Title: Invasive Species: The Emerald Ash Borer (EAB) and North American Ash Trees

Overview: This lesson allows students to explore how some living things found in our own backyards are considered alien invaders. Sometimes they move into new locations as the local environment changes, and sometimes they are carried by people, in things, or on things we move around the world. From the student's perspective invasive species can be described as "aliens", some of which can be harmful or cause trouble. They may become too abundant because there are no natural predators in their new home, they may grow and reproduce very quickly, taking up all the food and space, and push out the animals and plants that are native "originally/naturally there". They are unwelcome invaders who do not behave the same as the natural animals and plants, upsetting the balance of nature or harming the environment.

In this class students will learn about the Emerald Ash Borer (EAB) as an insect that comes from a different place. World globes can be used to show where "we" are compared to where the EAB comes from (northeastern Asia, specifically regions of China, eastern Russia, Japan, and Korea). Students will learn that this beetle was first detected in Detroit Michigan over 20 years ago (2002, multiple times their own age), and how it may have been transported into the country in infested wooden pallets. EAB has hitchhiked its way to Wisconsin, likely tucked away in a piece of ash firewood. EAB can only fly about ½ mile in a year.

Beetles hatch from eggs, and the larvae tunnel in the bark and outer trunk of ash trees, then pupate, going through complete metamorphosis before becoming an adult that looks completely different from larval beetles.

How do they kill ash trees? The EAB, like many insects, has four distinct life stages: adult, egg, larva, pupa. EAB larvae live underneath the bark of ash trees, feeding on the layer of the tree's trunk that lies just below. When they do this, they cut off the flow of water and nutrients in the tree. Most trees die after about 3 years of infestation. Students will hear how the feeding of the larvae disrupts water and nutrient uptake and movement in ash trees, and that this causes the tree to weaken and eventually die. So EAB kill millions of ash trees, which are important plants in the ecosystem.
Finally, students will learn about how EAB can be detected and what teams of people do to prevent EAB from infesting trees.

Duration: One 50-minute class for K-2nd or 3-4th graders

Project Question: There's a new beetle in the US, and it might kill off our ash trees. What is happening and why?	
Enduring Understandings (1-2)	**Essential Questions** (1-2)
● Survival of organisms ● Effects of invasive species on their non-native habitat (Ash trees)	● How does the environment support animals and plants with different adaptations? ● How do plants and animals change the environment? ● What components make up an environment? ● Define native versus invasive species
Unit Standards *(Skills to develop in students to help drive the material)*	
NGSS Unit Standards: 3. Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms 3- LS4- 3: Construct and argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. *Full list of Science and Engineering Practices: https://my.nsta.org/ngss/PracticesFull.aspx* **NGSS Science and Engineering Practices** ●	

Summative Assessment (Unit exam)	*Add content to unit exam.*

Scope and Sequence			
Date	**Objective(s)**	**Lesson Agenda**	**Materials Needed**
	Students will be able to active prior knowledge of good bugs / bad bugs and associate the Emerald Ash Borer	[5 min] Good Bug / Bad Bug exercise. • Ask students to name some good bugs (ladybugs, honeybees, praying mantis) and some bad bugs (mosquitoes, cockroaches, flies). Make a table on the board with answers. • Then, ask students why the bad bugs are bad (they can carry disease and cause harm). • Next, tell students there are bad bugs for plants, and that's what we're going to study one	Video: Understanding the life cycle of EAB, https://www.youtube.com/watch?v=3KA0s_wTbo0

	with the bad bugs.	of them. It's called the Emerald Ash Borer, and it's threatening ash trees in our area.
		[10 min] Video Intro
		• Show the USDA Video, The Nature Walk: Understanding the Life Cycle of the EAB (5 min)
		• Ask basic comprehension questions:
		  ○ What is the beetle that the video talked about? Emerald Ash Borer.
		  ○ What types of trees do they attack? Ash.
		  ○ What parts of the trees do the beetles eat? Larvae (grubs / worms) eat the wood, adults eat the leaves.	

	Students will be able to recognize an ash tree.	[10-15 min] Ash Tree Identification Option 1 (younger students): Use page 4 of the APHIS / USDA activity book to have students draw an accurate branch of an ash tree. Option 2 (older students): Display or print the MN State DNR page with ash leaves and have students draw what a branch of an ash tree looks like. Option 3: Cut one or more small branches from ash trees and other types of trees and have students compare the two, then draw the ash.	https://www.aphis.usda.gov/sites/default/files/eab-color-activity_0.pdf https://www.dnr.state.mn.us/invasives/terrestrialanimals/eab/idashtrees.html
	Students will be able to explain the lifecycle of the Emerald Ash Borer, what the exit hole looks like, and how an ash tree might die from an infestation.	[10 min] Emerald Ash Borer Damage and Lifecycle • Ask: What is the lifecycle of a butterfly? Draw out the answers on the whiteboard, it should be egg, caterpillar, cocoon, adult. • The Emerald Ash Borer has the same lifecycle, only a couple of names are different. Instead of caterpillar, we use the scientific term, larva (pronounced lar-va). Instead of cocoon, we say pupa (pronounced pew-pa). • Pass out page 6 of the APHIS / USDA activity book and have students complete the maze, imagining themselves as the larva eating the tree's wood. • There's a mistake on the maze! Have students fix this by making the end, where the adult comes out, have a D shape, and label it as the "D-shaped Exit Hole." This is how you can recognize an infested tree. • Have students put all their mazes together on one table, putting the exit holes on the outside. Now, imagine if this was a real tree. How many beetles were infesting it? (It's the same as the number of students.) Now, one beetle probably doesn't hurt a tree, but what about this number of beetles? It would do a lot of damage, and maybe even kill the tree.	https://www.aphis.usda.gov/sites/default/files/eab-color-activity_0.pdf
	Students will be able to describe an adult Emerald Ash Borer.	[15 min] Characteristics of an Emerald Ash Borer Option 1: Coloring. Use page 2 of the APHIS / USDA activity book and have students color in the Emerald Ash Borer. Display the MN DNR website to show students an image of the beetle to use. Option 2: Build a Beetle. Use the EEK WI website instructions to build an Emerald Ash Borer.	https://www.aphis.usda.gov/sites/default/files/eab-color-activity_0.pdf https://www.dnr.state.mn.us/invasives/terrestrialanimals/eab/index.html

			https://www.eekwi.org/activities/arts-crafts/build-beetle https://www.eekwi.org/sites/default/files/2019-11/BuildABeetle.pdf

Resources:

- https://www.eekwi.org/animals/insects/emerald-ash-borer
- This is the standard that I think best matches with this lesson: https://www.nextgenscience.org/topic-arrangement/3interdependent-relationships-ecosystems-environmental-impacts-organisms
- 3rd grade, Survival of Organisms, http://www.nap.edu/openbook.php?record_id=13165&page=164
- Outdoor activity, https://www.aphis.usda.gov/sites/default/files/EABoutdooractivity_030414_02.pdf