



WETLAND PLANT ADAPTATIONS

Wetlands are a challenging place to live! What specialized structures do wetland plants have that allow them to function and survive here?

LESSON AT A GLANCE

GRADE LEVEL

- 6th - 8th grades

CORRELATING STANDARDS

- SC.6.9.3.A
- SC.7.8.4.E
- SC.8.10.5.C

ACTIVITY TIME

- 5-10 min - Warm Up:
 - Wetland Challenges
- 30 min - Main Activity:
 - The Toughest Trees

MATERIALS

- 100 dice or more if available
- "Only the Strong Survive" guide sheet with "Number of Trees Remaining" chart on back
- Worksheet for graphing
- Extension Materials as needed

INTRODUCTIONS

Wetlands are unique aquatic ecosystems in Nebraska. The plants that live there have amazing adaptations that allow them to thrive! Using their special structures like roots, stems, and flowers they are able to function and reproduce, continuing the cycle of life in wetland habitats.

OBJECTIVES

This lesson was designed to be used in partnership with the video "Wetland Plant Adaptations". The video and lesson will allow students to better understand that many plants can be found in Nebraska wetlands. Students will see that changing environments like wetlands can lead to changes in populations within that habitat. Plant growth can be affected by this phenomena.

As a result of this lesson:

- Students will provide evidence for how plant adaptations affect the probability of successful reproduction.
- Students will understand that the genetic traits in plants lead to specialized structures that can increase the plants' probability of survival.

BACKGROUND INFORMATION

What is a Wetland?

How do we define wetlands? This type of habitat is made unique by three key characteristics:

1. **Vegetation** - water loving plants adapted to growing in highly saturated conditions grow here
2. **Hydric soils** - soils found here have developed under saturated conditions that limit oxygen (anaerobic conditions), they often carry a rotten egg smell
3. **Hydrology** - wetlands are saturated by water at some time during the growing season (the time when plants are actively growing)

Wetlands in Nebraska include marshes, lakes, river and stream backwaters, oxbows, wet meadows, fens, forested swamps, and seep areas. These wetlands vary greatly in nature and appearance due to physical features such as geographic location, water source, water permanence, and chemical properties. At some points during the year we may find that some wetlands are bone dry while others always contain some amount of water. There are instances where we may come back after a steady rain and the wetland will be filled to the brim with water. Some wetlands receive their water from groundwater aquifers while others are totally dependent on precipitation and runoff. And finally, the water chemistry of wetlands ranges from fresh to saline, and from acidic to basic. These descriptions identify the extremes of wetland characteristics. Nebraska's wetland resources possess these extremes and virtually every combination in between.

The vegetation, soils, and water that make up a wetland provide habitat for the many species found in Nebraska. The plants that depend on these habitats for survival often face challenges while living in such a dynamic environment. Many plant species have incredible adaptations that allow them to grow and reproduce in wetlands, while other species without these specialized structures would not be able to survive as well. Using their unique features these plants are able to function well in floods, droughts, saline conditions and more.

Begin by watching the video Wetland Plant Adaptations found at:

https://youtu.be/rFU21Or_jEo
or scan the QR Code



The Challenges Plants Face in Wetlands

When the Water Dries Up

One thing people don't usually realize is that wetlands go dry. Depending on the year, they might even stay dry all the time. While many plants would not be able to survive without water, there are other species that have adapted specifically to make it through these circumstances. The endangered plant Saltwort lives in Saline Wetlands surrounding the Lincoln, Nebraska area. The salty soil of these wetlands might cause other plants to wither away, but the Saltwort thrives! The succulent-like stem and leaf structures hold in water, much like a cactus does in a desert. Saltwort also has a root structure called a tap root. This single root structure taps deep into the earth, reaching water and nutrients found in the groundwater even when the topsoil is dry and crusted. Though this plant is listed on Nebraska's endangered species list, the Saltwort survives well in these unique saline wetlands found nowhere else in the state.

Lack of Oxygen in Wetland Soils

While not all wetlands have salty soil, many of them do have soils that develop in conditions that lack oxygen. It's one of the qualities that make wetlands different from other habitats. And though plants don't have lungs like humans, they still need oxygen to survive. The cattail is an emergent plant, usually found standing in three foot deep water on the edges of wetlands. It addresses this watery challenge by taking in oxygen at the top of the plant and moving air down its stem to the roots and rhizomes underground and often, under water. It's almost like when humans use a snorkel to breathe while our mouth is underwater! This rigid stem structure also provides the cattail great support when faced with heavy floods or wind. Multiple cattail species can be found throughout Nebraska and are highly adaptive.

