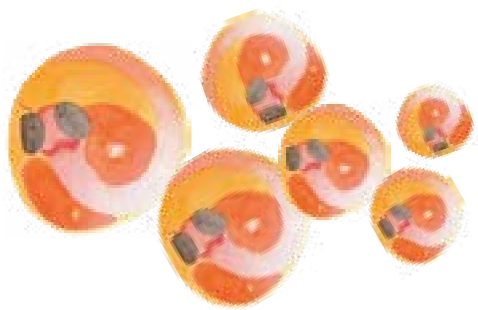
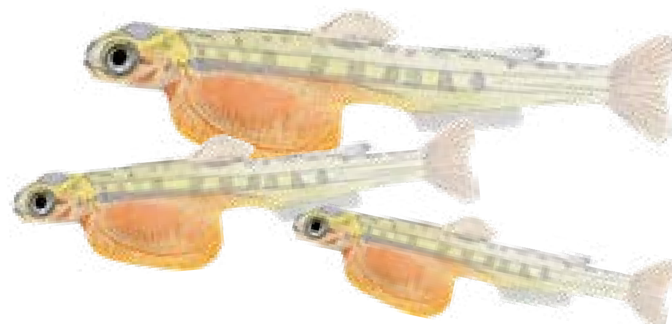
State of Salmon

3rd grade lesson bundle on Washington's salmonids





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Appreciations

This lesson bundle has been designed in collaboration with the Washington Office of the Superintendent of Public Instruction (OSPI) to facilitate alignment with the Next Generation Science Standards (NGSS) . It is structured to allow students to engage in sense making around a real-world fish and wildlife conservation issue as a central phenomenon. Each lesson incorporates a disciplinary core idea (DCI), a cross cutting concept (CCC), and a science and engineering practice (SEP) to allow for three-dimensional learning. This lesson bundle is designed to engage students through interdisciplinary learning by including English language arts (ELA), mathematics, social studies, and environment and sustainability subject matter.

This lesson could not have been written without the collaboration and review from partners. Special thanks to staff at the Office of the Superintendent of Public Instruction who reviewed the lesson and provided thoughtful feedback and connections. Specific gratitude goes out to:

- **Kimberley Astle**, Associate Director of Elementary Science, Early Learning and Elementary Education at OSPI for her feedback and advice on this lesson bundle. Her work was instrumental in supporting development of phenomena and the three dimensions of NGSS in the materials.

- **Elizabeth Schmitz**, Environment and Sustainability Education Program Supervisor at OSPI for her help evaluating this lesson bundle for connections with environment and sustainability education standards and for collaborating on ideas for incorporating best practices in environmental education.

- **Jerry Price**, Social Studies Program Supervisor at OSPI for his help familiarizing the WDFW education team with social science standards, and for facilitating connections with teachers across the state.

Finally, many thanks to **Melissa Pearcy** and the students of Jefferson Elementary School for allowing the WDFW education team to trial lessons in her science classroom and ensure they were suitable for all students of all learning levels.

The fish and wildlife conservation education team hopes you and your students enjoy, engage, and become engineers in this lesson bundle.

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OVERVIEW

How to Grow Fish

3rd grade lesson bundle on Washington's salmonids

Introduction:

This learning sequence is anchored in the phenomena: Salmon populations in the Pacific Northwest are declining.

Part of the job of Washington Department of Fish and Wildlife (WDFW) is to figure out why salmon populations are declining and create plans for how to help increase fish populations. Throughout this unit, students will engage with the phenomenon of Pacific salmon population decline as they explore salmonid species and discover how WDFW raises healthy fish in hatcheries.

Students will explore salmonid life cycles and discover patterns among life cycles of plants and animals who interact with salmon. Students will then learn what makes healthy habitats for salmon. They will evaluate solutions to the problems of salmon migration above and below dams and examine salmons' role in a healthy river system. Students will embark on a virtual field trip (in person field trips also available) to a WDFW fish hatchery to learn about current practices in hatchery management and identify ways the hatchery meets the habitat needs of fish. Finally, students will be called to work as an engineering team and help develop a tool to support salmon recovery by working as conservation engineers.

This learning sequence is designed to be used as a stand-alone lesson bundle, or with the salmon/trout in the classroom program. If you are participating in a salmon/trout in the classroom program, the conservation engineering lesson could be re-tooled to prepare students to set up the aquarium to include components of a healthy habitat.

These lessons can be made even more place-based by focusing on species that are endemic (found nowhere else in the world) to your area.

TEACHER'S NOTE

Redband trout (a subspecies of rainbow trout) and bull trout are both salmonid species, but their life cycle does not have them travel to the ocean and back. However, these land locked fish do migrate to spawn. Steelhead are rainbow trout that migrate to and from the ocean. A rainbow trout that makes it all the way to the ocean, becomes a steelhead!

For more information on salmonid species in Washington state, check out the Washington Department of Fish and Wildlife website. Species specific information can be found at the sites linked below.

- Chinook salmon
- Coho salmon
- Pink salmon
- Chum salmon
- Sockeye salmon
- Steelhead
- Redband trout
- Bull trout
- Kokanee

Explore the SalmonScape interactive map for more information on distribution of salmonids throughout the state.

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Standards

This learning sequence builds toward the following performance standards:

Next Generation Science Standards

- 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-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.
- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Common Core State Standards

Literacy

- RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.
- RI.3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

Math

- Math.Content.3.MD. B.3
  Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent 5 pets.

Washington State Standards

Environmental & Sustainability Education

- Standard 1: Ecological, Social, and Economic Systems. Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.
- Standard 2: The Natural and Built Environment. Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments
- Standard 3: Sustainability and Civic Responsibility. Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.

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Essential Questions:

- How do salmonids change throughout their life cycle?
- What do the life cycles of all organisms have in common?
- How do changes in salmonids' habitat relate to changes in their bodies throughout their life cycle?
- How do healthy river habitats allow salmonids to survive well?
- How do unhealthy river habitats keep salmonids from surviving well, or from surviving at all?
- How do dams create a problem for wild fish populations? How can solutions to this problem be evaluated?
- How can change in one part of an ecosystem affect other parts of the ecosystem?
- What happens to salmon if the river system changes?
- What happens to the river system if salmon disappear?
- How do plants and animals rely on each other to create a healthy system?
- How are hatcheries like and unlike the wild habitats of salmon?
- Why are hatcheries used in Washington?
- How can we help support healthy salmon populations and river systems?

Big Ideas:

- Changes—whether caused by nature or by humans—in one part of the system will affect other parts of the system.
- Organisms reproduce, develop, and have predictable life cycles.
- Organisms and their environment are interconnected.
- Healthy river systems rely on salmon.
- Salmon rely on healthy river systems.

Vocabulary:

- Salmonid
- Life cycle s
  - eggs, alevins, fry, smolts, ocean phase, spawners: stages of salmon life cycle
- Redd: A shallow nest in gravel for depositing eggs created by a female salmon.
- Reproduction
- Anadromous
- Claim
- Evidence
- Trend
- Fish passage
- Migration

TEACHER'S NOTE
vocabulary words students may encounter are listed here. Throughout the course of these lessons, it is advised that students be allowed to use their own language to describe and define the vocabulary listed. For more information check out this resource.

How to Grow Fish

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Lesson Description Chart

Lesson	Strategy	Duration	Standards	Overview	Assessment
1 Intro. to Phenom.	Engage	30-45 minutes	3-5-ETS1-1 ESE Standard 1 3.MD. B.3	Students will: · Interpret bar graph about salmon decline. · Watch video from WDFW biologist about importance of salmon. · Generate class schema on salmon. · Identify questions they need answered to understand salmon decline.	1. Schema chart
2 Salmonid Life Cycle	Explore	45 minutes-1 hour	3-LS1-1	Students will · Explore the life cycle of salmonids. · Craft initial life cycle model.	1. Initial lifecycle model
3 Finding Patterns in Lifecycles	Explore	45 minutes-1 hour	3-LS1-1 ESE Standard 1 3.MD. B.3 RI.3.4	Students will: · Develop models of life cycles of other organisms. · Identify common components to life cycles: birth, growth, reproduction, death. · Describe relationship between components and identify causal direction of cycle.	1. Life cycle model comparison 2. Extension: bar graph
4 Healthy Habitats	Explain and Evaluate	2-3 days	3-LS4-3 3-LS4-4 ESE Standard 1 Standard 2 ELA	Students will: · Create and deliver presentations on salmon at different stages of their life cycle focusing on habitat needs and threats. · Evaluate solutions to fish passage over dams in Washington state. · Create models of healthy river habitats for salmon.	1. Presentations 2. CER arguments about solution fish passage 3. Habitat models

Lesson Description Chart Continued

Lesson	Strategy	Duration	Standards	Overview	Assessment
5 Healthy Systems	Elaborate	1-2 days	3-LS4-3 ESE Standard 1 RI.3.3	Students will: · Engage in a short video detailing the interconnectedness of salmon and their ecosystems. · Expand on their understanding of healthy habitats to include the other biotic and abiotic pieces of a healthy river ecosystem. · Explore the effects of changes in one part of an ecosystem on the system as a whole. · Construct an argument with evidence from text, activity, and video that changes in the population of salmon in a river ecosystem affect other aspects of the ecosystem.	1. Keystone species activity 2. CER argument about effects of salmon population decline on ecosystem health
6 How to Grow Fish	Evaluate	30 min-45 min	3-5-ETS1-1 ESE standard 1	Students will: · Navigate a virtual field trip of a WA state hatchery. · Identify similarities and differences between the habitats of wild fish and hatchery fish.	1. Fish hatchery virtual field trip worksheet
7 Student Conservation Engineering	Evaluate	1-2 days	3-5-ETS1-1 ESE Standard 3	Students will: · Engage in engineering design process to create a solution to a problem facing salmon.	1. Salmon solution design process 2. Self-evaluation rubric 3. Conservation engineering prototype

LESSON 1: Introduction of Phenomena

Learning Performance

5E Strategy: ENGAGE

Students will activate prior knowledge about salmonid species and will engage in analyzing and interpreting data about Chinook salmon populations in Washington.

Standards

3- LS4-3 PE: 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		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and interpreting data	LS4.C For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Systems and Systems Models-A system can be described in terms of its components and their interactions.

This lesson supports student learning in elements of the following:

CCSS.MATH.CONTENT.3.MD.B.3

Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent 5 pets.

Environmental Sustainability Education Standards:

Standard 1: Ecological, Social, and Economic Systems. Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.

Materials

- chart paper
  - salmonid schema anchor chart
  - anchoring question chart- what is causing salmon populations to decline?
- sticky notes

LESSON 1: Introduction of Phenomena Continued

1. Introduce the topic of the unit: "Today we are going to begin a unit exploring a specific type of animal that makes its home in Washington state." Play Video of Salmon. To set video as loop on YouTube, right click on video and select loop.

2. Allow students to observe the fish swimming at least one time through (approx. one minute) before asking them what they notice.

