Ecological Succession

Image from Ducks Unlimited Canada

Specific Learning Outcomes

7-1-01: Use appropriate vocabulary related to their investigations of interactions within ecosystems.
7-1-04: Describe ecological succession and identify signs of succession in a variety of ecosystems.
7-1-05: Identify and describe positive and negative examples of human interventions that have an impact on ecological succession or the makeup of ecosystems.

General Learning Outcomes

7-0-4c: Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise.
7-0-4d: Assume various roles to achieve group goals.
7-0-7g: Communicate methods, results, conclusions, and new knowledge in a variety of ways.
7-0-7f: Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts.

Vocabulary

Ecosystem, abiotic, biotic, ecological succession, homogeneous, heterogeneous, zonation, disturbance event, pioneer, seral, climax community, submerged, emergent, upland vegetation

Summary

Students are introduced to the concept of ecological succession through the example of a prairie wetland. They learn the difference between zonation and succession, and the characteristics of organisms that are indicative of successional stages. Finally, students explore succession in a plant community by enacting the successional community themselves, with an emphasis on the impacts of disturbance on the timeline of succession.

Materials

- *Projector and computer to present slideshow*
- *Whiteboard/chalkboard to record results*
- *Open space*
- *Species Cards - one per student (print double-sided and cut out)*
- *Disturbance Event Cards - one copy (print single-sided and cut out)*
- *A coin*
- *Wetland Succession Activity instructions*

Procedure

Warm Up

Begin by reminding students of their recent visit to Oak Hammock Marsh, asking students to think about the plants they saw. Review that different plants have different requirements and tolerance for growth. Some can tolerate shaded conditions while others need full sunlight. Similarly, some tolerate deep water, growing fully submerged or emerging above the surface; others cannot grow if too much water is present as their roots drown. Discuss some plants the students might have seen on their field trip to Oak Hammock Marsh (cattails, Phragmites, pondweed, trees, shrubs, etc.), and what kind of growing conditions each might require. Did the different kinds of plants grow in the same place? If not, why?

Deliver the provided slideshow presentation, which discusses the changes that take place in an ecosystem over space (zonation) and time (succession), and what those changes look like in a wetland habitat. The slideshow will introduce the concepts explored in the activity, and at the end summarize what was learned in the wrap up.

Activity

Read through the *Activity Instructions* before you begin. Set up the place markers and timelines, and proceed with Parts 1 and 2 of the activity.

Wrap Up

Discuss the results of the activity with your class. Did the final community from Part 2 look the same as that from Part 1? Why not?

Of the disturbance events you experienced, which were natural and which were human-caused? If humans, were absent from the environment would succession occur in a more straightforward fashion? Is this always true?

What effects does succession have on the animals in an ecosystem? What effect would disturbance events have?

What kind of disturbance events might occur in other habitats? What effect would they have on the communities living there?

Emphasize that changes in ecosystems are inevitable, though we often don't recognize them because they occur on large timescales (100's of years).

Conclude by reflecting on how a real ecosystem such as Oak Hammock Marsh may have changed. What did it look like 100 years ago? What might it look like 100 years from now?

Animal Highlight - the Peregrine Falcon

On the cover of this section, and in the insets you will see pictures of the Peregrine Falcon. Peregrine Falcons are found in open habitats such as wetlands and coastlines on every continent except Antarctica. Their large size, pointed wings, and long tails offer a distinctive silhouette, while barred bellies and steely-grey heads give them a striking appearance.

Peregrine Falcons are best known for their remarkable hunting abilities. The fastest animal on Earth, they have been clocked at over 380 km/h when diving in pursuit of prey. These falcons specialize in hunting other birds and commonly eat pigeons, shorebirds, songbirds, and ducks.

Traditionally nesting on steep cliff ledges, Peregrine Falcons are a cosmopolitan species and many are now seen nesting on skyscrapers, transmission towers, and bridges. Historically, these birds suffered severe population declines in the 1950's, 60's and 70's as a result of DDT poisoning. Conservation efforts such as captive breeding programs and pesticide bans have been successful, and the species is no longer considered endangered in North America.

