Inquiry-Based 5E Model
Climate Literacy Lesson

GONZAGA UNIVERSITY | Center for Climate, Society, and the Environment

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Invaders!

Grade Level: 5th – Middle School
Duration: 45 Minutes

Lesson Overview: This lesson aims to teach kids about what invasive species are, the difference between an invasive species, native species, and non-native species. They also should understand the potential damages that an invasive species can cause to an ecosystem.

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Disciplinary Area:
Life Science

Key Concepts:
- Invasive species
- Native species
- Nonnative Species

Key Lesson Information

Materials List

NGGS Performance Standards Addressed

MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services
Disciplinary Core Ideas	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **LS4.D: Biodiversity and Humans** • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. *(secondary)* **ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary)*
Performance Expectations	Students should learn that invasive species are a threat to biodiversity because invasive species have the power to make ecosystems collapse, leading to the organisms of that community needing to find new homes. Possibly becoming invasive themselves.

MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
Disciplinary Core Ideas	**LS2.A: Interdependent Relationships in Ecosystems** • Similarly, predatory interactions may reduce the number of organisms or eliminate

	whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.
Performance Expectations	Students after playing Invaders should have an understanding of the many variables that go into the impact a nonnative organism has in a new community. They should know that the impact these animals has is unpredictable.

Learning Outcomes:

- Students should know the difference between an invasive species, a native species, and a non-native species
    - Students will be given definitions and examples of each
    - Students will also play a game that will help them see how invasive species can hurt native species' populations in an ecosystem
    - Students will learn how an invasive species can have a negative impact on climate change

Key Vocabulary List/Big Question:

Big Question: What is an invasive species and why are they dangerous to ecosystems they are not native to?

Vocab:

- Invasive Species:
  a species of plant or animal that outcompetes other species, causing damage to an ecosystem.

- Native Species:
  a species that originated and developed in its surrounding habitat and has adapted to living in that particular environment.

- Nonnative Species:
  a species that originated somewhere other than its current location and has been introduced to the area where it now lives

***5E model part 1: Engage* (10 minutes)**

Introduction and Background

In this lesson we will focus on what an invasive species is and the potential damage that invasive species can cause in their non-native ecosystems. Students will start by answering a few questions so we can see how much they know already about invasive species. After, they will watch an introductory video highlighting what an invasive species is, what usually causes a species to become invasive, and learn about several examples of them around the world. After the video, we will have a discussion as a class based on some discussion questions. Afterwards, they will get definitions for an invasive species, a native species, and a nonnative species.

Video Link: https://www.youtube.com/watch?v=spTWwqVP_2s

***5E model part 2: Explore* (20 minutes)**

Introduce Activity

Students will now learn the rules of the game, *Invaders!* Which will teach them about invasive species' relationship with a new ecosystem.

Activity: Invaders!

Students will play a game that will demonstrate how an invasive species interfering with a food chain can impact an entire ecosystem

Essential Concepts To Learn:

This activity help to introduce students to understand the potential damage that an invasive species can cause to an ecosystem. As the population of the rabbits grows faster than the mice, students will see a few of the factors that invasive species change with their presence.

Material	Units Needed	URL For Purchase (via Amazon)
Game Pieces (beads)	2 (each a different color, 25 tokens per player)	https://tinyurl.com/323kwm7d
6-sided dice	1 per class	https://tinyurl.com/ssdev85s
Expo Markers	1/player	https://tinyurl.com/4rwaxzn4
Score Cards	1 per player	PDF is in the lesson plan
Game Boards	1/pair of players	PDF is in the lesson plan

	Start of the Round:	End of the Round:
1		
2		
3		
4		
5		

Activity Procedure

Invaders Rules:

Setup:

- Players will receive:
  - A game board
  - 25 pieces each that represent their species
  - An expo marker and a game board
- Before Starting the game:
  - Decide who will be the mice and who will be the rabbits
    - Mice are black
    - Rabbits are blue
  - Players will each start with five animals

