Killer Whale Recovery

High school: Threats, Recovery Goals, and Delisting Criteria
Lesson 3: Are the Issues Black and White?

	Subject Area(s): Look at factors or threats impacting population size and calculate ideal population size	**Duration:** one – two 50 minute period(s)
	Key words: bioaccumulation, biomagnifications, PCBs, PBDEs, persistent organic chemicals, immune disruptors, acoustic impacts exponential growth, delisting criteria, inter-birth intervals, exponential functions, recruitment	
Materials:	worksheet computer access with internet	
State Standards: WA, OR, and ID	WA: EALR 2, 9-12 INQC (explain or draw conclusions supported by evidence) EALR 2, 9-12 INQD (communicate clearly) EALR 3, 9-12 APPD (solve problems with math, computers, probes, or data) OR: H.2E.4 (evaluate the impact of human activities on environmental quality) H.4D.6 (evaluate ways how ethics, public opinion, and government policy influence the work of engineers and scientists) ID: SS.9-12.E.3.2.2 (explain and illustrate the impact of economic policies and decisions made by governments, businesses, and individuals)	
Focus Questions:	Salmon are endangered (main diet of the Southern residents, so not abundant and not healthy due to toxins), and noise might be interfering with their ability to find food…how do these issues get resolved? How could multiple threats interact or have cumulative effects?	
Learning Objectives:	At the end of this lesson students will be able to: • Discuss how the three threats together are interrelated • Calculate a growth rate using an algebraic equation to see what target population size is considered healthy enough to delist the currently endangered orcas of the PNW • Explain that a recovery plan lays out goals, objectives, and criteria to follow and problem solve the issues	
Engage and Encounter	Analyzing population declines, what questions can we generate to help understand the population and the effect of threats on these animals?	
Explore and Investigate	Look at three threats (prey, toxins, and vessel effects or noise)	
Reflect and Explain	Work on the biological delisting criteria to see what the population of the Southern Residents is now and what the target number they are striving for in order to remove from the endangered species list.	
Apply and Extend	Have students analyze the following questions in their journals/notebooks: Is it realistic that a population would have the same growth rate every year? Why might it change from year to year? How does one measure population growth for species where you do not know every single individual? Like fish in the ocean?	
Background for teacher	When a species is listed as threatened or endangered under the ESA, one of the three specific statutory requirements is that each recovery plan incorporate objective measurable criteria which when met would result in a determination, in accordance with the provisions of this section, that the species be removed from the list. The ultimate goal is to achieve the recovery of the Southern Resident killer whale distinct population segment and its ecosystem to a level sufficient to warrant its removal from the Federal List of Endangered and Threatened Wildlife and Plants under the ESA. The intermediate goal is to reclassify this population from endangered to threatened. To accomplish these goals population abundance and demographic parameters, along with addressing the threats. In this lesson, students will use the biological criteria to see where we are at and what ideal population would be needed to delist. In lesson 5, students will problem solve and suggest recommendations of how to address the threats.	
Contact NOAA	For a guest speaker in lesson 5 email: nwr.education@noaa.gov	

Lesson 3 Procedures

Threats, Recovery Goals, and Delisting Criteria

I. Anticipatory Set: (20 minutes)

A. **Brainstorm:** The top three issues facing this small population: Prey, Toxins, and Noise. What questions can help us understand the effect of threats on these animals? Prey: what is the abundance of available food; is the food healthy; diet specific (will they change prey if salmon is not available), etc. Toxins: what kinds of chemicals, where do they come from, etc. Noise: what is making the most noise, loudest noise, duration, frequency, etc.

