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Orca Conservation Utilizing Technology in the Pacific Northwest *Curriculum Resource Guide for Educators & Students*

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OVERVIEW

This resource guide was developed to supplement our WAC Global Connections Club session, "Orca Conservation Utilizing Technology in the Pacific Northwest," and is designed to support educators and students in exploring orca conservation through the lens of youth leadership, technology, and environmental stewardship, locally and globally. Centered on the critically endangered Southern Resident Killer Whales, the guide connects local ecological issues to broader themes of civic engagement, innovation, and responsibility. It aligns with environmental science, social studies, and civic learning frameworks, encouraging students to examine how individuals and communities can respond to urgent environmental challenges.

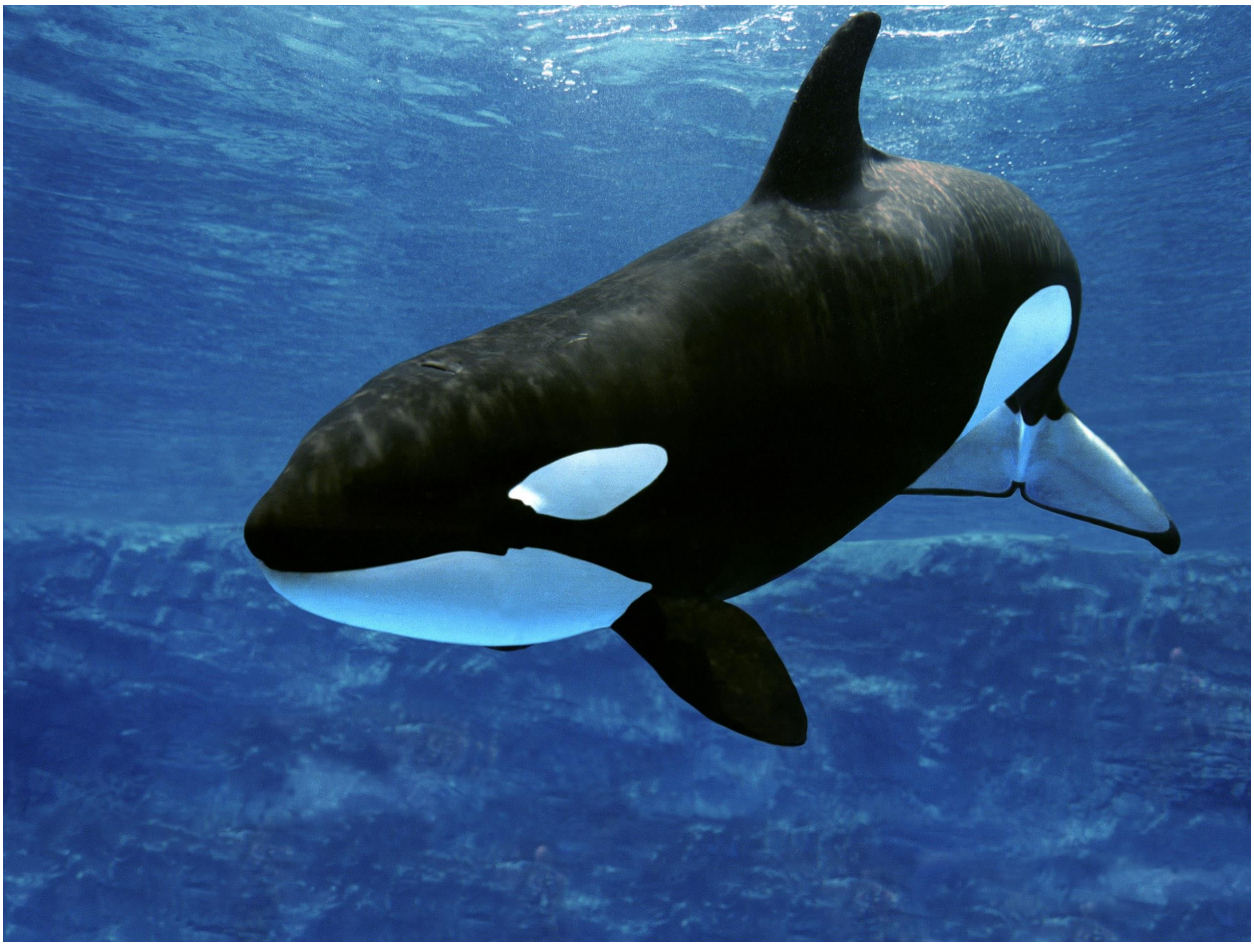
The guide introduces featured youth changemaker Arihana Shah, an 8th-grade student from Redmond, WA, documentary filmmaker, and founder of Change in Current. Through her research and documentary work, Arihana highlights the extinction crisis facing the Southern Resident orcas—now numbering only 74 individuals in the Puget Sound. Learning objectives and key terms help build foundational knowledge around orca ecology, conservation efforts, and the role of technology and storytelling in environmental advocacy.

Educators will find a curated collection of multimedia resources, including videos, research articles, and youth-led initiatives, that showcase how technology and creative media can be leveraged for conservation. The guide also explores actionable pathways for student engagement, such as community awareness campaigns, ethical fundraising, and partnerships with conservation organizations. By uplifting youth voices and emphasizing real-world impact,

this guide empowers students to see themselves as active participants in protecting their local environment.

This resource is part of Global Classroom's *For a Better World* series, which highlights youth making meaningful social, civic, and environmental contributions in their communities. We are proud to feature Arihana Shah as the first of two youth changemakers this school year and to support ongoing efforts to protect the Southern Resident Killer Whales of the Pacific Northwest.

Navigating This Resource Guide



This interactive guide is designed to move educators and students from foundational understanding to meaningful, action-oriented learning. While the sections are organized to build upon one another, each can also be explored independently to meet diverse classroom needs. Throughout the guide, hyperlinked terms, images, and resources invite deeper exploration and encourage inquiry into this critical topic.

Section 1: The Orca Ecosystem: Ecology, Culture, and Threats

Explores the biology and behavior of Southern Resident Killer Whales, their relationship with Chinook salmon, environmental threats, and their cultural significance to Coast Salish and Indigenous communities.

Section 2: Technology in Orca Conservation

Highlights how scientists and conservationists use tools such as hydrophones, drones, satellite imaging, fin identification, and data visualization to monitor and protect orca populations.

Section 3: Climate Change and Ocean Health

Examines the impacts of warming oceans, acidification, and sea level rise on salmon, orcas, and Pacific Northwest marine ecosystems, along with technologies used to track and respond to these changes.

Section 4: Environmental Stewardship and Youth Engagement

Showcases youth-led conservation efforts, citizen science platforms, classroom projects, and partnerships that empower students to take action for orca and ocean conservation.

Section 5: Indigenous Knowledge and Co-Management

Centers Traditional Ecological Knowledge *(TEK)*, Indigenous-led stewardship and policy initiatives, and ethical approaches to conservation and technology use.

Section 6: Policy, Advocacy, and Global Connections

Explores U.S.–Canada collaboration on orca protection, the role of government agencies and NGOs, and how scientific data informs environmental policy and advocacy.

Section 7: Innovation and the Future of Conservation

Introduces emerging technologies such as AI, remote sensors, and sustainable maritime solutions, and invites students to consider future pathways in conservation science.

Photography and Media Credits

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Outlining Standards

A Note on Learning Standards Presented in this Guide

Three sets of standards have been linked to each of the learning objectives in this packet. The **Washington State K-12 Social Studies Learning Standards** and the accompanying Grade Level Requirements are the social studies standards for WA State.

The College, Career,& Civic Life C3 Framework for Social Studies State Standards are the standards published by the National Council for the Social Studies. Guiding the packet as a whole is the Framework for Global Learning created by the Asia Society and the Council of Chief State School Officers titled *Educating for Global Competence: Preparing Our Youth to Engage the World (2011)*.