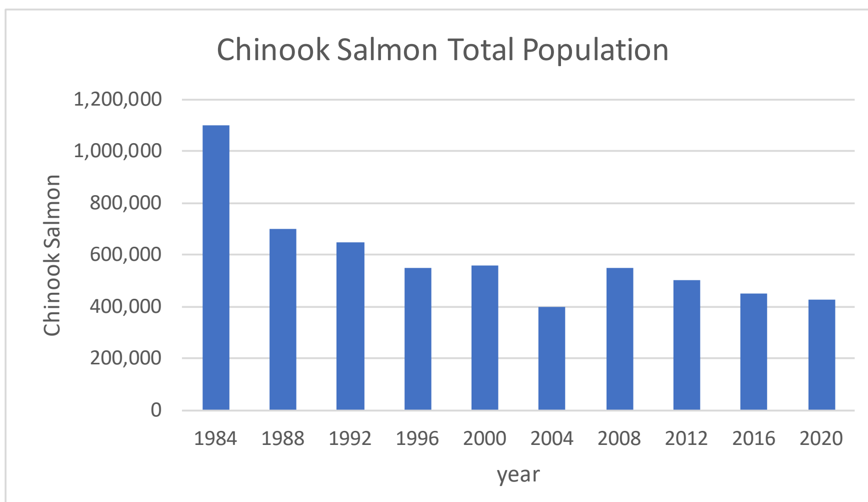
> **TEACHER'S NOTE**
> This is one example of a Know, Want to Know, Learned (KWL) chart.

3. As a class discussion, have students share information about what they know about salmon. Record this information on a "salmon schema" interactive anchor chart (modified **K**now, **W**ant to know, **L**earned chart).

Anchoring Phenomenon

4. Introduce graph showing population trends for Chinook salmon (slide two in PPT).

5. Lead students in discussion about what they observe in the graph. Allow students to engage in sense making about the trend depicted in the graph.



Suggested questions:

a. What is the title of the bar graph?
b. What is the scale of the bar graph?
c. What informaion is the scale showing us?
d. What do the bars represent?
e. Which year had the most Chinook salmon?
f. Which year had the fewest Chinook salmon?
g. Describe what patterns you see in Chinook salmon population over time.

6. Ask students to brainstorm questions they have about salmon and their population decline. Pass out sticky notes and have students record their questions. Compile sticky notes on a class anchoring question chart: "What is causing salmon populations to decline?"

7. Have students work to begin classifying questions. Students can come up with ways to classify with some teacher guidance. Which of these questions will we need to answer to gather information about what is causing salmon population decline?

LESSON 1: Introduction of Phenomena Continued

Have students identify which of their questions should be researched, and which should be tested. (Reaches Science and Engineering practice 1- asking questions).

Common student questions include:

- Where do salmon live?
- What do they eat?
- How do you know if they are male or female?
- Where do the fish live?
- How fast are salmon?
- How long do salmon live?
- Who eats salmon, besides us?
- Why does it (salmon population decline) matter?
- How are salmon part of the ecosystem?
- If the population is going down, why are we still eating them?
- How can we help?
- What is being done to help salmon?

Connect student questions to what they will investigate in upcoming lessons:

I. Salmon Life Cycle (Lesson 2)

- How big do salmon get?
- How are they born?
- Do they live in the river their whole lives?

II. Patterns in Life Cycles (Lesson 3)

- How long do salmon live?
- Do other animals move around like salmon?

III. Healthy Habitats and Threats (Lesson 4)

- What do salmon eat?
- What eats salmon?
- Where do salmon live?
- How far do they travel?

IV. Healthy systems (Lesson 5)

- How are salmon part of a healthy ecosystem?
- Why should we care about salmon?

V. Fish hatchery tour: how to grow a fish-What is being done to help salmon? (Lesson 6)

- How big are typical hatcheries?
- When do they release salmon?

LESSON 2: Salmonid Life Cycle

(Based on Salmon Life Cycle Mix & Match from Science World)

Learning Performance

Students will organize the life stages of a salmonid into a model life cycle.
Essential Question: How do salmonids change throughout their life cycle?

Standards

3-LS1-1 PE: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Modeling- Develop models to describe phenomena.	3-LS1.B Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	Cause and Effect- Mechanism and Prediction: Cause and effect relationships are routinely identified, tested, and used to explain change.

Materials

Whole Class

- Salmonid life cycle image cards
- Salmonid life cycle name/info cards
- Chart paper

Individual

- Science notebook
- Life cycle model worksheet
- Sticky notes

Anchoring Phenomenon

Say "In our last lesson we looked at a graph that showed us that populations of salmon are declining. You all asked some excellent questions about salmon that we will need to answer to figure out why salmon populations are going down. Today we are going to try to answer a couple of your questions by learning about how and where salmon live throughout their lives."

5E Strategy: Engage

Lesson Phenomena: introduce video on salmon leaping up stream. Ask students: What do you: notice, wonder, think? Have students think, pair, share their ideas about what the salmon are doing. "Why would a salmon want to swim against the current of a river, and leap up a waterfall?"

5E Strategy: Explore

Ensure students are sitting in small groups of three to four. Give students in each group image cards of the life

LESSON 2: Salmonid Life Cycle (Continued)

stages of salmon: egg, alevin, fry, smolt, adult, spawner. Have students organize image cards from youngest to oldest. Ask students to identify features of the salmon at each stage and observe what features or evidence they have for putting salmon images in order. Engage in class discussion about life cycle. Ask students to think, pair, share the following questions:

1. How have the fish changed in each stage?
2. What observations did you use as evidence for putting your images in your order?

5E Strategy: Explain

Pass out name/info cards. Have students add the info card to the correct image (based on observable features and by looking for evidence in the text).

Lead class discussion on salmon life cycles. "We have explored the life cycle of a salmon. Who can explain this life cycle in their own words?" As students explain the life cycle, begin to create a draft model of the salmon life cycle on a large poster based on student responses. This is a draft model and can and should be changed to match class discussion. Be sure to help clear up any misconceptions about the sequence of events in the salmon life cycle.

TEACHER'S NOTE
Anadromous salmon and trout have very similar life cycles to land locked species with one major difference: land locked Salmonids never go through a smolt phase. Instead, they become what is called "parr". These are just bigger versions of fry, and they continue to live in freshwater streams, rivers, and lakes. They do undertake a migration to spawn, but the migration is much shorter and remains in freshwater systems. Trout species (including Steelhead) do not die after spawning, and may spawn multiple times over their lives. Salmon species die after spawning and complete their life cycle.

If you have trout in your classroom or teach in an area where trout are the dominant species be sure to include a discussion on the difference between the life cycles of anadromous fish and land locked fish.

5E Strategy: Elaborate

Ask students what would happen if something changed at one step in the life cycle:

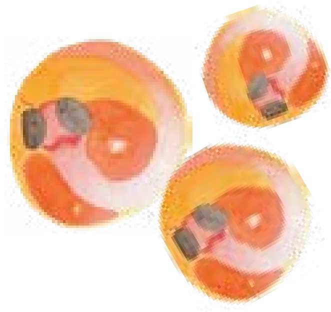
- What would happen if fewer eggs hatched?
- What would happen if something prevented adults from making it back up the river to spawn?
- What would happen if the smolt weren't able to reach the ocean?

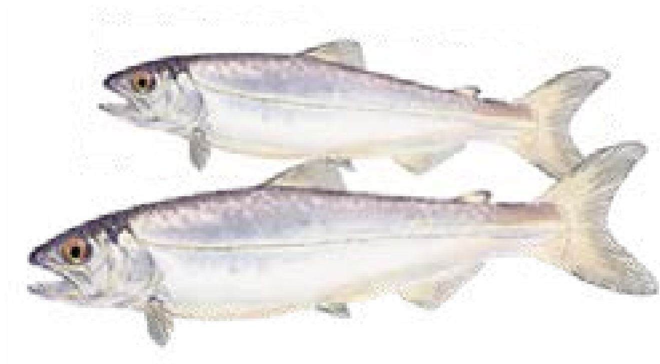
Introduce the term "anadromous". Watch short video: I Am Salmon (can end video at five minutes). Stop video frequently at each stage of the salmon life cycle. Ask students what the salmon at that stage is called and have them chart it on their own life cycle model.

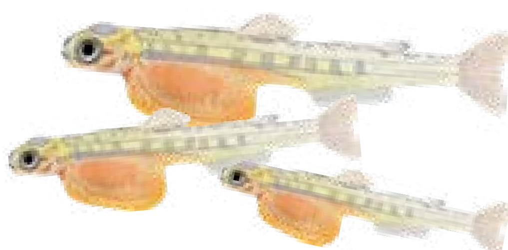
After video, allow students to construct their own individual model of a salmon life cycle in their science notebook. They may draw their own stages or glue the images from the life cycle cards.

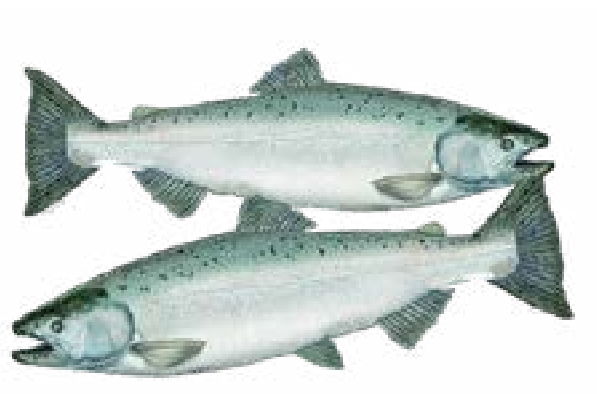
Return to questions about salmon generated in first lesson. Have any of your "want to know" questions been answered? Move answered questions to the "what we have learned" chart. Based on what students learned about the salmon life cycle, do students have any additional questions they would like to add to the questions chart?

Refer to anchoring question chart: "What is causing salmon population decline?" Has learning about the life cycle of a salmon given us any answers for our anchoring question?









Egg– I'm just a tiny round ball. I get all of my food from inside this ball. You might be able to see my black eyes!

Smolt– I'm still a little fish, but my body is changing a lot to deal with the journey from freshwater rivers to the saltwater ocean. I've lost my parr marks (vertical stripes) and am starting to look more like an adult.

Alevin– I'm starting to look like a fish, except I have a big egg sac that I carry around for food. I spend my time hiding in the gravel where I hatched.

Adult– I live in the ocean, and have grown really big from all the great food available. I don't have any fancy colors, but silver helps me blend into the water and helps keep me safe from predators.

Fry– I'm a baby fish! Look for my parr marks (vertical stripes) on my side. Now I have to find my own food, because I have eaten my entire egg sac. I live in the stream where I hatched, and spend a lot of time hiding from predators!

Spawner– I have been living in the ocean for years, but now it is time to find my way back to the stream I was born in. I have changed a lot, in order to move from saltwater to freshwater, and to attract a mate. I have stopped eating and am putting all of my energy in my amazing journey!

LESSON 3: Finding Patterns in Life Cycles

Overview

This lesson bundle focuses on the decline of salmon populations, and this focus can be disheartening for students. This lesson offers an opportunity to introduce an example of a successful intervention where people identified the problem causing bald eagle populations to decline, and by making changes, were able to bring those populations back from the brink of extinction. Avian Report offers additional information on the timeline of bald eagle population decline and recovery.

Standards

3-LS1-1 PE: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Modeling- Develop models to describe phenomena.	3-LS1.B Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	Patterns: Patterns of change can be used to make predictions.

<u>This lesson supports student learning in elements of the following:</u>

Environmental Sustainability Education Standards:

<u>Standard 1</u>: Ecological, Social, and Economic Systems. Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.

<u>CCSS.MATH.CONTENT.3.MD.B.3</u>

Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent five pets.

<u>CCSS.ELA-LITERACY.RI.3.3</u>

Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Learning Performance

5E Strategy: Explain

Students will develop models of the life cycles of animals and plants from Washington and will identify relevant components of a life cycle: birth, growth, reproduction, and death. Students will describe relationships between components and identify causal direction of the cycle.