Flooding

Nebraska's state tree is the Eastern Cottonwood. When the waters rise in a wetland, plants like the Cottonwood tree are the first to become submerged because they usually grow nearby. Oftentimes, this flooding can interrupt the normal exchange of oxygen and carbon dioxide between the tree and its environment, weakening the tree and making it susceptible to diseases. The impact to the tree is usually determined by how long it is covered with water. However, our Eastern Cottonwood has a strategy - shallow roots! By keeping its roots close to the earth's surface, they are the first to dry out when flood waters recede. While this isn't a total guarantee that they will survive, it certainly does help!



The Challenges Plants Face in Wetlands continued

Fast Flowing Water

In especially harsh flooding conditions, water can move swiftly through an area and cause problems for the plants growing there. That's why you'll notice that many Nebraska wetland plants have narrow and pointed leaves. The Arrowhead is one of these, with its triangular leaves that allow water to pass more smoothly by, therefore sparing the plant from large damage.

Reproduction

We know that the ultimate goal of living things is to create more of themselves through various methods of reproduction. Plants have some truly incredible methods to achieve this, dispersing their seeds far and wide. If we take a look at wetland plants, we will notice that there are unique methods of reproduction happening there.

- Cattail plants actually use two methods to spread and create more of themselves. **Rhizomes** are thick branching tubers at the base of the plant that spread horizontally by sending out shoots or nodes. When you look at a giant stand of cattails you may actually be looking at just one plant! Cattails also spread through the seeds that will puff out of the fruit - a long hot-dog looking seed pod. These seeds can be dispersed by wind or water.
- Similarly, the Eastern Cottonwood tree also has wind dispersed seeds. There are actually male trees that produce pollen which is carried on the wind to the female trees and their "catkins" - the flowering body. Once pollinated, the catkin pods will produce millions of white fluffy seeds to be carried away on the wind and water. Hence the name, cottonwood!
- A completely different plant with an explosive reproductive strategy can be found growing in the damp wetland areas surrounding Nebraska streams. Jewelweed, which looks similar to an orchid with its yellow and orange petals - attracts pollinators like hummingbirds. Once this flower is pollinated, it develops into an elongated seed pod structure. When disturbed, this structure undergoes a process called "explosive dehiscence" where the stored energy in the tissues of the pod are transferred to the seeds, thereby launching the seeds into the air in an effort to disperse them.



ACTIVITY PROCEDURES

Warm Up Activity:

What Challenges do Wetland Plants Face (5-10 minutes)

Setting: Indoors

1. Begin with a class discussion. Ask the questions below, giving students time to answer each one and process as a group.
2. What types of challenges do plants encounter in wetland habitats?
 - o Potential answers may include:
 - Drought
 - Flooding
 - Lack of Oxygen
 - High Winds
 - Water Pollution
 - Stagnant standing water
 - Insect Attacks
3. What are challenges we didn't think of that might exist in other Nebraska habitats, such as a prairie or grassland?
 - o Intense sunlight, Heat, High Winds, Chemical Spraying, etc.
4. Is there a certain type of plant you can think of that has evolved specifically to survive an environmental challenge?
5. Did you learn anything new from the video that you didn't know before?
6. How many of you have been to a wetland before? If you have, share what that experience was like. What do you like to do there? Have you ever noticed plants living there?



ACTIVITY PROCEDURES CONTINUED

Main Activity: The Toughest Trees (30 minutes)

Setting: Indoors

1. When eastern cottonwood trees reproduce, they can release more than 40 million windblown seeds from one single tree. This reproductive strategy means that only a few strong individuals with the appropriate traits will survive to adulthood. For this activity, we'll look at 100 theoretical seeds released from just one catkin - the flower and eventually the seed pod - of the cottonwood tree.
2. Divide 100 dice among students. You may do this in student pairs or on their own.
3. Each die will represent a cottonwood Tree making its way through its life cycle. Instruct students to roll their set of dice and make a note of what numbers were rolled. Read what happened to the cottonwood based on the number rolled.
4. Remind students to closely track how many cottonwood trees move on in each round and how many perish.
5. Students will use the worksheet (preview below) to track the cottonwood seeds and their survival rate.

