s river system drains the Sierra Nevada and Coastal Ranges. The northern rivers flow down from the Sierra Nevada Mountains (Sacramento, Feather, and American) and drain into the Sacramento River. The southern Sierra Nevada rivers (Cosumnes, Mokelumne, Calaveras, Tuolumne, and Merced) drain into the San Joaquin River. The Sacramento River and the San Joaquin River join at the Sacramento-San Joaquin Delta to flow into the San Francisco Bay and then to the Pacific Ocean.

The Klamath and Eel are coastal rivers with tributaries that drain from the Coastal Ranges into the Pacific Ocean. Coastal rivers without tributaries include the Noyo River, Big Albion River, and Russian River. These coastal rivers are often seasonal, depending on rainfall, running though the winter and spring and dropping dramatically in volume of water they contain in the summer and fall. (Note that the Noyo River and Big Albion River are not on the map in this lesson because the map needed to be simplified for students’ use.)

Human impacts such as water diversions and dams have drastically changed the flows of the most rivers in Northern California. As a result, much of the habitat critical to plant and animal (e.g., Chinook salmon) survival has been lost. There are 1417 dams within California, which are 25 feet of more in height or have an impounding capacity of 50 acre-feet or more. This number does not include private dams. The dams provide a serious obstacle to the life cycle of the Pacific salmon species. Dams can cause sediment build up in the rivers and block access to historical spawning areas. Excessive water diversions may lead to low water levels, keeping salmon from their spawning grounds. Sediment can smother salmon eggs, which are deposited on gravel beds. Sediment can also trap the salmon fry causing them to starve. Furthermore, suspended sediments lower the oxygen content of water, which can suffocate the fish.

Positive effects of dams: A dam can protect against flooding by not letting too much water flow through a river at a one time. Water rushing through a dam can be used to turn large machines that make electricity. Stored water can be sent through canals and aqueducts to irrigate farms and provide water to homes in dry areas.

Negative effects of dams: Sections of wilderness are flooded causing loss of plant and animal life and habitat. Stored water is not always distributed to all needy communities. Sometimes dams break causing destructive flooding. Salmon and trout (fish having cycles in fresh and salt
water) are cut off from large portions of their “home” rivers. This may keep them from completing their life cycles.

Note that there is a list of terms and definitions at the end of this lesson. This could be used as a reference throughout the unit.

PREPARATION
- For each student, make a copy of “California River System Map”. (provided in this lesson)
- For each student, make a copy of “Mapping California River Systems” students’ questions sheet (these can be copied back to back).
- Make one transparency or projection slide of the “California River System Map”.

MATERIALS
- A road map of California (if possible obtain several copies so groups of students could look at their own maps)
- “California River System Map” handout for each student, overhead for teacher
- “Mapping California River Systems” question handout for each student
- The “California Water Map” (in kit) A road map of California
- Set of colored overhead pens
- Colored pencils for all students to include the following colors: brown, green, blue, black, red, purple, and yellow or orange
- Plastic sweater box (about 3 feet long and two feet wide)
- Enough sand or soil to cover the bottom of the box approximately two or three inches
- Water in a garden watering can

TIME
Preparation: 20 minutes
Lesson: 60 minutes

ENGAGEMENT
1. Tell students: “California has MANY rivers! These rivers are home for many types of plants and animals. In fact, the salmon runs up and down these rivers once numbered in the hundreds of thousands! Explorers were said to have exclaimed, ‘There were so many salmon, you could walk across a river on the backs of the salmon’. Human impacts such as dams, pollution, and diversions for agriculture, have greatly affected the salmon’s population. For example, in 1991 only 191 Chinook salmon returned to spawn in the Sacramento River system compared to 117,000 that returned in 1969.”

EXPLORATION
2. Show students a road map of California. If you have more than one copy of the map, provide one to each group of students. Ask students to locate on the map the community in which they live. Locate the closest waterway, such as a river or creek that is shown on the map.
3. Review with students the regions of California using the “California Water Map” from the kit or on a general map of California. These regions should include the Central Valley, Sierra Nevada Mountains, Coastal Mountain Ranges, Sacramento and San Joaquin rivers, and Pacific Ocean. You may want to include general directions of north, south, east, and west. You might also use the large map to indicate the water flow of the Sacramento River (south then west) and the San Joaquin River (north then west).

4. Distribute a copy of “California River System Map” and the “Mapping California River Systems” question handout to each student. Provide colored pencils. Tell students that they will be cartographers (map makers) and will label the important parts of California’s river systems. This will help them to learn more about California and the Chinook salmon that they are going to study later in this unit.

**Note:** The following can also be done as a class as you model coloring the parts on a transparency of the “California River System Map”.

5. Ask students to follow the directions on “Mapping California River Systems.” For any student without map experience or not understanding how to complete the assignment, model the tasks on the overhead transparency so they can work independently.

6. After students have completed the assignment, model on the overhead, as you and your class work through each of the 12 questions on the sheet.

7. Discuss human impacts, such as dams, reservoirs, and other water diversions. Have the discussion point out the positive and negative effects of these water diversions. Help students to understand how the choices were made and possibly suggest better ways the problems could have been solved.

8. Discuss with students how the moving water in the Sacramento-San Joaquin Delta erodes landforms and reshapes the land. Show this by making a model using sand or soil in a plastic sweater box. Tilt the box and pour water over the sand or soil, and have students observe how areas are eroded and how the soil is deposited downstream.

**EVALUATION**

While students are creating legends, check for understanding by asking questions about their maps. Here are some ideas for questions:

- Where are the Sierra Nevada Mountains?
- Identify the Sacramento River and San Joaquin River. Show the path these rivers take to drain into the Pacific Ocean.
- Name and identify two rivers that drain into the Sacramento River.
- Name and identify two rivers that drain into the San Joaquin River.
- Which rivers do not have a dam or reservoir on them?
ELABORATION
Read to students *Letting Swift River Go* by Jane Yolen. Discuss the impact the dam had on the area as well as the benefits that it brought.

RESOURCES
Website
http://www.sacdelta.com/charts/index.html  simple, colored map of Delta

Book
•  *Letting Swift River Go* by Jane Yolen

Maps
“The Delta” from the Water Education Foundation
http://www.watereducation.org/
“California Water Map” from the Water Education Foundation
http://www.watereducation.org/
Vocabulary
Relating to Natural Water Systems
and Human-Made Water Diversions

Bay: body of water that is part of a lake, sea, or ocean and is partly enclosed by land.

Coast: land along the sea or ocean.

Dam: a barrier built across a stream of river to prevent the flow of water.

Delta: land built up at a river’s mouth. For example, a large delta has formed in the Central Valley, where the San Joaquin River joins the Sacramento River.

Erosion: the process whereby water, wind, or ice carries soil from one area to another.

Estuary: an arm of the sea at the mouth of the river.

Lake: body of water with land on all sides.

Reservoir: a lake made by people to collect and store water. When a dam is built across a river, the moving water floods the land behind the dam. This becomes a human-made lake. Example: The Hetch Hetchy Reservoir lies behind the Tuolomne Dam. This dam was built across the Tuolomne River and completed in 1931.

River: large waterway that flows across the land.

Sediment: silt and other small particles of soil which end up in streams and rivers following erosion of water.

Slough: tidal or wetland channel. Can be stagnant or flowing on seasonal or tidal basis.

Tributary: stream or river that empties into a large river. For example, the American River and the Feather River are both tributaries of the Sacramento River. The Merced River is a tributary of the San Joaquin River.
MAPPING CALIFORNIA RIVER SYSTEMS
STUDENT'S SHEET

DIRECTIONS: Color the map of the river systems following the directions below.

RIVERS FLOWING FROM THE SIERRA NEVADA MOUNTAINS:

1. Label the Pacific Ocean in blue and the Sierra Nevada mountain range in brown.

2. Color the main stem of the Sacramento and San Joaquin Rivers green. Use an arrow to show the direction they flow.

3. Make a star where the town you live would be on this map. Hint: look for the rivers near where you live.

4. Color the reservoirs on the tributaries of the Sacramento and San Joaquin rivers blue.

5. Many rivers in California are dammed, which creates a reservoir/lake. Draw a short black line to show the locations of all the dams. Remember the dam is always on the downstream side of the reservoir.

6. Fish, such as salmon, cannot get past these dams to look for good spawning habitat. Color all the rivers above the dams in red. This is the spawning habitat of salmon and steelhead trout that is now blocked.

7. Color the rest of the tributaries to the Sacramento and San Joaquin Rivers in purple.

8. Put an X at the place where the Sacramento and San Joaquin Rivers join. From here west to the San Francisco Bay is called the Sacramento-San Joaquin Delta color it yellow or orange.

