NCSE National Center for Science Education

It Isn't Easy Being a Tree

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Overview

The strongest effect of climate change on plants is the increasing variation in precipitation from year to year. In this game, participants will role-play as trees experiencing changing precipitation due to climate change. The goal of this experiment is to demonstrate that unpredictability of water is stressful to trees and may, ultimately, lead to extinction.

Learning Goals

1. Gain an understanding of how variability in precipitation affects trees.
2. Experience the stress of being a tree trying to live during variable precipitation years.
3. Observe how the impacts of climate change can vary by tree species.

Overview

- Tree Species Placemats
- Precipitation Event Cards
- Leaves
    - 50+ Deciduous-style leaves (e.g., maple, oak, etc.)
    - 50+ Coniferous-style leaves (i.e., clumps of pine needles
- Dice
    - 1 White die with black dots (sides can have one, two, or three dots)
    - 1 Black die with red dots (sides can have four, five, or six dots)
    - 2 Wood die with green dots (sides can have four, five, or six dots)

Set-Up

1. Shuffle the Precipitation Event Cards and arrange the deck so it is reachable by all participants.
2. Place a few tree species placemats so they are facing any participants that approach.
3. Place the other placements to the side. Participants may choose to use the species already on the table or can look through the stack to find a species.
4. Separate the leaves into deciduous-style and coniferous-style piles. Deciduous leaves can be used on oak and maple trees and coniferous leaves on pine, fir, and spruce trees. Leaves can be mixed and matched for an added element of creativity.

Procedure

1. Engage participants by pondering together what it is like to be a tree. Based on their knowledge of plant biology, discuss how plants live differently from animals and how being stuck in one place makes getting enough resources a challenge.
2. Set the scene. Tell participants they are going to pretend to be a tree and their goal is to live for as long as possible under climate change.
3. Have the participant(s) place approximately 10 leaves onto their Tree Species Placemat. Participants can get creative with how the leaves are arranged on the branches. Try to use 8-12 leaves; too few and they will die too early, too many and they will live forever.
4. Ask one participant to draw a precipitation event card and have all the participants follow the instructions on the card. For trees that are sensitive to the kind of precipitation represented on the card, roll the die indicated on the Tree Species Placemat.
5. After everyone has taken a turn, have their trees experience a "growth spurt" by placing more leaves onto the branches. The Tree Species Placemats will instruct the participant on how many to add based on their species' growth pattern.
6. Continue playing until someone's tree dies (loses all its leaves) or until participant interest wanes.
7. Discuss how the participant(s) felt while playing the game. Point out that, although trees do not have emotions, they can experience physical stress. Connect the activity to any recent local precipitation extremes if possible.

Definition of Success:
Participants who complete this activity will be able to:

1. *Express how trying to anticipate precipitation was stressful.*
2. *Explain why having multiple stressful precipitation years in a row is harmful to trees.*
3. *Make predictions about future impacts of climate change on different tree species.*

Modifications and Guiding Questions

Younger guests may need assistance with counting. For deeper engagement, have participants compete against each other as though they are saplings growing in the same forest. I originally had a mechanic for trading in leaves to produce seeds. A participant would need to have the most seeds to "win" but also had to weigh the cost of possibly having multiple bad precipitation events in a row and few leaves. I ultimately removed this concept to shorten the activity's total time, but it could easily be added back. Trading 4-5 leaves for a seed provides a challenge without dramatically increasing the likelihood a tree will die by the next turn. If enough participants are playing at once (e.g., a whole classroom), the trees that die could be replaced by the species of the participant with the most seeds. This would allow you to model forest succession and community dynamics under climate change.

Further Resources

- USDA PLANTS database has additional tree species that could be added to the game.
- The original article this activity is based on has more information about climate science using tree data. https://advances.sciencemag.org/content/advances/5/10/eaaw0667.full.pdf

NGSS Standards

K-LSI-1 From Molecules to Organisms: Structure and Processes: Use observations to describe patterns of what plants and animals (including humans) need to survive.

3-LSI-1 From molecules to Organisms: Structure and Processes: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-LSI-3 Biological Evolution: Unity and Diversity: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3 -LS4-4 Biological Evolution: Unity and Diversity: Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.*

MS-LS1-5 From Molecules to Organisms: Structures and Processes: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Modification Guide

Additional Data: The data used in this game are derived from Dannenberg, Wise, and Smith. (2019, *Science Advances*). I tried to include as many trees as possible from their paper, however, their data are limited by which tree species leave behind good tree rings. The USDA PLANTS database has good information on other species of trees, with information on growth rates, drought tolerance, and moisture use. Search for a tree species of interest, then select "Characteristics". Facilitators can customize their Tree Species Placemats to reflect local species and/or species of cultural importance.

Graphics*:* A link to the graphics for the Precipitation Event Cards and Tree Species Placemats are provided. Species and precipitation events can be altered to reflect local conditions (e.g., adding additional winter precipitation cards if your area receives most of its precipitation in the winter).

Troubleshooting: As stated in the "Deeper Engagement" section above, I originally tried to have a reproduction mechanic, but found it added too much time between rounds. I think it could be added back, provided the participants are going to engage with the activity for a longer period of time. Facilitators would need to buy or make game pieces to represent seeds. A key component of this activity is allowing the trees to have a growth spurt at the end of every round, otherwise everyone dies. Young children do not seem to mind (they enjoy the dice-rolling and leaf-counting so much they sometimes just continually roll dice and remove leaves until the tree is bare), but older children will catch on and refuse to continue playing when they can sense they are going to lose. The point is to demonstrate the stress trees are under, not necessarily that climate change will kill all trees, so allowing the trees to grow leaves back is key. The disease event cards must be explained to participants under a certain age – young children seemed very confused at the idea of a plant getting sick! Participants overall reacted positively to this activity.