Seed	Seedling	Sapling	Adult
1 - This seed flies in the air only to land in conditions that prevent it from growing	1 - This seedling becomes a tasty snack for a rabbit	1 - This sapling becomes crowded out by other competing plants	1 - This adult tree falls to the ground during a windstorm
2 - There was a drought, and this seed never germinated	2 - This seedling is flooded with water for too long causing it to rot	2 - This sapling is cut out by a beaver and stored for winter	2 - This adult tree is torn down by a homeowner
3-6 - These seeds germinate and begin to put down roots!	3 - This seedling is in poor soil conditions that stunt growth	3 - This sapling is eaten by a deer	3 - This adult tree is destroyed by a fire
	4-6 - These seeds survive well, sprouting leaves and growing	4 - This sapling endures a tough drought and does not survive	4 - This adult tree doesn't get enough oxygen to its roots and dies
		5-6 - These saplings thrive, growing a thicker trunks with plenty of space	5 - This adult tree becomes sick and is attacked by fungi and insects
			6 - <u>Congratulations!</u> This adult tree survives, living to be over 120 feet tall and over 100 years old, with a trunk that is 5 feet thick!
Remove all 1-2 dice. Keep all dice with 3-6. These seeds hatched. Reroll remaining dice.	Remove all 1-3 dice. Keep all dice with 4-6. These survived. Reroll remaining dice.	Remove all dice 1-4. Keep all dice with 5 and 6. These survived to become adults. Reroll remaining dice.	Remove all dice 1-5. Keep all dice with a 6. These survived to become adults!



ACTIVITY PROCEDURES CONTINUED

6. To review what happened as the dice were rolled, fill out this chart as a class or have students fill it out individually. See worksheet for details.

Number of Cottonwood Trees Remaining	
A cottonwood catkin (seed pod) releases 100 seeds into the environment.	100
How many seeds did not germinate?	
How many seeds did not have suitable habitat?	
How many seedlings do not survive due to poor habitat conditions?	
How many seedlings and saplings are eaten by something?	
How many trees are removed by humans?	
How many saplings are crowded out by other plants?	
How many trees become sick and attacked by fungi?	
How many trees are scorched by fire?	
How many trees survived to adulthood?	

7. If you have more dice, you can certainly use them and adjust calculations accordingly.

8. After rolling all of the dice, how many trees survived? Instruct students to graph their results!

- See attached worksheet for a graphing guide

9. Instruct students to answer the questions on the worksheet regarding their graph. Analyze the data to understand what happened.

Calculations for tree survival will look like this:

$$\text{Percent} = \left(\frac{\text{number of seeds that survive}}{\text{number of seeds total}} \right) \times 100$$

10. Group Discussion: What does this activity tell us about overall tree survival as time goes on? Did things turn out like students thought they would?



ACTIVITY PROCEDURES CONTINUED

Wrap Up:

Discussion Questions

- What types of challenges or environmental changes do plants face in a wetland?
- Are these different from some of the challenges an animal would face?
- How can environmental and even genetic factors influence the growth of an organism?
- What plant utilizes asexual reproduction in the video? Is the genetic information created by this form of reproduction identical or varied?
 - Cattails spreading by rhizome is asexual and creates genetically identical cattails.

Extension Activity:

Dissect a Cattail (45-60 minutes)

Setting: Indoors

Tools

1. Evaluate your dissection tools on a regular basis. Only use quality dissection tools that are sharp and free of rust. Handle all scalpels, razor blades and other sharp instruments with caution, and don't use excessive force when working with or cleaning sharp instruments. Dull and dirty scissors, scalpels or blades are much more dangerous than sharp, clean ones. Throw away any instruments that are damaged and cannot be repaired.
2. If dissection is new to students, practice the procedures first with a fruit like an orange and utilize the needed tools to ensure proper usage and student's ability to follow instructions.
3. Instruct students on proper dissection techniques and procedures, including how to safely remove the scalpel cover, how to safely cut with a scalpel and how to dispose of materials if needed. Always cut away from the body and away from other people. Reposition the specimen or move it to ensure safety if needed.