Cross-objective standards are listed at the beginning of the packet, and content-specific standards can be found after each learning objective. The standards provided have been selected for relevance, but are not exclusive: many other standards, such as Common Core, may be applicable to the resources and learning objectives identified in this packet. The intention for

this packet's organization is to provide educators with an idea of resources available and possible uses for resources. Users should feel free to create their own learning objectives and to select resources according to the specific needs of their classrooms.

WASHINGTON STATE K-12 SOCIAL STUDIES LEARNING STANDARDS

There are five EALRs in Social Studies, one for each of the discipline areas: civics, economics, geography, and history, and a fifth for social studies skills.

(1) Social Studies EALR 1: CIVICS

The student understands and applies knowledge of government, law, politics, and the nation's fundamental documents to make decisions about local, national, and international issues and to demonstrate thoughtful, participatory citizenship.

(2) Social Studies EALR 2: ECONOMICS

The student applies understanding of economic concepts and systems to analyze decision-making and the interactions between individuals, households, businesses, governments, and societies.

(3) Social Studies EALR 3: GEOGRAPHY

The student uses a spatial perspective to make reasoned decisions by applying the concepts of location, region, and movement and demonstrating knowledge of how geographic features and human cultures impact environments.

(4) Social Studies EALR 4: HISTORY

The student understands and applies knowledge of historical thinking, chronology, eras, turning points, major ideas, individuals, and themes on local, Washington State, tribal, United States, and world history in order to evaluate how history shapes the present and future.

(5) Social Studies EALR 5: SOCIAL STUDIES SKILLS

The student understands and applies reasoning skills to conduct research, deliberate, and form and evaluate positions through the processes of reading, writing, and communicating.

COLLEGE, CAREER, & CIVIC LIFE C3 FRAMEWORK FOR SOCIAL STUDIES STATE STANDARDS

The C3 Framework is organized into the four Dimensions, which support a robust social studies program rooted in inquiry.

The four Dimensions are as follows:

(1) Developing questions and planning inquiries;

(2) Applying disciplinary concepts and tools;

(3) Evaluating sources and using evidence;

(4) Communicating conclusions and taking informed action

DIMENSION 1: DEVELOPING QUESTIONS AND PLANNING INQUIRIES	DIMENSION 2: APPLYING DISCIPLINARY TOOLS AND CONCEPTS	DIMENSION 3: EVALUATING SOURCES AND USING EVIDENCE	DIMENSION 4: COMMUNICATING CONCLUSIONS AND TAKING INFORMED ACTION
Developing Questions and Planning Inquiries	Civics	Gathering and Evaluating Sources	Communicating and Critiquing Conclusions
	Economics		
	Geography	Developing Claims and Using Evidence	Taking Informed Action
	History		

1 - Dimension 2 has four disciplinary subsections: (1) Civics; (2) Economics; (3) Geography; (4) History. Each disciplinary subsection has three to four additional categories, which provide an organizing mechanism for the foundational content and skills within each discipline.

https://www.researchgate.net/figure/C3-Framework-Applying-Disciplinary-Tools-and-Concepts-Reprinted-from-The-College_fig2_333610103

CIVICS	ECONOMICS	GEOGRAPHY	HISTORY
Civic and Political Institutions	Economic Decision Making	Geographic Representations: Spatial Views of the World	Change, Continuity, and Context
Participation and Deliberation: Applying Civic Virtues and Democratic Principles	Exchange and Markets	Human-Environment Interaction: Place, Regions, and Culture	Perspectives
Processes, Rules, and Laws	The National Economy	Human Population: Spatial Patterns and Movements	Historical Sources and Evidence
	The Global Economy	Global Interconnections: Changing Spatial Patterns	Causation and Argumentation

2 - C3 Framework Organization

https://www.researchgate.net/figure/C3-Framework-Applying-Disciplinary-Tools-and-Concepts-Reprinted-from-The-College_fig2_333610103

EDUCATING FOR GLOBAL COMPETENCE

Frameworks taken from *Educating for Global Competence: Preparing Our Youth to Engage the World (Asia Society and the Council of Chief State School Officers 2011).*

"Global competence is the capacity and disposition to understand and act on issues of global significance." *(Chapter 2)*.

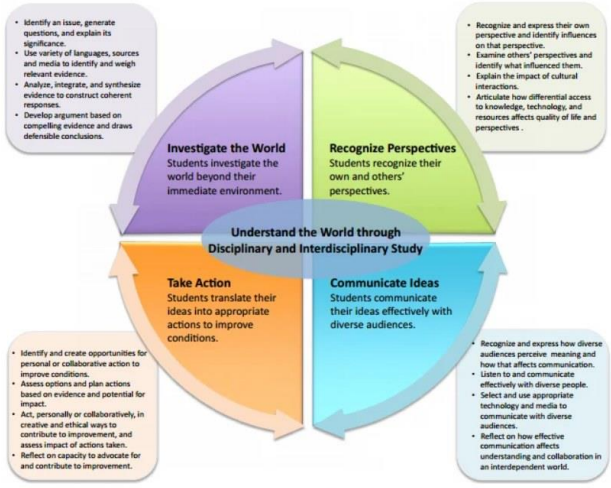
Globally competent students are able to perform the following four competences:

1. **Investigate the world** beyond their immediate environment, framing significant problems and conducting well-crafted and age-appropriate research.

2. **Recognize perspectives** others' and their own, articulating and explaining such perspectives thoughtfully and respectfully.

3. **Communicate ideas** effectively with diverse audiences, bridging geographic, linguistic, ideological, and cultural barriers.

4. **Take action** to improve conditions, viewing themselves as players in the world and participating reflectively.



Framework for Global Competence by Mansilla and Jackson (2013)

3 - https://pressbooks.pub/drrashijain/chapter/unit-1-global-competence/

Key Terms and Learning Objectives

Key Terms

- **Orca *(Killer Whale)*:** "Largest member of the dolphin family…easy to identify by its size and its striking coloration: jet black on top and pure white below with a white patch behind each eye, another extending up each flank, and a variable "saddle patch" just behind the dorsal fin."
- **Salish Sea:** "Extends from the north end of the Strait of Georgia and Desolation Sound to the south end of Puget Sound and west to the mouth of the Strait of Juan de Fuca including the inland marine waters of southern British Columbia, Canada and northern Washington, USA."
- **Ecosystem:** "The complex of living organism, their physical environment, and all their interrelationships in a particular unit of space."
- **Food Web:** "Complex network of interconnecting and overlapping food chains showing feeding relationships within a community. A food chain shows how matter and energy from food are transferred from one organism to another, whereas a food web illustrates how food chains intertwine in an ecosystem."

- **Chinook Salmon:** “Prized North Pacific food and sport fish of the family Salmonidae. It weighs up to 60 kg *(130 pounds)* and is silvery with round black spots. Spawning runs occur in spring, adults swimming as far as 3,200 km *(2,000 miles)* up the Yukon.”
- **Conservation Technology:** “Conservation technology refers to the use of technology to protect, preserve, and manage natural resources and the environment. It involves the development and application of innovative technologies to address environmental challenges such as climate change, habitat loss, and biodiversity conservation.”
- **Acoustic Monitoring:** “Monitors the travel time of sound pulses with an array of echo-sounding systems. In general, the amount of data collected is directly proportional to the product of the number of transmitters and receivers, so that much information on averaged oceanic properties can be gathered within a short period of time at relatively low cost.”
- **Drone Surveillance:** “Surveillance drones can be equipped with sophisticated imaging technology that provides the ability to obtain detailed photographs of terrain, people, homes, and even small objects. Drones regularly carry high-resolution cameras, infrared cameras, heat sensors, GPS, sensors that detect movement, and automated license plate readers.”
- **Remote Sensing:** “The process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect remotely sensed images, which help researchers ‘sense’ things about the Earth.”
- **Marine Protected Areas *(MPAs)*:** ”Discrete parcel of ocean or estuarine ecosystem that is managed according to special regulations. Marine protected areas *(MPAs)*, which are also known as marine reserves or marine sanctuaries, are—like their terrestrial counterparts, biosphere reserves—set-asides designed to balance biodiversity conservation with sustainable use by human beings.”
- **Environmental Stewardship:** "The responsibility for environmental quality shared by all those whose actions affect the environment. This sense of responsibility is a value that can be reflected through the choices of individuals, companies, communities, and government organizations, and shaped by unique environmental, social, and economic interests. It is also a behavior, one demonstrated through continuous improvement of environmental performance, and a commitment to efficient use of natural resources, protection of ecosystems, and, where applicable, ensuring a baseline of compliance with environmental requirements.”

