



Credit: Allison Shelley/EDUimages

Activity 3: Ripple Effects

During a graphics-heavy slide show, students learn about the ripple effects of various plant and animal extinctions around the world. Afterward, a jigsaw activity guides students through the potential cultural, economic, and environmental effects of Southern Resident decline and extinction.

Key Student Questions

- Does it matter if one single species goes extinct?
- How can the extinction of a species cause ripple effects throughout cultures, economies, and ecosystems?
- How are the Southern Residents an integral part of cultures, economies, and ecosystems?

Key National Standards

NGSS

- [LS2.A](#): Interdependent Relationships in Ecosystems
- [LS2.C](#): Ecosystem Dynamics, Functioning, and Resilience
- [LS4.D](#): Biodiversity and Humans
- [ESS3.C](#): Human Impacts on Earth Systems

CCSS

- CCSS.ELA-LITERACY.RI.[6.7](#)
- CCSS.ELA-LITERACY.W.[6.2.B](#); CCSS.ELA-LITERACY.W.[6.2.B](#), [7.2B](#), [8.2B](#)
- CCSS.ELA-LITERACY.RST.[6-8.2](#)

Keywords

Culture—The behaviors, beliefs, arts, and products (things) of a community or group of people.

Economy—The system of production, distribution, and consumption of goods and services.

Ecosystem—A community of organisms (plant, animal, and other living organisms) and the abiotic parts of their environment.

Environment—The physical surroundings in which we live, including living (biotic) and nonliving (abiotic) factors.

Ripple effect—A situation in which one event causes a series of other events to happen.

Supporting Vocabulary

Apex predator—A predator that, as an adult, has no natural predators in its ecosystem.

Indicator species—A species whose presence, absence, or relative well-being in a given environment is a sign of the overall health of its ecosystem.

Secondary extinction—Once one species goes extinct it may cause other extinctions.

Systems—A collection of parts that have some influence on one another and the whole.

Time immemorial—Very old or ancient. From a time so long ago that it cannot be remembered.



Materials

- **Slide deck:**
Ripple Effects
Project the presentation or print the slides and speaker's notes for a jigsaw or gallery walk.
- **Handout:**
[Ripple Effects](#)
Pg 40-41
1 per student
- **Handout:**
[Southern Resident Ripples](#)
Pg 42-44
1 per student
- **Driving Question Poster**
from Activity 1

Umbrella species—Species that are selected for conservation-related decisions because the conservation and protection of these species indirectly affects the conservation and protection of other species within their ecosystem.

Preparation

1. The Introduction can be completed in several different formats, such as a presentation, gallery walk, or jigsaw. Decide how you would like the class to complete the [Ripple Effects](#) handout and set up the room accordingly.

Introduction

1. Give students a minute or two to reflect on the following question: Does it really matter if one single species goes extinct?
2. Ask students to put their thumbs up if they agree and their thumbs down if they disagree with the statement.
3. Have a few students from each side to explain their rationale.
4. Share the following excerpt with the class:

When a species becomes extinct, there are often disruptions to food webs, ecosystems, cultures, and economies. These disruptions are called ripple effects. Ripple effects can be so great that they can lead to secondary extinctions. In this activity, we will take a look at a few examples of ripple effects around the world. After this activity, we will research the ways cultures, economies, and the environment could be affected if the Southern Residents become extinct.

5. Give each student a copy of the [Ripple Effects](#) handout.

6. Instruct the class how to complete the handout (i.e., by listening to the *Ripple Effects* presentation, working in jigsaw format, or conducting a gallery walk).
7. Lead a short discussion or Think-Pair-Share exercise and have students respond to the following prompts:
 - What did you notice about the ripple effects?
 - Is it possible to predict all of the effects of a single species extinction? Why or why not?
 - Why do the extinctions of some species have bigger consequences than others?

Activity

1. Share the following excerpt:

The Southern Residents are an integral thread woven into the fabric of the environment, economy, and cultures of the Pacific Northwest. Their extinction would have major consequences for both people and the environment. Next, we will read a short passage about the ways Southern Residents are connected to cultures, economies, and ecosystems of the Pacific Northwest. We will then discuss the potential ripple effects of their extinction.

2. Give each student a copy of the [Southern Resident Ripples](#) handout. This handout can be completed individually, in pairs, or in jigsaw format. Instruct students how you would like them to complete the handout. If you would like students to complete more independent research, only give them the worksheet.
3. Give students about 20 minutes to complete the handout.