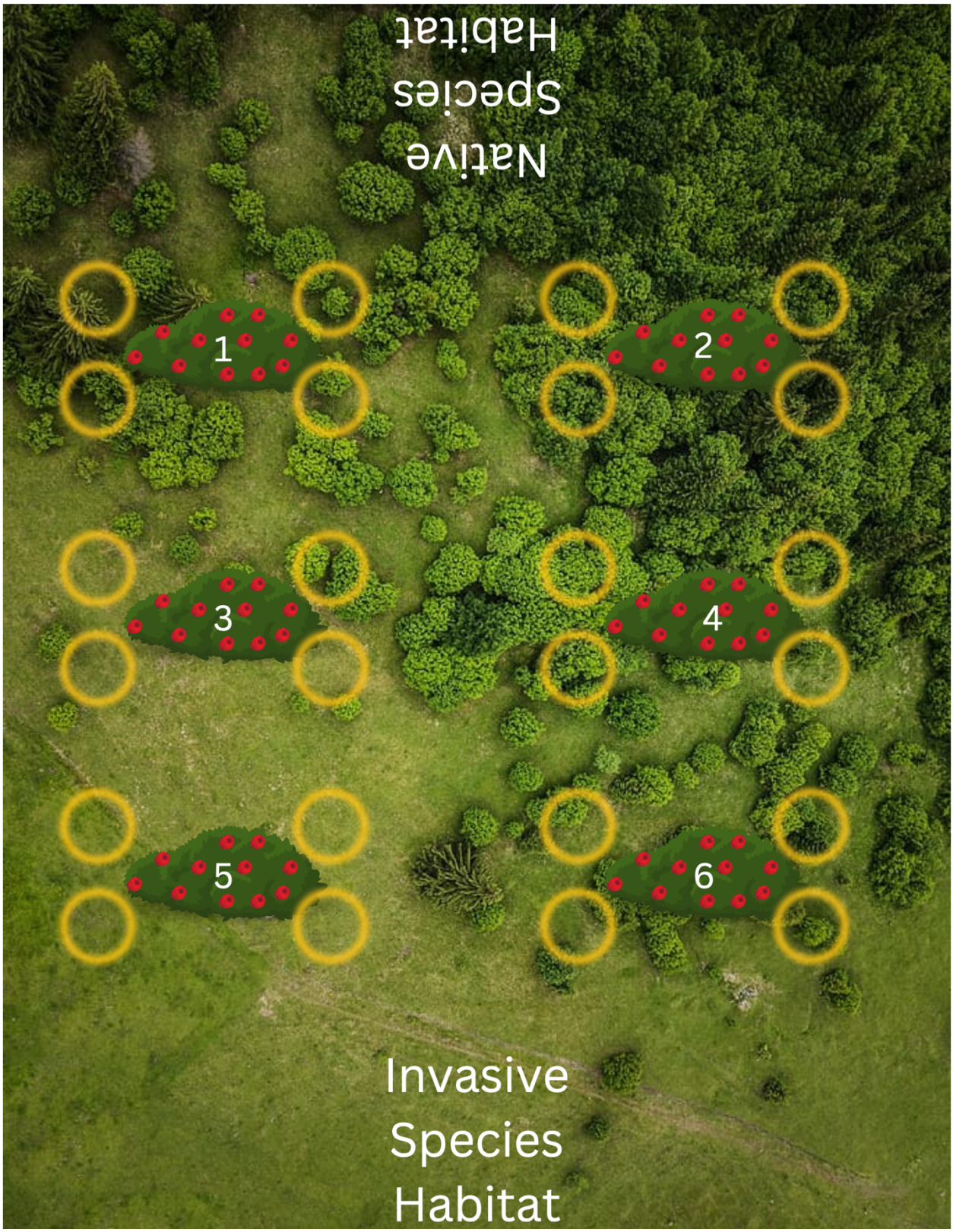
Goal of the Game: The winner of the game is the player with the most animals at the end of the game!

Gameplay:

- The game will take 5 rounds, and each turn will have 3 steps:
  - Step 1: Foraging for Food
    - At the beginning of each round, players need to count the number of pieces they have BEFORE placing them on the game board and record this number in the "Start of the Round" column for that round.
      - This will be important as we play because as animals are hunted and as your population reproduces, it will be important to be able to see how your population changed throughout the game
    - Once you have counted and recorded how many animals you have, players place all of their animals in the rings on 1 of the 6 grasslands that are on the game board
      - For example, in round 1, each player will have 5 pieces, so you will put all 5 of your animals on the board
      - If there are too many animals and not enough places to put them on the board, the ones there aren't room for immediately are removed from the game
        - This is to represent the carrying capacity of the ecosystem. If there is not enough food for the animals to eat, then they would starve.