- **Citizen Science:** “The practice of public participation and collaboration in scientific research to increase scientific knowledge. Through citizen science, people share and contribute to data monitoring and collection programs… Collaboration in citizen science involves scientists and researchers working with the public. Community-based groups may generate ideas and engage with scientists for advice, leadership, and program coordination.”
- **Climate Change Impact: “**Refer to the effects on natural and human systems resulting from observed climate change, including alterations in temperature, precipitation, and sea-level rise, which threaten ecosystems and cultures globally. These impacts are exacerbated by the sensitivity of various systems to changing climate conditions.”
- **Traditional Ecological Knowledge *(TEK)*:** "At its core, TEK is a body of knowledge developed by Indigenous peoples over centuries through direct interaction with the environment. It fosters stewardship and sustainability by promoting a harmonious relationship between humans and nature."

Learning Objectives

By engaging with this resource guide, educators and students will be able to:

1. **Explain the ecological role of Southern Resident Killer Whales** by describing their biology, behavior, dependence on Chinook salmon, and the environmental threats impacting their survival.
2. **Analyze the cultural significance of orcas** to Coast Salish and other Indigenous communities and recognize how cultural values inform conservation and stewardship practices.
3. **Evaluate the role of technology in conservation science**, including the use of hydrophones, drones, satellite imaging, fin identification, and data visualization to monitor marine ecosystems.
4. **Assess the impacts of climate change on ocean health**, particularly how warming waters, acidification, and sea level rise affect salmon populations, orcas, and Pacific Northwest ecosystems.
5. **Engage in environmental stewardship and civic action** by exploring youth-led conservation efforts, citizen science tools, and classroom projects that support real-world conservation outcomes.

6. **Understand Indigenous co-management and ethical conservation practices** by examining how Traditional Ecological Knowledge *(TEK)* and modern science work together in policy and environmental decision-making.
7. **Explore pathways for advocacy, innovation, and future careers** by connecting scientific data to policy, global cooperation, and emerging technologies shaping the future of marine conservation.

The Orca Ecosystem: Ecology, Culture, and Threats

(Lesson Plan) San Juan Nature Institute Teacher's Guide

"This chapter will provide an introduction to marine mammals found in the inland marine waters of Washington State and British Columbia, also known as the Salish Sea. Although seals, sea lions, and sea otters are worthy examples of marine mammals, you will notice that information - especially in sections III and IV - is oriented primarily towards whales, dolphins, and porpoises—the cetaceans."

(Lesson Plan) How Increased Ocean Noise Affects Whales

"Hands-on activities and a selection of videos will show students how increasing ocean noise affects whales and their ability to communicate with each other. Students will learn how whales communicate, how sound travels in waves, and how sound travels faster in water than in air. Students will also learn how the deployment and recovery of acoustic mooring devices help scientists measure ocean noise. After students take a mini-assessment, the lesson invites students to think of solutions to help the whales."

(Lesson Plan) PodSquad Activity Booklet *(ORCA UK)*

"Welcome to the Pod Squad Activity Book! This booklet is full of fun whale-themed activities that you can complete individually or with your friends, family or classmətes. After you've worked through this booklet, we hope you'll pledge to join the Pod Squad; a community of ocean loving kids, who are passionate about whales, dolphins and porpoises and the conservation of our oceans!"

Threats To Orca *(World Orca Day, 2025)*

“Unlike humans, whose primary sense is vision, orca rely on their echolocation and hearing to navigate the ocean, communicate with each other and hunt prey. In areas where there is a lot of boat traffic or military activity, particularly using sonar, their behaviour and ability to carry out normal activities is affected. In some cases, noise pollution can lead to physical injury, stranding and death. The Southern Resident orca population in the Pacific Northwest has been particularly exposed to this threat, with heavy vessel traffic from both commercial and tourist activity on their habitat’s waterways."

Species Directory: Killer Whale *(NOAA Fisheries, 2025)*

*“*Found in every ocean in the world, they are the most widely distributed of all cetaceans *(whales and dolphins)*. Scientific studies have revealed many different populations with several distinct ecotypes *(or forms)* of killer whales worldwide—some of which may be different species or subspecies. Taken as a whole, the species has the most varied diet of all cetaceans, but different populations are usually specialized in their foraging behavior and diet. They often use a coordinated hunting strategy, working as a team like a pack of wolves.”

(Video) The Southern Resident Killer Whales (*TikTok, 2024)*

"The Southern Resident Killer Whales *(SRKWs)* are exclusively salmon eaters. They pretty much eat nothing else outside of Chinook/King Salmon. But, there have been dozens of documented cases of the SRKWs engaging in “hunting” behavior with porpoises; biting, tossing, holding, and ramming is observed. But, after the porpoise passes away, the SRKWs involved simply leave. A new study looks into the possible reasonings behind this odd behavior. Lets talk about it."

Food Quality Matters for Southern Resident Whales *(University of British Columbia, February 17th, 2023)*

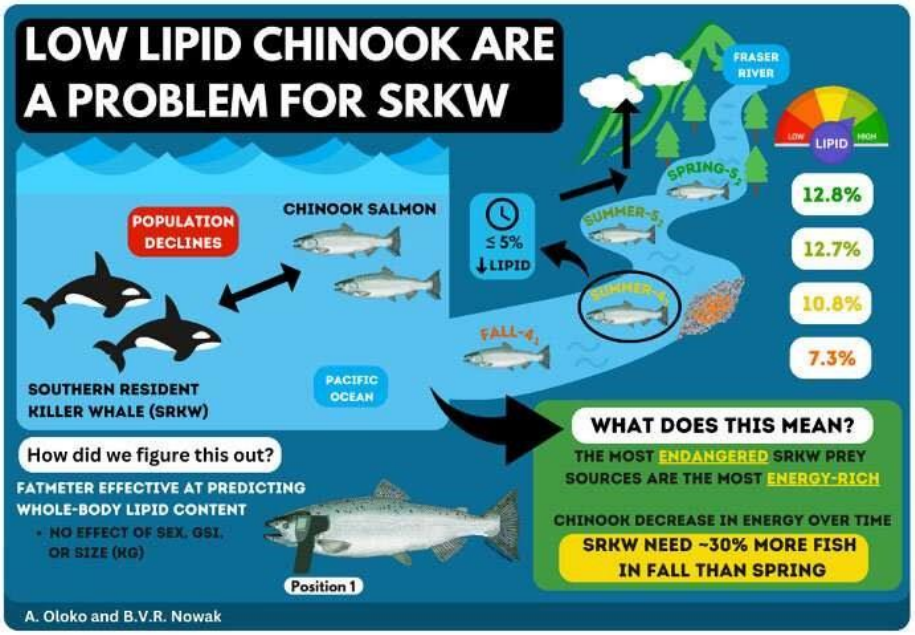
“A recent study quantified the lipid content in Fraser River Chinook salmon—the southern resident's preferred meal—and found that spring-run Chinook salmon, the earliest to arrive to the Salish Sea are lipid-rich and energy dense; a critical factor for the killer whales who prey on them. Fraser River Chinook salmon that come later in the season have lower energy density.”