4. Call the class back together and ask for volunteers to share their responses.

Driving Question

Review the list of questions from Activity 1. Cross off any questions that were answered in today's activity. Add additional questions that may have arisen.

Discussion Questions

1. Beyond extinctions, what other actions might produce ripple effects?
2. How might people better predict or understand potential ripple effects of their actions?
3. How could some actions produce positive ripple effects?
4. How do communities benefit when we protect the Southern Residents and their habitat?
5. How could a loss of tax revenue from whale watching tourists affect communities in the Pacific Northwest?

Public Product Option

By examining the potential ripple effects of an extinction, students can practice systems thinking. [LOOPY](#) is a free, web-based application that allows students to model and visualize the components of complex systems. Have students create their own model to show how the decline and extinction of the Southern Residents can impact the wider ecosystem in addition to cultures and economies in the Pacific Northwest.

Share Your Students' Work

Help inspire Southern Resident conservation around the globe by sharing your experience with this unit. Tag photos, student work, and student quotes.

- Facebook: [@NOAAFisheriesWestCoast](#)
- Twitter: [@NOAAFish_WCRO](#)
- Instagram: [@NOAAFisheries](#)



Additional Resources



Articles

[For Coast Salish communities, the race to save southern resident orcas is personal](#)

This article describes how the plight of the Southern Resident killer whales is bringing together a coalition of state and tribal leaders, scientists, and grassroots communities.

[Salmon enhancement helps restore our economy](#)

This opinion column describes how the restoration economy works to create good jobs in local communities.

Lesson

[Why is biodiversity so important?](#)

In this TED-Ed lesson, Kim Preshoff explains the importance of biodiversity to different ecosystems.

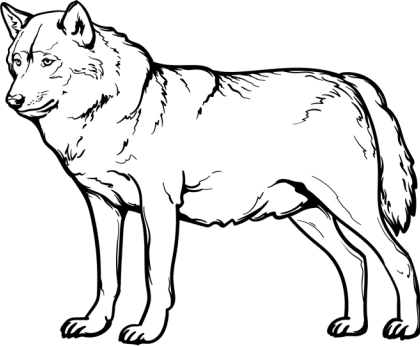

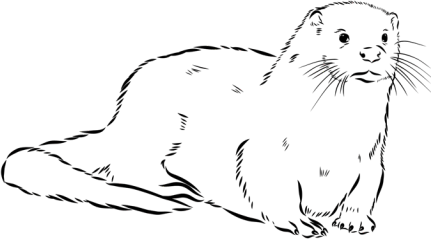
Report


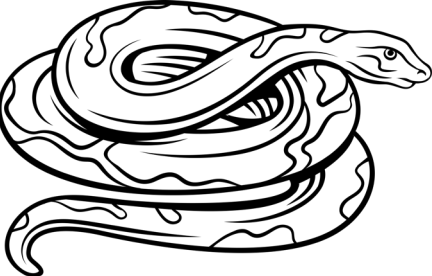
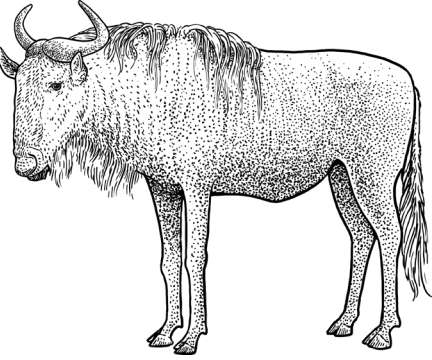
[The Economic Impact of Killer Whales in the Salish Sea](#)

This report shows the economic impact of whale watching in the Puget Sound Region.

Name: _____ Date: _____ Class: _____

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Species	Primary Problem	Ripple Effect(s)
 <p data-bbox="232 810 410 877">Grey Wolf <i>Canis lupus</i></p>		
 <p data-bbox="126 1360 516 1428">Northern Long-Eared Bat <i>Myotis septentrionalis</i></p>		
 <p data-bbox="159 1911 483 1978">Southern Sea Otter <i>Enhydra lutris nereis</i></p>		

Species	Primary Problem	Ripple Effect(s)
 <p data-bbox="196 621 444 695">Mangrove <i>Rhizophora spp.</i></p>		
 <p data-bbox="180 1171 464 1245">Brown Tree Snake <i>Boiga irregularis</i></p>		
 <p data-bbox="142 1724 500 1797">Blue Wildebeest <i>Connochaetes taurinus</i></p>		

Southern Resident Ripples - Page 1

Like us, Southern Residents are intelligent, curious, and long-lived. They also have a similar life history—they produce one offspring at a time, feed their young milk, and form tight-knit communities. These apex predators have been the focus of public interest, scientific curiosity, and awe—perhaps because they remind us of ourselves. The Southern Residents are much more than a study or news headline; they are the lifeblood of the Pacific Northwest. They are inextricably tied to the health of the region’s cultures, economies, and ecosystems.

feedings are just a few of the ways that these beloved creatures are honored.