B. **Worksheet:** Are the Issues Black and White; do this side with the students and help them make connections.

1. Prey availability and quality (What do we know…Salmon and other fishes are the preferred prey of these whales; endangered salmon in particular, preferably Chinook salmon. What does it mean for the whales…not enough food to eat and the health of that food is questionable, due to potential harmful chemicals.
2. Environmental Contaminants/oil spills (What do we know…there are high levels of PCB's, PBDE's, Persistent organic pollutants (POPs), mercury, heavy metals, etc. in the ecosystem and food chain. What does it mean for killer whales…it biomagnifies up the food chain and toxins are stored in fatty tissues, blubber and milk. Mother whales off load toxins to their calves; the first-born calf often receives the highest concentrations. These high toxin levels can cause immune and reproductive problems in animals.
3. Vessel effects and sound (What do we know…boats make sound and there are a lot of boats around the whales in the summer months when the Chinook salmon are abundant. What does it mean for killer whales…noise impacts their ability to navigate, find food, and communicate with their pod.
4. What does it mean, "Are the issues black and white?" Not necessarily. Could there be confounding effects and why is this important to recovery? Possibly, how might one study this?

II. Direct Instruction: (30 minutes)

A. **Review:** Northern resident population to the Southern resident population. Why do you think these populations are so different? Today they will calculate what the TARGET population size would be in order to downlist to threatened status and delist this species off of the Endangered Species Act list. Have students take out their calculators, while you hand out the worksheet.

B. **Recovery Activity:** Read the recovery goals and objective at the top. Tell them if they have ever done a compound interest or other algebraic problems dealing often with money, then this should be a review.

C. Get the current population either from lesson 1 or The Center for Whale Research website.

D. When finished they can think back to lesson 2's worksheet of the other parameters like:
-number of juveniles ~47% how many whales would that approximately be (<50%)?
-number of reproductive females ~24% how many whales (1/4) would that be?
-number of post reproductive females ~11% how many whales (10%) would that be?
-number of adult males ~18% how many whales (20%)

III. Assessment:

A. Classroom participation

B. Worksheet

IV. Apply and extend:

A. Is it realistic that a population would have the same growth rate every year? Why might it change from year to year?

B. How does one measure population growth for species where you do not know every single individual? Like fish in the ocean?

Are the Issues Black and White?

Background on threats: Recovery Plan section II-71 (Prey Availability= II-75; Environmental Contaminants= II-87; Vessel Effects and Sound=II-103)
Northwest Fisheries Science Center: Research Update

TOP three threats facing the Southern Resident killer whale population	**Prey availability:**	What do we know about salmon… What does it mean for the whales?
	Environmental contaminants:	What do we know… What does it mean for the whales?
	Vessel effects and sound:	What do we know… What does it mean for the whales?

The above threats are just some of the issues facing these animals; do scientists know what factor is the most important? What do you think?

Why is this important to recovery?

Do you think there are any gaps in the data collection, what research question or strategy would you propose?

Recovery Goals, Objectives, and Criteria

Recovery Plan section IV-1 through 11

Biological delisting criteria: Recovery Plan section IV-4

Goal: Remove from Endangered Species List or delist them from endangered to threatened as a first step.
Objectives: How are you going to do it? What actions will be established to address the biological and threats criteria.

DOWNLIST from Endangered status to Threatened status:

If the Southern Resident DPS can exhibit an increasing population trend at an average growth rate of 2.3% per year for 14 years…then these animals would no longer be endangered but listed as threatened.

1. Current population number right now: N_o = _____
2. What would the population need to be to downlist: N= _____
3. How many more whales is that from now? _____

Use the following formula to address the growth rate over the 14 years.

$N=N_o(1+r)^t$

N=population requirement to downlist
N_o=current population
r= rate of growth (2.3% convert to a decimal first)
t= time period (days, weeks, years, etc.)

Make sure you round to a whole number.

REMOVE from Endangered Species List:

If the Southern Resident DPS can exhibit an increasing population trend at an average growth rate of 2.3% per year for 28 years…then it can be delisted.

4. Current population number right now: N_o = _____
5. What would the population need to be to delist: N= _____
6. How many more whales is that from now? _____

Use the following formula to address the growth rate over the 28 years.

$N=N_o(1+r)^t$

N=population requirement to delist
N_o=current population
r= rate of growth (2.3% convert to a decimal first)
t= time period (days, weeks, years, etc.)

Make sure you round to a whole number.

Besides these target numbers, what other parameters are needed for evaluating the status of this species?