(Video) Familial Connections Among the Southern Resident Orca *(YouTube, June 7th, 2021)*

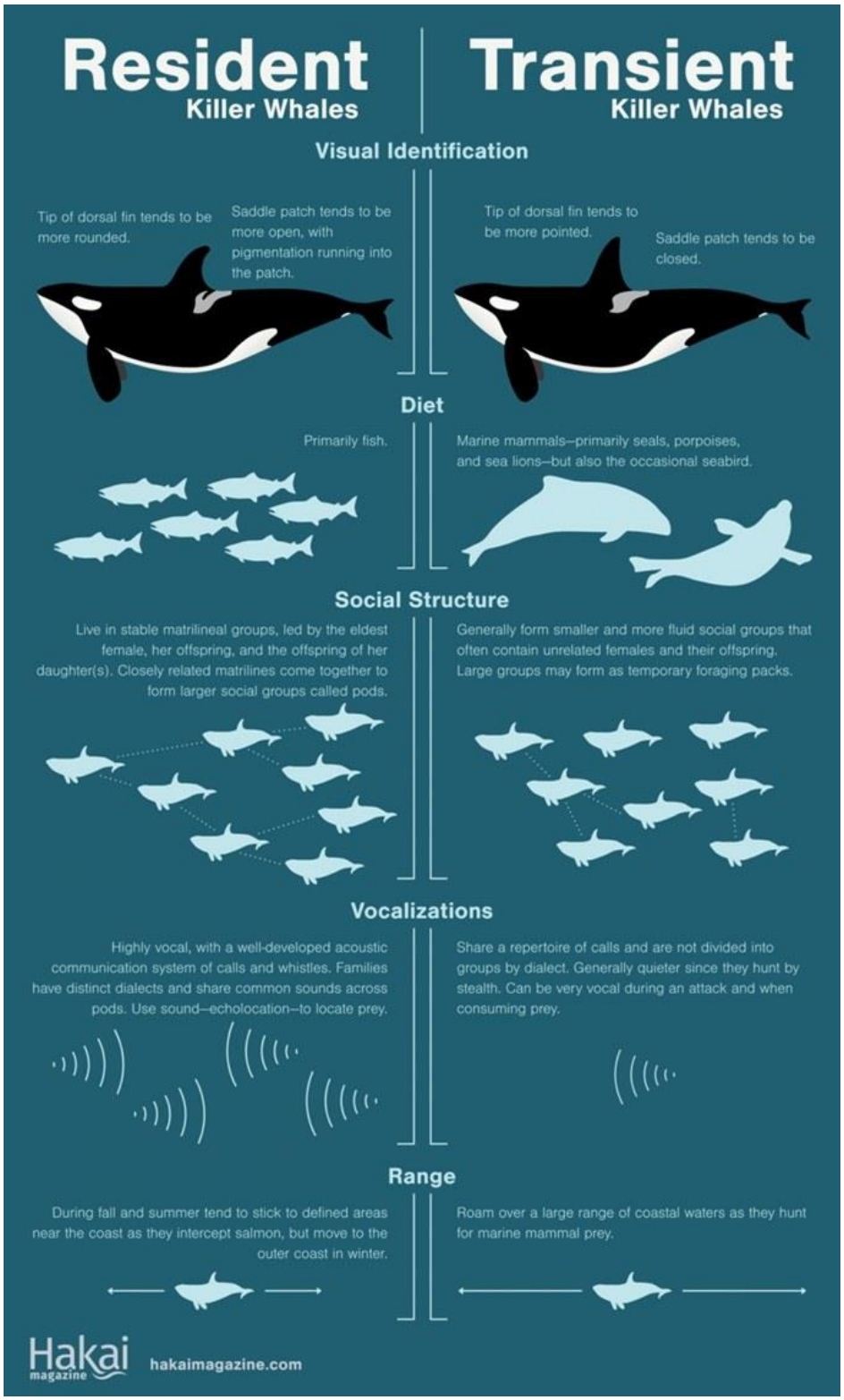
"Many animals have nests, dens, burrows, hives, or caves that serve as home bases, but for orcas, who are constantly on the move, their families are their homes. Resident orcas are especially unique in the animal kingdom in that they have no natal dispersal from their matrilineal groups, with both male and females staying with their mothers for their entire lives. These family ties form the core of Southern Resident orca society and help define how they travel, communicate, and survive. In this talk, Monika Wieland Shields of the Orca Behavior Institute will tell stories of some of the familial relationships among the Southern Residents, known thanks to the decades of research and observation from dedicated whale scientists and advocates. She will also answer your questions about what we know and don't know about the social lives of orcas, with a focus on how families define Southern Resident orca culture."

(Podcast) Pod of Orcas *(April 2021)*

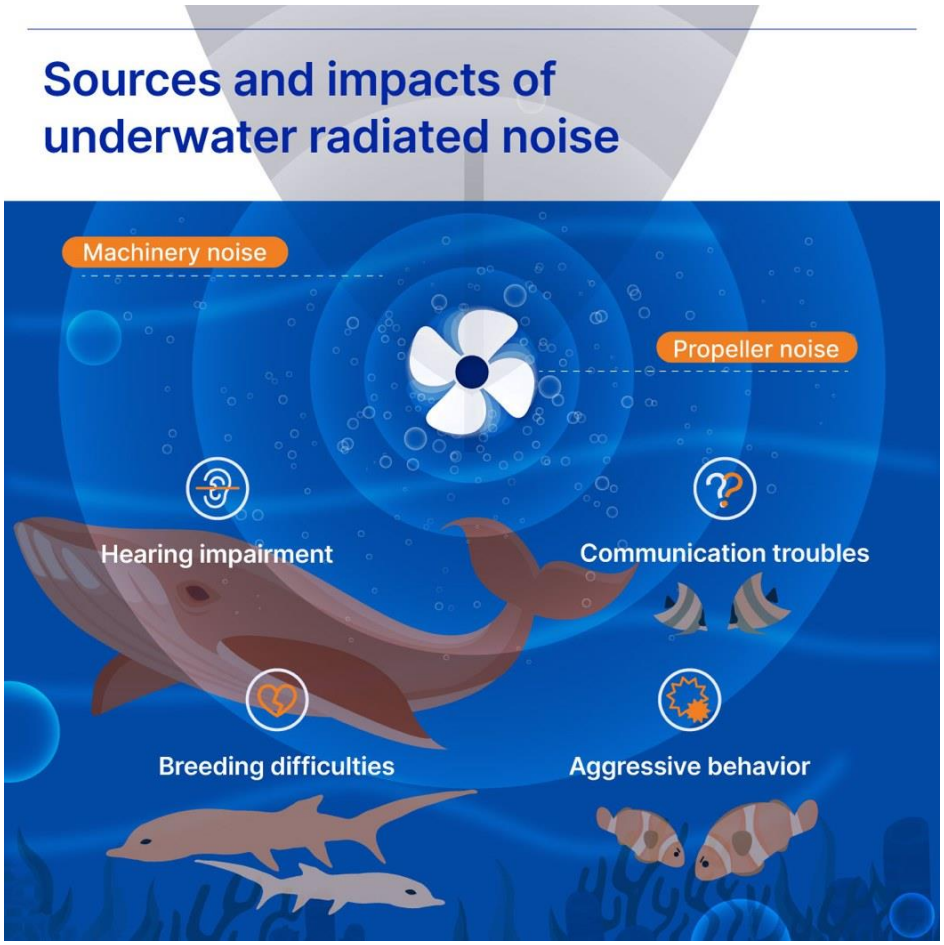
"Season One of *Pod of Orcas* is a seven-episode podcast series about Southern Resident Killer Whales. Season Two covers a wide range of issues and stories related to the Salish Sea ecosystem."