RIVERS FLOWING FROM THE COASTAL RANGE:

9. Color all of the coastal rivers with tributaries orange.

10. Name one coastal river without a tributary. ________________________.

11. Color this coastal river without a tributary yellow.

12. Make a key or legend for your map that explains what all the colors mean. Be sure to draw a compass rose to show the directions on your map.
Activity 2
The Seven Components of a Habitat

OBJECTIVE
Students will be able to show the seven components of a habitat (food, water, shelter, space, sunlight, soil, and air) by drawing and labeling their own habitat and a habitat of one Sacramento-San Joaquin Delta animal.

BACKGROUND
It is important for students to understand the difference between wild animals and pets. An animal is considered any living organism that is multicellular and eats other organisms. Pets are usually domesticated animals or those that humans have tamed or trained. Pets are usually kept in captivity or cannot run free. All pets have origins in wild ancestors, but have been bred, or tamed for human use. This includes cats, dogs, birds, and fish kept as pets as well as cattle, sheep, and horses kept as farm animals. Some domesticated animals are hard to distinguish from wild animals. For example, cats that have become feral can survive and reproduce on their own. Wild animals are those that are not domesticated or tamed.

Wildlife usually lives free of humans, acquiring its own food, water, shelter and other needs in its environment. Wildlife can be large or small and includes, but is not limited to, insects, birds, reptiles, fish, amphibians and mammals that are not domesticated. Animals that live in the Sacramento-San Joaquin Delta and discussed in this lesson include the following: Pallid Bat, Common Egret, raccoon, gopher snake, western fence lizard, Chinook salmon, coyote, beaver, gray fox, California (meadow) vole, Red-tailed Hawk, white catfish, Screech Owl.

All animals both domestic and wild live in their own habitat. An animal’s habitat is an area where an animal gets all its basic needs to live including food, water, shelter, space, sunlight, soil and air. They need all of these things in a suitable arrangement. For example, if an animal has lots of food but no water, it will not survive.

Note: The following information about bats in general and about the Pallid Bat will be used in Procedure step 3.

Bats emit high frequency sounds that bounce off objects in the environment back to the bat. Therefore they sense their world primarily using sonar. Bats are very important in their role in insect control. Some species eat nearly their own weight in insects (including mosquitoes) every night.

Pallid Bat: *Antrozous pallidus*
Description: The Pallid Bat is a medium-sized bat with sandy-colored fur on back and almost white in the front. Its ears are very long.
Food: Unlike many other bats in the Delta area, the Pallid Bat feeds largely on flightless insects on the ground, like scorpions, Jerusalem crickets, and June beetles. It scoops them off the ground and often carries them to be eaten at a roosting area.

Shelter: The Pallid Bats are especially common in open lowland areas. They roost by day in crevices, houses, and barns.

Space: Pallid Bats require a moderate amount of area where they can hunt at night and roost during the day.

PREPARATION
- Make a copy or a transparency or projection slide for the illustration of the Pallid Bat.
- Make copy of “Animal Cards”, one card for each group of two or three students (There are 12 cards, use as many as needed)
- Make copy each of “Basic Needs Cards”, one card for each group of two or three students (There are 12 cards, use as many as needed)

MATERIALS
- Examples of three domesticated animals (dog, chicken, and cow) and three wild animals (hummingbird, Red-winged Blackbird, and Rainbow Trout) (in this lesson)
- One copy of the illustration of the Common Egret (in this lesson)
- Drawing paper for all students
- One copy of “Animal Cards” per group
- One copy of “Basic Needs Cards” per group

TIME
Preparation: 30 minutes
Lesson: 60 minutes

ENGAGEMENT
Have students share with the class what pets they have or would like to have.

EXPLORATION
1. Begin by discussing the difference between pets (domesticated animals) and wildlife. Show the illustrations of three domesticated animals and three wild animals. Have students give additional examples of both and make a list on the chalkboard.

2. When you are comfortable that all the students understand the difference, you will need to stress the similarities between the basic needs of both of these groups and of humans. Begin by making three lists on the board. HUMAN NEEDS, WILDLIFE NEEDS, and PET NEEDS. Have students brainstorm things that each of these groups need. Direct their suggestions into the following seven categories. FOOD, WATER, SHELTER, SPACE, SUNLIGHT, SOIL, AND AIR. These are the seven components of a habitat. Note that sunlight is included because it is necessary for green plants to produce their own food and the plants are the beginning of most food chains. Therefore all animals indirectly depend on sunlight for food. (Food chains will be studied in the next lesson.) Soil is needed for most plants to grow, for animals to walk on, and for some animals to burrow into.
3. Using the example of a wild animal, the Pallid Bat, that lives in the Sacramento-San Joaquin Delta (see “Background”), make a list of how this animal meets its needs (FOOD, WATER, SHELTER, SPACE, SUNLIGHT, SOIL, AND AIR) in its habitat.

4. Distribute the picture cards for each group (only one picture card per group) and ask students to brainstorm how these animals meet their seven habitat needs in the wild. When students have determined how their animal meets these needs, give them the basic needs cards for their animal so that they can check their work.

5. Have a reporter from each group share the seven habitat needs of the group’s animal with the class.

6. Discuss with students the definition of habitat to make certain that they understand what they will need to do in step 7. Remind students that an animal’s habitat is the area where an animal lives and where it gets all the things it needs to survive, such as water, food, and shelter.

7. Have students choose one of the animals presented to draw that animal in its habitat.
   - They should be very specific and must include all of the seven habitat needs the class discussed.
   - Each illustration should contain an animal, each component of the habitat, a label for each component, and at least one other animal that might share its habitat.
   - On the other side of the paper, the students should draw themselves in their own environment showing how they satisfy their seven habitat needs at home or in their community.

**EVALUATION**
- Informally check for understanding while students are conducting their group discussion.
- Review drawings, checking to make certain each of the seven habitat needs is labeled.

**ELABORATION**
Have students make dioramas and label each habitat component. They could include pictures of a variety of animals that would live in this habitat.

**REFERENCES**
- Lonero, Pete. *California Delta Creatures*. Published by Pete Lonero (3205 Polk Way, Stockton, Calif. 95219). No Date of Publication Given.
- Madden, D. and K. Charters. *California Outback; Ecology of the Central Valley and Sierra Nevada Foothills*. Derek Madden and Ken Charters Publishers (P.O. Box 1422, Sutter Creek, Calif. 95685), 1998.
## BASIC NEEDS CARDS

| **Raccoon:** Procyon lotor  
**Description:** The raccoon is covered in thick fur that is gray-brown in color. It has a black face mask and black bands on its tail. It has long toes on its front paws. A raccoon weighs about 8-25 pounds and is about 2-3 feet long. It is considered nocturnal (most active at night).  
**Food:** Raccoons are omnivores and feed on berries, small animals, birds, eggs, fish, clams, crayfish, insects, mice, figs, and other fruits.  
**Shelter:** Raccoons live in hollow trees near streams or wooded areas.  
**Space:** Raccoons require a moderate area for their territory. | **Common Egret (also called Great Egret):** Casmerodius albus  
**Description:** Common Egrets are very large birds standing 3 feet tall and have a 5-foot wingspan. They are white with a yellow bill and black legs and feet. Their long legs permit wading into water where they fish for food.  
**Food:** Common Egrets eat frogs and fish. They can also forage in field for mice and gophers.  
**Shelter:** Common Egrets make nests in trees located near water. They also roost in trees. They are found along rivers and marshes in the Delta.  
**Space:** Common Egrets require a moderate amount of area for their territory. |
| --- | --- |
| **Gopher snake:** Pituophis melanoleucus  
**Description:** The gopher snake is one of the most common snakes in the Delta. It ranges from 2 1/2 to 6 feet long and is a yellowish brown in color, with dark rectangular or diamond markings on the back. This snake mimics a rattlesnake by placing its pointed tail into dry grass or leaves and vibrating it, sounding like a rattlesnake rattle. However, its bite is not poisonous.  
**Food:** Gopher snakes eat rodents, such as mice, gophers, rats, and voles.  
**Shelter:** Gopher snakes live in cultivated fields, along riverbanks, or in brushy areas.  
**Space:** These animals require a moderate amount of area for territory. | **Western fence lizard:** Sceloporus occidentalis  
**Description:** This lizard is often called the “blue-belly” and is one of the most common lizard in the valley. It is black or gray in color, with black markings on its back. Males have blue patches on their sides, whereas females do not necessarily have this coloring. Their adult length ranges from 5 to 7 inches.  
**Food:** Western fence lizards eat insects and spiders. Typical insect prey includes ants, beetles, wasps, aphids, and insect larvae.  
**Shelter:** Western fence lizards live in rocky and wooded areas around fences, old buildings, and stone piles.  
**Space:** Western fence lizards require a small amount of area for territory. |
**BASIC NEEDS CARDS**