ACTIVITY PROCEDURES CONTINUED

Cattails

1. Identify an area where Cattails are abundant, and removal won't harm existing activities such as bird nesting. Remove enough plants for students to split in groups of 3 to 4 (ex. 27 students - about 9 stems of cattail)
2. Reach out to your local natural resources group if you're not sure where to source cattails. Resource professionals should be able to advise you.
 - If possible, remove the invasive Narrow-leaved cattail. To identify, visit:
 - <https://elibrary.dcnr.pa.gov/GetDocument?docId=1738749&DocName=cattails.pdf>
 - Broadleaf or Common Cattail is native to Nebraska.
 - https://www.wildflower.org/plants/result.php?id_plant=tyla
3. Once you have acquired enough cattails, begin by securing the specimen to something secure. Because cattails are quite long, you may want to use several dissection trays or simply a long piece of cardboard where it can be secured.
4. If it's easier, assign students in their small groups to separate the cattail by its structures.
5. Each cattail structure could have its own tray. The flower/seeds, stem, leaf, and roots make up four separate structures on the cattail and each could be looked at individually. This could allow for each student to take a turn making observations with each structure.

Procedures

1. You may choose to use the I Notice, I Wonder worksheet to begin the observation phase. Otherwise, begin by having students sketch all the different parts of the cattail from observation, using the worksheet attached if desired. If you are going to split the cattail into pieces, it may be best to sketch before this is done, allowing students to view the whole plant. If possible, students should label each part of the plant as well.
2. Inspect the roots.
 - What shape are they?
 - Do they have a smell?
 - Can they identify the roots?
 - Can they find any rhizomes attached? If so, cut a cross-section!
3. Check out the shoot area.
 - Cut a cross-section and sketch what you see.
 - What is the texture of this area like?

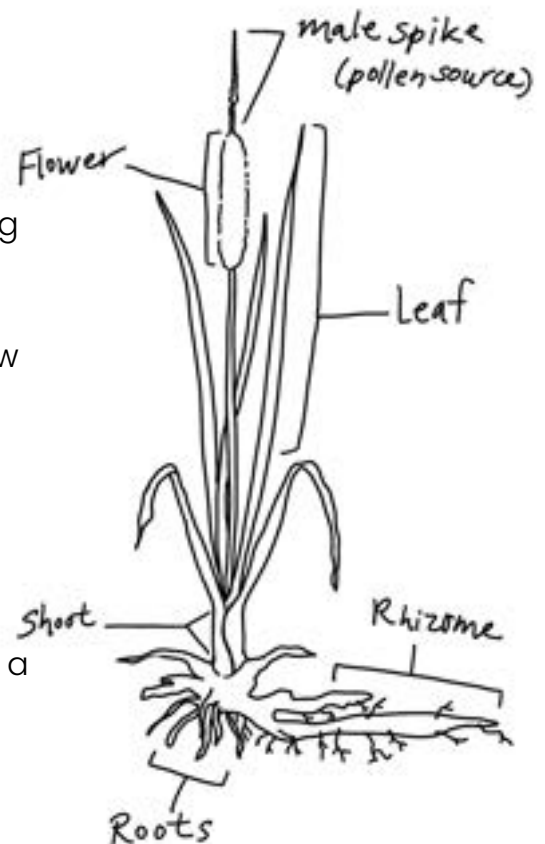


Illustration by Grace Gaard

ACTIVITY PROCEDURES CONTINUED

4. Examine the stem. Note that the inner part of the stem is called the pith.
 - o What is the stem's function?
 - o Does it have a texture?
 - o Cut a cross-section of the stem and use a microscope if needed to see what it looks like. Sketch what you see! Does it differ from other cross-sections?
 - o What are those holes for? (Hint: It's in the video!)
 - o If desired, cut a section of the stem length-wise. What is inside?
5. Examine the leaf.
 - a. Where does it attach to the stem?
 - b. Does the leaf look the same on both sides?
 - c. Does the cattail leaf tear easily?
 - d. Cut a cross-section of the leaf and sketch what it looks like. Use a magnifier to view more closely if needed.
6. Explore the "cat's tail" or "hot dog" part of the cattail. This is the flower and eventual seed pod structure if pollinated. Pollen usually emerges from the top half of the flower structure, with the female structure and future seeds (if pollinated) lying below.
 - a. Pull out some of the seeds. Are they developed?
 - b. Sketch an individual seed.
 - c. Inspect the area above the flower where pollen is released by wind. Can they see any signs of this?
 - d. If possible, cut a cross-section of the flower area. What do you see? Sketch this by making close observations.