To learn more visit: www.allaboutbirds.org/guide/Peregrine_Falcon

Extensions:

- Have students create a visual timeline of succession, using the timeline created in Part 1 and/or 2, drawing what the ecosystem would look like at each point.

- Oak Hammock Marsh is a managed wetland, meaning natural disturbances such as floods and droughts are artificially recreated. Discuss why this is necessary, and what the habitat might look like in 100 years without such management. Have students choose an ecosystem and develop a management plan of their own to prevent succession to a climax community.

- Some human-caused disturbances have very far-reaching impacts. Assign students (individually or in small groups) an ecosystem, and have them research how climate change will change the community of plants and animals living there today. Present their findings to the class.

Succession Activity Instructions

Part 1

1) Have students sit on the floor in a circle. The inside of the circle is your wetland.

2) Draw a blank timeline of succession on the board (see example timeline below). *Leave room on the board to draw a second timeline under the first for Part 2 of the activity.*

3) The students will be acting out different plant species in an aquatic freshwater ecosystem as succession occurs. Hand out one *Species Card* to each student *(will need to print multiple copies of the Species Card so that every student has a card)*. Each card is double-sided and represents two species. Some students may end up with identical cards.

4) Have the students read their card and discuss the information given. Ensure students are aware of both the species' water depth tolerance and type.

5) Explain the rules of the activity: Instruct students that they will be 'growing' in the wetland. Students will use the information on their *Species Card* to determine whether they can grow in the ecosystem based on water depth. To enter the ecosystem their plant must be able to grow and have a place to grow in *(see maximum number of plants in Succession Key.)* If the maximum is reached, they will have to wait. *You will need to decide which students enter and exit the wetland each round to ensure that all students have an opportunity to take part.*

    a) To help illustrate the different species in the ecosystem, have students pose according to their species type when they are in the activity (*they can still stay in the circle or can move to the middle of the wetland*).

        - Fully submerged vegetation should sit down (milfoil & algae)
        - Emergent vegetation should kneel (cattails & broadleaf arrowhead)
        - Grasses and shrubs should stand with arms by their sides (sandbar willow & phragmites)
        - Trees should stand with arms above their head (poplar & aspen)

    b) As time passes the environmental conditions will change, and students may find they are no longer able to live in the wetland, and their plant might die (for instance, water becomes too shallow or too deep). If a suitable conditions reappear they can begin to grow again (i.e. re-enter the wetland).

    c) You will be flipping a coin to determine how much the water depth changes. **If the coin is heads move ahead two rows on the Succession Key table; if tails move ahead one row**. Record the water depth on the board in your timeline of succession each time you toss a coin. *Can get a different student to do this each round to keep them engaged.*

d) After each roll, help students decide what should be happening in the ecosystem, and record it on your timeline. *Use the Succession Key to help you guide the succession process; it lists water depth and species present.* Ask the students questions about their water depth tolerance and speed of growth to help them decide who should be exiting/ entering, such as:

- How deep is the water?
- Why is the water depth changing?
- Would these changes affect the animals that can live here? How?
- What kind of community is being represented? Pioneer, seral, or climax?

5) Begin the activity by describing the features of the ecosystem at the start. The wetland is a deep marsh, filled with clear water (2m deep). *The students representing submerged vegetation can enter the wetland after a few years (roles of the die) and begin growing in the wetland.*

6) Proceed as listed above, flipping the coin to determine how quickly the wetland dries up, and recording the results of succession on your timeline. As time passes, dead vegetation and silt will fill in the wetland, and the plant community will change. Taller emergent plants such as cattails will create shaded conditions and outcompete other species. *Use the Succession Key to help you guide the succession process; it lists water depth and species present. Finish once you reach the no more water with soil mostly dry state. Make sure students flip over their card and be the other species so they will have a second chance to enter the activity.*

Part 2

Discuss with your students what happened during Part 1 of the activity. What evidence of succession did you see? Did the ecosystem proceed in a straightforward manner through the stages of succession?