4 - https://phys.org/news/2023-02-food-quality-southern-resident-killer.html#google_vignette



5 - https://www.smithsonianmag.com/science-nature/tale-two-killer-whales-180967358/



6 - https://www.hanwha.com/newsroom/news/feature-stories/seeking-tranquil-waters-how-to-improve-marine-ecosystems-by-reducing-underwater-noise.do

Technology in Conservation Science

7 - https://www.uwb.edu/news/2025/10/15/using-light-to-hear-the-whales

(Lesson Plan) Day of Data: Orcas

"Connect with the J pod population, a close-knit family of 24 endangered Southern Resident orca whales living in the Salish Sea, and specifically Kiki—a six-year-old female who carries the fate of the pod on her shoulders. Explore data related to Kiki and her family that may lead to insights that protect her family, their ecosystem and ultimately us! Immerse your students in a fun and interactive data science project as you learn about Kiki and her family in the J pod.

Choose from two 50-minute activities that are suited for remote learning, created for teachers by teachers! Your students can swim with Kiki using HoloLens and explore data in a self-paced Excel workbook."

Drone Surveys Offer Early Warnings on Whale Health and Survival *(Mongabay, October 16th, 2025*)

"Durban and his team are deploying drones and photogrammetry to complement their existing work and determine how whale health is being impacted by climate change. They measure the size and shape of whales from high-resolution aerial photos captured by drones. Using this data, they've been able to make a link between environmental factors and the animals' health, giving them a clearer picture of how whale populations are faring and fluctuating."

Using Light to Hear the Whales *(University of Washington, October 15th, 2025)*

"The project offers a groundbreaking approach using novel technology called Distributed Acoustic Sensing that provides detailed, real-time monitoring of vast ocean areas. This technology has the potential to make a global impact by enabling the thousands of kilometers of underwater cabling currently deployed across the world. This is especially compelling for research into endangered species that are difficult to track, such as Southern Resident orcas."

Dogs and Drones: How Scientists are Saving Washington's Endangered Orcas *(The Guardian, October 2nd, 2025)*

"Through the study of whale faeces, researchers can uncover a wealth of biological insights from a single sample, including diet, hormone levels, exposure to toxins, pregnancy, gut microbiome composition and the amount of microplastics in their system, as well as the presence of parasites, bacteria and fungi."

(Interactive) Understanding Marine Artificial Intelligence *(Marine Biodiversity & Sustainability Learning Center, 2025)*

"Explore marine artificial intelligence to revolutionize conservation efforts by leveraging innovative technologies in capturing, analyzing, and interpreting oceanic data. Engage with projects that utilize AI for enhancing marine biodiversity observation by participating in citizen science initiatives and supporting organizations dedicated to ocean conservation. Recognize the importance of marine biodiversity by educating others on its vital role in sustaining ocean health, sharing insights from leading marine biologists and their firsthand experiences. Support responsible AI developments by advocating for ethical practices that ensure data transparency and protect sensitive marine ecosystems. Volunteer with networks focused on advancing AI-driven conservation methodologies, contributing to projects that seek innovative solutions for real-world environmental challenges. Participate in workshops and forums to expand your

understanding and involvement in AI applications, offering a pathway to actively contribute to preserving our oceans' future."

(Video) The Last 73 Orcas in the Pacific Northwest: Can AI Help Save Them? *(Museum of Science, 2025)*

"Can AI help save endangered orcas? The answer is yes! In the Pacific Northwest, only 73 southern resident orcas remain, threatened by ocean pollution and declining salmon populations. But scientists are turning to AI and machine learning to help protect them. Gracie Ermi, a passionate conservation technologist, writes AI-driven code to identify individual orcas from drone images, helping researchers track their health and well-being without disturbing them. Learn how technology and conservation are working together to protect these incredible animals."

Research & Whale Watching Enhanced with Artificial Intelligence to Identify Individual Orcas *(Puget Sound Institute, University of Washington, April 7th, 2025)*

"Thanks to artificial intelligence with deep learning, amateur whale watchers can now contribute to science by submitting photos of orcas to a website. From there, a computer model takes over, compares each submitted photo to images of known whales, and then "predicts" each whale's identification. The system — something like facial recognition technology used to identify people — is designed to get faster and more accurate over time."

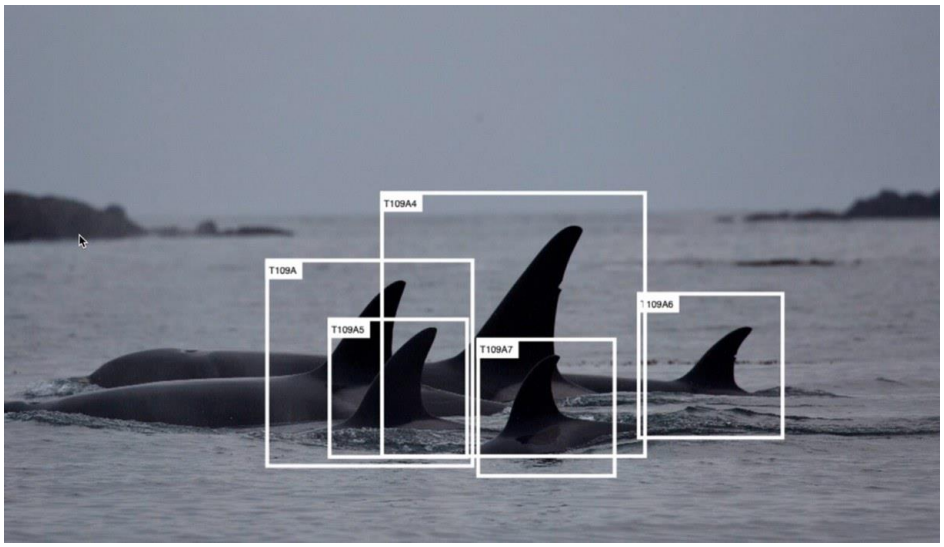
(Lesson Plan) Lesson Plan: Ocean Kings & Queens- Killer Whales & Great White Sharks *(The Digital Classroom, March 4th, 2024)*

"It may seem that the true ruler of the ocean is black and white – but not in the way you might think. While the great white shark has long been considered the apex predator, surprising new footage has revealed a solo killer whale devouring one. Such an event has never been seen before. Videos captured by tourists and scientists aboard a boat off the coast of Mossel Bay, South Africa, were crucial to scientific observations published in a new study in the *African Journal of Marine Science*. Source: BBC Science Focus."

(Podcast) SSAMN Stream Podcasts *(2021)*

"Includes archived episodes on killer whales and salmon conservation topics."

8 - https://www.uwb.edu/news/2025/10/15/using-light-to-hear-the-whales



9 - https://www.pugetsoundinstitute.org/whale-watching-now-enhanced-with-artificial-intelligence-to-identify-individual-orcas/

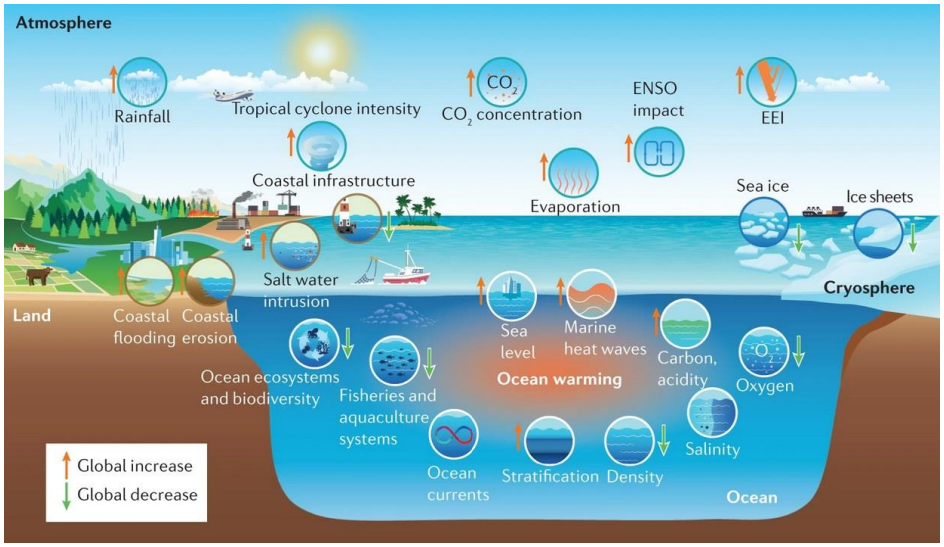
10 - https://www.theguardian.com/environment/2025/oct/02/endangered-orcas-southern-resident-killer-whales-sniffer-dogs-drones-scientists-washington

Climate Change and Ocean Health

DID YOU KNOW?