<table>
<thead>
<tr>
<th><strong>Chinook salmon: Oncorhynchus tshawytscha</strong></th>
<th><strong>Coyote: Canis latrans</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> The Chinook salmon are native anadromous fish that range in size from 5-70 pounds. They are bluish gray on the back with silver sides and black spots on the back and dorsal fin, upper and lower caudal fin. During the spawning season, males turn bright red and develop a hooked jaw. <strong>Food:</strong> Chinook salmon feed on small fish and shrimp in the ocean. Fry feed on aquatic insects in the river. Smolts eat insects that fall into water as well as aquatic insects, smaller fish, algae, and small shrimp that live in the rivers and Delta estuary. <strong>Shelter:</strong> Adult salmon live in rivers for the spawning part of their life cycle, but spend most of their adult lives in the ocean. Alevin, fry, and smolts live in fresh water rivers and streams that open into the ocean. The alevin and fry require gravel to protect them from predators. The fry and smolts require fresh water shaded by trees or marsh plants for protection from predators. <strong>Space:</strong> Salmon need fresh water rivers, estuary, and ocean water in order to complete their life cycle. Throughout their life cycle they require a large area for their needs.</td>
<td><strong>Description:</strong> Coyotes are dog-like in appearance with a gray or yellowish-brown coat. They may appear very shabby. They are about the size of a medium-sized dog, 3-4 feet long. <strong>Food:</strong> Coyotes are opportunistic consumers and will attack young livestock, such as sheep, but their diet usually consists of rabbits, rodents (such as, mice, gophers, voles), insects, and a wide variety of fruits. They will also eat carrion (dead animals). <strong>Shelter:</strong> Coyotes usually live in grasslands and scrub, which often borders rivers in the Central Valley. <strong>Space:</strong> Coyotes require a large area for their territory that is determined by the amount of food animals available.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Beaver: Castor canadensis</strong></th>
<th><strong>Grey fox: Urocyon cinereoargenteus</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Beavers are large brown rodents weighing from 30 to 40 pounds. They have a large flat tail and large head with small eyes and ears. <strong>Food:</strong> Beavers eat bark and twigs from streamside shrubs and trees, such as willows. They also eat aquatic plants, such as tules. <strong>Shelter:</strong> Beavers require deep water and access to their shelter made of sticks. In the Delta beavers may burrow into levees instead of making stick lodges. <strong>Space:</strong> Beavers require a large aquatic area for their territory.</td>
<td><strong>Description:</strong> Grey fox are about 3 feet long or the size of a small dog. They are gray in color with dark color down the back. They have a long bushy tail. <strong>Food:</strong> Grey fox eat small rodents (mice, gophers, voles) fruit, birds and bird eggs. <strong>Shelter:</strong> Grey fox live in brushy or wooded areas often near rivers. They live in dens in rocky areas or in hollow logs. <strong>Space:</strong> Grey foxes require a large area for their territory.</td>
</tr>
</tbody>
</table>
**BASIC NEEDS CARDS**

<table>
<thead>
<tr>
<th>California (meadow) vole: <em>Microtus californicus</em></th>
<th>Red-tailed Hawk: <em>Buteo jamaicensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> The California vole is a stocky rodent about 7 inches long including the short tail. The fur is long and a brown color. <strong>Food:</strong> California voles eat seeds and grasses, plant bulbs, and insects associated with damp grasslands and open fields. <strong>Shelter:</strong> California voles make runways in the grasses where they live. These runways protect them from predators while they scurry from one place to another. They live in grasslands and fields that border the riparian habitat in the Delta. <strong>Space:</strong> The California voles require a small area for their territory.</td>
<td><strong>Description:</strong> The Red-tailed Hawk is a large hawk about 20 inches long. It has dark bars on leading edge of the under-wing and has a rusty red tail. It is often seen soaring on thermal air currents over grasslands, foothills, and along river corridors. <strong>Food:</strong> Red-tailed Hawks feed on rabbits, ground squirrels, insects, birds, and reptiles. <strong>Shelter:</strong> Red-tailed Hawks nest in tall trees or cliffs, and build nests out of sticks and roots. <strong>Space:</strong> Red-tailed Hawks require a large area for their territory.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>White catfish: <em>Ictalurus catus</em></th>
<th>Western Screech Owl: <em>Otis kenneicottii</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> The white catfish is the most abundant catfish in California. It can weigh 8 to 20 pounds. Its color is bluish to black and a silver color on the lower surface. Its tail is forked, and like all catfish, have barbells (sensory whiskers) on their large heads. They have three sharp spines on their dorsal and pectoral fins. <strong>Food:</strong> The white catfish feed on plants and animals located in and on the bottom sediments. They are scavengers. They feed at night and hide in the daytime. <strong>Shelter:</strong> White catfish live in warmer shallow ponds and slow-moving waters, such as found in sloughs associated with the Sacramento-San Joaquin Delta. <strong>Space:</strong> White catfish require a medium amount of space in their aquatic habitat.</td>
<td><strong>Description:</strong> The Screech Owl is a small owl about 7 to 10 inches long. It has ear tufts and camouflage coloring. Its color may be gray or rusty brown. <strong>Food:</strong> Screech Owls feed on rodents and large insects. <strong>Shelter:</strong> Screech Owls live in woodlands and orchards and use tree cavities for nesting sites. <strong>Space:</strong> Screech Owls require a moderate area for their territory.</td>
</tr>
</tbody>
</table>
Pallid Bat
Dog
Chicken
Cow
Hummingbird
Red-Winged Blackbird
Rainbow Trout
Raccoon
Gopher Snake
Western Fence Lizard
Chinook Salmon
Coyote
Beaver
Grey Fox
California (meadow) Vole
Red-Tailed Hawk
White Catfish
Screech Owl
Activity 3
Food Chains in an Ecosystem

OBJECTIVE
Students will learn that food webs are composed of producers and consumers and that energy flows through a food web. Students will also construct a food web that exists in the Sacramento-San Joaquin Delta.

BACKGROUND
The different roles of living things within the ecosystem include producers and consumers. Producers are those organisms (plants and algae) that can trap the light energy from sunlight and combine carbon dioxide and water to form food (carbohydrates, proteins, and fats). Consumers are organisms (usually animals) that eat other living things. Consumers can be categorized as primary consumers or herbivores (those feeding on plants or algae); carnivores (those feeding on the flesh of other animals); omnivores (those feeding on both plants and animal flesh); scavengers (those feeding on dead or decaying matter); detritivores (those filtering organic particulate matter from the water); decomposers (those recycling dead organisms into primary nutrients or raw materials). Examples of decomposers are bacteria and fungi.

A food chain represents the order in which energy is transferred from sunlight and then from one organism to another. An example might be the following: native grasses and seeds, meadow vole, coyote. At each level of the food chain, the conversion of energy is not 100%. Each time an organism eats another one, some energy is stored or used by body of the organism to maintain life’s functions, and some is lost as heat.

It is important for students to understand that all animals and plants in an ecosystem die and in turn provide food or energy for other organisms. The decomposers (bacteria and fungi) recycle the nutrients from bodies of plants and animals to soil and these nutrients are used once again by plants in a continuous cycle.

PREPARATION
• Duplicate one “Food Web Card” (plants and animals) for each student
• Cut pieces of yarn to tie the cards around the students necks (or use clothespins to affix a food web card to the clothes of each student)
• Consider creating a word wall to help develop vocabulary.

MATERIALS
• One card with organisms per student
• Examples of food chains
• Ball of yarn
• Pieces of yarn to tie the cards around the student’s necks or clothespins to affix to clothing so that their hands will be free

TIME
Preparation: 30 minutes
Lesson: 60 minutes

ENGAGEMENT
1. Introduce the word “organism”. An organism is a living thing. Ask students: “What do you think is a food chain?” Draw and discuss an example of a food chain. A food chain represents the order that the energy flows from a green plant (that originally gets it energy from sunlight) to an animal that eats the plant to an organism that eats the animal.

EXPLORATION
2. Distribute a “Food Web Card” (plants and animals) to each student.

3. Describe what defines a PRODUCER. (A producer is an organism that produces its own food using sunlight; therefore all green plants are producers.) Have all the students who are wearing cards that represent “producers” stand up.