LESSON 3: Finding Patterns in Life Cycles (Continued)

Materials

Whole Class

- Organism life cycle sequencing photos
- Chart Paper

Individual

- Science notebook
- Life cycle model comparison worksheet
- Sticky notes

TEACHER'S NOTE

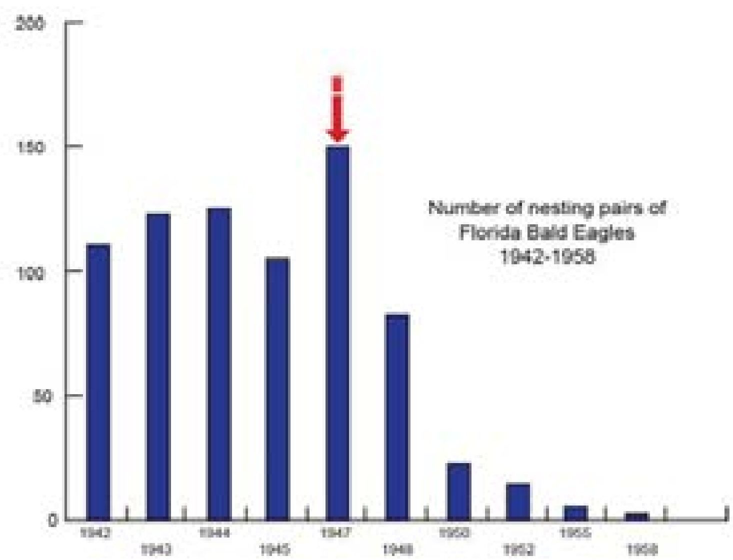
At this point in the lesson, we want students to see in the graph that something changed, but we don't want to tell them what. They will engage in sense-making around the change in bald eagle population through the lesson identifying patterns in life cycles, and through reading the article later in the lesson.

PART 1: Bald Eagles- an Interrupted Life Cycle

1. Set up lesson: "Today we are going to look even deeper at life cycles and find out what happens when something changes in the environment that impacts that life cycle. We are going to start by taking a closer look at some plants and animals that salmon interact with in their environment, then we are going to search for patterns that emerge when we compare their different life cycles. The first animals we are going to learn about are bald eagles."

2. Show video clip of bald eagles hunting salmon (one-minute video. May mute video and set on loop to encourage discussion.) "How do you think bald eagles and salmon are connected?"

3. Show graph of bald eagle populations. (also found as slide 3 in PowerPoint) Walk students through interpreting the graph, emphasizing the trend change that occurs after 1947.



5E Strategy: Elaborate

4. Pass out organism life cycle sequencing photos of bald eagles. Have students work in pairs or in small groups to place their life cycle cards in order based on what they know of life cycles from prior lesson. (*formative assessment*)

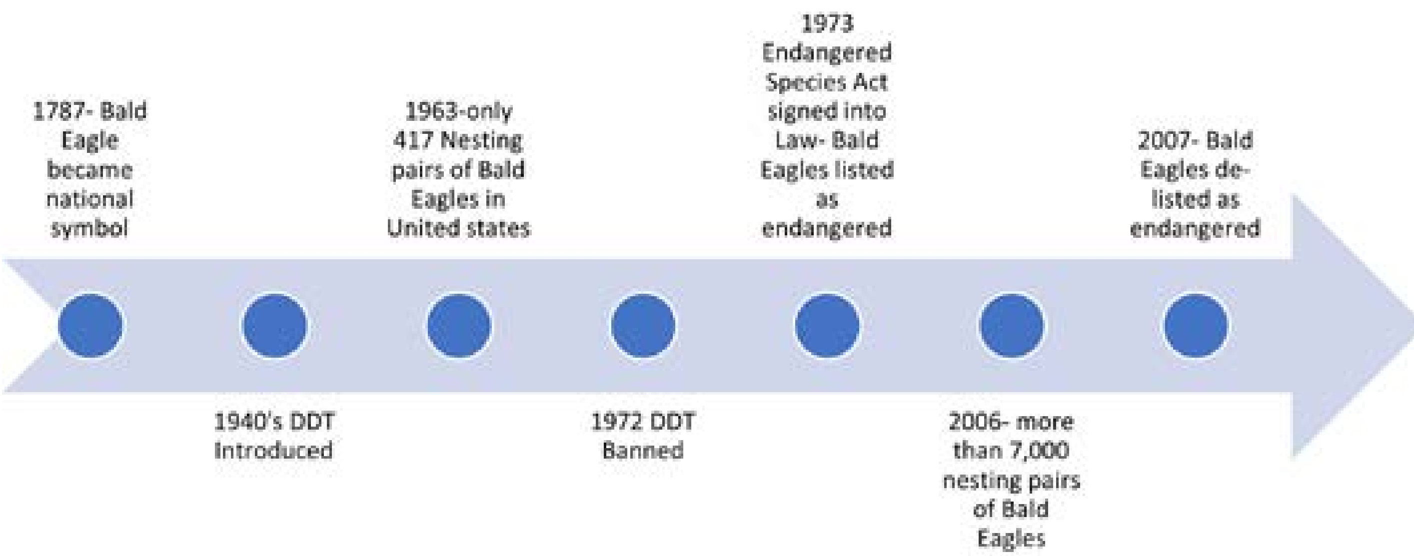
5. Return to phenomena and explain that scientists figured something out. A new variable in the system: DDT. DDT is a pesticide that became widely used in the US around 1947. DDT was used by the U.S. government to try and control diseases carried by insects and to protect crops like cotton and soybeans from insect damage. DDT was really effective, but it carried an unintended consequence for birds like bald eagles.

LESSON 3: Finding Patterns in Life Cycles (Continued)

6. Introduction of DDT into the ecosystem caused malformation of eggs- eggshells were too thin leading to breakage. Lead students in discussion of what would happen to the population of bald eagles if the eggs couldn't hatch. Have students predict how the malformation of the bald eagle eggs would affect the next stages of the life cycle.

7. Pass out student reading "Back From the Brink". Have students read through the article either alone or as a pair reading.

8. As a class, construct a timeline of bald eagles. Have students pick out key dates from the reading to help construct the timeline. See timeline below for example.



9. Have students calculate how long it took from the beginning of the drastic decline in bald eagle populations to the adoption of the Endangered Species Act. Then have them calculate the time between the adoption of the Endangered Species Act, and bald eagles being delisted as endangered.

10. In the timeline, highlight the success story of bald eagle population recovery due to banning the use of DDT and the creation of the Endangered Species List. Stress that this success story is one that can inspire us and give us hope for the recovery of salmon populations in the state. We are still in the period of time when we are trying to figure out what to do about salmon population decline. We also know that even once we make changes it will take time for those changes to start allowing the salmon population to rebound. But just like in the case of bald eagles, we are certain there are things we can do as a state to help salmon recover.

TEACHER'S NOTE
Optional math extension lesson: graphing bald eagle population recovery. Have students create their own bar graph representing the bald eagle population from the data table included in the student pages below. This graphing activity could be scaffolded to meet the needs of your students by reducing the data set points and rounding the numbers of nesting pairs to make graphing easier.

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Part 2: Patterns in Life Cycles

1. Pass out organism life cycle sequencing photos for bean plants and bears. Explain that we are looking at the life cycles of two other organisms related to salmon, eagles, and the use of pesticides like DDT. Have students work in small groups or pairs to put their life cycle photos in order. Have students begin to think about what patterns they see among all the different life cycles. Can they name similar events in these life cycles? Pass out sticky notes to each design group, and have students write notes on the patterns they observe.

2. Pass out "Patterns in Lifecycles" student worksheet. Introduce the terms "birth, growth, and reproduction". After explaining the terms, have students review their notes on the events in their life cycles and add the terms to those events.

TEACHER'S NOTE
Why bean plants and bears? Soybeans have been one of the major commercial crops for a long time and would have been sprayed by DDT to control pest damage. Bears are a major predator of salmon and are a key species in the forest ecosystem salmon are a part of.

Explain that the fourth event that occurs in every living animal and plant is death. Ask students to identify when in these cycles animals or plants could die. Remember, death can happen at any point in the life cycle.

3. Return to class model of the salmon life cycle. Ask students if they observe the same events occurring in the salmon life cycle. Again, ask students at which stage in the salmon life cycle could they die. Change class model to include the labels birth, growth, reproduction, and death. Be sure to include information that shows that death could occur at any stage in a life cycle (and for salmon, it often does). Have students return to their individual salmon life cycle model and label each event.

Optional lesson extension: Scientist Spotlight: Rachel Carson

Rachel Carson was instrumental in bringing the impacts of widespread use of DDT on bird populations to the attention of the public. Her book, "Silent Spring" is credited with sparking the modern environmental movement. An exploration of Rachel and her work creates an opportunity for integrating 3rd grade Social Science and ELA standards. The following are some available resources that can be used to learn more about Rachel Carson and examine her impacts on science, bald eagles, and fish.

Video:

- PBS: Rachel Carson
- Children's Books: (Be sure to check out your local library for these titles)
  - Rachel Carson and Her Book That Changed the World, by Laurie Lawler
    - YouTube read-aloud
  - Spring into Spring: How Rachel Carson Inspired the Environmental Movement, by Stephanie Roth Sisson
    - YouTube read-aloud

Back from the Brink


Photo by Leia Althauser

After years of protection, a number of endangered animals are making a comeback.

The future looks bright for some endangered animals! Thanks to tough laws and hardworking scientists, many of these animals are doing well.

Bald eagles are making a comeback.
The bald eagle is one success story. The bird became the symbol of the United States in 1782. At that time, about 100,000 bald eagles lived in what is now the continental United States. By 1963, only 417 nesting pairs remained.

Hunting and loss of habitat contributed to the decline, or drop in number. However, the biggest threat came from DDT, a chemical used for farming. DDT made the birds' eggshells so thin that chicks couldn't survive.

Saving the Bald Eagles

In 1972, DDT was banned, or not allowed. In 1973, the Endangered Species Act was created. That law protects threatened plants and animals. Bald eagles soon gained protection under this law.

By 2006, there were more than 7,000 bald eagle nesting pairs in the lower 48 states. In August 2007, the bald eagle was officially taken off the federal list of threatened and endangered animals. However, it has continued to be protected by other laws.

"It is a good endangered species success story," spokesperson Nicholas Throckmorton of the U.S. Fish and Wildlife Service told Weekly Reader. "Caring citizens have brought our national symbol back from the brink of extinction."

Strength in Numbers

The bald eagle isn't the only species to have seen an increase in its population. Here are some other success stories.

- Grizzly bears in and around Yellowstone National Park were endangered as a result of hunting and habitat loss. By 1975, only 220 to 320 bears lived in Yellowstone. By 2007, there were more than 600.
- People used to hunt Hawaiian green sea turtles. In 1973, scientists counted only 67 nesting females. 35 years later the number of nesting females jumped to more than 400.
- Southern sea otters of California were once killed by pollution and fishermen. There were only 700 otters off the coast of California in 1938. By 2007, there were more than 2,500.