- Step 2: Predators Come Hungry
  - After everyone has placed all their animals on the board, it is time for the snakes to hunt! The snakes will hunt by having someone roll a dice to pick where they go hunting
    - We start the game with one snake, but every round we add one more. So by round 5, we will have 5 snakes
  - Rules for how the snakes hunt:
    - If there is a mouse and a rabbit at the same location, the snake ONLY eats the mice and the rabbit is safe from that snake
      - Snakes in this ecosystem have adapted to hunt for mice, so if a snake goes to a grassland with both animals, it will hunt the mice first because that's what it knows to do.
    - If a snake lands on a space that has more than one mouse, it can eat up to two mice at this location
      - This is because mice are much smaller than rabbits, so snakes need to eat more of them in order to eat enough to survive

- Step 3: Preparing for the Next Season
  - Once the snakes are done hunting, all of the animals in this ecosystem leave the board and go back to their players.
  - Count the number of animals you have and record this number in that round's "end of the round" column
    - MAKE SURE TO COUNT YOUR ANIMALS BEFORE YOU ADD MORE ANIMALS FOR THE NEXT ROUND
  - Once you have counted your animals, see how many pairs you have left. For every pair of animals you have, you can add one more animal to the group of animals you play with.
    - If you have an odd number of beads, they do not count as a pair
    - Example: If the rabbits have 5 animals after the round, you have two pairs. So you can add 2 more rabbits to your group of animals for the next round, letting you start the next round with 7 rabbits
  - After this, we will start back at step one for the next round, and play until we have played through 5 rounds.


Native
Species
Habitat
1
2
3
4
5
6
Invasive
Species
Habitat

5E model part 3: Explain

Time to check in and recap!

After the game, students will be asked a few questions about what they observed during the game that allowed the rabbits to thrive and outcompete the mice

- What advantages did the rabbit have over the mouse that gave them such an upper hand?
- How different would this game have been if both players played as the same animal?

They will also be challenged to think critically about how this might have a larger impact on the planet by connecting this lesson to climate change.

Key Takeaway:

Invasive species affect different ecosystems in different ways. Some have a larger impact on their new environment than others, but invasive species as a whole have negative impacts on their environment. This should also help to address the difference between an invasive species and a nonnative species.

Important Concept Check in: Vocabulary/Big Question

Key Vocabulary List/Big Question Recap:

Vocab:

- Invasive Species:
  a species of plant or animal that outcompetes other species, causing damage to an ecosystem.

- Native Species:
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5E model part 4: Elaborate

Clarify the connection here

Slides 11 and 12 are visual tools to use to explain how the decreasing or extinct mouse population affects the snake population. This specific example from the game will help them understand why if one animal is harmed in a food web, it can impact the entire ecosystem. The choices that this mice population makes have direct impacts on their predators, forcing them to adapt to try and survive and causing a chain reaction through the ecosystem. If the adaptations other animals make exceed the carrying capacity of the ecosystem or if these changes kill off other species, then this will damage the ecosystem.

Connections between climate change and the rabbit example:

- If the mouse population disappears, the snakes will either have to adapt to eat the rabbits or they will die off
  - If they switch to eating rabbits, this changes their food chain and may impact animals that depend on this food chain
  - If the snake population dies off, the animals that hunt them will also die off. Impacting the food chain, and in turn impacting the food web they are connected to
- If the rabbits and mice coexist in this ecosystem, the grasses they eat will have two animals competing to eat them
  - This will drastically decrease the grass' population in the ecosystem, hurting the soil in the ecosystem and decreasing the amount of water that it can absorb
    - Example: The Dust Bowl (kids may not know what this is but it's a great illustration for teachers)
  - Harming the grass population could also decrease the pollinators in the ecosystem, reducing the number of other plants that will produce offspring for the following seasons
  - If the mice and the rabbits have less grasses, they also have less space to run or hide from predators