"The ocean absorbs heat about 90% of the extra heat from greenhouse gases. This warms the sea, harming the ecosystem and causing marine species to move to more excellent areas. It also affects coral reefs, leading to bleaching and death and causing oxygen levels to decline."

https://www.oceans-research.com/how-technology-monitor-ocean-health/



(Lesson Plan) Hungry Orcas, Declining Salmon, 6-8 Grade *(Washington Department of Fish and Wildlife)*

"Remote learning modification: Lesson can be taught over Zoom or Google Classrooms. You can provide students with the whale trail map and the salmon run map and encourage them to visit one of these locations with an adult. Lesson can be taught in the classroom. To make these topics more tangible, we encourage a trip to a WDFW hatchery when open. You could also plan a field trip to see a salmon run or make a stop on the whale trail to see some orcas."

4 Emerging Technologies That Are Helping Us in the Fight Against Climate Change *(Earth.org, May 2nd, 2025)*

“Blockchain is improving transparency in supply chains, particularly for sustainable and ethically sourced products. Businesses use it to track the journey of products from raw materials to end consumers, which allows them to verify that their products meet sustainability standards.”

(Podcast) Prince of Whales PODcast | Episode 6: Orca Ecotypes & Salmon Hats *(January 5th, 2025)*

"Welcome to Episode 6 of the *Prince of Whales PODcast*! In this episode, Claudia, Nik, and Brendon explore the fascinating world of orca ecotypes and the challenges they face. From the playful yet mysterious “salmon hat” behavior of resident killer whales to the critical differences between Southern and Northern Resident orcas, this episode dives deep into the interconnected lives of orcas and their essential prey: Chinook salmon. Discover how human activities, environmental changes, and historical captures have shaped the current plight of these iconic marine mammals."

6 Technologies to Help the World Adapt to Climate Change *(World Economic Forum, February 8th, 2024)*

"Drones – or unmanned aerial vehicles *(UAVs)* – are unpiloted aircraft that can be equipped with advanced cameras and cover large distances…Drones can also help in search-and-rescue situations after a climate disaster, for example by identifying affected communities in hard-to-reach areas."

King Tides Showcase Future Sea Level Rise *(Department of Ecology, State of Washington, January 23rd, 2023)*

“In Washington, sea level rise is caused by the combined effects of global sea level rise, local factors such as vertical land movement variability stemming from our region’s active tectonics and seasonal ocean elevations due to atmospheric circulation effects. Sea level rise will increase the severity of existing coastal hazards, such as shoreline and coastal bluff erosion, storm surge, flooding, and saltwater intrusion. These effects will contribute to loss of habitat, damage to homes and key infrastructure, loss of access to shoreline areas, salinity changes in streams and groundwater, threatened food security, and other social, cultural, and economic impacts.”

Whales and Climate Change: Big Risks to the Ocean’s Biggest Species *(NOAA Fisheries, June 23rd, 2022)*

“There are only 73 Southern Resident killer whales remaining. This is due to several factors including limited access to their preferred prey, Chinook salmon, and high levels of contaminants from environmental pollution. Climate change has the potential to increase these two threats. “

Orcas: Sentinels for Ocean Health *(Diver Magazine, August 10th, 2021)*

“In these areas, in these species of killer whales, we see population level consequences. We see reduced reproduction. We see increased mortality. We see increased incidences of diseases. And in putting together the collective results of these multiple lines of research, we can start to understand what chemicals such as PCBs [polychlorinated biphenyls, which were banned in 1976 but still present in the environment] or PBDEs *[polybrominated diphenylethers, a class of chemicals mainly used as flame retardants]* might be doing to animals at the top of the food chain, like the killer whale. And of course we share the environment with marine mammals. If a marine mammal is heavily contaminated with industrial chemicals, that’s starting to tell me something is amiss with our environment. It means our activities are impacting on the health of the ocean and it’s not good for the marine mammal in question, it’s not good for the environment, and it’s not good for the humans who rely on these same food webs.”

Salmon and Climate Change in Southwest Alaska *(Climate Hubs, U.S. Department of Agriculture, 2019)*

"Ocean acidification occurs when the pH of the ocean decreases *(becomes more acidic)* over an extended period. It is caused primarily by the increased amount of atmospheric carbon dioxide that dissolves into the ocean. As global greenhouse gas emissions rise, the ocean takes in more carbon dioxide, increasing the acidity of the water. Colder waters like Alaska's coastal waters tend to be more susceptible to ocean acidification."

Climate Change *(Southern Resident Orca Recovery, 2019)*

"With fewer salmon to eat, Southern Residents are hungry. As they lose weight, they process more of the metals and toxins stored in their bodies, which increases their chances of disease and neurological problems. In addition, more acidic ocean water spreads out underwater noise making it harder for orcas to find food."

Sea-Level Rise & Habitats in the Pacific Northwest *(National Wildlife Federation, July 2007)*

"Human-enhanced global warming poses a serious threat to the worlds natural systems, including those in the Pacific Northwest...This warming is disrupting the planet's entire climate system."

Environmental Stewardship and Youth Engagement

United Nations Sustainable Development Goal #14: Life Below Water

"Healthy oceans and seas are essential to our existence. They cover 70 percent of our planet and we rely on them for food, energy and water. Yet, we have managed to do tremendous damage to these precious resources. We must protect them by eliminating pollution and

overfishing and immediately start to responsibly manage and protect all marine life around the world."

(Lesson Plan) Protect Our Ocean Activity Book | BE AN OCEAN GUARDIAN *(NOAA)*

"NOAA invites you to become a member of the National Marine Sanctuary System's Ocean Guardian Kid's Club—to learn about your ocean, to understand your connection to the environment, and to take positive steps to conserve our ocean world."

Seattle Urban Green

"The SCA has been fielding Urban Green crews in Seattle since 2007. Help protect Seattle's parks, restore habitats, build trails and learn about the region's unique environmental challenges and opportunities. After working with the SCA, program participants emerge with increased environmental awareness, social responsibility and leadership skills."

Youth Conservation Corps

"YCC is an excellent resource for kids and families living in the San Juan Islands. The YCC is an opportunity for youth to not only spend time outdoors learning about local conservation and stewardship efforts, but actually improving wilderness areas and public lands across the islands. Our program is dedicated to establishing an ethic of care and stewardship among youth while also providing mentorship and professional development training from local environmental professionals."

Orca Recovery Day

"Orca Recovery Day is an intentional day of action to build awareness and make a difference for Puget Sound's local orca pod, the Southern Residents. Whether it's through habitat restoration parties, raising awareness amongst friends, or hands-on learning for the family, let's show the world that the Pacific Northwest cares about these animals."

Change in Current *(2025)*

"Our mission is to raise awareness for the critically endangered Southern Resident Killer Whales. These orcas, native to the Puget Sound region, currently number a mere 74 individuals. Our goal is to raise funds to donate to non-profits and organizations dedicated to researching this species."

(Video) Change in Current, Documentary *(2025)*

"Arihana Shah, an 8th grade student based in Redmond, WA, created this documentary to raise awareness for the critically endangered Southern Resident orcas. Arihana's documentary brings

attention to the urgent extinction crisis facing this population; now only 74 individuals remain in the Puget Sound."

(Lesson Plan) ORCA ML Workshop *(Change in Current, November 20th, 2025)*

"Hi everyone! We all know orcas are amazing, but did you know that the orcas here in the Pacific Northwest are in trouble? A big reason is that they are hard to spot and track. To help spot and track them, scientists need to know which orca they are spotting with AI."