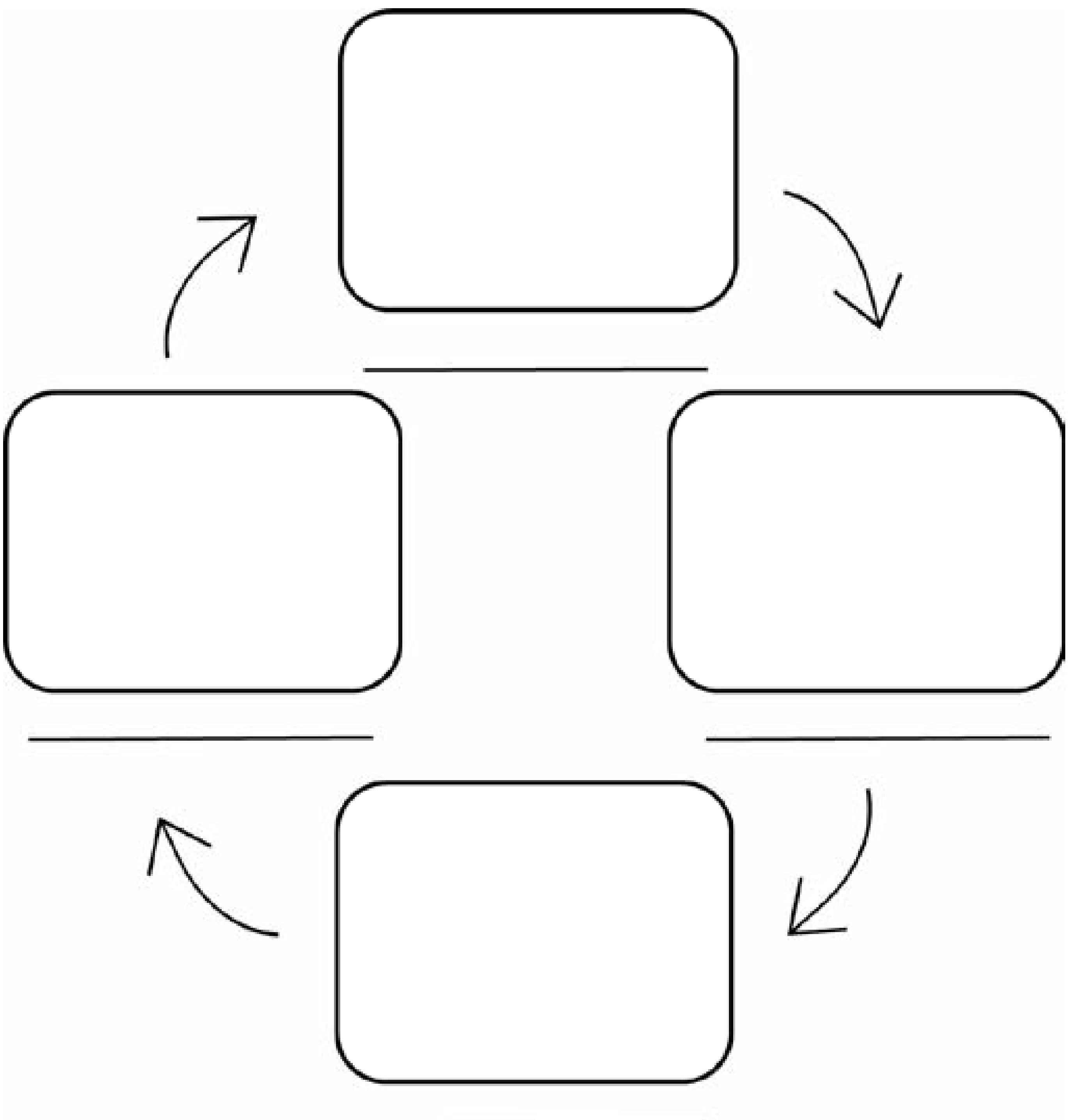
Students should create bar graph of population rebound following outlawing of DDT and placement of Bald Eagles on Endangered Species List.

Year	Number of nesting pairs in the lower 48 states
1963	487
1974	791
1981	1188
1984	1757
1986	1875
1987	2238
1988	2475
1989	2689
1990	3035
1991	3399
1992	3749
1993	4015
1994	4449
1995	4712
1996	5094
1997	5295
1998	5748
1999	6404
2000	6471
2005	7066
2006	9789
2007	11,040

Illustrations by Madeline Schill

Photo from USFWS

Patterns in Life Cycles



How to Grow Fish

3rd grade lesson bundle on Washington's salmonids

LESSON 4: Healthy Habitats

Learning Performance

For salmon, each stage of their life cycle takes place in a specific habitat and where the salmon have specific needs. In this lesson, students will research what makes a healthy habitat for salmon at these different life stages and will present their findings to their classmates. Next, they will learn about what elements make up healthy river habitat and students will examine habitat threats that fish face today. Specifically, students will look at the Merwin Dam on the Lewis River. This dam has been in the news recently as it will soon include fish passage facilities (some way of allowing fish to migrate past the dam). Students will evaluate different kinds of fish passage being considered for the Merwin Dam and will craft an argument with evidence about which solution they think will work best. Finally, students will create a model of a healthy river habitat for salmon.

Standards

3- LS4-3 PE: 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		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Arguing from Evidence-Construct an argument with evidence.	LS4.C For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Systems and Systems Models-A system can be described in terms of its components and their interactions.

3-LS4-4 PE: 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.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Arguing from Evidence-Construct an argument with evidence.	LS4.D Populations live in a variety of habitats, and change in those habitats affects the organisms living there.	Systems and Systems Models-A system can be described in terms of its components and their interactions.

This lesson supports student learning in elements of the following:
Environmental Sustainability Education Standards:

Standard 1: Ecological, Social, and Economic Systems. Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.

Standard 2: The Natural and Built Environment. Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments

Lesson 4: Healthy Habitats (Continued)

5E Strategy: Explain and Evaluate

Essential Questions:

- How do changes in salmonids' habitat needs relate to changes in their bodies throughout their life cycle?
- How do healthy river habitats allow salmonids to survive well?
- How do unhealthy river habitats keep salmonids from surviving well, or from surviving at all?
- How do dams create a problem for wild fish populations? How can solutions to this problem be evaluated?

Materials

Whole Class

- Habitat and Threat information sheets
- Habitat Needs PowerPoint
- Tin foil
- Containers (plastic bins, foil baking tray, etc.)
- Sand
- Gravel
- Stones
- Fake trees and vegetation (can be gathered in school yard or at home. Moss, lichen, sticks, twigs from plants all work well)

Individual

- Science notebook
- Chart paper
- Markers or crayons
- Habitat needs and threats presentation worksheet
- Salmonid needs and threats chart
- Fish passage evaluation worksheets

Anchoring Phenomenon

Today we are going to continue learning about salmon and explore why salmon populations are declining. We have learned a lot about the life cycles of salmon, and how they are like the life cycles of all living organisms. We have learned how salmon need to move from rivers into the ocean and back to rivers to complete their life cycle. This unique life cycle requires salmon to live in different ecosystems throughout their lives. Today we are going to dive deeper into learning about the specific habitat needs of salmonids at different stages of their lives. Ask, "Which questions do we have on our 'questions' chart that relate to habitat?"

> **TEACHER'S NOTE**
> Some of the habitat needs and threats sheets may include some vocabulary words students need help interpreting. Estuary-where fresh and saltwater mix together. Silt/sediment- small particles of dirt that are suspended or carried in the water.

Learning Performance

Salmon need healthy places to live. Students will research salmon at different stages of their life cycle to determine their unique needs, habitats, and threats.

How to Grow Fish

3rd grade lesson bundle on Washington's salmonids

Lesson 4: Healthy Habitats (Continued)

Part 1: Habitat Needs and Threats and Salmon Migration Simulation

1. Put students into 6 small groups, each representing one phase in a salmon's life cycle.

2. Pass out the habitat needs and threats information sheets for each life cycle stage to the groups (eggs to the group presenting eggs, etc.) along with a presentation worksheet. Have students work in small groups to create mini presentations with information about what the salmon in their stage of the life cycle needs, the components of a healthy habitat, and threats that salmon face. Have students present from the first-person view of fish (example: "We are eggs. We live in nests in gravel called redds. We need….").

3. After students have created and practiced their presentations (taking time to ensure each student has something to present), set up the salmon migration using cones to mark each life cycle stage. See the layout below for overview.

4. Start at the first cone and begin with the group presenting eggs and have students share their life cycle stage needs and threats with the class. Add the information students deliver to the life cycle chart.

5. After each presentation, move to the next cone. Allow students to "float" down river as fry, then actively "swim" as smolt and adult salmon. When students are at the adult cone, have them run 3-4 laps around a nearby area to represent the 3-4 years salmon spend in the ocean. (Some salmon spend up to 7 years in the ocean, but that may be too many laps!)

6. After students have spent 3-4 "years in the ocean", have them migrate back to the first cone for the presentation on spawners.

7. Students fill in information individually on their salmonid needs and threats chart.

Key questions:
1. Where do salmon live at this stage in their life cycle?
2. What do they eat?
3. What eats them and how do they avoid being eaten?
4. Do they have any special needs unique to this stage in their life cycle?
5. If something were to change in the habitat, what would happen to the fish at that stage in their life cycle?

TEACHER'S NOTE
This lesson is best done outdoors to allow students to move freely but could be modified to be used in the classroom or in a gym if the weather is not cooperating.

Lesson 4: Healthy Habitats (Continued)

Part 2: River Habitat Needs PowerPoint

Learning Performance

Students will examine how a healthy river system meets the habitat needs of salmon, and determine that changes to a healthy river system can make it so salmon are unable to live there.

TEACHER'S NOTE
This part of the lesson may be heavy on desk work. If a break from sitting is needed, a dance-along to the "I'm a Wild Salmon" song can be a fun addition!

In the previous activity, students presented information on habitat needs of salmon at different stages of their lifecycle. Now you will lead them through a presentation on what makes a healthy river habitat for all, and how that habitat is being threatened.

1. Move through slides 3-17 in the Salmon Habitat Needs PPT. Presentation includes teacher notes for leading discussion. Make sure to enable notes in PPT.

Part 3: Fish Passage Solutions Evaluation (part two adapted from Stanford NGSS Assessment Project "SNAP" planning the playground short assessment)

Teacher Background info: Lewis River Fish Passage.

Students evaluate solutions to fish passage over dams in Washington state.
Essential question: How do dams create a problem for salmonid populations? How can solutions to this problem be evaluated?

1. Read aloud to the class the article on Lewis River Dams. You can also pass out the article for students who want to read along with you. Lewis River Fish Passage

2. Return to Habitat Needs PowerPoint and move through slides 18-26.

3. Pass out copies of "fish passage solutions evaluations" tables one and two (or evaluate as a whole class under document camera).

4. Pass out advantages and disadvantages table to each student.

5. Go through the four different solutions to allowing free passage for fish migration, and help students identify the advantages and disadvantages of each solution.

TEACHER'S NOTE
To incorporate movement into the lesson you may have students engage in the four corners strategy prior to crafting their argument. This would allow students to discuss more thoroughly their claim and evidence about which fish passage solution they believe would work best.

6. Explain that students are going to spend some time crafting an argument about which solution they think will work best. Pass out the "claim and evidence" graphic organizer.

7. Have students fill out graphic organizer, then share their argument with their table group.

Lesson 4: Healthy Habitats (Continued)

Part 4: Healthy Salmon Habitat Model

Learning Performance

Students will create a model of a healthy river habitat for salmon and will identify habitats that salmon can live in, habitat changes that may cause them to survive but not thrive, and habitats in which they cannot survive at all.

Pass out prepared river models, and have students work in small groups to:

a. Add features to the river to help create a healthy salmon habitat.
b. Label their models and identify habitat features that would reach the needs of all life cycle stages.
c. Identify parts of the system and explain their interaction.

River models could be made of stream tables with materials like rocks, gravel, fake trees, and fake plants. See this river model example (this example is oversimplistic and represents an unhealthy river system). Have students begin with creating a complex river channel, then add features that help provide healthy habitat. River models could also be rivers drawn on butcher paper. If you choose to do this, have students draw and label parts of a healthy river habitat. This option could still include some 3D materials such as plants and gravel glued onto the 2D river drawing.