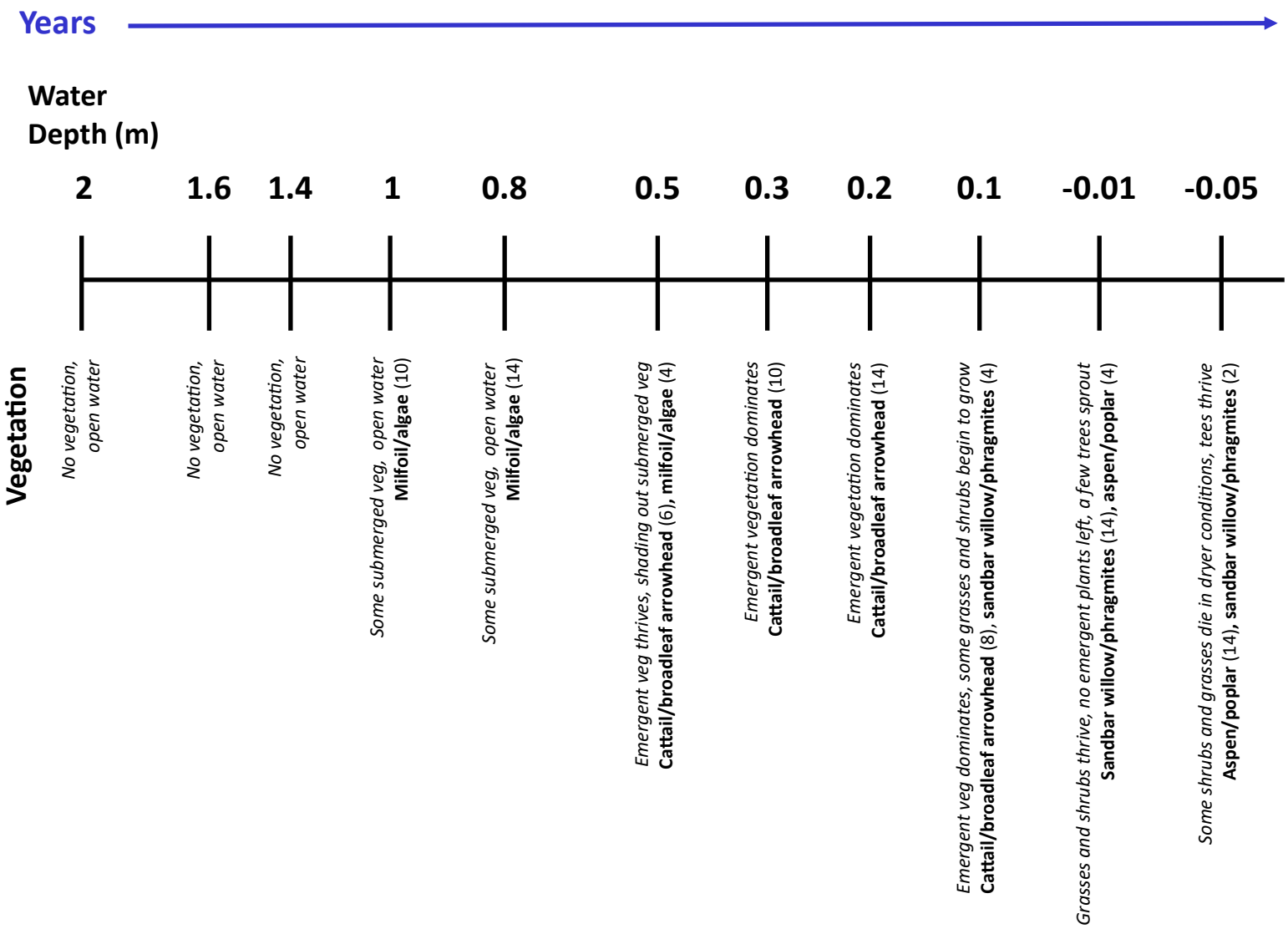
1) Draw a second timeline under the first, and prepare to go through the activity again, but explain that this time you will be introducing disturbance events.
2) Begin the activity as before, but this time read out a disturbance card after every other coin flip, selecting one randomly. Finish with the results of the coin flip and then discuss what the disturbance means for the species present, and how the landscape will now look. Make any adjustments to the plants that are needed based on the new water depth/disturbance.
3) The next round starts at the new water depth.
4) Continue until you run out of disturbance cards. You will likely not have reached a stable climax community as you did in Part 1. Discuss the reasons for this with your class.