(Podcast) The Orange Orca Podcast: Whale Science Made Simple *(2023)*

"The Orange Orca Podcast explores whale and cetacean research, making scientific studies on conservation and ecology easy to understand. Using AI-powered tools, we bridge the gap between complex science and everyday awareness, helping listeners connect with why whale conservation matters. Whales are not just majestic creatures; they play a critical role in ocean ecosystems and, ultimately, in our own survival. Through this podcast, we aim to highlight why their protection matters."

(Lesson Plan) NOAA Fisheries West Coast Region | SAVING THE SOUTHERN RESIDENT KILLER WHALES *(NOAA Fisheries, August 4, 2021)*

"News headlines about the Southern Resident killer whales are often bleak. When students are flooded with media coverage of environmental destruction, they can experience chronic anxiety. So, how can we inspire young people to become environmental stewards when they are inheriting seemingly insurmountable problems—like saving a critically-endangered marine mammal from extinction? Project-based learning *(PBL)* is one evidence-based tool that can advance student achievement and empower student-led action. Rather than passively learning, PBL empowers students to coach, facilitate, and co-learn. PBL has also demonstrated that students learn best when they experience and solve real-world problems. Southern Resident conservation and recovery are natural topics for PBL."

Indigenous Knowledge and Co-Management

DID YOU KNOW?

"For some cultures, the orca whale symbolizes harmony between people and nature, community, and family. Some Indigenous groups even believe that orcas sometimes purposefully sink canoes to try and be "closer to their loved ones," which shows how deep these spiritual ties run"

https://smea.uw.edu/currents/weaknesses-in-us-canadian-transboundary-whale-conservation/

First Nations Group Calls for Urgent Action to Save Southern Resident Killer Whales *(National Post, October 3rd, 2025)*

"To mitigate these issues and restore the community's cultural connection to the whales, the W̱SÁNEĆ killer whale program is combining traditional knowledge of the whales *(KELŁOLEMEĆEN)* with modern technology. It uses a variety of tools, including hydrophones, thermal imaging and high-resolution cameras, to detect and track whale movements and their sounds in their habitat as well as monitor marine traffic noise and pollution. The group

collaborates with various partners, including Parks Canada, to conduct this research. These efforts demonstrate the value of Indigenous science to the government, especially when making conservation decisions, says Dick."

Harnessing Indigenous Wisdom for a Thriving Planet *(Earthwise Aware, April 15th, 2025)*

"At its core, TEK is a body of knowledge developed by Indigenous peoples over centuries through direct interaction with the environment. It fosters stewardship and sustainability by promoting a harmonious relationship between humans and nature—relationships maintained from generation to generation *(Francis, 2021)*. TEK emphasizes this reciprocity between humans and nature, is informed by cultural memories, is sensitive to change, and continuously evolves *(Oregon State University)*. It is also preserved through oral tradition and cultural expressions, including arts, crafts, ceremonies, and traditional food collection, preparation, and cultivation *(Finn et al., 2017)*."

Justice and Ethics in Conservation Remote Sensing: Current Discourses and Research Needs *(Science Direct, November 2023*)

"The 'technological turn' *(Parris-Piper et al., 2023)* in biodiversity conservation raises major ethical and social justice questions. Remote sensing technologies can enable forms of conservation which also advance social justice, such as when Indigenous peoples and Local Communities *(IPLCs)* use drones to support their stewardship of highly biodiverse lands. However, new technologies can also enable socially harmful forms of surveillance — such as when drone technology is coupled with the use of Google's Facial Recognition AI to 'hunt' poachers *(Newton, 2018)*. Monitoring technologies can be used to legitimise militarised and violent interventions on the ground *(Büscher, 2016; Lunstrum and Ybarra, 2018)*, with IPLCs criminalised without due process *(Parris-Piper et al., 2023)*."

Integrating Traditional Ecological Knowledge into US Public Land Management: Knowledge Gaps and Research Priorities *(Frontiers in Ecology and Evolution, March 8th, 2023)*

"Traditional Ecological Knowledge *(TEK)* is an understanding of natural systems acquired through long-term human interactions with particular landscapes. Traditional knowledge systems complement western scientific disciplines by providing a holistic assessment of ecosystem dynamics and extending the time horizon of ecological observations. Integration of TEK into land management is a key priority of numerous groups, including the United Nations and US public land management agencies; however, TEK principles have rarely been enshrined in national-level US policy or planning. We review over 20 years of TEK literature to describe key applications of TEK to ecological understanding, conservation, restoration and land management generally. By identifying knowledge gaps, we highlight research avenues to support the integration of TEK into US public land management, in order to enhance

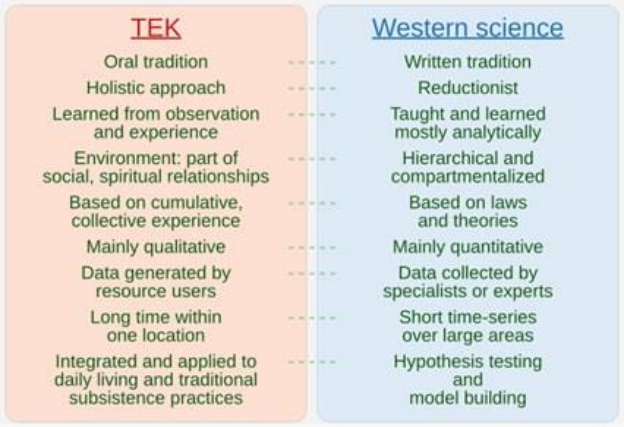
conservation approaches and participation of historically underrepresented groups, particularly American Indian Tribes, in the stewardship of ancestral lands critical to the practice of living cultural traditions."

(Video) Traditional Ecological Knowledge: Integrating Western Science into Indigenous Knowledge Processes *(Ecological Society of America, November 23rd, 2021)*

"This series organized by ESA's TEK Section facilitates a virtual space to welcome and hear from Indigenous voices who work to sustain and nurture traditional ecological knowledge in their communities. This presentation was made by Steve DeRoy from The Firelight Group."

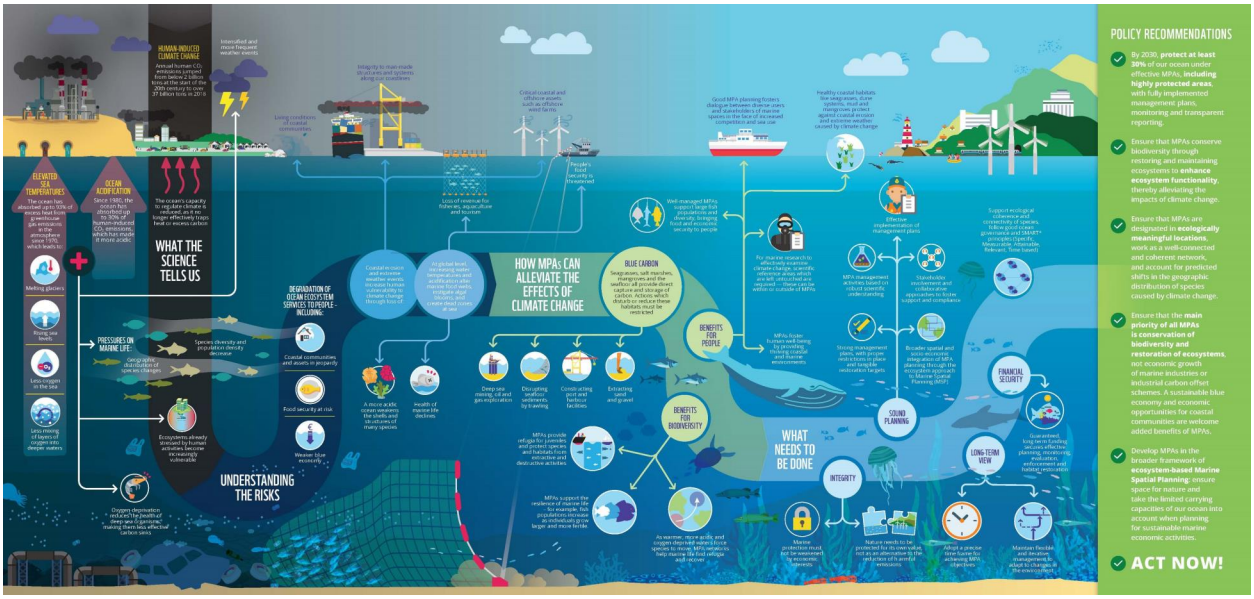
(Podcast) Whale Scout Podcast *(October 13th, 2021)*

"Learn more about Pacific Northwest whales and beyond from experts including scientists, book authors, resource managers, naturalists, and more!"