Allow student groups to present their river habitat model. This could be done through group presentations to the whole class, or through a river model gallery walk with student feedback given through sticky notes.

Part 5: Habitat Review and Connection to Population Decline

1. Refer to salmon questions chart. Allow students to look through previous questions and identify which questions have been answered. Move questions that were answered to the "what we have learned" section of the salmon schema chart.

2. Pose question, "By studying the habitat needs of salmon, have we uncovered any information that could help us understand what is causing salmon populations to decline?" Lead discussion about specific habitat threats that could be contributing to population decline.

Possible ESE integrated Lessons

Smell Your Way Home- lesson on finding natal streams with scent
Hooks and Ladders- lesson on challenges facing salmon on their migration

Student Habitat Pages

The following pages can be passed out to small groups to be used as a resource in their preparation of a presentation on the habitat needs and threats of salmon at different stages in their life cycles. The information on these pages was obtained from the US Fish and Wildlife Service Salmon and Steelhead Coloring Book, and Alaska Department of Fish and Game's Salmon in the Classroom Curriculum. Additional information on the stages of the lifecycle can be found in both resources.

Stage: EGGS

Details: Eggs are laid in redds, shallow nests made in gravel on the river bed. 2,000-6,000 eggs are laid at a time, depending on the species of salmon.

Time: Eggs incubate for 4-6 months, and hatch in spring. The time it takes the eggs to hatch depends on the water temperature.

Needs: Eggs get their food from the egg sac, and they get their oxygen from the water. Eggs do not like to be moved, but do need fresh water to flow over them. The eggs need cold water, high oxygen levels, and protection from predators (provided by the gravel nest)

Threats:

Changes in Habitat:

- gravel movement
- low oxygen in the water
- low water levels
- changes in water temperature
- pollution
- silt or sediment (can bury eggs and cause disease)

Predators:

- birds
- fish

Stage: ALEVIN

Details: When the fish hatch out of their eggs, they are called Alevin. The tiny fish carry a food supply (a sac of egg yolk) attached to their bellies. They will not leave the protection of the gravel until the yolk is used up.

Time: It takes up to 12 weeks for Alevin to use up their egg yolk sac. They stay in the redd (gravel nest) during this time and continue to develop their mouth and stomach.

Needs:

- food: alevin get their food from the egg yolk sack.
- fresh, flowing water
- cold water
- shade (to keep water temp cool)
- hiding spaces (under gravel)
- oxygen rich water

Threats:

Changes in Habitat:

- gravel movement
- low oxygen in the water
- low water levels
- changes in water temperature
- pollution
- silt or sediment (can bury eggs and cause disease)

Predators:

- birds
- fish

Stage: FRY

Details: Once an alevin uses up its egg yolk sac, they change into Fry. Fry look like tiny fish and start to emerge from their gravel redd. When they first come of out the gravel they have to swim up toward the surface of the water, and gulp in air to fill their air bladder. This allows them to float in the middle of the water column. Once they have done this, they start to search for food and shelter. They aren't very strong swimmers at this stage, so they drift downstream guided by gravity and stream flow until they find a small pool.

Time: The time fry spend living and growing in the freshwater depends on the type of salmon: pink salmon head straight for the ocean, while chum salmon stay in their home rivers for up to 3 years.

Needs:

- food: land and water insects and larva, plankton
- fresh, flowing water
- cold water
- shade (to keep water temp cool)
- hiding spaces (large boulders, overhanging bushes, fallen logs or tree stumps in water)
- oxygen rich water

Threats:

Changes in Habitat:

- gravel movement
- low oxygen in the water
- low water levels
- changes in water temperature
- pollution
- silt or sediment (can bury eggs and cause disease)

Predators:

- birds
- fish

Stage: SMOLT

Details: In spring, the salmon fry become restless. They turn silvery in color and lose their spots. As snow melts in the mountains and streams run faster, they begin swimming to the sea. Now they are called smolts. The transition from freshwater to saltwater is difficult, and salmon must spend time in estuaries (where freshwater rivers and saltwater meet) in order to become adapted to saltwater enough to venture into the ocean. Estuaries are rich in food, and the smolt feast!

Time: Young salmon may spend as little as a few days up to many months in the estuary getting adapted to salt water in a process called "smoltification." When they are fully adapted to saltwater the smolts will be silver colored and ready to travel to the open ocean.

Needs:

- food: insects, smaller fish, and crustaceans (like tiny shrimp) The bigger they get as a smolt the better their chances of survival in the ocean.
- flowing brackish water (mix between freshwater and saltwater)
- cold water
- hiding spaces
- oxygen rich water

Threats:

Changes in Habitat:

- pollution
- silt or sediment
- disease
- dams in the path of smolt swimming from their home stream to the estuary
- human development
- habitat loss from human activities changing estuaries for building sites

Predators: There are many predators in the estuary. While approximately 30 fry from a redd of 2,000 to 2,500 eggs grow into smolts, less than four survive to become adults.

- birds including gulls, eagles, herons, seabirds, etc.
- fish
- seals and sea lions
- snakes
- orcas

Stage: ADULT

Details: When salmon enter the ocean they are considered adult fish. They continue to grow and move up the food chain. Some salmon stay close to shore, but others will swim up to 2,000 miles into the ocean! When the time is right, they begin their long journey back to lay their eggs in the same stream where they were born.
Time: Adult salmon spend one to five years in the ocean swimming and feeding.

Needs:
- food: smaller fish, squid, and shrimp
- clean, cold oxygen rich water

Threats:
Changes in Habitat:
- disease
- temperature changes

Predators:
- fish
- seals and sea lions
- orcas
- humans

Stage: SPAWNERS

Details: In the final stage of the salmon's life cycle, the adults return to the river they hatched in and swim back to the stream or lakeshore in which they grew as fry. They follow the scent of the water from their home stream, past rapids and other obstacles, such as dams, rock slides, and log jams, before reaching their destination. When they find their home stream, the salmon then spawn. This involves the female salmon digging a shallow nest called a redd in the gravel on the bottom of the stream. Male salmon then fertilize the eggs, and the male and female work to cover the eggs with gravel. The adult salmon have accomplished their mission and then die.. Their life cycle is complete.

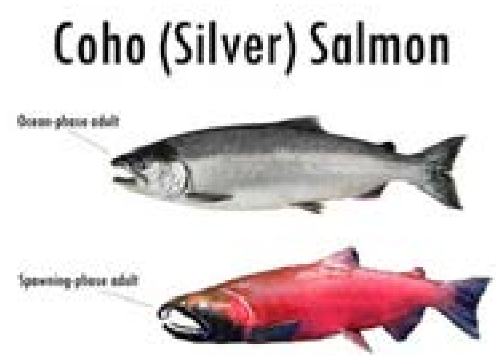
The salmon's appearance changes dramatically, with males and females developing distinct differences. Both males and females lose their silvery color and take on deep red, green, purple, brown, and grey colors. Their teeth become long and they develop a hooked jaw, which is particularly noticeable in the males. The body shape can change, with some species developing a pronounced hump on their back.

Time: Depending on where they were born, salmon may spend a few months traveling back to their home stream. Salmon from inland rivers may travel many hundreds or thousands of kilometers, swimming from 30 to 50 km (20-30 miles) a day against the current.

Needs:
- food: None. Spawning fish stop feeding when they re-enter freshwater. They must have enough fat and energy stored to allow them to make the journey back to their spawning sites, and dodge all the obstacles in their way!
- clean, cold, oxygen rich water
- passage through dams
- gravel beds at spawning grounds
- deep enough water to swim through

Threats:
Changes in Habitat:
- temperature changes
- dams
- habitat loss (loss of resting spots)
- shallow water in small streams

Predators:
- seals and sea lions
- orcas
- bears
- small mammals: otters, racoons
- birds: eagles, herons, etc.



Life Cycle Stage	Time in Stage	Needs		Threats	
		Habitat	Food	Predators	Others
Egg					
Alevin					
Fry					
Smolt					
Adult					
Spawner					

Habitat Needs and Threats Presentation Worksheet

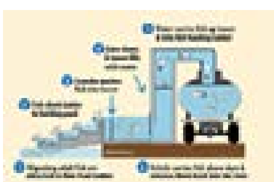
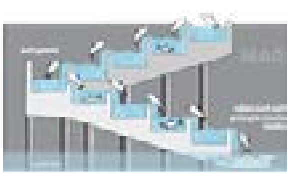
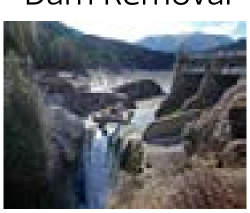
What stage in the life cycle are you?

Where do you live?

What do you need to live? (habitat needs, food)

What threats do you face? (predators, other)

Any interesting facts:

Fish Passage Solutions Details				
	Solution	**Description**	**Details**	**Cost**
1	Salmon Cannon 	A series of flexible tubes that sends fish one by one from below the dam to above.	· System is mobile. · May be stressful for fish. · Not effective at moving young fish. · Needs careful maintenance. · Ongoing costs for workers and materials.	Least Expensive
2	Trap and Haul 	A series of pools built like steps to enable fish to bypass a dam	· Effective at moving young and adult fish. · Needs a lot of humanpower, equipment, and monitoring. · May be stressful for fish. · Ongoing costs for workers and equipment.	
3	Fish Ladder 	Fish are trapped from the river, then loaded into a truck or other vehicle to transport fish above dam.	· Permanent structure built into dams. · Must have other way down dam for small fish. · Only usable by salmon. Other fish are not able to climb the "ladder". · One time cost of install.	
4	Dam Removal 	Completely taking dam out of river system	· Completely opens fish passage. · Very difficult to get permission to remove a dam. · Must find other ways of creating power, and for storing water. · One time cost.	Most Expensive

Use the information in the tables above to evaluate solutions and identify their advantages and disadvantages.

Solutions	Advantages	Disadvantages
Fish Ladders	Cheap	
Trap and Haul		
Salmon Cannon		
Dam Removal	100% effective at allowing fish to travel freely	

Solution	How Effective is Solution in Allowing Fish to Move Freely
Salmon Cannon	
Trap and Haul	
Fish Ladder	
Dam Removal	100% Effective

Complete the following graphic organizer to answer the following two questions.

What do you believe is the best solution for allowing salmonoid fish passage above and below dams?	
Claim: Answer the question.	
Evidence: Provide evidence to support your claim.	
Evaluation: How well does the solution meet the given criteria and constraints of the solution?	
Criteria: The solution allows fish to move freely above and below the dam.	Constraint: The solution does not waste money or injure other species.

LESSON 5: Healthy Systems

Standards

3- LS4-3 PE: 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		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Arguing from Evidence- Construct an argument with evidence.	LS4.C For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Systems and Systems Models-A system can be described in terms of its components and their inter-actions.

This lesson supports student learning in elements of the following:
Environmental Sustainability Education Standards:

Standard 1: Ecological, Social, and Economic Systems. Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.

CCSS.ELA-LITERACY

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

RI.3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

Learning Performance

5E Strategy: Elaborate

Students will use information from videos, texts, and activities to craft an argument that salmon are part of a healthy ecosystem, and without a healthy river ecosystem, salmon cannot survive.
Essential Questions:

- How can change in one part of an ecosystem affect other parts of the ecosystem?
- What happens to salmon if the river system changes?
- What happens to the river system if salmon disappear?
- How do plants and animals rely on each other to create a healthy system?

Anchoring Phenomenon

Today we will continue to look at causes of salmon populations to decline. Recap what students have learned in past lessons. Look at anchoring questions chart and highlight unanswered questions that relate to ecosystems' health. Explain that today we will be exploring how healthy ecosystems support salmon, and how salmon are part of healthy ecosystems.