Succession Key

Water depth (m)	Vegetation present (maximum # of plants)
2	*No vegetation, open water*
1.8	*No vegetation, open water*
1.6	*No vegetation, open water*
1.4	*No vegetation, open water*
1.2	*Some submerged vegetation, but some open water remains* **Milfoil/algae** (4)
1	*Some submerged vegetation, but some open water remains* **Milfoil/algae** (10)
0.8	*Some submerged vegetation, but some open water remains* **Milfoil/algae** (14)
0.6	*Submerged vegetation, a few emergent plants* **Milfoil/algae** (8)**, cattail/broadleaf arrowhead** (4)
0.5	*Emergent vegetation thrives, shading out most submerged vegetation* **Cattail/broadleaf arrowhead** (6)**, milfoil/algae** (4)
0.4	*Emergent vegetation thrives, shading out most submerged vegetation* **Cattail/broadleaf arrowhead** (8)**, milfoil/algae** (2)
0.3	*Emergent vegetation dominates* **Cattail/broadleaf arrowhead** (10)
0.2	*Emergent vegetation dominates* **Cattail/broadleaf arrowhead** (14)
0.1	*Emergent vegetation dominates, some grasses and shrubs begin to grow* **Cattail/broadleaf arrowhead** (8), **sandbar willow/phragmites** (4)
0 - *Soil is fully saturated with water; a few puddles*	*Emergent vegetation, a few grasses and shrubs* **Cattail/broadleaf arrowhead** (6)**, sandbar willow/phragmites** (8)
-0.01 - *Soil partially saturated, no surface water*	*Grasses and shrubs thrive, no emergent plants left, a few trees sprout* **Sandbar willow/phragmites** (14)**, aspen/poplar** (4)
-0.05 - *Soil is mostly dry*	*Some shrubs and grasses die in dryer conditions, trees thrive* **Aspen/poplar** (14)**, sandbar willow/phragmites** (2)