4. Reinforce this concept by choosing students as examples of PRODUCERS.

5. Ask the CONSUMERS to stand up. Check to make sure all students standing are “consumers”. (Consumers are organisms that eat other organisms.) Explain that there is more than one level of CONSUMERS. Ask:
   • Who might eat plants? (Many animals we call consumers, which include microscopic animals called zooplankton, insects, crayfish, and beavers. These animals eat only plants and are called herbivores.)
   • Who might eat animals that eat plants? (Carnivores, like snakes, mountain lions, foxes, hawks, and owls.)
   • Who eats carnivores? (Some fish that eat fish that eat fish; a river otter that eats a fish that eats fish; a hawk that eats a snake. These top carnivores not only eat other carnivores, but also may eat herbivores and omnivores. Omnivores are animals that eat both plants and other animals.)

6. Choose a PRODUCER to use at the bottom of a food chain. This will be the beginning of the food chain. Create a number of food chains using producers and consumers with top carnivores at the top.

7. Once the students grasp the concept of food chains, ask how they might interconnect. Could two different animals eat the same producer? Could some top carnivores eat more than one herbivore?
8. Lead students outside. Have them stand in a large circle. Start with sunlight. The person with the yarn holds onto the end of the yarn that uses sunlight. Then let that person pass the yarn to another person that represents either an organism that eats it, or an organism that it eats. In this way each student should be able to be part of the web at some point.

**Note:** A food chain doesn’t stop with a predator. The decomposers (bacteria and fungi) recycle the nutrients from bodies of plants and animals to soil and these nutrients are used once again by plants in a continuous cycle.

9. At the end of the game, have students representing the sunlight (or decomposers) either pull or drop the yarn and discuss who else felt the pull or felt a slack in the yarn. Then students can then see how dependent we all are on one another (how everything is interconnected).

**VARIATION**
Separate the class into several groups and call each group to demonstrate to the class at least three different food chain possibilities. Assess their understanding by the presentations done in small groups.

**EVALUATION**
While playing the game, check for understanding while students are passing the ball of yarn.

**Vocabulary Words**
- **PRODUCERS** are usually green plants that make food their own food using sunlight for energy. They also provide food for many organisms that eat them. Producers may vary in size from microscopic phytoplankton in the water, to algae, to green plants including large trees.
- **CONSUMERS** are organisms that eat plants or animals or both.
- **HERBIVORES** eat only plants.
- **CARNIVORES** eat animals.
- **OMNIVORES** eat both plants and animals.
- **DECOMPOSERS** include bacteria and fungi; they recycle dead organisms into primary nutrients for plants to use.

**RESOURCES**

**Books**
- *Who Eats What?* by Patricia Lauber
- *What Are Food Chains and Webs?* by Bobbie Kalman

**Video**
*Fish and the Web of Life*, Water Education Foundation (503-230-5972)
EXAMPLES OF FOOD CHAINS OF RIPARIAN / DELTA ECOSYSTEMS

FOOD CHAIN #1:
Cattails
Butterfly
Red-winged Blackbird

FOOD CHAIN #2:
Native grasses/seeds
Harvest Mouse
Red-tailed Hawk
Dead Hawk
Turkey Vulture

FOOD CHAIN #3:
Native grasses/seeds
Harvest Mouse
Gopher Snake
Red-tailed Hawk

FOOD CHAIN #4:
Water plants
Duck
Coyote

FOOD CHAIN #5:
Phytoplankton and algae
Freshwater Shrimp
Small fish
Chinook Salmon

FOOD CHAIN #6:
Phytoplankton and algae
Zooplankton
Salmon smolts
River Otter

FOOD CHAIN #7:
Dead plant matter (detritus)
Crayfish
Raccoon
FOOD CHAIN #8:
  Tules
  Grasshopper
  Frog
  Egret

FOOD CHAIN #9:
  Algae/phytoplankton
  Zooplankton
  Water Boatman (beetle)
  Chinook salmon fry

FOOD CHAIN #10:
  Cottonwood trees
  Ladybug
  Western fence lizard
  Crow

FOOD CHAIN #11:
  Willow tree
  Beaver

FOOD CHAIN #12:
  Native grasses/seeds
  Harvest Mouse
  Kit Fox

FOOD CHAIN #13:
  Dead plant matter (detritus)
  Catfish
  Great Blue Heron

FOOD CHAIN #14:
  Blackberries
  Skunk
  Great Horned Owl

FOOD CHAIN #15:
  Blackberries
  Mosquito
  Tree Frog
Food Web Cards

Beaver

Blackberries

Cattails

Catfish
Food Web Cards

Butterfly

Duck

Gopher Snake

Coyote
Food Web Cards

Red-Tailed Hawk

Native Grasses/Seeds

Great Egret

Harvest Mouse
Food Web Cards

Dead Bird (Hawk)

Grasshopper

Crayfish

Kit Fox
Food Web Cards

Western Fence Lizard
Freshwater Shrimp

Red-Winged Blackbird
Mosquito
Food Web Cards

Small Fish (Minnows)    River Otter

Great Horned Owl    Phytoplankton
Food Web Cards

Willow

Skunk

Tree Frog

Raccoon
Food Web Cards

Chinook Salmon

Cottonwood

Tules

Dead plant matter (detritus)
Food Web Cards

- Waterboatman (Beetle)
- Turkey Vulture
- Water Plants
- Zooplankton
Food Web Cards

Salmon Fry

Ladybug

Frog

Crow
**Activity 4**  
The Life Stages of Salmon

**OBJECTIVE**  
In this lesson students will learn the general life cycle of the salmon, then jigsaw into groups to get more specific information about each stage. The students will present and add their stage to a class bulletin board displaying the life cycle.

**BACKGROUND**  
Salmonids are all fish in the same family that includes the salmon, trout, char and graylings (see the Salmon of the Pacific Coast posters in the kit to show species). Both trout and salmon live in the waters of California. Chinook salmon, also called the pacific or king salmon (scientific name *Onchorynchus tschawytscha* (on-cor-een-cuss cha-wee-chuh), is a species of concern because its population has been decreasing.

The Chinook salmon are anadromous, which means that they begin life in rivers and streams (fresh water) that flow into the Sacramento and San Joaquin valleys through the Delta and estuaries (areas where fresh and salt water mix) and migrate out to the ocean (salt water) where they spend most of their adult life. The salmon then return to the same river to spawn. It is important to discuss with the students that salmon have different habitat needs at different stages of their life cycle. We call it a life cycle because it begins with the first stage of the organism and continues through one or more stages such as growth, maturation, reproduction, and death.

Salmon have the outstanding ability to learn the odors of their “home” river or stream. This is called imprinting, which happens during the fry stage of the life cycle. Pollution greatly affects this and can be devastating for young salmon.

Lastly, salmon and very few other species of fish (lampreys, sturgeon, shad, and striped bass) are anadromous. This means they have the ability to move to salt water as adults and return to fresh water to reproduce. This of course means that as smolts they must be able to adjust to the amount of salt in the water. As adults, they have a special ability to remove the excess salt from their bodies when entering and living in salt water. This seawater would kill most freshwater fish.

**PREPARATION**  
- Make a transparency of the “Salmon Life Cycle”.
- Make copies of “The Life Cycle Stages of the Salmon” for each stage and cut into cards. Each group of students will receive one stage. Provide one copy of a specific life stage to each student in the group.
- Cut construction paper to make labels for life cycle stages approximately 4"x18".
• Tape blue butcher paper together and display on the wall in your classroom. This will be the background for the bulletin board.

MATERIALS
• The “Pacific Salmon Life Cycle” posters (in the kit)
• “The Life Cycle Stages of the Salmon” handout
• Six pieces of 12" x 18" construction paper (one for each of the six stages)
• Strips of 4" x 18" construction paper for life cycle labels
• Two pieces of butcher paper 3' x 10' (preferably blue)
• Optional: Two pieces of paper for or journals for each student to take notes or you could make a template for students to complete when other groups are presenting. For example: Eggs in one column, then five lines for students to write notes about the eggs in the second column, etc.
• Optional: Vials of the preserved specimens of the various stages of the salmon life cycle (in kit)

TIME
Preparation: 30 minutes
Lesson: 90 minutes

ENGAGEMENT
Tell students that they are going to be research biologists, and they will become experts in the life cycle of a salmon. Each group will be in charge of one part of the life cycle and each group will teach the rest of the class about that stage.

EXPLORATION
1. Present the general life cycle of a salmon through class discussion using transparency “Salmon Life Cycle.” The “Pacific Salmon Life Cycle” poster in the kit could also be used. Emphasize the unique aspects of this fish’s life cycle (long and difficult migration, imprinting, homing, and the many hazards faced by salmon). Also emphasize the differing needs of the salmon at the six different stages of its life cycle.