“WE HAVE A CONTINUING SPIRITUAL CONNECTION, THAT’S WHAT THAT CEREMONY’S ABOUT, IS HONORING THAT SPIRITUAL RELATIONSHIP BETWEEN THE ORCAS AND US AS HUMAN BEINGS.”

- Reuben George, Tsleil-Waututh First Nation²⁸



In recent years, indigenous communities have been important advocates for the Southern Residents. They have called on local, state, and federal agencies to take bold actions to recover Southern Residents. Indigenous communities have lived in harmony with Southern Residents and have used their marine resources sustainably for millennia. It is important that we call upon their experience, expertise, and wisdom when developing conservation and recovery plans and actions.

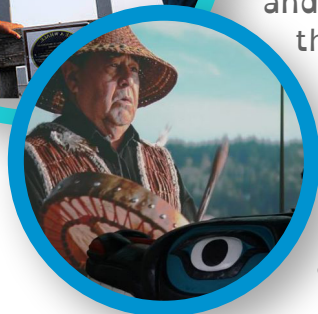
Cultural Connections

Since time immemorial, Southern Residents have been part of the cultural and spiritual fabric of indigenous communities in the Pacific Northwest. Some communities feature Southern Residents in their beliefs, stories, symbols, and art. Others consider the whales to be ancestors, protectors of humankind, and family members. The Lummi people call the orcas qwe ‘lhol mechen, which roughly translates to “our relatives that live under the water.”

“THE SOUTHERN RESIDENT KILLER WHALES ARE LIKE US: THEY DEPEND ON THESE WATERS FOR THEIR SURVIVAL, FOR THEIR WELL-BEING, FOR FOOD AND RECREATION, FOR THEIR SPIRITUALITY AS WELL. WHAT THEY NEED IS MORE SALMON, MORE CLEAN WATER, LESS VESSEL TRAFFIC. THEY’RE ASKING FOR THE SAME THINGS THAT WE’VE BEEN ASKING FOR.”

- Leonard Forsman, Chairman of Suquamish Tribe²⁹

Indigenous communities around the Pacific Northwest gather to mourn deaths, celebrate births, and empathize with the struggles of the Southern Residents. Drumming, prayers, wooden spirit boards, and ceremonial



Economic Connections

People from around the world travel to the Pacific Northwest in the hopes of seeing the J, K, and L Pods. Tourists watch the whales from shore, aboard commercial boats, and

while paddling kayaks and canoes. Beyond whale watching tours, many companies benefit from whale watching tourists, including hotels, coffee shops, restaurants, souvenir shops, and more. In Washington State whale watching activities generate approximately \$216 million in economic activity, \$12 million in tax revenue, and 1,800 jobs.³⁰

“PEOPLE AREN’T COMING HERE TO SEE HARBOR SEALS. IF THERE WERE NO MORE ORCAS, THIS ECONOMY WOULD COLLAPSE.”

- Jason Gunter, manager of Discovery Sea Kayak³¹

San Juan County, where many Southern Resident tourists visit, relies on whale watching. Whale watching supports more than 1,400 (13%) jobs in the County.³² From tour operators to restaurant staff, many people’s livelihoods could be impacted by the extinction of the Southern Residents.

Ecosystem Connections

From the smallest microorganisms to the fiercest predator—every species plays a role in its ecosystem. In a healthy ecosystem, there is a subtle dance between predators and prey. This balancing act helps maintain healthy populations of plants and animals throughout the ecosystem.

