

Lesson Title:

How Do Populations Respond to Environmental Change?

Essential Question:

How might changes in the Santa Cruz River change a willow population over many generations?

Time:

2-3 class periods (50 min each) + a field trip to the river

Overview:

Students will investigate how environmental conditions along the Santa Cruz River influence the survival of native willow seedlings. Through a simulation, students model variation within a willow population and examine how traits such as root growth affect survival under changing environmental conditions. Students then develop a scientific model explaining how natural selection changes the frequency of a trait in a population over time. Students can compare scenarios before and after river restoration to consider how changing environmental conditions alter which traits are advantageous.

Learning Objectives:

- I can analyze data to identify environmental changes in the Santa Cruz River.
- I can identify variation among individuals within a population.
- I can explain how environmental changes create selection pressures.
- I can develop a scientific model that explains how natural selection changes populations over multiple generations..

Arizona Standards:

8.L4U1.11 Develop and use a model to explain how natural selection may lead to increases or decreases of specific traits in populations over time.

- Natural selection leads to the predominance of certain traits in population and the suppression of others.
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

Lesson Flow:

Day 1

Driving Question	How did changes to the Santa Cruz River create challenges for willow trees?
Activity	Teacher Actions
I Notice, I Wonder, It Reminds Me Of	10 min Show students two photographs: • A historic photograph of the Santa Cruz River with dense willow forests • Modern photograph of a dry reach with little riparian vegetation For each picture, students should write observations using the I Notice, I Wonder, It Reminds Me Of protocol. A student will likely wonder what happened to the trees or why there aren't as many.
Explore	10 min Have students look at graphs of changes in the Tucson area • Tucson population • Depth to Groundwater • Water Consumption • River Flow Ask • How might these environmental changes affect plants living along the river? 20 min Have students analyze the depth to groundwater graph alongside a willow abundance/restoration graph. Questions: 1. What patterns do you notice? 2. What changed first? 3. What changed later? 4. What evidence supports your ideas? Have a class discussion about their ideas.

Exit Ticket	If willow seedlings are not all identical, which characteristics might help some survive when groundwater drops?
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Day 2

Driving Question	Why would some willow trees survive while others do not?														
Activity	Teacher Actions														
Brainstorming	10 min														
	Have students form a list of different characteristics of willow seedlings. This should be an all encompassing list.														
	Then ask students:														
	Which of these traits might help seedlings have a better chance of survival, considering the changing conditions along the river?														
	If students struggle with this, you can provide an example of three trees with different characteristics and ask them which one they think would have the best chances of survival and why.														
	<table><tr><th>Seedling</th><th>Root Depth</th><th>Water Need</th></tr><tr><td>A</td><td>4 ft</td><td>High</td></tr><tr><td>B</td><td>8 ft</td><td>Medium</td></tr><tr><td>C</td><td>12 ft</td><td>Low</td></tr></table>	Seedling	Root Depth	Water Need	A	4 ft	High	B	8 ft	Medium	C	12 ft	Low		
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C	12 ft	Low													
	Don't confirm if they are right or wrong. Let the students discuss it and work together to form conclusions. If needed, refer back to the groundwater depth graph to help kids make connections.														
Examine Evidence and Make Predictions	20 min														
	Show students the makeup of an entire population. (Generation 1)														
	<table><tr><th>Root Depth</th><th>Number of seedlings</th></tr><tr><td>4 ft</td><td>40</td></tr><tr><td>8 ft</td><td>40</td></tr></table>	Root Depth	Number of seedlings	4 ft	40	8 ft	40								
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12 ft	40
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Ask students:

- Would all of these seedlings survive changing conditions?
- Predict how many of each type would survive during a 5 year drought.

Reveal the survival of the seedlings:

Root Depth	Number of seedlings
4 ft	5
8 ft	18
12 ft	34

Have students create a graph showing changes in the population.

Questions:

- What do you notice?
- What happens next?
- Optional: Why do some of the seedlings with shallower roots still survive? (This can lead to a conversation about how trees may have other traits that might be beneficial in the environment that aren't included in the current data.)

Students should notice that the seedlings with deeper roots had a much higher survival rate. When answering, "What happens next?", they should say things like

- The trees will continue to grow.
- They will make seeds.

Questions:

- Will the next generation look the same as the first generation of trees?
- How will it be different?

Reveal Generation 2

Root Depth	Number of seedlings
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	4 ft	15
	8 ft	40
	12 ft	65
	Students should write an explanation of the changes in the numbers of seedlings with different root depths from Generation 1 to Generation 2. Partner share - students will share their explanations with a partner.	
Explain	20 min Introduce vocabulary: • Variation • Selections Pressure • Survival • Reproductions • Population Changes • Natural Selection Some students may already be using this vocab, other students will be describing these terms in their own way. The goal of this part of the lesson is to ensure all students can have a common vocabulary. Class Model Using their written explanations and new vocabulary, students should participate in discussion to develop a class consensus model of what is happening to willow trees over time.	

Day 3

Driving Question	How can we use a model to explain how willow populations change over time?
Activity	Teacher Actions
Model Construction	Students should refer to their written explanation and the class consensus model to develop their own model explaining how

	groundwater changes can affect willow populations over generations. ● Provide students with a single point rubric for their model. ● Possible Formats: ○ Flowchart ○ Annotated diagram ○ Concept map ○ Sequential illustration ● Models should include ○ Environmental change ○ Variation within the population ○ Selection pressure ○ Survival ○ Reproduction ○ Inheritance of advantageous traits ○ Changes in the population over multiple generations ○ Annotations connecting the model to evidence from the Santa Cruz River
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