Optional: In available, show the vials of the preserved specimens of the various stages of the salmon life cycle (from kit).

2. When students understand the concept of the salmon’s life cycle, inform them that they are to work in groups to research one stage of the life cycle, and will be illustrating and reporting on this to the class.

3. Divide the class into seven groups. Six groups will research and prepare one stage of the salmon life cycle. One group will prepare a bulletin board background and labels.
4. Distribute the information cards “The Life Stages of a Salmon” to each group. Each group will receive one stage of the cycle with enough copies for each student in the group.

5. Distribute the 18" x 12" construction paper to six groups. Inform students that they will be presenting the information to the class and that each presentation should include the following (write these requirements on the chalkboard or chart paper):
   - A large label with the name of the part of the life cycle.
   - Three important facts from that stage.
   - Drawing of that stage, to include the salmon and its habitat at that stage. (Students should use the information on the cards for this.) The habitat needs should be clearly identified.

6. As the six groups begin their work, meet with the seventh group and give students their instructions for creating the bulletin board. They will start by making the labels for each stage that will be presented. Then they should decorate the bulletin board paper by dividing the paper in half lengthwise and on one side drawing things that can be seen in a river environment including areas for the eggs, alevin, fry, and smolt. On the other side, the group should draw the ocean environment where stages for smolt, adult, and spawner will be included.

7. When groups are ready, have the students present their stage (a drawing and three facts) and have them add it to the bulletin board to create a complete salmon life cycle.

Optional: Provide two pieces of paper or journals for each student. As groups present, have students take notes on each stage of the salmon (these notes will be valuable for Lesson 8).

EVALUATION
Informal: Question and discuss with students aspects of salmon life cycle stages as they are working in groups.

Formal: Check to see that the groups have included three facts for their stage of the life cycle and indicated the habitat needs of that particular stage of the life cycle.

EXTENSIONS
- Raise salmon egg in the classroom (contact the California Department of Fish and Game).
- Visit a fish hatchery, such as the Mokelumne River Hatchery or the Nimbus Fish Hatchery.
RESOURCES
Website
http://www.streamnet.org/ff/Lifehistory/anad_table.html
This site gives life history profiles of pacific anadromous fish including Chinook, Coho, and Steelhead. In the section called “Interactive Salmon Life cycle” you will receive a detailed description of the salmon life cycle and click on key words and get photos of that part of the life cycle. Excellent pictures to print for your classroom and to accompany information about salmon life cycle.

Books
• Salmon Story by Brenda Guiberson
• The Life Cycle of a Salmon by Lisa Trumbauer, et al (Life Cycle Series)
• Salmon Stream by Carol Reed-Jones (Sharing Nature With Children Book)
• The Salmon by Sabrina Crewe
• Salmon by Sylvia M. James
• Salmon by Ron Hirschi (Carolrhoda Nature Watch Book)
• What Is a Life Cycle? by Bobbie Kalman and Jacqueline Langille (The Science of Living Things series)

Other Resources
• Life Cycle of the Salmon, a coloring book available from the National Park Service.
• Salmonids in the Classroom Project. You can bring the salmon experience right to your classroom through the “Salmonids in the Classroom Project”. After attending an in-service sponsored by California Department of Fish and Game, you will receive salmon eggs to raise in your classroom. The in-service is usually in the fall and the eggs received in January. Website for more information: https://www.wildlife.ca.gov/caep

FIELD TRIPS
• Mokelumne River Hatchery in Clements, CA; 209-759-3383
• Nimbus Fish Hatchery in Rancho Cordova, CA; 916-358-2820
• Moccasin Hatchery in Moccasin, CA; 209-989-2312
The Life Cycle Stages of a Salmon

EGGS

The female salmon, which is called a Jill, creates a nest by using her tail to fan the gravel. This makes a little crater from 6-24 inches deep. She then lays her bright orange eggs in this nest which is called a "redd" (homophone of red and read). The male, or Jack, comes by and fertilizes the eggs and the female fans her tail to put a thin layer of gravel on top to protect them, and to keep them from washing away. The eggs are very sensitive to light and silt or mud. The eggs need to have cold clean water flowing over them to bring them oxygen and take away the waste. The eggs also need to be protected from the sunlight. Salmon will not build their nests in muddy water.

The Life Cycle Stages of a Salmon

ALEVIN

When the salmon eggs hatch, the tiny fish come out of the eggs, but stay in the gravel for protection. Each is only about one inch long and has a tiny yolk sac attached to its belly, to give it food (a "sac lunch" for the new fish). The fish is now called an "alevin." The alevin is still sensitive to light and stays in the shade or shadows of trees along the stream bank. It uses the shallow areas along the sides of the stream to hide from larger fish that might be in the deeper center of the river. The alevin are not very strong swimmers since they are so small, and must stay in the gravel to hide from predators. As the fish grows, the yolk sac shrinks and gets absorbed by the fish's body. When this happens, the alevin have to start finding its own food. If flooding has occurred, and mud and silt is heavy, the alevin could get trapped and die. Only about 10 percent of the alevin will survive to the next stage.
The Life Cycle Stages of a Salmon

Fry
Since the salmon are still less than 6 inches long, they are very vulnerable to predators. They must eat and grow so that they can begin to migrate out to the ocean. They must swim only when necessary to get food such as small aquatic insects at the surface of the water or that fall from trees along the banks. They must use camouflage to hide in the gravel and shady areas along the edges of the river. They have special dark markings on their sides called "parr marks" which help them blend in to their environment. These look like black ovals on their sides and help them hide. At this stage the fish are called fry. The fry begin noticing the smells in the river where they were born and this is called imprinting. This is very important so that they can return to spawn in 3-5 years when they are mature salmon.

The Life Cycle Stages of a Salmon

Smolt
The salmon are now larger and stronger swimmers and can begin their dangerous voyage to the ocean. They are about six or more inches long, and changes begin to occur in their bodies to help them prepare for life in the salt water. Their gills change as they start to head towards the Delta and estuary where the fresh water mixes with the salt water from the bay. The Sacramento-San Joaquin Delta is a very dangerous place for the smolts. Besides the predators here, the salmon have to find their way out of the Delta and avoid the large pumps that suck water from the Delta for irrigation and to be sent to southern California. If they make it through, they will find the estuary. The estuary is rich in food and they may spend a few days or weeks here to grow larger and stronger to help them to survive in the ocean. The fish loses its parr marks and becomes a silvery color on its belly and sides and dark on its back. This is to help it to camouflage (blend into its environment) in the ocean. When a predator is looking from above, they see the dark back, which blends in with the darkness of the ocean below. If the predator is below, it sees the silvery color, which blends in with the sunlight shining down from the surface of the ocean. These changes, which help the salmon survive, are called "smoltification."
The Life Cycle Stages of a Salmon

**ADULT**

Once the smolt (stage of the salmon before the adult) has survived the treacherous voyage through the delta, and have reached the ocean, they usually stay together in schools for protection from larger fish. The salmon will spend 3-7 years eating and getting larger and stronger. They eat primarily crabs, shrimp, and many smaller fish. They may eventually reach up to four feet long when mature. Ocean salmon may travel up to thousands of miles away from the bay, but when they are mature, they come back to the bay and find their way back to their "home stream" to spawn. This is called their homing instinct. They use the imprinting they did while in the fry stage (the third life stage of the salmon) to help them "smell" their way back home. When the salmon begins the journey back to their "home stream", there are again many dangers. Besides commercial fishermen, recreational fishermen, and pollution, the fish have to travel upstream (against the current) often through waterfalls. Adult salmon returning from the ocean also pause in the estuary (area where salt and fresh water mix) to allow their bodies to adjust to the freshwater before moving upstream to spawn (lay their eggs).

The Life Cycle Stages of a Salmon

**SPawner**

No one knows what makes salmon travel thousands of miles to come back to the exact place where they were hatched, but they do. The journey is much harder because the spawner has to travel upstream. But at this stage of its life cycle, it is a very strong swimmer. It has only one thing on its mind and that is to find a good place for its redd and spawn. Most salmon do not eat on their migration upstream, and their appearance changes. They become darker red or black, and may get sick. Males develop large teeth and their jaws become hooked (hence the scientific name *Oncorhynchus* or "hooked jaw"). They may fight with each other when competing for spawning females. Once the female's eggs are ripe, she has only a short time to find suitable habitat for her redd (nest for eggs). If she does not find clean gravel with cold running water, she may lose her eggs and they will die and float down stream. If she does find good habitat, she will turn onto her side and fan her tail to create her redd; and deposit her eggs and the cycle starts all over again. Both male and female Chinook salmon die after spawning. Very few have the strength to survive the journey back to the ocean after spawning. The bodies of the dead spawners provide nutrients and food for other animals such as raccoons and turkey vultures in the river environment.
Salmon Life Cycle

Salmon

Ocean Salmon

Salmon Eggs

Smolt

Alevin

Fry
Activity 5  
Changing Salmon Populations

**OBJECTIVE**
Discuss the ways humans impact the salmon populations and learn of the fluctuations in the numbers of salmon coming through the Sacramento-San Joaquin Delta from one year to the next.