- General connections between invasive species and climate change
  - Can cause more extreme weather events, causing more animals in different ecosystems to need to migrate to find new homes, creating more invasive species
  - Changing climates can cause animals that prefer certain climates to move to new ecosystems that have those conditions as their home ecosystems no longer have those conditions
  - If an invasive species makes the food web of an ecosystem collapse and the entire ecosystem suffers, all the plants that were storing carbon (ex: trees) will re-release all of those resources back into the atmosphere

5E model part 5: Evaluate

The end of the lesson should explain to students how damaging ecosystems can connect to climate change. Some ways this may happen are:

- If an ecosystem collapses, all of the carbon that was stored in the ecosystem in the plants, in the soil, or anywhere else will be released as these plants die. Releasing all of the stored carbon dioxides they have collected into the atmosphere. Contributing greenhouse gases to the ozone layer
- The loss of an animal's home ecosystem leads to them needing to find a new home. If they have to travel far enough from home, they may have unforeseen negative impacts on other animals' ecosystems. Creating more invasive species that will damage other ecosystems and repeating this cycle.

By the end of this Lesson

Concepts Learned:

- Students will learn the key concepts of this lesson (invasive species, a native species, and a nonnative species) and know the difference between the types of species.
- Students should be able to list some impacts invasive species have on a new ecosystem

Connection/Evidence Gathered:

- Students can identify some of the native, non-native, and invasive species in Spokane
- Students can see how these animals impact the ecosystem

Learning Outcomes:

- Students will be given a set of definitions (invasive, native, and non-native species)
- Students will learn how invasive species have certain advantages that allow them to outcompete native species
- Students will learn about the harmful effects that an invasive species can have on an ecosystem and why we need to prevent invasive species

Key Definitions:

Key Vocabulary List/Big Question Recap:
Vocab:

- Invasive Species:
  a species of plant or animal that outcompetes other species, causing damage to an ecosystem.

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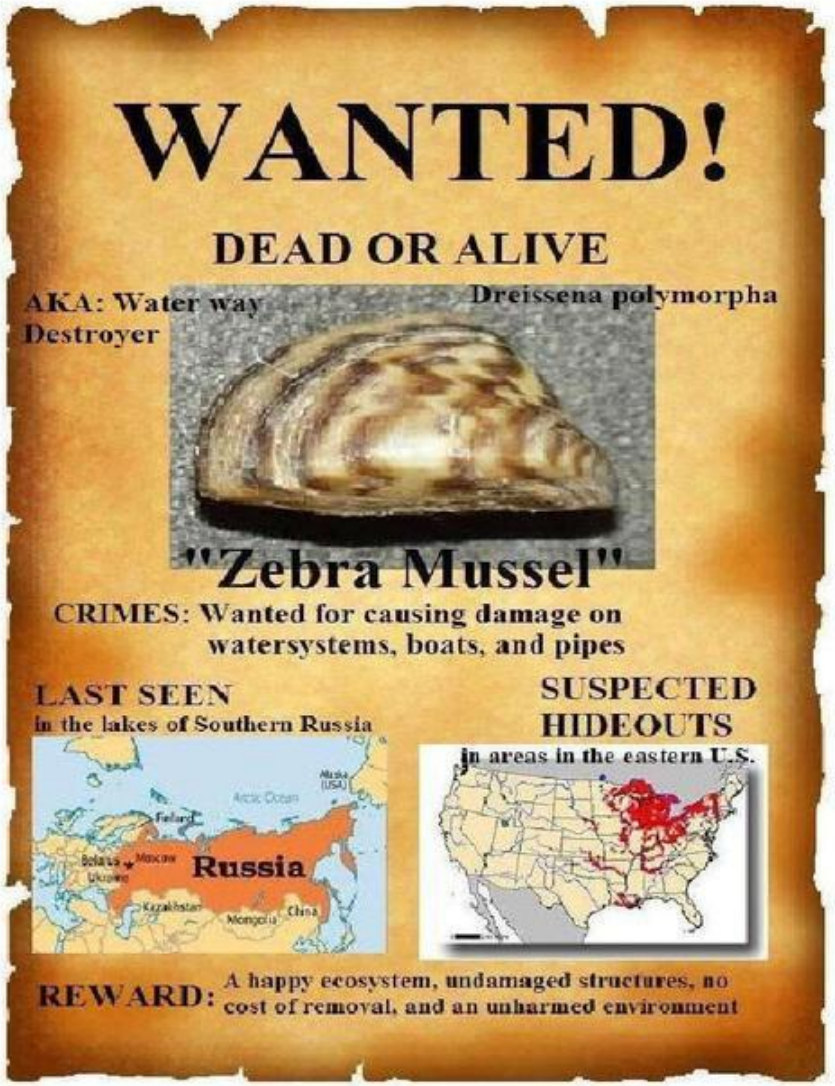
Invasive Species