Wrap Up:

Discussion Questions

- What did students learn about cattails from this exploratory dissection?
- What surprised them the most?
- What was most interesting about the flower part of the cattail?

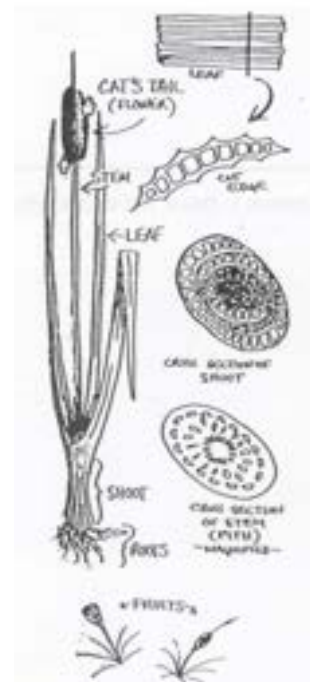


Diagram by allegheny.edu

Check out the entire Wetlands of Nebraska Project:

Take a deep dive into Nebraska’s best wetlands resources, including expanded website content, documentaries featuring Nebraska’s five main wetland types, printed guides and more!

Find it at www.nebraskawetlands.com, or scan the QR code.



Author: Grace Gaard
Nebraska Game and Parks Commission, 2023

Contact: NGPC.WildlifeEd@nebraska.gov

The Toughest Trees

Instructions: Each die will represent a Cottonwood Tree making its way through its life cycle. Roll your die and make a note of what numbers were rolled. Read what happened to the tree based on the number rolled.