**BACKGROUND**
*Note: Refer to the “Human Impacts On Salmon Student Reader” in Lesson 6 for additional information.*

Salmon populations are impacted by many things that humans do, as well as by natural phenomenon. By using fertilizers in lawns and polluting the waterways with trash or other waste, people have had a huge impact on the salmon. Floods and periods of drought have also affected salmon populations. The following describes several things that have directly affected salmon populations in our waterways:

1. Water diversions by people and natural droughts dry up creeks and strand fry in pools, making them easy prey for fish-eating birds and other predators.
2. Agricultural, urban, and industrial pollution kills salmon fry and makes it harder for returning spawners to find their way to their spawning areas.
3. Floods, whether natural or caused by human activity, can sweep fry from streams before they are ready to migrate, or smother them with silt before they hatch (salmon eggs need oxygen to survive).
4. Removing streamside vegetation and allowing livestock to graze beside the waterways reduce shade along streams. This raises water temperatures, sometimes to lethal levels, and reduces insect food available to young salmon.
5. Poorly constructed dams and natural rockslides often block migration of salmon to suitable habitat.
6. Many smolts are killed or injured passing through hydroelectric turbines or over spillways or are sucked into pumps in the Sacramento-San Joaquin Delta.
7. People can frighten spawning salmon by approaching too closely, preventing them from spawning.
8. Pollution of estuaries kills or weakens smolts, and reduces their food supply at a critical time in their life cycle.

Included in this unit are some actual population estimates from previous years. The figures in the table for students have been rounded to the nearest hundred to facilitate graphing. The actual figures and their possible explanation are provided at the end of the lesson.

It is important that students understand that they can make a difference in salmon survival. The following describes things people can do to help the salmon:
1. Do not dump antifreeze, motor oil, or any other chemicals into storm drains. Many storm drains empty directly into rivers and streams.
2. Conserve water and electricity. Many dams are built to generate electricity. The less water is used the less need there would be for additional dams and reservoir.
3. Recycle and reuse paper products. The manufacturing of paper requires a lot of water and energy. Reducing demand for these products could help save habitat and fish.
4. Volunteer your time to help restore and enhance streams and habitat that salmon need for their survival.
5. Report violations of fishing laws.
6. Avoid walking, boating, or canoeing through areas that adult salmon use for spawning.
7. Spread the word by educating others about salmon and what they can do to help the salmon population to increase.
8. Make wise decisions and be an informed consumer. Don’t use products that are harmful to the environment where safer alternatives exist.
9. Support salmon restoration projects. Encourage appropriate agencies to provide adequate habitat protection.

PREPARATION
- Optional: Obtain examples of simple bar graphs.
- Make copies for each student and an overhead of “Salmon Run Populations For Delta Rivers (1980-2002)”. Note that these figures were rounded to nearest hundred to make it easier for students to graph. Actual figures are provided as a reference at the end of this lesson.
- Make a copy of “Graph of Salmon Populations: 1980-2002” for each student (or groups of students) and a transparency.

MATERIALS
- Copies and a transparency of “Salmon Run Populations for Delta Rivers (1980-2002)” table
- Copies and a transparency of “Graph of Salmon Populations: 1980-2002”
- Erasable felt-tipped pens to use on the transparency
- Chart paper
- The book Come Back Salmon by Molly Cone
- Writing paper or journals for students

TIME
Preparation: 30 minutes
Lesson: 60 minutes

ENGAGEMENT
1. Tell students: “One way scientists show data is to graph information. A graph gives people a picture of the results of an experiment or shows the results of observations over time. Today you will create a bar graph of the salmon populations over many years.” If available, show examples of bar graphs to students.
EXPLORATION

2. Discuss with the class some of the ways we impact salmon survival. Discuss the pros and cons of these impacts. For example, dams have a very detrimental impact on salmon, but they provide humans with a supply of water, flood control, and recreational areas, and often the generation of electricity.

3. Distribute a copy of the “Salmon Run Populations for Delta Rivers (1980-2002)” data sheet and the “Graph of Salmon Populations: 1980-2002” to each student. Model for the class how to make a bar graph that shows the fluctuations in populations of salmon for the Stanislaus River. You might want to graph the first five years, then have one student at a time come up and graph each additional year on the transparency.

4. Discuss with students what this graph means (what does it tell us about the status of the salmon population?). Discuss why graphs are important (e.g., they allow us to read data at a glance and spot trends).

5. Have students create a bar graph on their own, in partners, or groups of four to show the data for another river: Tuolomne River or Merced River. If this will be done in partners, one student could plot the first 10 years and the other student the other years. If done in groups, each student can plot about five years, while other students check for accuracy.

6. For example they can create a horizontal or vertical bar graph showing specific years. You might need to show students an example of such graphs.

7. Ask students to come up with ways they could help the salmon. Write their suggestions on chart paper.

8. Read to students parts of the book Come Back Salmon by Molly Cone. Ask students what they would be willing to do to help the salmon.

9. Have students write down one thing that they would be willing to do to help the salmon.

EVALUATION
Check the graphs that students created and review what students have written concerning what they would be willing to do to help the salmon.

RESOURCE
Book
• Come Back Salmon by Molly Cone
FOR TEACHER REFERENCE: SALMON RUN POPULATIONS FOR DELTA RIVERS

<table>
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<th>Year</th>
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<th>Trib. Total</th>
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Population information supplied by Tim Ford, Aquatic Biologist, Turlock Irrigation District, May 2003.

Note about the data for this table:
The “unprecedented” six-year drought of 1987-92 led to the lower runs returning in the fall during the 1989-95 period. The lower flows combined with high water export in the south delta likely reduced juvenile survival in the winter/spring of the drought years (the out migration can generally be from January through May and even June in wetter years). There is a lag effect in observing this impact to the populations as most of the salmon return at age 2, 3, or 4 (this accounts for the different sizes seen in the rivers). For example, the runs in 1993 were comprised mostly of progeny of the runs from 1989-91. There was also a high ocean harvest rate in those years. The higher recent runs benefited from much better water years in 1995-2000, some river and delta measures to improve juvenile survival, and reduced ocean harvest rates.

The numbers in the table above include both naturally-produced and hatchery salmon. There is a salmon hatchery on the Merced River and some of the juveniles produced there are tagged and marked (by a small fin being removed). Since not all hatchery fish are marked, it is difficult to determine the actual percentage of hatchery fish in the runs. There are also some strays from other river systems. The hatchery fish make it difficult to determine the natural production of the runs, since the hatchery fish are allowed to spawn in the rivers.
Graph of Salmon Populations: 1980-2002

Stanislaus River
Graph of Salmon Populations: 1980-2002

Tuolumne River
Graph of Salmon Populations: 1980-2002

Merced River
### SALMON RUN POPULATIONS FOR DELTA RIVERS (1980-2002)

#### San Joaquin Basin Chinook Salmon Spawning Run Estimates

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**Note:** The above figures were rounded to nearest hundred.
Graph of Salmon Populations: 1980 - 2002

Your Name ________________________________

Name of River: ____________________________

over
20,000
19,500
19,000
18,500
18,000
17,500
17,000
16,500
16,000
15,500
15,000
14,500
14,000
13,500
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
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6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Activity 6
Human Impact: Problems and Solutions

OBJECTIVE
After students receive background on human impact on salmon, they will write a persuasive letter to a representative in congress.

BACKGROUND
Refer to background information in Activity 5, “Changing Populations of Salmon” and to the “Human Impact Student Reader” in this lesson.

Notes concerning this lesson:
Students may not know enough about how government works and the purpose of the city council. So that needs to be explained. For example, City Council members help to govern and make decisions that affect the community and its members and are usually voted by people living in the city to represent their views.

Students also need to understand the purpose of the speakers: that they are trying to get the city council to vote for their opinion. It is important to make certain that everyone participates and that each student has a job.

Read the “Variations” section at the end of the lesson to determine whether these ideas will work better for your students than the city council meeting.