What Will We Be Learning:

- We will be learning the difference between:
  - A native species
  - An invasive species
  - A nonnative species
- Why invasive species are dangerous in other ecosystems
- How invasive species can change an ecosystem and the relationships animals have in it



Questions for the Video:

- What determines if a species is invasive?
- Do you think there is a difference between an invasive species and a non-native species? If so, what is the difference?
- How can an invasive species damage a food web by being present in a new ecosystem?

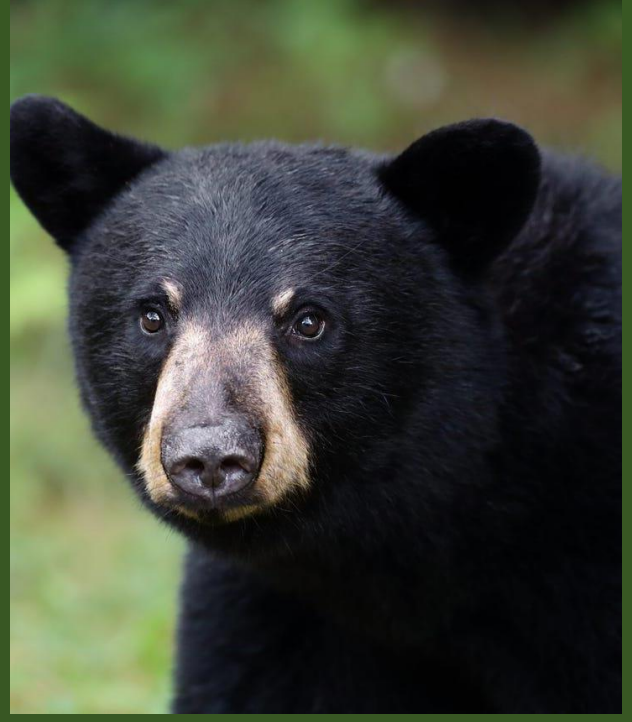

INVASIVE SPECIES
TEDEd

Post-Video Class Discussions:

- What is an Ecosystem?
- How is a food chain different than a food web?
- Can you think of examples of invasive species that weren't mentioned in the video?
- What is the difference between a native and a nonnative species?

Invasive Species

- A species of plant or animal that's not in its native environment and outcompetes other species, causing damage to an ecosystem.
  - Invasive species come in all shapes and sizes.
    - Some are more dangerous than others
    - Some are almost impossible to notice
- Examples in Washington:
  - Northern Giant Hornet
  - Northern Pike
  - Zebra Mussels



Native Species

- A species that originated and developed in its surrounding habitat and has adapted to living in that environment.