Apex predators, such as killer whales, play an important role in structuring their ecosystem. Southern Residents seek out the oldest, largest Chinook salmon. These Chinook provide more calories than smaller fish. If Southern Residents consume only



large adult Chinook, adult female killer whales would consume up to approximately 13 Chinook per day and adult male killer whales would consume up to approximately

16 Chinook per day.³³ Depending on the population size, the J, K, and L pods must catch around 300,000 Chinook salmon a year. But these numbers depend a lot on the ages of the killer whales, as well as the species, size, and calorie content of their salmon prey. If fewer large, adult Chinook are available, the killer whales will have to eat more of the smaller fish to meet their caloric requirements.

“KILLER WHALES DON’T SHOW A LOT OF INTEREST IN CHINOOK UNTIL THEY REACH A CERTAIN SIZE, AND THEN THEY FOCUS INTENSELY ON THOSE INDIVIDUALS.”

- Jan Oehlberger, research scientist at the University of Washington³⁴

Chinook populations in the Salish Sea are facing many pressures including historical overfishing, passage barriers such as dams, and changing ocean conditions due to climate change and ocean acidification. As populations of seals, seal lions, and Northern Residents have rebounded, they place additional pressures on fragile salmon populations.

With all of these stresses, large and old Chinook are becoming more rare.³⁵

The reductions in size could have a long-term effect on the number of Chinook salmon. Smaller females carry fewer eggs.

Over time the number of fish that hatch and survive to adulthood may decrease. Smaller and fewer fish means the Southern Residents will have to work extra hard to get enough to eat.

As indicator species, Southern Residents can tell us a lot about the health of their environment. Pollutants from the Southern Resident’s prey and environment become concentrated in their blubber. Some of these pollutants can cause disease or



Supporting Vocabulary

Apex predator—A predator that, as an adult, has no natural predators in its ecosystem.

Inextricably—Impossible to separate.

Indicator species—A species whose presence, absence, or relative well-being in a given environment is a sign of the overall health of its ecosystem.

Lifblood—An important part.

Time immemorial—Very old or ancient. From a time so long ago that it cannot be remembered.

Umbrella species—Species that are selected for conservation-related decisions because the conservation and protection of these species indirectly affects the conservation and protection of other species within their ecosystem.

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reproductive disorders. Pollutants are also passed from mothers to their calves. Since the Southern Residents are in trouble, it likely means the Salish Sea is in trouble, too.

Southern Residents are also considered to be an umbrella species. When we protect an umbrella species, we indirectly protect many other species that share the same habitat. Since many species are threatened or endangered, identifying umbrella species can make conservation decisions easier. It can also help species that are not as well known or popular—such as sea snails and eelgrass—gain much-needed protection.

“Orcas are canaries in the coal mine. What happens to them will affect many other species, and also affect us. By protecting orcas, we also protect our quality of life in the Northwest.”

- Stephanie Solien, vice chair of Puget Sound Partnership³⁶

Summary

We know that cultures, economies, and ecosystems of the Pacific Northwest will be greatly impacted if the Southern Residents become extinct. However, we cannot predict all of the potential ripple effects. What would a world without the Southern Residents look, feel, and sound like?

Name: _____ Date: _____ Class: _____

Culture

The behaviors, beliefs, arts, and products (things) of a community or group of people.



1. How are the Southern Residents part of human cultures?

2. How might cultures be affected by the extinction of the Southern Residents?

3. Imagine you are a member of the Lummi tribe. Ever since you were a child, you spent springtime eagerly awaiting the return of the Southern Residents. Seeing the pods for the first time each year fills your heart with happiness. You have heard your parents and grandparents tell stories about these majestic whales. Write at least two sentences to describe how you might feel if the Southern Residents become extinct.

Economy

The system of production, distribution, and consumption of goods and services.



1. How are the Southern Residents part of the economy?

2. How could economies be affected by the extinction of the Southern Residents?

3. Imagine you are a naturalist working on a whale watching boat. You have spent the last 10 years of your life helping people view marine mammals in their natural habitat and educating them about the Southern Residents. You have watched people cry tears of joy, hug one another, and cheer when they see the Southern Residents. Write at least two sentences to describe how you might feel if the Southern Residents become extinct.

Ecosystem

A community of organisms (i.e., plants, animals, and other living organisms) and the abiotic (nonliving) parts of their environment (e.g., temperature, light, water, salinity, etc.).



1. How are Southern Residents connected to their ecosystem?

2. How could the ecosystem be affected by the extinction of the Southern Residents?

3. What could the health of Southern Residents tell us about the broader ecosystem?

Summary

Write at least two sentences in response to the following statement question: Should we care that the Southern Residents are facing extinction? Why or why not?