11 - https://www.earthwiseaware.org/traditional-ecological-knowledge-tek/

Policy, Advocacy, and Global Connections



[DFO Considers Further Restrictions on Recreational Fisheries to Help Southern Resident Killer Whales](#) *(British Columbia Wildlife Federation, October 14th, 2025)*

“Fisheries and Oceans Canada *(DFO)* is conducting a consultation with the Southern Resident Killer Whale Indigenous and Multi-Stakeholder Advisory Group and Technical Working Group Members on five measures intended to address imminent threats to the survival and recovery of orcas resident to the south coast of British Columbia. These incremental measures are being proposed in response to a petition made to the federal government in 2024 seeking an Emergency Order under the Species at Risk Act to protect Southern Resident Killer Whales. The government declined to make an Emergency Order, offering several alternatives to strengthen existing protections.”

Weaknesses In US/Canadian Transboundary Whale Conservation *(School of Marine and Environmental Affairs, University of Washington, February 7th, 2025)*

“Despite nearly 50 years of conservation collaboration between the United States and Canada, SRKW numbers are not increasing. It seems clear that staying the current course of issuing broad policies and intentions will likely continue to harm SRKW populations in the Salish Sea region.”

Born Free/Orca Conservation Effort *(2025)*

“OrcaLab is the world’s longest field study of wild orca and has monitored these cetaceans for more than 50 years. Born Free has funded and supported the OrcaLab team since 1994, as they work to understand the behaviour of the Northern Resident population and safeguard their future."

Leveraging Machine Learning for Environmental Policy Innovation: Advances in Data Analytics to Address Urban and Ecological Challenges *(September 2nd, 2025)*

“Machine learning, with its ability to analyze vast amounts of data, identify patterns, and generate insights, has the potential to revolutionize environmental policy development. By harnessing the power of data analytics, machine learning can offer valuable support in creating more efficient and responsive environmental policies that can adapt to dynamic urban ecosystem”

(Podcast) How To Protect The Ocean *(2023)*

"Dive into the Depths: Join Andrew Lewin on 'How to Protect the Ocean' – Your Gateway to Exclusive Ocean Insights! Explore the latest, uncharted realms of ocean science and conservation that you won't find anywhere else. Andrew takes you on an inspiring journey to uncover the hidden gems of oceanic discovery and initiatives. Tune in to discover how you can transform your life for a better ocean, one episode at a time. The How To Protect The Ocean is your resource to keep you informed on the latest ocean news; teach you how to speak up for the ocean; and, how you can take action to live for a better ocean."

(Report) NOAA / Species in the Spotlight/ Priority Actions 2021-2025 *(NOAA Fisheries, March 2021)*

"In 2015, the National Marine Fisheries Service (NOAA Fisheries) launched the Species in the Spotlight initiative to provide immediate, targeted efforts to halt declines and stabilize populations, focus resources within and outside of NOAA on the most at-risk species, guide agency actions where we have discretion to make investments, increase public awareness and support for these species, and support for these species, and expand partnerships. We have renewed the initiative for 2021–2025."

Pacific Salmon Commission *(Updated 2019)*

“On May 3, 2019, the Parties implemented a new 10-year agreement for these fisheries that is now in force through 2028. The Fraser River chapter was renewed effective January 1, 2020 through 2028.”

Innovation and Future Directions

(Podcast) Listening to Whales *(To the Best Of Our Knowledge, August 24th, 2024)*

"What can we learn from whales — and whales from us? Technology like AI is fueling new scientific breakthroughs in whale communication that can help us better understand the natural world. And, there’s an international effort to give whales a voice by granting them personhood."

How Can Technology Help in Monitoring Ocean Health *(Oceans Research, July 11th, 2024)*

“Using remote sensing, we can monitor sea surface temperature changes over time. These data can be crucial for understanding climate change's impacts on the marine ecosystem. A tiny drone can attract less attention than a submarine or a diver. It can enable scientists to study the unique species in their habitual environment without stressing them out.”

(Podcast) Planet NOAA Podcast Episode 6: Jaws *(July 2nd, 2024)*

"Janet Coit, Asst. Administrator for Fisheries, and special guests unpack how NOAA conserves and manages living marine resources, including endangered and threatened marine species."

Seeking Tranquil Waters: How to Improve Marine Ecosystems by Reducing Underwater Noise *(Hanwha, February 16th, 2024)*

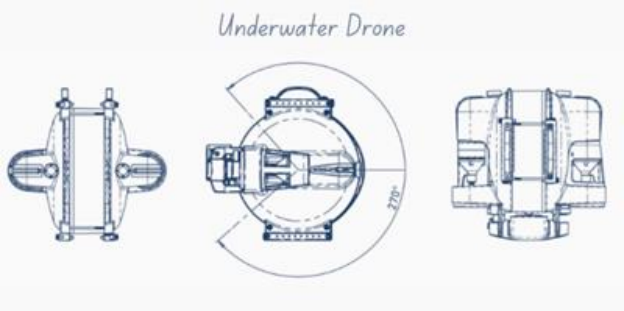
“While problems like climate change and chemical pollution will take years to remedy, industries can take action now to control underwater noise pollution. The solutions are already here. Changes to ship design and shipping routes could make a substantial difference. Some ships could run at slower speeds. Most importantly, with ship quieting technologies in place, ocean ecosystems would begin to recover almost immediately.”

(Video) Technology for a Peaceful Ocean: How Hanwha is Innovating to Reduce Underwater Noise *(YouTube, February 15th, 2024)*

"An ocean full of ships sailing across the water paints a peaceful picture. But in fact, the noise caused by commercial and specialized ships radiates underwater and damages sea creatures and ecosystems. With a relentless commitment to sustainability, Hanwha Ocean is wielding the power of technological innovation to reduce underwater noise on both specialized vessels and commercial ships."

Inspiring Entrepreneurial Leadership in Arctic Youth *(World Wildlife Fund, 2023)*

“Sataar is CEO of Small Economy Works and founder of Inspire, an innovative entrepreneurial leadership programme designed by and for young people and educators in three northern Canadian territories: Nunavut, Northwest Territories and Yukon. The 12-week programme enables young people, many of whom are Indigenous, to tap into their own interests as a way to set their career or business paths. Sataar spoke to The Circle about why he thinks harnessing the wisdom and knowledge of the past could be the innovation we need today.”



12 - https://www.oceans-research.com/how-technology-monitor-ocean-health/

DID YOU KNOW?

"New research shows southern resident killer whales grooming each other using kelp they've modified, and researchers think it's the first time researchers have documented marine mammals making tools."

https://www.nbcnews.com/science/science-news/orca-killer-whales-kelp-tools-rcna213895

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Paul Nicklen/Pod od Orcas in Norway

Paul Yoder/Research Gate

Mansilla and Jackson/Framework for Global Competence

Key Terms and Learning Objectives

National Geographic

The Orca Ecosystem: Ecology, Culture, and Threats

JessicaJ70/Wallpaper Safari

Hanwha

Ayodele Oloko & Benita Nowak/Phys.org

Mark Garrision/Hakai, Smithsonian Magazine

Technology in Conservation Science

Wallpaperbetter.org

University of Washington, Bothell

Jennifer Steven/Puget Sound Institute

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Climate Change and Ocean Health

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