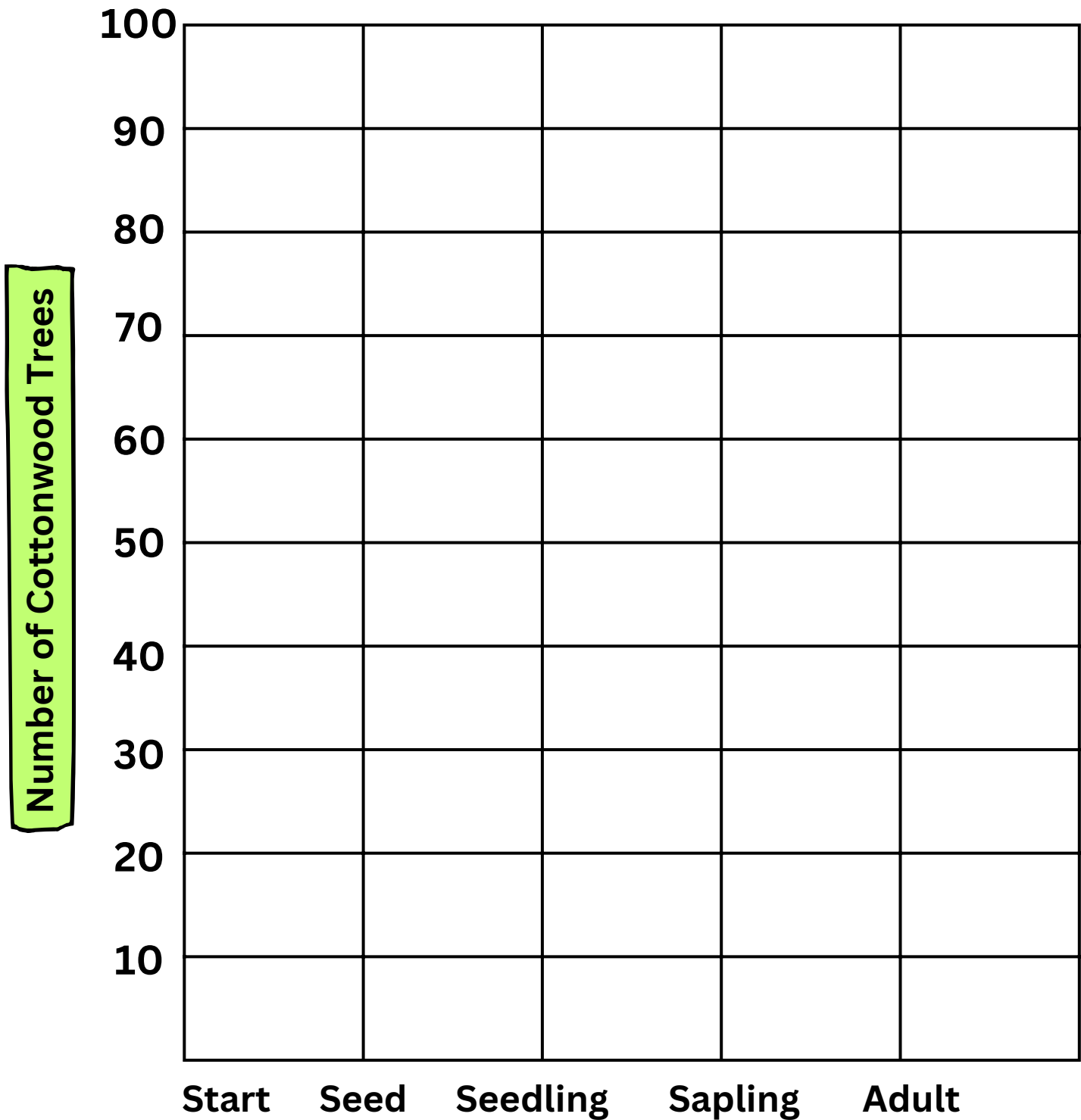
Seed	Seedling	Sapling	Adult
1 – This seed flies in the air only to land in conditions that prevent it from growing	1 – This seedling becomes a tasty snack for a rabbit	1 – This sapling becomes crowded out by other competing plants	1 – This adult tree falls to the ground during a windstorm
2 – There was a drought, and this seed never germinated	2 – This seedling is flooded with water for too long causing it to rot	2 – This sapling is cut out by a beaver and stored for winter	2 – This adult tree is torn down by a homeowner
3-6 – These seeds germinate and begin to put down roots!	3 – This seedling is in poor soil conditions that stunt growth	3 – This sapling is eaten by a deer	3 – This adult tree is destroyed by a fire
	4-6 – These seeds survive well, sprouting leaves and growing	4 – This sapling endures a tough drought and does not survive	4 – This adult tree doesn't get enough oxygen to its roots and dies
		5-6 – These saplings thrive, growing a thicker trunks with plenty of space	5 – This adult tree becomes sick and is attacked by fungi and insects
			6 – <u>Congratulations!</u> This adult tree survives, living to be over 120 feet tall and over 100 years old, with a trunk that is 5 feet thick!
Remove all 1-2 dice. Keep all dice with 3-6. These seeds hatched. Reroll remaining dice.	Remove all 1-3 dice. Keep all dice with 4-6. These survived. Reroll remaining dice.	Remove all dice 1-4. Keep all dice with 5 and 6. These survived to become adults. Reroll remaining dice.	Remove all dice 1-5. Keep all dice with a 6. These survived to become adults!

The Toughest Trees Cont...

Assess how many cottonwood trees did not survive through their cycle of life using the chart below.

Number of Cottonwood Trees Remaining	
A cottonwood catkin (seed pod) releases 100 seeds into the environment.	100
How many seeds did not germinate?	
How many seeds did not have suitable habitat?	
How many seedlings do not survive due to poor habitat conditions?	
How many seedlings and saplings are eaten by something?	
How many trees are removed by humans?	
How many saplings are crowded out by other plants?	
How many trees become sick and attacked by fungi?	
How many trees are scorched by fire?	
How many trees survived to adulthood?	

Graph Your Results



What percentage of cottonwoods survived the seed phase? _____

What percentage of cottonwoods survived the seedling phase? _____

What percentage of cottonwoods survived the sapling phase? _____

What percentage of cottonwoods survived to adulthood? _____

I NOTICE...

I WONDER...

IT MAKES ME THINK OF...

MAKE A DIAGRAM OF THE CATTAIL PLANT AS YOU DISSECT IT. LABEL ITS STRUCTURES AS YOU GO. TURN OBSERVATIONS INTO SKETCHES.