LESSON 5: Healthy Systems (Continued)

Part 1. Video and class discussion
1. Watch Salmon: Healthy Dinner, Healthy Forests.

2. Brainstorm with students how salmon are important to healthy river systems. Example questions: How would the forest change if salmon disappeared? How would the river system change if suddenly there were more predators? What would happen to the salmon if the populations of the macroinvertebrates they eat suddenly declined?

TEACHER'S NOTE
Help students make links between the animals and plants that rely on salmon, and how salmon rely on the river system.

Part 2: Keystone Species Activity (*Adapted from an activity developed by the Vancouver Aquarium Maine Science Center, Vancouver, British Columbia*)
1. Have students identify which ecosystems salmon belong to (e.g., river, estuary, ocean).

2. Tell students that we are going to do an activity that represents how important salmon are to the river and ocean ecosystems where they live, and how salmon need healthy ecosystems to survive.

3. Have students brainstorm components of healthy ecosystems that salmon live in. Organize it by ocean or river ecosystems.

4. Divide the class into groups so all students can participate.

5. Assign students to be elements in salmon ecosystems using the name tags provided. Elements include:

sun	air	water
bear	caddisfly	stream
tree	woody debris	frog
eagle	mosquito	plankton
small fish	salmon	killer whale (orca)

6. Assign the student with the salmon tag to stand in the middle of an open area. Give the salmon a piece of string and have them name something they need to survive. Give the other end of the string to the student wearing that nametag. That student will then name something they need to survive or something that relies on their element for survival and join strings with that student (be sure students choose the elements listed above). Continue until all the students are connected in some way.

7. Once students are all connected, describe potential scenario that impacts the system, and have students predict what would happen to individual elements in the system and the system as a whole.
Possible scenarios and potential outcomes:

A. The community builds a road through the forest and over the stream. Road construction removes trees and adds silt from erosion to the stream.

- Increased sunlight from the loss of trees raises water temperature.

LESSON 5: Healthy Systems (Continued)

- Silt smothers salmon eggs and ruins spawning areas. The stream and the salmon would be impacted.

B. Pesticide application to nearby farms is over sprayed.
- Runoff into creeks and waterways kills aquatic invertebrates.
- Young salmon have no food.
- Frogs have no food.

C. Salmon are fished without regulation.
- Salmon spawners returning to river are decreased
- Decreases fertilization to trees.
- No food for upriver predators.
- Overabundance of aquatic invertebrates.
- Loss of riparian plants.

Part 3: Salmon and Sitka Trees
1. Students read handout on the connection between healthy forests and salmon runs. This is best done as a read aloud activity as there may be some unfamiliar vocabulary. Alternatively, you can also have students watch this video.

2. Have students return to their science notebooks and fill out the CER Argument graphic organizer arguing that salmon are an important species in Washington's rivers and ocean. Evidence must include two examples of how salmon benefit these ecosystems, and at least one example of how the ecosystems would suffer if salmon populations declined significantly.

Part 4: Healthy Systems and Salmon Review
1. Refer to student questions generated at beginning of unit. Have students identify questions that have been answered through the lessons on healthy systems and salmon and add that information to the "what we have learned" section of our salmon schema chart.

2. Pose question, "by studying how salmon are part of healthy ecosystems, have we uncovered any information that could help us understand what is causing salmon populations to decline?" Lead discussions about how changes in the ecosystems salmon live in can be contributing to population decline.

Keystone Species Activity Name Tags

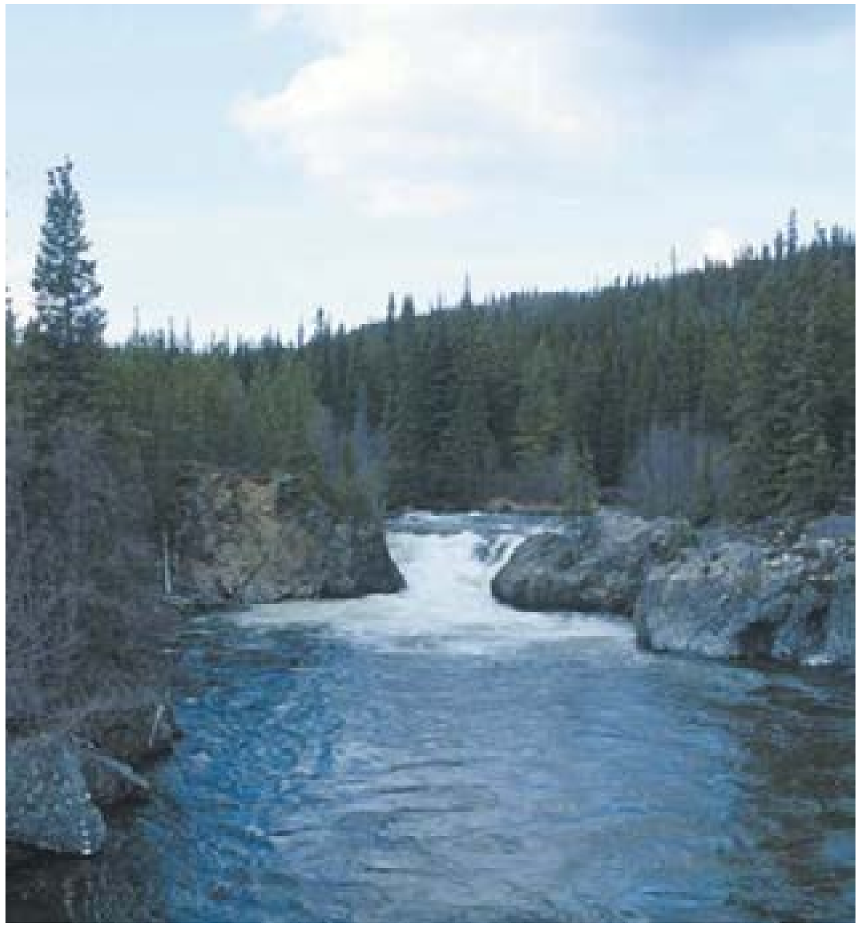
SUN	AIR	OCEAN
BEAR	CADDISFLY	RACCOON
TREE	SHRIMP	FROG
EAGLE	MOSQUITO	PLANKTON
STREAM	SALMON	KILLER WHALE

CER Argument

How are salmonids important to the ecosystems they belong to?
Claim: Answer the question.
Evidence: Provide evidence to support your claim.
Salmonid benefit to ecosystem: Salmonid benefit to ecosystem: How would ecosystem suffer if salmonids disappeared?
Reasoning: Why and how does the evidence support your claim.

Salmon and Sitka Spruce:
A Mutually Dependent Relationship

The relationship between the salmon and the forest is intriguing and complex. Many studies have been conducted to explore how the presence of spawning salmon influences the health of streams and the adjacent riparian areas. Although it is known that the marine-derived nutrients from the decaying bodies of spawned-out salmon are spread throughout the stream and sur rounding riparian areas, how much does this natural fertilizer affect tree growth along stream banks? In one case, the results were quite surprising.



Sitka spruce along an Alaskan stream

In a study done on two streams in Alaska, researchers discovered a significant difference in the growth rates between Sitka spruce trees that grow along streams where salmon spawned and trees upstream from spawning areas (Helfield and Naiman 2001). These two streams support dense runs of pink salmon and smaller runs of coho and chum salmon. The study found that spruce trees along spawning sites had a growth rate that was more than three times faster than spruce trees in upstream areas not influenced by salmon. The conclusion was that the decaying bodies of spawned- out salmon provided tremendous amounts of nutrients that contributed to the accelerated growth of the spruce trees.

The relationship between the salmon and the spruce tree is not just a one way street. The larger spruce trees have a very positive impact on the stream habitat necessary for salmon survival. Larger trees provide more shade, which helps moderate water temperatures, creating ideal conditions for salmon reproduction. The larger root systems of the spruce trees stabilize stream banks and filter sediment, reducing erosion into the stream, which increases the rate of survival of salmon embryos. Leaf litter from the trees falls into the stream, providing organic nutrients for insects that are an essential part of the juvenile salmon's diet. Stream habitat is also enhanced by fallen trees. Large woody debris in streams helps moderate flow, protecting salmon embryos and fry from being washed downstream by high winter flows. Downed trees also trap sediment, keeping spawn ing beds free of silt that can suffocate developing embryos. Again, larger trees make a difference. Due to the increased heights of the spruce trees, even trees farther away reach the stream banks when they fall.

The mutually dependent relationship between the salmon and these Sitka spruce trees has evolved over millions of years. Traditionally, fisheries management has focused on a single-species model where salmon were regarded only as a commercial resource. This model ignored the relationship between salmon and their ecosystem. The realization that salmon is the keystone species in a complex ecosystem is a fairly recent discovery. As people learn and understand more about salmon and forests, new management strategies can be developed to ensure the survival of wild salmon.

Bibliography

Helfield, J. M. and R. J. Naiman. 2001. "Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity." Ecology 82: 2403-2409.

How to Grow Fish

3rd grade lesson bundle on Washington's salmonids

LESSON 6: How To Grow Fish

In this lesson students will explore a WDFW fish hatchery through a self-guided virtual tour. They will evaluate the ways the hatchery mimics the natural life cycle of salmonids and will discuss how hatcheries provide the habitat needs of salmon. Students will also evaluate how well the hatchery mimics the natural habitats of salmon. Students will then work to begin to brainstorm ideas for how students can be involved in helping salmon populations.

For more information on hatcheries in Washington state, check out WDFW's website.

Standards

3- LS4-3 PE: 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		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Arguing from Evidence- Construct an argument with evidence.	LS4.C For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Systems and Systems Models-A system can be described in terms of its components and their inter-actions.

This lesson supports student learning in elements of the following:
Environmental Sustainability Education Standards:

Standard 1: Ecological, Social, and Economic Systems. Students develop knowledge of the interconnections and inter-dependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.

5E Strategy: Evaluate

Essential Questions:
- How are hatcheries like and unlike the wild habitats of salmon?
- Why are hatcheries used in Washington?

Materials

- Virtual tour worksheet
- Computers, either for students to work individually (or in pairs) or can walk through tour as a whole class.
- Chart paper/oversize paper
- Markers or crayons
- Design criteria page

Lesson 6: How To Grow Fish (continued)

Anchoring Phenomenon

We have learned more about the needs of salmonids throughout their lives and have discovered some of the threats facing wild salmon in the rivers. Today we are going to learn about how WDFW fish scientists use this information to run fish hatcheries. We will learn about some of the successes and challenges of hatcheries and will evaluate how hatcheries meet the habitat needs of salmonids. We will also determine what role hatcheries play in working to bring back salmon populations.

> **TEACHER'S NOTE**
> If a field trip to one of the many hatcheries in Washington is available, this lesson can be modified to support learning in the field. Check out information of fish hatcheries in your area.

1. Have students use computers (either individually, in pairs, or in small groups) to move through the virtual hatchery field trip. Students will complete field trip questions as they read texts, watch videos, and view images of the hatchery.

2. After students have had time to explore the virtual hatchery tour, allow students extra time to work independently to complete their field trip worksheet.

3. Put students in pairs for a Walk, Talk, and Decide activity. Pose the question, "We have many fish hatcheries operating in Washington but still have salmon population decline, how could schools/students help?" This is the last question on field trip worksheet.

4. Bring students back together to share out their ideas for student/school involvement.

> **TEACHER'S NOTE**
> The next part of the lesson leads students to begin thinking about how they can be involved in helping salmon. This initial brainstorming will lay foundation for the engineering design lesson that follows.

