Investigating the American Chestnut

Investigative Question: How has the American Chestnut's role in the ecosystem changed due to introduction of the blight?

Goal: Students will be introduced to the history of the American Chestnut and then observe several leaves from an American Chestnut Tree, a Chinese Chestnut tree, and a hybrid between American and Chinese Chestnut.

Objectives
Knowledge: Students gain an understanding of the historical range and ecological role of the American Chestnut and examine backcross of American and Chinese chestnuts.
Skills: Using graph paper, students measure the area and perimeter of the leaves and compare the dimensions of the individual trees and between trees. Students measure the area and perimeter of leaves, as well as compare and describe the leaves of similar tree species.
Value: Students learn about ecosystem impacts of human behavior and appreciate the extent of the effort it takes to correct an anthro-catastrophe.

Location: Experimental hybrid American-Chinese chestnut plot at Blandy Experimental Farm, UVA

- Contact the American Chestnut Foundation at this address to request leaves and other Learning materials. https://acf.org/resources/education/

Target Grade Level: 3

Activity Time: 45 minutes

Possible Assessments: rubric with proper use of measuring tools, metric scale use, determining area and perimeter, comparison skills, graphing of data, citing evidence to make conclusions, etc.

Virginia Standards of Learning

- Science (2018) 3.1, 3.5, 3.8
- Math (2016) 3.2, 3.5, 3.16, 3.8, 3.15

Special Safety:

- The walk to the chestnut grove has many holes, and there may be nuts on the ground. Participants need to walk with care.
- This area does have tree nuts around. Classes that include students with tree nut allergies need to be instructed NOT to handle any fruits. An alternative location may need to be procured.

Materials:

- Pencils
- Cm graph paper
- Cm rulers/meter sticks
- Field Meter tape
- Clipboards
- String
- Scissors

- Tape
- American Chestnut, Chinese Chestnut, and hybrid leaves
- Large Dry erase board and markers
- Historic photographs of Am. Chestnut
- Optional: calculators

Setup

1. Collect several leaves of various sizes from the American Chestnut, Chinese Chestnut, and backcrossed hybrids.
2. Determine how much experience students have done with area and perimeter and using measuring tools. If this is an introduction to any of the skills and concepts, the activity may need to be simplified.

Instructional Strategy

1. Introduce the American Chestnut – demonstrate the average trunk diameter and circumference (the perimeter of a circle) and briefly describe its ecological and economic importance and the chain of events that led to the chestnut blight and human response elimination the population.
2. Describe a healthy, mature American chestnut: average: h = 30m (about 10 stories) w(dbh) = 1.5m, tall, straight trunk (The largest American chestnut tree ever reported in the United States was in Francis Cove in Haywood County, NC: 17 feet/5.2m in diameter)
    i. For older students, have them estimate the circumference. (average 4.71m, record 16.33m)
    ii. Use the field tape to measure out the diameter and then circumference. Have students connect both ends of the tape and gently create a circle. After creating the circumference of the largest American chestnut, have students gently lower the tape to the ground and then step "inside the chestnut".
    iii. Ask students to look around, do they see any trees that match the description (nope!)
    b. If available, find a chestnut burr with some seeds inside. Ask students to consider how the chestnuts can be used as a resource for animals:
        i. The tree flowers in late May/ early June so it was more reliable source of food since it was less susceptible to frost damage (unlike Oaks for ex).
        ii. Producing high quantity and quality of food (Lead them to identify bear, deer, turkey, and squirrels as species that relied on the chestnut)
        iii. The massive trees served as an "apartment complex" for animals.
    c. Describe chestnuts trees as a resource for humans
        i. The rot-resistant wood was perfect for lumber, fences, carpentry and homes.
        ii. Bur and nut production meant lots of free food & free animal feed.
        iii. Bark was used for tanning leather.
    d. Mention that other types of chestnuts are used for other things: for example, Chinese chestnut (the one with a branching trunk) is used ornamentally and for nuts.
    e. Description of the blight: in the early 1900s, the blight was recognized as a potential threat to American chestnuts. Some Chinese chestnuts which were introduced and planted at Arboreta, including New York appeared to have the blight. With these plantings, came a fungus that didn't harm the Chinese chestnut, but which spread quickly to the American chestnut trees, killing many and making others sick.
        i. People tried to stop the spread by cutting down sick trees, but that just meant that sick trees didn't get a chance to get better.

ii. By the 1940s, almost no American chestnut trees were left in the tree's native range.
    1. Before the blight, 1/4 to 1/3 of the forests in eastern mountains were made up of this dominant species. Use images to illustrate the description (see resources).
    2. Demonstrate the impact of blight by counting off the students, assigning each a 1, 2, or 3. Ask them to hold a hand with the appropriate number of fingers up so they don't forget.
    3. Request that all the 1s, 2s, or 3s fall to simulate the impact of the blight.
    4. Have students brainstorm the impact on the forest ecosystem and human economy.

iii. Inform students that the roots of some trees survived, and that they keep trying to grow new trunks. Most American chestnuts now look like a sick shrub!