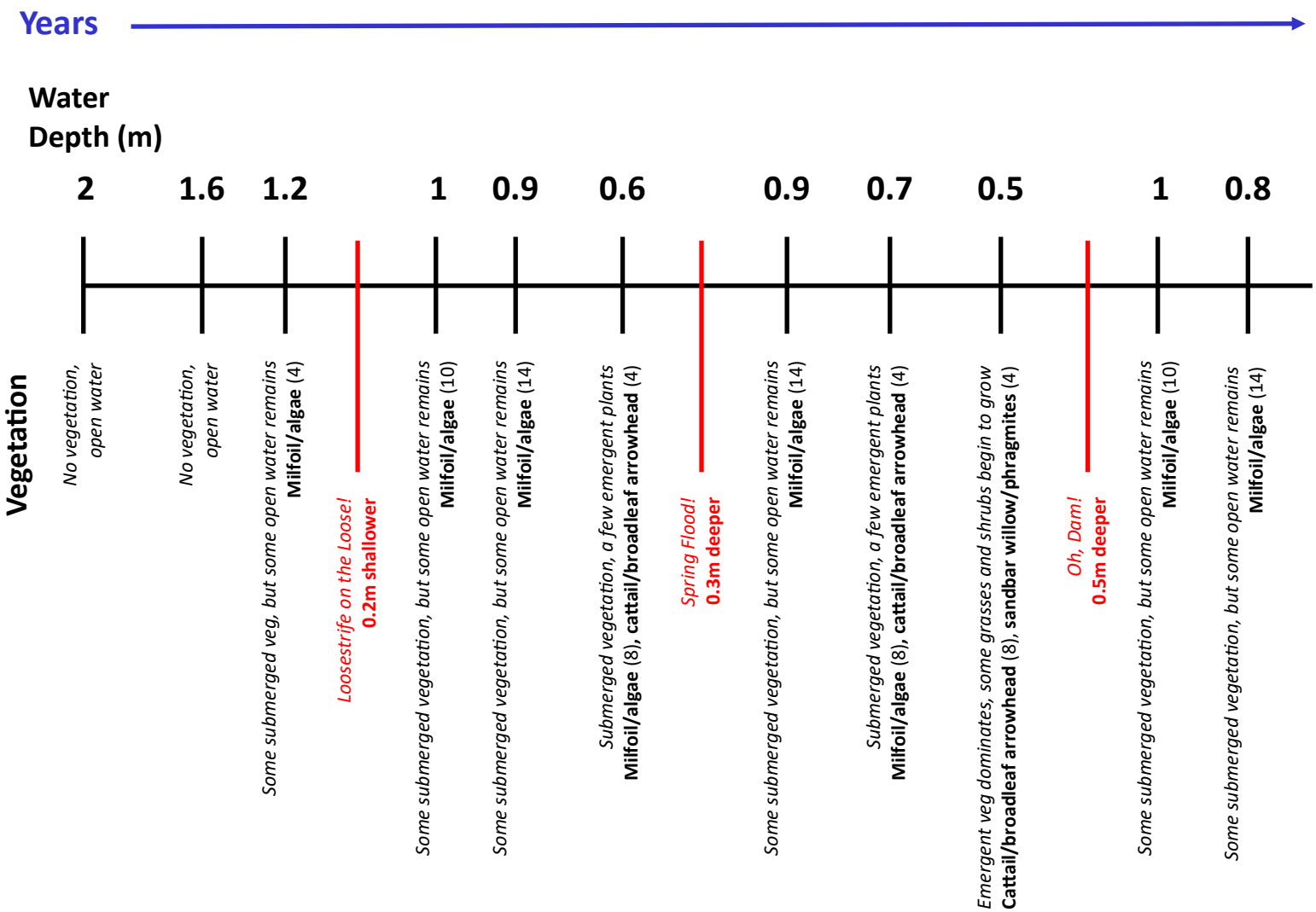
Timeline Example

Round 1



Timeline Example

Round 2



*Disturbances are in **RED (select and read aloud the card)**.*

Have students adjust plant numbers for new water depth.

****Print Species Cards double-sided****

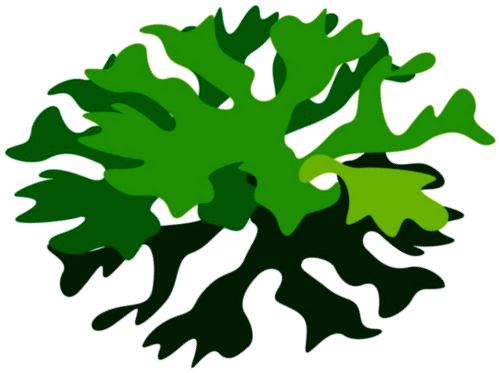
Species Cards Page 1

Milfoil

- Grows submerged, floating near surface
- Cannot grow out of water
- Can grow in deeper water (>1m deep)
- Fast-growing, short lived

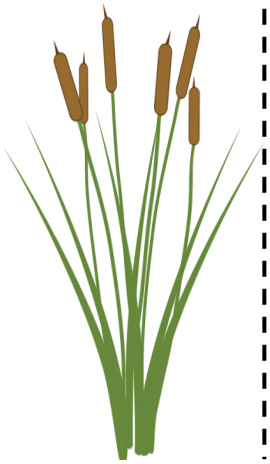
Algae

- Grows submerged, floating near surface
- Cannot grow out of water
- Can grow in deeper water (>1m deep)
- Fast-growing, short lived



Cattail

- Emergent plant
- Prefers shallow water (<0.5m deep), but can grow if soil is fully saturated
- Cannot grow in deep water (>0.5m)
- Fast-growing, relatively short lived