Fish Hatchery Virtual Field Trip

You're about to go on an online adventure to a Washington Department of Fish and Wildlife salmonid hatchery! As you learn and explore, make sure to use your observation skills: What do you see? Are there sounds? What do you think it would smell like?

In this virtual field trip, we are going to compare a fish hatchery to the natural environment salmonids would live in.

Life cycle stage	Fish Hatchery	Wild
Egg		
Alevin		
Smolt		
Adult (ocean)		
Spawner		

Fish Hatchery Virtual Field Trip

Why do we have hatcheries?

How does the hatchery meet the needs of fish?

How could a hatchery be more like the natural habitat salmon live in?

We have state hatcheries but still have fish population decline, how could schools/students help?

How to Grow Fish

3rd grade lesson bundle on Washington's salmonids

LESSON 7: Student Conservation Engineering

In the past lessons, students have learned all about salmon; their life cycles, what they need in a healthy habitat, and how they are a part of a healthy system. They have also been able to go on a virtual or in-person field trip to a fish hatchery. Students will now work with the problem of salmon population decline and engage in conservation efforts by designing a solution to work toward helping salmon populations recover.

Throughout these lessons students have discovered that habitat loss is one of the major causes of salmon population decline. In this lesson, students engineer a solution to one of two major problems causing habitat decline: fish passage over dams and habitat loss due to changes or blocks in rivers and streams. Alternatively, students could engineer a better hatchery; one which mimics the natural habitat salmon and salmonid fish live in.

Standards

3- LS4-3 PE: 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		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	LS4.C For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Systems and Systems Models-A system can be described in terms of its components and their interactions.

3-5 ETS 1-1 Engineering Design PE: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	People's needs and wants change over time, as do their demands for new and improved technologies.

<u>This lesson supports student learning in elements of the following:</u>
Environmental Sustainability Education Standards:

<u>Standard 3:</u> Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.

LESSON 7: Student Conservation Engineering (Continued)

Learning Performance

Students will follow the engineering process to work to help solve the problem of salmon population decline.

5E Strategy: Evaluate

Essential Questions:

- How can we help?

Materials

- Materials to create model of engineering design solution
- Post it notes
- Defining problem student sheet
- Self-evaluation rubric student sheet

1. Read letter from Director of Washington Department of Fish and Wildlife.

Introduce the conservation engineering project students will be working on. Explain, "As we have learned more about what is causing salmon populations to decline, we have identified a couple of major problems salmon face: fish passage over dams, habitat loss due to changes and blocks in rivers and streams, and the challenges of raising fish who are released in the wild. Today we will begin working on an engineering design project to try to help solve one of these major problems.

TEACHER'S NOTE
Refer to anchoring question chart with student answers to highlight student work in generating this information.

2. Introduce the engineering design process chart found below.

Over the next few days, we will be moving through the stages of the design process.

- We will start by identifying the problem we are trying to solve and will create a rubric to help guide our design process.
- We will then imagine and plan a solution by brainstorming ideas and drawing simple models of our design.
- Next, we will create a prototype (model) of our design to share with our classmates.
- To test our designs, we will do a peer share of our work to receive feedback and suggestions.
- We will revise and improve our designs.
- Finally, we will share our designs with Washington Department of Fish and Wildlife.

TEACHER'S NOTE
You may wish to print and laminate one design chart per student. Students can then move a paperclip around the chart as they move through the process.

Step 1: Define a problem

3. Have students create design teams of three to four students.

4. Walk students through the defining problem student worksheet. Allow students to choose a problem to work to solve and fill out worksheet with their design team.

LESSON 7: Student Conservation Engineering (Continued)

5. Pass out conservation engineering self-evaluation rubric. As a class, brainstorm some of the constraints and criteria for success. Identify which of these constraints and criteria the class will use in evaluating the conservation engineering designs and fill them out in the rubric.

TEACHER'S NOTE
The design rubric is open ended to allow for students to help come up with the constraints and criteria for success. This brainstorming session is particularly important as it helps reach the PE: 3-5 ETS 1-1. Possible constraints could be cost, space, using only existing technology, time, etc.

Step 2: Imagine and Plan
6. Refer to the brainstorm chart created at the end of the fish hatchery lesson. In this brainstorm session, students came up with different ideas for how they could engage in helping solve the problem of salmon population decline.

7. Give students time to work in their design groups to brainstorm ideas of how they could engineer a solution to the problem they identified.

8. Ask students to choose one idea from their brainstorm, and have students create a simple drawing (with labels) of the design plan. Make sure to have students identify the materials they will need to create their prototype (model).

TEACHER'S NOTE
Have students present their plan to you to allow you to probe their thinking and sign off on their plan.

Step 3: Create
9. Students work with student design teams to create a prototype (model) of their design. Ensure students are working to meet the project criteria.

Step 4: Test design against rubric
10. Return to the conservation engineering self-evaluation rubric. Walk students through each section of the rubric and explain how they should work with their design team to evaluate their design.

Step 5: Improve
11. Have students work with their design team to evaluate their own design against the rubric. Ask them to determine what changes, if any, they would make to their design.

12. Allow students time to work with their design team to make changes to their prototype.

Step 6: Share- Peer Review Gallery Walk
13. Have students place final design model on their desk.

14. Pass out sticky notes to each student. Explain that they are going to review each other's designs. Students are expected to write one compliment and one critique per design.

15. Allow students to move freely around the room evaluating and critiquing each other's designs.

16. During this time, take photos of students with their designs to submit to Washington Department of Fish and Wildlife. We would love to see and share what students come up with!

Dear students,

On behalf of the Washington Department of Fish and Wildlife, I want to thank you for your hard work learning about the struggles facing salmon in the Pacific Northwest. It is exciting to have you join us in solving the problems our Department works on every day!

Salmon uniquely define the Pacific Northwest experience. They have shaped our cultures. They sustain our ecosystems. They feed our souls and bodies.

Through your studies, I know you have identified some of the key problems causing salmon population decline in Washington state. I am writing to you today to ask for your help in designing a solution to one of those problems.

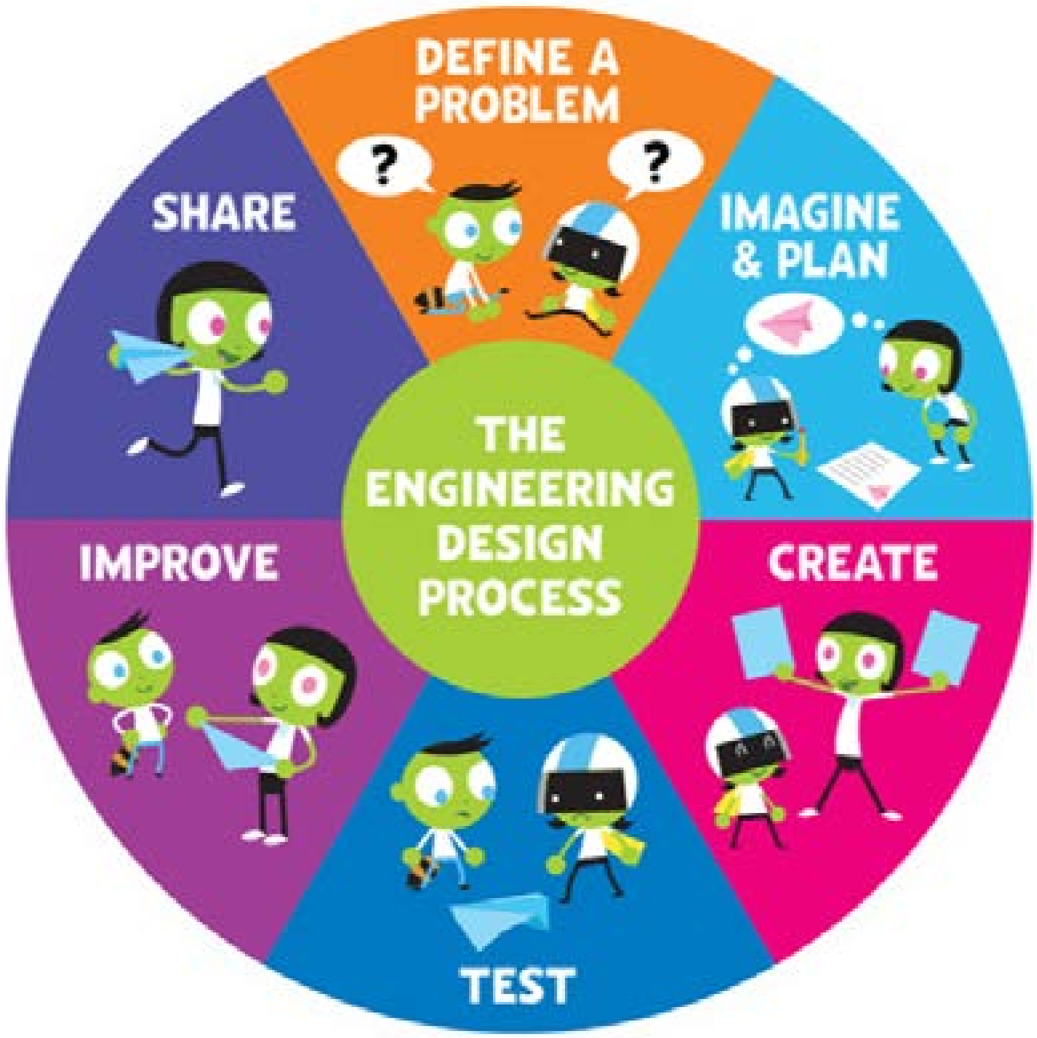
- Fish passage over dams
- Changes or blocks in rivers and streams.
- Engineer a better hatchery

We will one day all rely on the creativity of today's youth to help solve the problems of tomorrow, and we are confident that you can help us solve this problem today as well.

With gratitude,

Kelly Susewind
WDFW Director

Conservation Engineering Design Process: Defining Problem	
Part 1	
What problem do you intend to solve?	
What does the design need to do to be successful?	
What are the limitations on your design?	
What other solutions have already been tried to solve this problem?	


DEFINE A PROBLEM
IMAGINE & PLAN
CREATE
TEST
IMPROVE
SHARE
THE ENGINEERING DESIGN PROCESS

Conservation Engineering Design Self-Evaluation Rubric			
Project Criteria	Meets All Project Requirements	Meets Some Project Require-ments	Fails to Meet Project Require-ments
Project Constraints	Meets All Project Requirements	Meets Some Project Requirements	Fails to Meet Project Requirements

How to Grow Fish

3rd grade lesson bundle on Washington's salmonids

Background information:

- Why We Protect Salmon

Used In Lessons:

- Video of Salmon
- Salmon Leaping Up Stream
- I Am Salmon
- Salmon: Healthy Dinner, Healthy Forests
- Virtual Hatchery Tour
- I'm a Wild Salmon Song

Extra Resources:

Videos:

- Salmon Crosses a Road
- Winthrop Fish Hatchery Tour
- Minter Creek Hatchery
- Riparian Zone Video
- Climate Change and Salmon Video
- SalmonScape Distribution Map
- Hood Canal Steelhead Cam
- Salmon Life Stages Facts

Teaching Resources:

- Introduction to CER for Writing Arguments in Science
- River Model Example

Parts of this lesson have been modified from the following resources:

- Alaska Department of Fish and Game: Salmon lessons
- Picture Stem: Designing Hamster Habitats Lessons
- ESD 112: Environments-4th grade life science storyline
- Stanford NGSS Assessment Project "SNAP" planning the playground short assessment)
- City of Eugene Salmon and the Ecosystem Lesson Plans
- NOAA Fisheries An Incredible Journey Salmon Curriculum

Idea: Show off your students' work! Share student projects from this lesson with WDFW.
Facebook:@WashingtonFishWildlife
Instagram:@TheWDFW
Twitter:@WDFW
E-mail: communications@dfw.wa.gov
#WildWashington #WildWa

Did you teach this lesson? Give us your feedback.