- Examples:
  - Beavers
  - Douglas Fir Trees
  - Black Bears

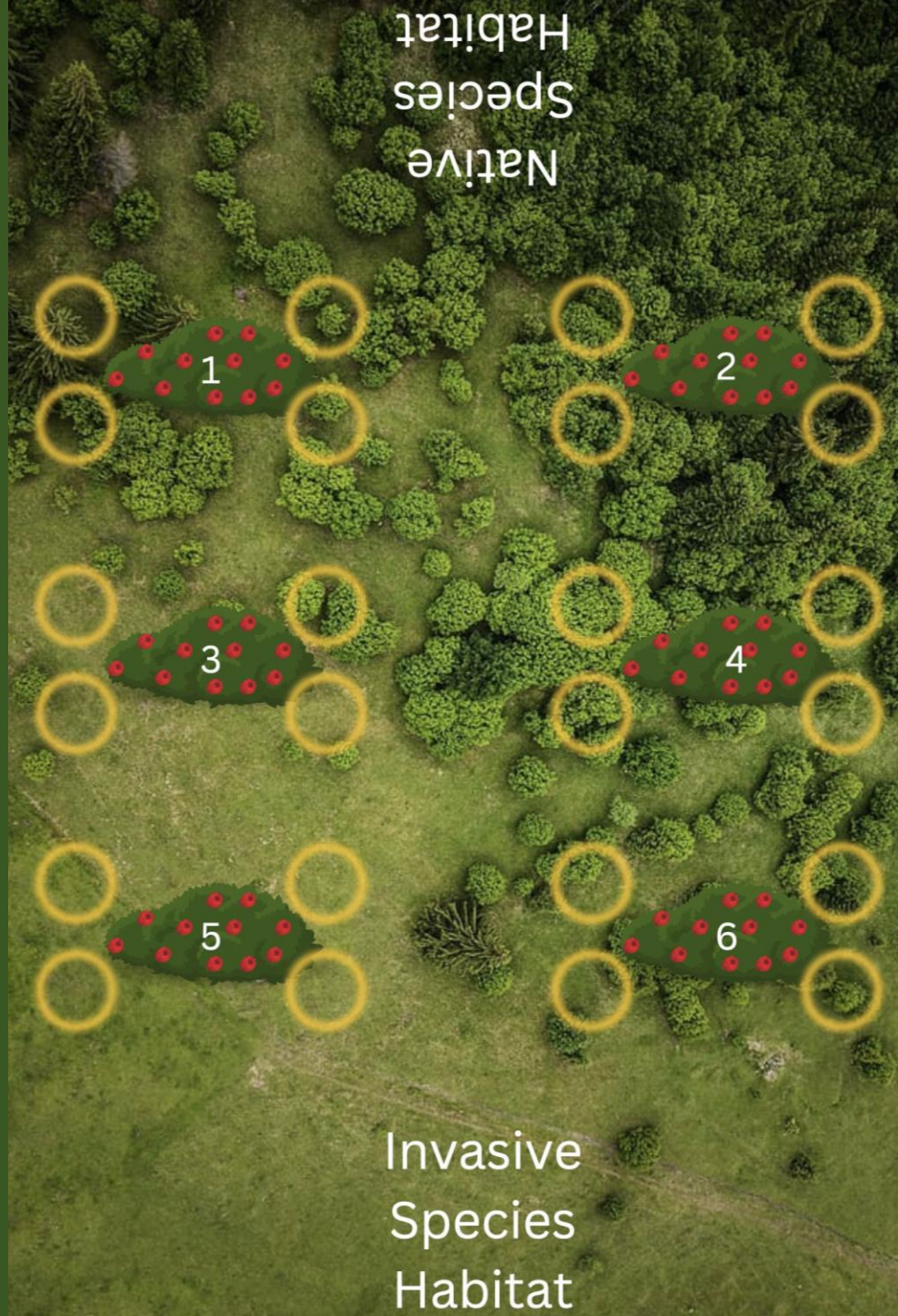
Nonnative Species

- A species that originated somewhere other than its current location and has been introduced to the area where it now lives
  - Non-Native Species do NOT stop or prevent the survival of other animals within the ecosystem
- Example:
  - Honeybees

INVADERS!!!

- Each game has two players competing for resources, so we will have everyone pair up before we pass out materials.