PREPARATION AND MATERIALS
• Duplicate the “Human Impact on Salmon Student Reader”, one for each student
• Duplicate and cut apart the “Human Impact Cards”, one card for each group of two or three students
• Binder paper for each student
• Duplicate “Human Impact Homework Assignment”, one for each student

TIME
Preparation: 30 minutes
Lesson: 60-90 minutes

ENGAGEMENT
Discuss how students think decisions are made about what people can do concerning salmon and its habitat.
EXPLORATION

1. Say to the students, “Today you are going to be decision-makers who can impact the salmon’s life and the health of river habitats. After finding out about the human impacts on the river system and the salmon, you will present an argument to our city council who will make a decision whether or not to put a dam on our river (use a local river name).”

2. As a class, read and discuss human impacts on river systems and habitat in the “Human Impact on Salmon Student Reader”.

3. Explain to the students that a dam (or an additional dam) is proposed for their river to help provide water for agriculture and their town, to create needed electrical power, and to protect their town from flooding (chose a local river or make one up if you are not near one).

4. Divide students for the following jobs:
   - 5 city council members (make certain that you have an odd number)
   - Rest of students will work in groups of two or three

5. Hand out the “Human Impact Cards”, one to each group of students. One student will read the information from the card to their group explaining the point of view the group will take concerning the possible construction of a dam in their town.

6. Student groups will have 10 minutes to prepare an argument from their point of view to present to the city council. They can use notes, charts, or pictures to help them in their presentation. Each presentation will be no longer than two minutes long. The group should decide if all group members will speak, or if there will be one spokesperson. Make certain that everyone participates and that each student has a job.

7. The city council members will review the “Human Impact Cards” while waiting for the groups to prepare. They may write questions they may want to ask of the presenters.

8. The groups will be given two minutes to present their point of view about the dam building to the city council.

Note: You might need to help students enhance their oral presentation skills. Encourage students to speak loudly and to use voice tone and body language to be convincing actors.

9. After the city council has heard the arguments for and against dam building, they will conduct a vote to make a final decision. Each council member will vote and give the reason for his or her vote.

10. Ask students to write a letter to their representative in Congress giving their opinion whether or not they should build a dam in their community. They will need to back up their choice using some of the information presented in the city council meeting.
Distribute “Human Impact Homework Assignment” sheet. If you plan to formally assess this letter, make certain that students understand the criteria you will be using as listed on their homework sheet.

11. Ask students to share some letters from their homework assignment.

EVALUATION
Conduct an informal assessment to include:
- Group participation during preparation for city council meeting.
- City council members’ questions during the city council meeting.
- Responses to city council members’ questions by group members.

For a formal assessment have students write the letter using the following criteria:
- Appropriate letter format (whatever your class/school standard is for letter writing is acceptable).
- Clearly written student opinion for or against the building of the dam.
- Three reasons are stated why their opinion should be considered by their representative in congress.
- Description of what action they would like their representative in congress to take about the dam building.

VARIATIONS
The “Student Reader” may have too much information for each student to read. You might want to place students in groups and ask them to read a specific topic and discuss the solutions. Then each group can present to the class the problem and ask the class for solutions. Compare the class’s solutions to what is written in the “Student Reader.” Students could develop a list of how each action affects the salmon and what can be done to help the salmon.

Or use the human impact cards by first listing the problems to Salmon (e.g., dams, water diversion, logging) and then discussing the effect on different human groups (farmers, home owners, river rafting company owners, etc.) if no dams were allowed, if water cannot be diverted, and if limited logging was enforced. Students could then read a human impact card and identify problems to people and problems to the Salmon and suggest a solution.

RESOURCES
Website
http://sfbay.wr.usgs.gov/
Overall good information about bay and delta issues including plant and animal life, invasive species, pollution, bioaccumulates, on-going delta projects, maps, and satellite pictures.
STUDENT READER
Human Impacts on Chinook Salmon

What people do on the land and in the water directly affects the survival of plants and animals. Chinook salmon populations have been affected by what humans have done since they arrived in California hundreds of years ago. What humans do on the land is very important to the survival of these fish. Because water runs off the land into streams and rivers, if the watershed has been disturbed in any way, the quality of the river habitat may suffer.

Over the years several factors have impacted the Chinook salmon of the Sacramento-San Joaquin Delta region of California. Human activities, such as building dams, water diversion, mining, agriculture, logging, and development of communities along streams and rivers have decreased the chances of survival for the salmon. But humans have also made efforts to solve some of these problems.

The following sections will explain some of the problems humans have created for the Chinook salmon, as well as some of the solutions to these problems. Although this student reader represents Chinook salmon, other salmon species face similar problems.

Dams: In the early 1900’s, dams began to be built to meet the water needs of the people of California. Part of the reason for this is that most of the rainfall occurs in the northern part of California, but most of the people and farmlands are located in the central or southern part of California. These dams provide water storage for people all over California for personal use and for farming. Dams also help with flood control and to provide the needed electricity in this large state.

Dams block the natural migration paths for salmon. Small dams can have fish ladders, allowing spawning fish to pass over, but it is impossible for large dams to have such ladders. This has resulted in hundreds of miles of fish habitat to be closed off and many types of fish to become extinct (no longer exist).

Dams can also negatively affect the river habitats located below them. The river’s natural flow and path is changed by a dam. The water released by a dam usually flows colder or warmer than a natural flowing river. This temperature can shock the fish and other animals living in the river or stream and sometimes kill them. A
naturally flowing river flushes out sediments that collect in it, but a dammed river can get clogged with sediments above the dam. Also, if water is released from a dam too fast, it will wash away gravel in the stream beds, which is necessary for spawning salmon.

**Some solutions:** To protect the salmon, laws have been made to regulate some of the dam flows. On many rivers, dams have to release water during the migration of salmon fry to the ocean. Also, many conservation and government groups have added gravel to spawning areas for salmon to help continue their life cycle.

**Water Diversions:** Most of the population of California is in the central and southern part of the state. Most of the rainfall and snowfall is in the northern part of the state. To take care of the water and electricity needs of all of the people of California, large water transportation or diversion systems have been built.

The result of taking a huge amount of water from northern California and sending to Southern California, has reduced a large amount of habitat for salmon and other plant and animal species. Much of the water is pumped into canals and waterways. During this pumping, fish can get trapped in the pumps and screens and die. Larger pumping systems around the San Joaquin Delta can actually change the flow of the rivers, confusing the salmon that are trying to make it to the ocean, or that are trying to go up the river and spawn. This confusion causes them to end up in the wrong waterway, get caught in irrigation pumps and pipes, and die.

**Solutions:** There are regulations in place that limit water diversion and pumping during spawning of salmon and their migration to the ocean. Screens have been placed over pumping areas and piping, reducing the trapping and killing of salmon.

**Logging:** Poor logging practices causes major damage to streams and rivers. The roots of the trees help to keep soil in place reducing soil erosion. Trees also use water in the soil, so the soil does not get too heavy. When too many trees are logged from an area, the soil becomes saturated and heavy and will start to collapse resulting in lots of sediment flowing into the river. This sediment clogs the river and can block the migration of salmon.
Some types of logging remove all the vegetation around the river. This causes the water temperature to rise. It also reduces the habitat for animals along the banks of the river. Without plant material on the banks, the sides of the river can get washed away down the river, reducing the places for fish habitat.

Logging does provide us with necessary items for our lives. It provides lumber for building our houses and schools. It provides raw materials for the paper and pencils we use every day. Paper products are used as containers for our food and for storage. Many pieces of art are designed out of wood. Logging and the processing of wood products provide many jobs for families.

**Solutions:** One solution to the effects of logging is to replant the logged area with new trees. As the roots of the trees grow into the soil, they hold the soil in place and reduce sediment going into the rivers. Check dams are also placed into newly logged areas to hold back the soil. Selective cutting is a logging practice where some trees are logged, but many are left to protect the soil and provide habitat for many living things.

**Agriculture:** Agriculture in California is extremely important. It provides food for many people as well as jobs. Agriculture is also away of life, connecting communities and cultures together in California.

Unfortunately, agriculture has also affected river habitats. Pesticides and fertilizers used by farmers on their fields of crops can wash into streams and rivers. They accumulate in the water systems and become poisonous to plants and animals, often weakening or even killing them. When livestock (cattle, sheep and other animals) are allowed to graze along streams and rivers, some go into the shallow waters and trample salmon beds killing eggs, alevin, and fry. If the livestock eat too many plants along the shore of a river, the soil will erode and wash away and the hiding habitat for small fish is destroyed.