Overview of Design Process

Introduce the engineering design process. Explain that engineers use this process along with science, mathematics, and creativity to understand a problem and create a solution.

- **DEFINE:** Engineers must define the problem and criteria (goals and limits).

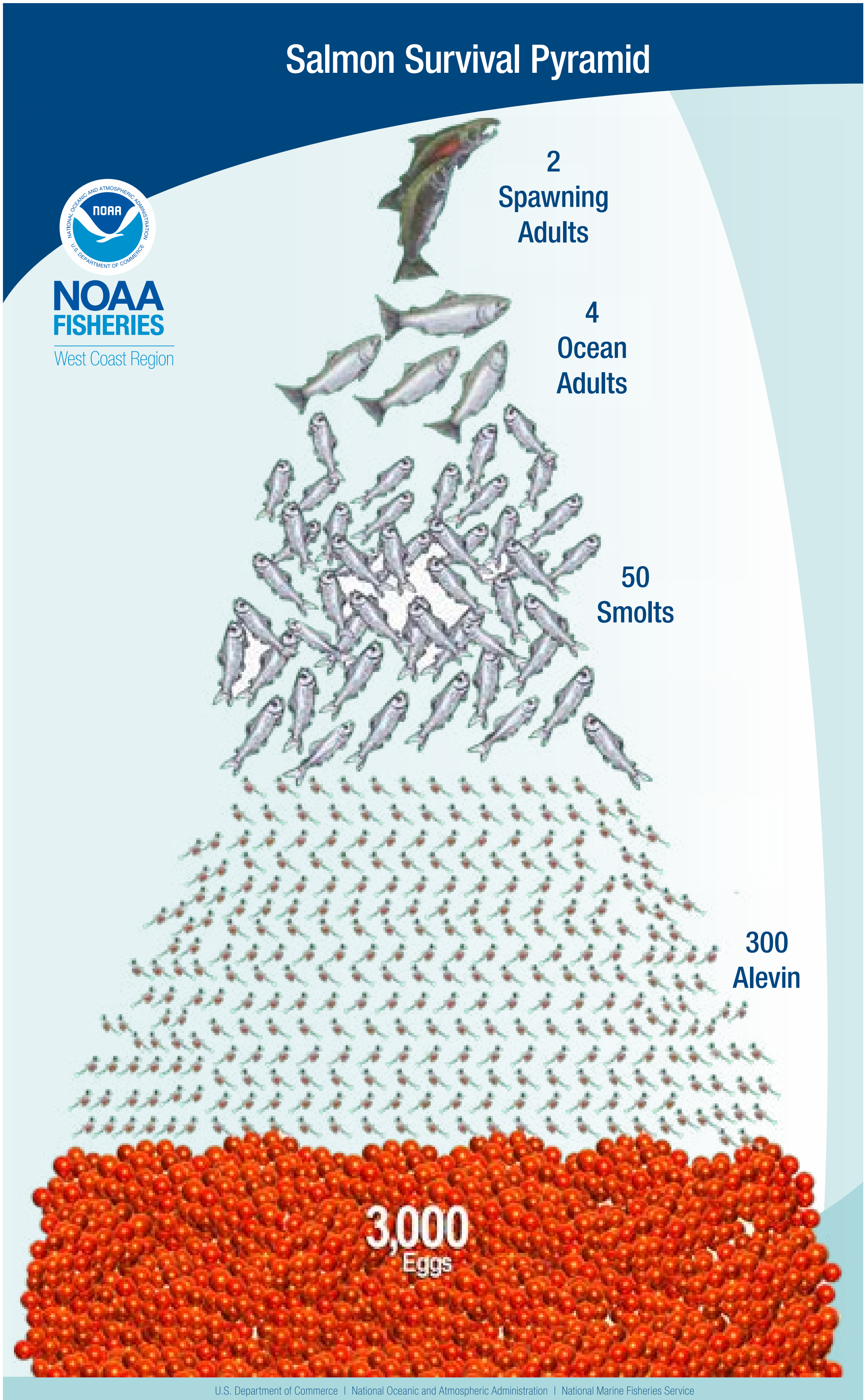
- **LEARN:** To better understand the problem engineers must learn about the science and other factors that impact how the problem can be solved. As they learn they must keep the problem and its goals and limits in mind.

- **PLAN:** Engineers brainstorm many ideas before deciding which one to try. They must make plans that clearly communicate their idea. Plans may include some of the following information in word and/or picture form: measurements, materials, colors, how things fit together and the order in which things should be done. Engineers must make sure that their plan meets the goals and limits presented in the problem as best as possible. While creating their plan engineers may find they need to go back and learn something before their plan can be finalized.

- **TRY:** Engineers use their plan to try to create a prototype of their planned solution. A prototype is a testable model used to test a design plan. Although a prototype allows the engineer to test parts of their design it is not the final solution or product. In fact, it may not even be the same size as the final design.

- **TEST:** Engineers test their plan to see if it is a good solution for the problem. Engineers must conduct fair tests and use mathematics to make sense of the data they collect.

- **DECIDE**: Engineers use the test results to make decisions about the solution. Does it solve the problem and meet the criteria (goals and limits)? Are there new things that need to be learned in order to better solve the problem? Should they try other ideas that were previously brainstormed or brainstorm new ideas to achieve a better solution?


Salmon Survival Pyramid
NOAA
FISHERIES
West Coast Region
2
Spawning
Adults
4
Ocean
Adults
50
Smolts
300
Alevin
3,000
Eggs
U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

3-5-ETS1-1 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

The performance expectation above was developed using the following elements from the NRC document *A Framework for K- 12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	**ETS1.A: Defining and Delimiting Engineering Problems** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies.

Observable features of the student performance by the end of the grade:		
1	Identifying the problem to be solved	
	a	Students use given scientific information and information about a situation or phenomenon to define a simple design problem that includes responding to a need or want.
	b	The problem students define is one that can be solved with the development of a new or improved object, tool, process, or system.
	c	Students describe* that people's needs and wants change over time.
2	Defining the boundaries of the system	
	a	Students define the limits within which the problem will be addressed, which includes addressing something people want and need at the current time.
3	Defining the criteria and constraints	
	a	Based on the situation people want to change, students specify criteria (required features) of a successful solution.
	b	Students describe* the constraints or limitations on their design, which may include:
		i. Cost.
		ii. Materials.
		iii. Time.

3-LS1-1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

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.** [Clarification Statement: Changes organisms go through during their life form a pattern.] [*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop models to describe phenomena.

- -

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns.

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.

Crosscutting Concepts

Patterns

- Patterns of change can be used to make predictions.

Observable features of the student performance by the end of the grade:			
1	Components of the model		
	a	Students develop models (e.g., conceptual, physical, drawing) to describe* the phenomenon. In their models, students identify the relevant components of their models including:	
		i.	Organisms (both plant and animal).
		ii.	Birth.
		iii.	Growth.
		iv.	Reproduction.
		v.	Death.
2	Relationships		
	a	In the models, students describe* relationships between components, including:	
		i.	Organisms are born, grow, and die in a pattern known as a life cycle.
		ii.	Different organisms' life cycles can look very different.
		iii.	A causal direction of the cycle (e.g., without birth, there is no growth; without reproduction, there are no births).
3	Connections		
	a	Students use the models to describe* that although organisms can display life cycles that look different, they all follow the same pattern.	
	b	Students use the models to make predictions related to the phenomenon, based on patterns identified among life cycles (e.g., prediction could include that if there are no births, deaths will continue and eventually there will be no more of that type of organism).	

3-LS4-3 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

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.** [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct an argument with evidence.	**LS4.C: Adaptation** • For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Observable features of the student performance by the end of the grade:			
1	Supported claims		
	a		Students make a claim to be supported about a phenomenon. In their claim, students include the idea that in a particular habitat, some organisms can survive well, some can survive less well, and some cannot survive at all.
2	Identifying scientific evidence		
	a		Students describe* the given evidence necessary for supporting the claim, including:
		i.	Characteristics of a given particular environment (e.g., soft earth, trees and shrubs, seasonal flowering plants).
		ii.	Characteristics of a particular organism (e.g., plants with long, sharp leaves; rabbit coloration).
		iii.	Needs of a particular organism (e.g., shelter from predators, food, water).
3	Evaluating and critiquing evidence		
	a		Students evaluate the evidence to determine:
		i.	The characteristics of organisms that might affect survival.
		ii.	The similarities and differences in needs among at least three types of organisms.
		iii.	How and what features of the habitat meet the needs of each of the organisms (i.e., the degree to which a habitat meets the needs of an organism).
		iv.	How and what features of the habitat do not meet the needs of each of the organisms (i.e., the degree to which a habitat does not meet the needs of an organism).
	b		Students evaluate the evidence to determine whether it is relevant to and supports the claim.
	c		Students describe* whether the given evidence is sufficient to support the claim, and whether additional evidence is needed.
4	Reasoning and synthesis		
	a		Students use reasoning to construct an argument, connecting the relevant and appropriate evidence to the claim, including describing* that any particular environment meets different organisms' needs to different degrees due to the characteristics of that environment and the needs of the organisms. Students describe* a chain of reasoning in their argument, including the following cause-and-effect relationships:
		i.	If an environment fully meets the needs of an organism, that organism can survive well within that environment.
		ii.	If an environment partially meets the needs of an organism, that organism can survive less well (e.g., lower survival rate, increased sickliness, shorter lifespan) than organisms whose needs are met within that environment.

3-LS4-4 Biological Evolution: Unity and Diversity
Students who demonstrate understanding can: **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.*** [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [*Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.*]
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.*(secondary)* **LS4.D: Biodiversity and Humans** • Populations live in a variety of habitats, and change in those habitats affects the organisms living there.	**Systems and System Models** • A system can be described in terms of its components and their interactions. - - - - - - - - - - - - - - - ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Engineering, Technology, and Science on Society and the Natural World** • Knowledge of relevant scientific concepts and research findings is important in engineering.

Observable features of the student performance by the end of the grade:			
1	Supported claims		
	a	Students make a claim about the merit of a given solution to a problem that is caused when the environment changes, which results in changes in the types of plants and animals that live there.	
2	Identifying scientific evidence		
	a	Students describe* the given evidence about how the solution meets the given criteria and constraints. This evidence includes:	
		i.	A system of plants, animals, and a given environment within which they live before the given environmental change occurs.
		ii.	A given change in the environment.
		iii.	How the change in the given environment causes a problem for the existing plants and animals living within that area.
		iv.	The effect of the solution on the plants and animals within the environment.
		v.	The resulting changes to plants and animals living within that changed environment, after the solution has been implemented.
3	Evaluating and critiquing evidence		
	a	Students evaluate the solution to the problem to determine the merit of the solution. Students describe* how well the proposed solution meets the given criteria and constraints to reduce the impact of the problem created by the environmental change in the system, including:	
		i.	How well the proposed solution meets the given criteria and constraints to reduce the impact of the problem created by the environmental change in the system, including:
			1. How the solution makes changes to one part (e.g., a feature of the environment) of the system, affecting the other parts of the system (e.g., plants and animals).
			2. How the solution affects plants and animals.
	b	Students evaluate the evidence to determine whether it is relevant to and supports the claim.	
	c	Students describe* whether the given evidence is sufficient to support the claim, and whether additional evidence is needed.	