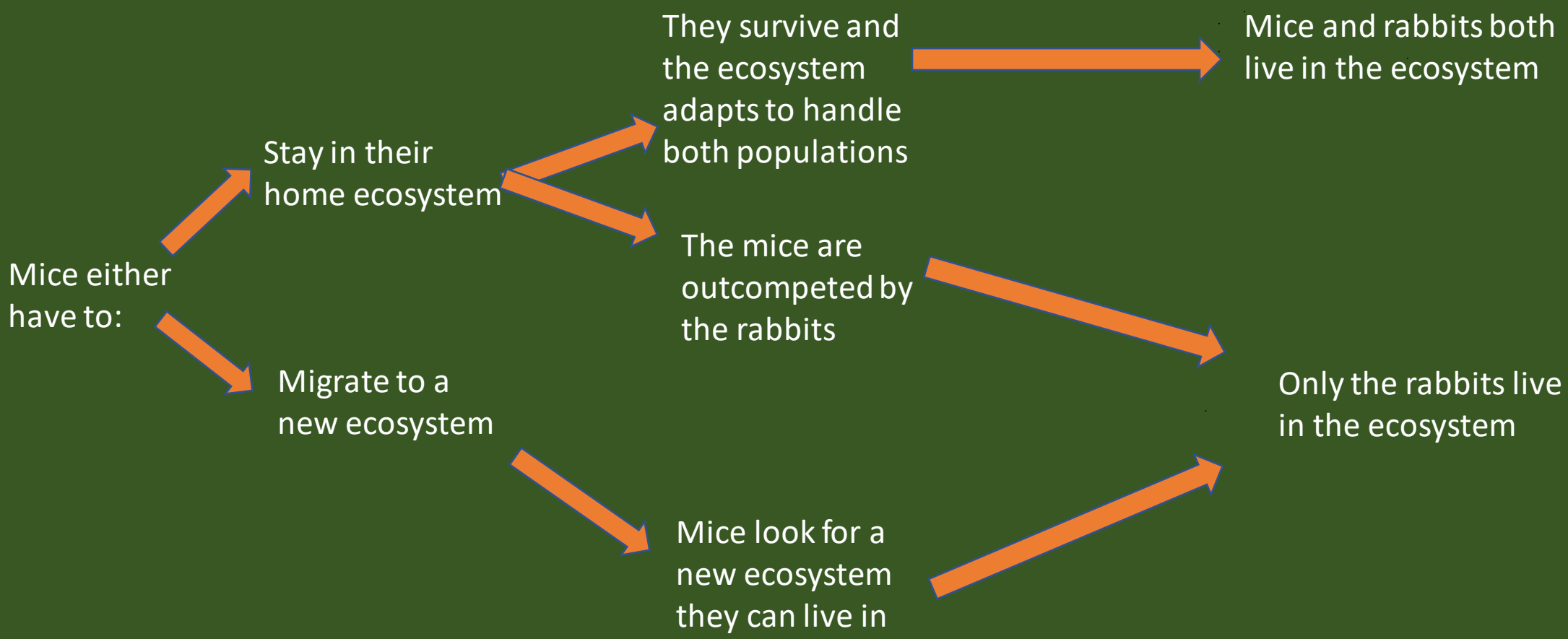
- Once you pair up, pick heads or tails. Winner of the coin flip chooses which animal to play as
    - Mouse
    - Rabbit



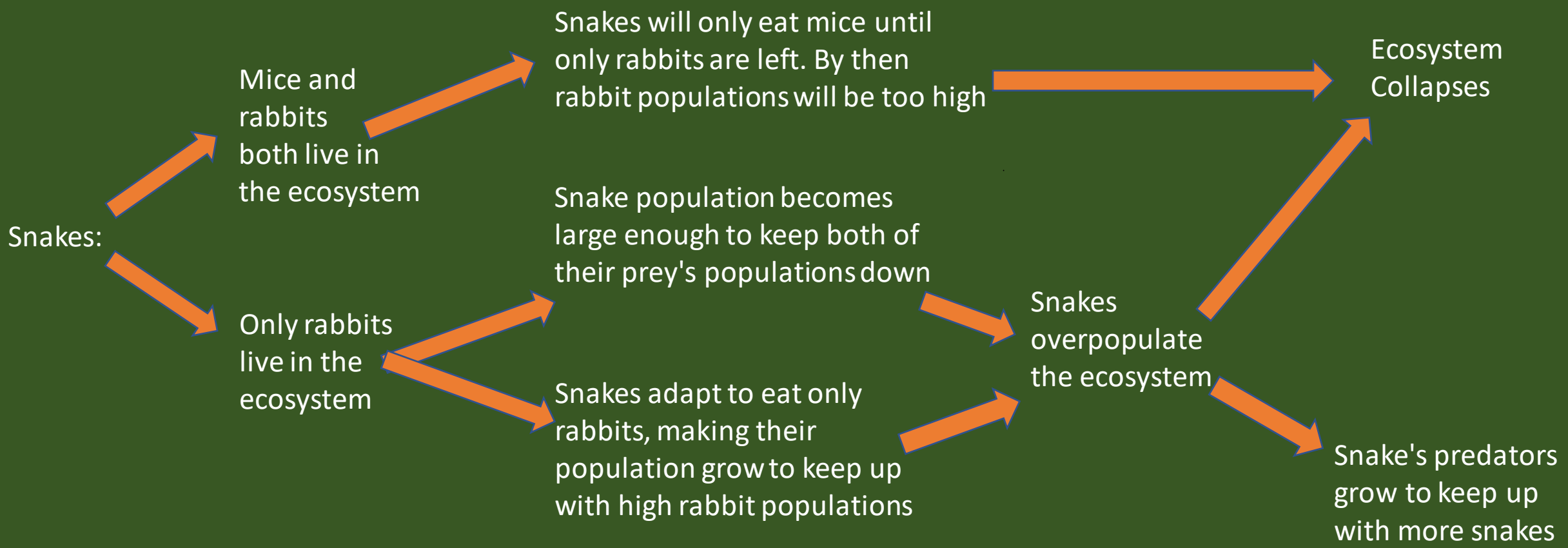
Invaders Rules:

- Beginning:
  - Players place their animals in vacant spots around each grassland
  - Once the animals are placed, the predators hunt for the mice
    - If there is a mouse and a rabbit at a location the snakes go to, the mice are eaten and the rabbits are untouched
    - Up to 2 mice can be eaten by one snake, but only one rabbit can be eaten per snake
  - After the snakes have hunted, all animals go home to reproduce
    - For every pair of animals that makes it home, you get to add one more to your population
    - If you have an off number of animals, you round down
      - Ex: If you have 4 animals, you get 2 offspring. If you have 5 you also only receive 2
  - The winner is the one who has the most amount of animals at the end

How Does This Affect The Mice?



How Do The Mice Affect The Snakes:

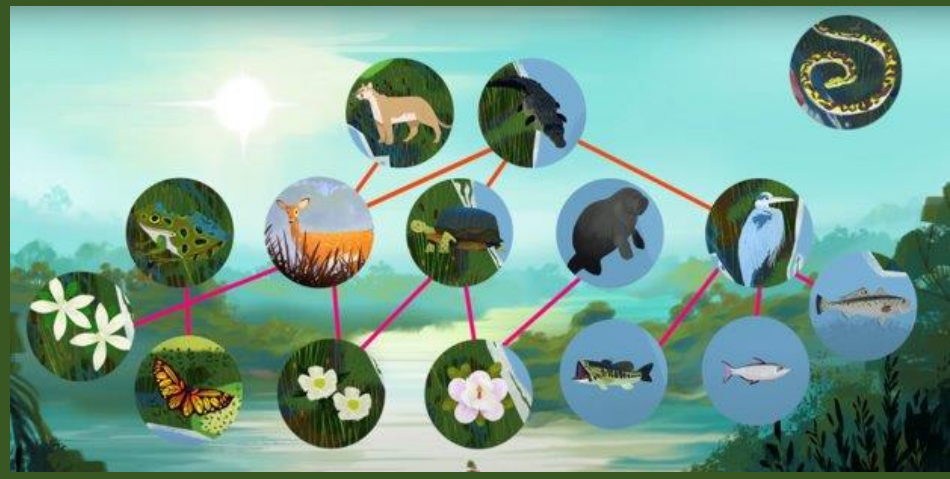


How does this Connect to Climate Change?

- If an ecosystem collapses, all the carbon stored there will be released into the atmosphere
- The destruction of an animal's home ecosystem causes them to have to find a new home, creating more invasive species
  - And when the climate changes, animals' preferred habitats will move to new ecosystems. Causing animals to prefer those conditions over the conditions of where they used to live

What we Learned:

- The difference between what an invasive, native, and nonnative species is
- In what ways an invasive species can negatively impact an ecosystem
- When one native animal in an ecosystem is harmed by an invasive species, it impacts the rest of the ecosystem
- How harming one native species can impact all the other animals in the same ecosystem, and how that can contribute to climate change



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Exit Tickets:

1. Can you list some examples of an invasive species?

a. _____

b. _____

c. _____

2. What is an invasive species?

_____

_____

_____

_____

_____

3. Today I learned new concepts that I did not know before.

A. Yes, I learned many concepts.

B. I learned a few.

C. I learned nothing new.

4. On a scale of 1-10, how much do you care about the environment?

I care a lot! I kind of care I do not care

10 9 8 7 6 5 4 3 2 1