3. Observe, compare and contrast the American Chestnut trees and the Chinese Chestnut trees.

<u>Area</u>[1]

1. Divide the class into two groups, assign one group the American Chestnuts and the other the Chinese Chestnuts. Then, create student pairs.
2. Ask students what the distance around an entire shape (in this case a leaf) is called. (perimeter) What do we call all of the space inside a shape? (Area)
3. With the help of a student volunteer trace a leaf onto a sheet of centimeter-squared paper. Show the tracing to the students. [2]
4. Ask students what strategies they would use to determine the area of the leaf they just traced onto cm square graph paper. Tell them they need to count all the squares inside the leaf to find the area. The partial squares need to be added up also. They will record the area on the leaf tracing, as so: Area = _____ square cm.
5. Have each student work with their partner to help each other trace leaves on the graph paper and calculate the area.
6. When everyone has finished, ask students to explain their various strategies for counting the squares, and partial squares, to calculate the area of their leaves.
7. OPTIONAL – find the average leaf surface area of each tree.
8. Graph the leaf surface areas to compare the two trees.
9. Ask: which tree tended to have leaves with more surface area? Why do they think the leaves are different? Do they notice any other similarities or differences between the leaves? Why might a forester or plant scientist might be interested in knowing leaf area (prompt - what jobs do leaves do for the plant)?

<u>Perimeter</u>

1. Have a student volunteer help you demonstrate how to use a string to measure the distance around the perimeter of a leaf. Once the string borders the entire leaf, cut the string and tape it next to the outline of the leaf on the cm graph paper.

[1] There may not be time to do both area and perimeter in the field.

[2] If students are new to the concept of area or are younger than 3rd grade, consider using a manipulative like pennies to determine area. See how many pennies it takes to completely cover the leaf. Compare that number to other students' leaves.

2. Hold up the paper and ask what the string represents. When everyone identifies perimeter, point out that a perimeter is a linear measurement. It only has length – unlike a square unit of measurement that has both length and width.
3. Measure the cut string in centimeters and record next to the string: Perimeter for "x" leaf= _____ cm
4. Have students work with their partners to measure and record the perimeter of their leaves.
5. Graph the leaf perimeters of each type of chestnut tree and compare the graph to the area graph. What do they notice?

Conclusion

1. Standing next to the hybrid chestnut plot explain the American Chestnut Foundation's restoration work based around backcrossing the American Chestnut with Chinese chestnuts to produce a tree with American characteristics we like (lots of tasty nuts, tall and straight, habitat for animals) as well as the Chinese characteristic we want (resistant to the blight).
2. Give each student a long strip of paper to demonstrate the crossing process[3]. Explain: Some scientists chose to backcross. The first cross resulted in a tree that was half American and half Chinese. Fold your paper in half. Ask, what fraction or percent of this offspring #1 was Am. and Ch.? This offspring was backcrossed which means an 100 % American with this 50/50 Am/Ch Fold again and ask, How much of the genetics of the tree is American and how much Chinese? The result was an offspring that was ¼ Ch and ¾ Am. Continue until 15/16ths is reached. Explain to students that the trees in the plot are 15/16ths American. It is the hope that the offspring from these trees will be resistant to the blight and will have all the character of the King of the Forest!
3. Remind students that it takes a long time before a tree is old enough to make seeds. In this case, each generation takes 5-10 years[4]. Count the folds in the paper and multiply by 10 to estimate how many years it took the get the seeds that grew the trees in the plot. Add one more generation to see the total time investment to get seeds from these trees!
4. Ask students to compare and contrast the hybrid leaves to the American and Chinese chestnut leaves. What similarities and differences do you observe?

[3] This task is great for older students or those who are working on understanding fractions up to 16ths to participate in as well.

[4] Note that as management practices have developed over time, the time it takes for trees to reach maturity in experimental orchards has shortened. Now it can take as few as 5-6 years for them to mature. Scaffold this activity by using different spans of years for students to add. Less mathematically adept students can count by tens, while those who may need a stumper can have fun with 7s! (Brinckman, 2014)