**Solutions:** Fencing can be placed along rivers and streams to keep grazing animals away from the edges of the water. Some farmers can also use fertilizers that are not poisonous or that are less poisonous to animals.
## HUMAN IMPACT CARDS

### HUMAN IMPACT CARD #1
You are an **ALMOND FARMER**. You are interested in a dam being built near your community because this will insure water throughout the year even in drought. It will also cost you less for the water you need to irrigate your crops. During the past year hardly any rain fell, and you have had to pay double for the water you needed. At times the water company could not provide you with irrigation water. Your crop suffered and you were not able to make a profit. It was very hard for you to pay your bills this year and you are worried about supporting your family and continuing your farming business. You WANT this dam to be built.

### HUMAN IMPACT CARD #2
You own a **RIVER RAFTING COMPANY**. For the past 20 years you have run a successful rafting business near the community in which you live. You have been able to employ six people in your office and over 40 river guides. Your business has been so successful you have been able to provide free river trips to school groups studying the environment. You have a family of 4 children and your river business is what supports your family and your employee's families. If the dam is built your company would have to close. You DO NOT want this dam built.

### HUMAN IMPACT CARD #3
You are a **Retired Community Member** who has watched your electricity bill triple in the past six months. You receive a moderate retirement check each month and are having a hard time paying your bills because of the rise in your electricity bill. You live in an area that gets very hot in the summer and very cold in the winter, so you need to use electricity to cool and heat your home and to keep you in good health. You WANT the dam to be built because it will provide electricity at much lower price you can afford.

### HUMAN IMPACT CARD #4
You are a **Homeowner** and you have just recently bought a home near the river. Last year flood waters came into your home causing $100,000 worth of damage. Some of the damage was repaired using Federal Disaster Relief Funds, but over half of the damage was not replaceable. You lost family photographs, family pets, and other family treasures. You WANT the dam to be built because you live near the river and you want to protect your family and property from future floods.
<table>
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<tr>
<th>HUMAN IMPACT CARD #5</th>
<th>HUMAN IMPACT CARD #6</th>
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<tbody>
<tr>
<td>You are the President of the Ground Level Gravel and Building Materials Company. Your business requires the collection of gravel resources for use in local building industry. You DO NOT WANT the dam because gravel resources will be washed down river with large releases from the dam. This will cost your company money because it will decrease your supply of materials necessary for a booming building industry in the community.</td>
<td>You are a member of the Save the Salmon Environmental Group. You are quite concerned about the dam being built on your river. This river is a spawning ground for Chinook salmon. Because of overfishing, Chinook salmon populations have decreased making it even more important to have gravel beds for salmon spawning. If a dam is built, the salmon will lose this important habitat for spawning. You DO NOT WANT the dam to be built.</td>
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<th>HUMAN IMPACT CARD #7</th>
<th>HUMAN IMPACT CARD #8</th>
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<tr>
<td>You are a Developer. You purchased 100 acres along the river 10 years ago as an investment. You and your partners have a plan to develop upscale housing that is in demand by commuters who wish to live in a country setting. Your property is located above the proposed dam site and would be flooded if the dam was to be built. You stand to lose $50,000,000 if you are unable to complete your project. You do NOT want this dam built. You and your investors will lose EVERYTHING if this dam is built!</td>
<td>You are the Mayor of this community. You are excited for this dam to be built because it would bring hundreds of jobs to your community and improve local economy. It will also reduce the cost of energy and water for the citizens of your community. The income from electricity could also be sold to other communities so your town could make a profit from this sale. You WANT the dam!</td>
</tr>
</tbody>
</table>
Our community is considering building a dam to help with water needs of our town and for agricultural uses. You have heard many points of view concerning the building of this dam presented at our city council meeting. Your city council voted to decide whether or not to build a dam. Their vote is now going to be considered by the state congress. Your job is to write to your representative in congress. You want to write a letter stating your own personal point of view about the building of the dam. You need to include the following information in your letter:

a. Your own opinion for or against the dam building in your community.
b. Three reasons why your opinion should be considered by your congressman or congresswoman.
c. What action you would like your congressman to take about the dam building.
Activity 7
Salmon Story: Culminating Unit Activity

OBJECTIVE
Students will show their understanding of the salmon life cycle by creating a booklet to include written information and a drawing for each stage.

BACKGROUND
Review background information from previous Lessons 1 through 6.

PREPARATION
• Make tag board tracers (shapes) of the anterior and posterior of the salmon, one set for each group of three or four students. (Illustrations for these tracers are in this lesson.)
• Cut red or pink and white construction paper in half lengthwise.
• Make up a sample salmon accordion book to show students.

MATERIALS
• Tag board or thick paper (12" X 18"), cut lengthwise in half
• Pink construction paper, one per every two students (12" X 18"), cut lengthwise in half
• White construction paper, one per every student (12" X 18"), cut lengthwise in half
• Scissors for students
• Pencils
• Glue
• Black felt tipped pens (thin)
• Crayons, colored pencils, or colored markers
• Overhead projector

TIME
Preparation: 30 minutes
Lesson: 60-90 minutes (plus additional time for some students to complete their booklets)

ENGAGEMENT
Tell students, “Today you will put all of your knowledge about the salmon and the river ecosystem into a creative accordion book.” Show students the sample accordion book and tell them you will guide them through how to build their book.

EXPLORATION
1. Ask students to trace the anterior (head) and posterior (tail) part of the salmon on red or pink construction paper. Have pairs of students work together, one student can hold the tracer while the other one traces.

2. Have students cut out the head and tail and set these aside.
   - Have students fold lengthwise each of the two pieces of white construction paper into four equal sections.
   - Have them refold so that both sections act like an accordion. Tell them they are forming the letter M or W.
   - Staple the two sections together so that there are a total of seven sections.
   - Tell students that there will be a total of six flaps on which they will create their story.

4. Have students label the six sections with the following labels and in the following order:

   1. Egg
   2. Alevin
   3. Fry
   4. Smolt
   5. Adult Salmon
   6. Spawning Salmon

   Students should write the enlarged letters in pencil first and then go over it with a black felt-tipped pen.
5. To create salmon pages:
   • Tell students that they will create a drawing and three to four sentences to describe each section of the life cycle. The description should include information about the life cycle as well as issues that the stage in the life cycle faces. The drawing has to reflect the description of that stage of the life cycle and the habitat surrounding that stage.
   • Do the first section together as a class:
     d. Brainstorm what the class knows about the egg stage and the issue it faces. Write a list on the board.
     e. Ask student volunteers to come up with three to four sentences to describe this stage. Write these on an overhead and all students will copy for their example. The writing will be on the bottom half of the section.
     f. Ask students what they could draw that would reflect their description of the egg stage. Draw on the overhead to give the students an example. They will also draw a picture. The picture will be drawn on the top half of the section. See example below.

   • Encourage students to complete their own drawings and sentences of the salmon’s life cycle.

EVALUATION
Informal assessment: Through discussion and observation of students as they complete project.

Formal: Accordion book to be assessed for completion of each stage of the life cycle to include the following aspects.
   • Three to four sentences about each stage of life cycle completed
   • Each stage is accurate and in proper order.
   • Each picture reflects the specific stage in the life cycle and the habitat.
   • Sentences are complete and no words are misspelled.
   • The work is neatly done.
Tracer for Head of Fish
1. A habitat is an animal’s home. List as many things as you can that an animal needs to survive.
   FOOD
   __________________
   __________________
   __________________

2. Name two rivers that empty into the Pacific Ocean.

3. Describe a food chain.

4. What is a salmon and where does it live?

5. Name two wild animals that live near the rivers in our area.
6. Name three ways humans help or harm the fish in our rivers.

7. What are the six life stages of a salmon?

8. What are some ways that we use the Delta?

9. Why is the sun so important to every living thing?

10. Complete the following paragraph.

There are many things I can do to help the salmon.
Assessment Answer Key

1. Food, water, shelter, space, soil, sunlight, air

2. Some possible answers are: Cosumnes, Sacramento, San Joaquin, Mokelumne, Tuolumne, Calaveras, Stanislaus

3. A food chain is a relationship between plants and animals within an area and shows the transfer of energy from plants to other organisms.

4. Salmon is a fish that spends the early part of its life in freshwater and migrates to the ocean to live as an adult. It returns to freshwater to spawn after four to seven years.

5. Raccoons, coyotes, owls, hawks, fox, beaver, Great Blue Heron, Common Egret, lizards, garter snakes, and many others.

6. Depends on how humans handle solid waste, toxic chemicals, water; what practices are used in agriculture, logging, industry, for recreation, and for development of land.

7. Egg, alevin, fry, smolt, adult, spawner

8. A river system that begins in the Sierra Nevada Mountains and empties into the Pacific Ocean.

9. Sunlight provides energy for plant growth and food production for all animals as well as warmth for animals.

10. Answers will vary from recycling to writing to your congressman to help in habitat restoration.
California’s Environmental Principles & Concepts

Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Principle V: Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.