Broadleaf Arrowhead

- Emergent plant
- Prefers shallow water (<0.5m deep), but can grow if soil is fully saturated
- Cannot grow in deep water (>0.5m)
- Fast-growing, relatively short lived

****Print Species Cards double-sided****

Species Cards

Phragmites

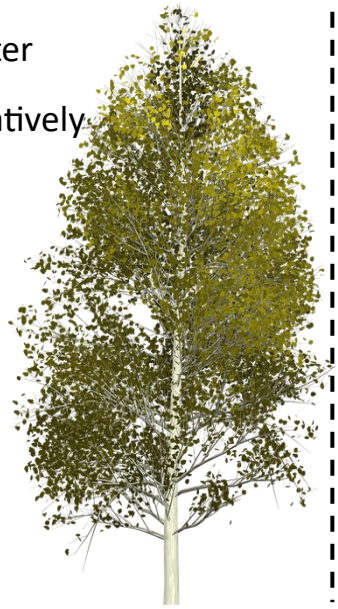
- A grass that grows in fully or partially saturated soil
- Cannot grow if roots are fully submerged in water
- Fast-growing

Sandbar Willow

- A shrub that grows in fully or partially saturated soil
- Cannot grow if roots are fully submerged in water
- Relatively fast-growing

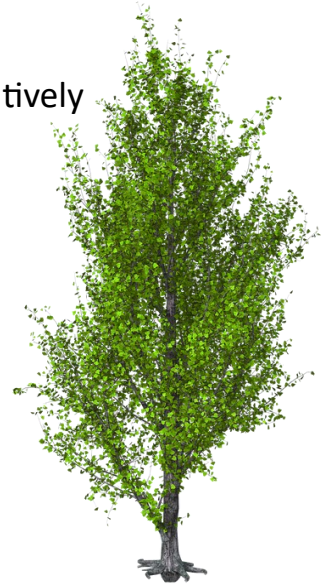
Aspen Tree

- Tree that grows in moist soil
- Cannot grow in fully saturated soil or water
- Slower-growing, relatively long lived



Poplar Tree

- Tree that grows in moist soil
- Cannot grow in fully saturated soil or water
- Slower-growing, relatively long lived



****Print Disturbances Cards single-sided****

Disturbance Cards Page 1

Beavers!

A beaver family has moved in next door and flooded the neighbourhood.

The beavers have flooded your wetland with 0.4 m of water!

- All trees, grasses, and shrubs will die off as their roots drown
- Submerged and emergent plants will continue to do well in shallow areas
- Deep areas (>1.5 m of water) will become patches of open water, with no vegetation

Thunder & Lightening!

Heavy spring thunderstorms have overrun the rivers, and are flooding the area.

The storm flood has added 0.2 m of water to your wetland

- All trees, grasses, and shrubs will die off as their roots drown
- Submerged and emergent plants will continue to do well in shallow areas
- Deep areas (>1.5 m of water) will become patches of open water, with no vegetation

Oh, Dam!

Too much water built up behind the nearby hydroelectric dam, and the extra water had to be released.

The dam release has added 0.5 m of water to your wetland

- All trees, grasses, and shrubs will die off as their roots drown
- Submerged and emergent plants will continue to do well in shallow areas
- Deep areas (>1.5 m of water) will become patches of open water, with no vegetation

Spring Flood!

An ice jam formed during the spring thaw, and the meltwater has nowhere to go - it's a flood!

The spring flood has added 0.3 m of water to your wetland

- All trees, grasses, and shrubs will die off as their roots drown
- Submerged and emergent plants will continue to do well in shallow areas
- Deep areas (>1.5 m of water) will become patches of open water, with no vegetation

Water, water, everywhere...

A unusually wet and rainy season has led to small floods all spring and summer.

The constant rain showers have added 0.1 m of water to your wetland

- All trees, grasses, and shrubs will die off as their roots drown
- Submerged and emergent plants will continue to do well in shallow areas
- Deep areas (>1.5 m of water) will become patches of open water, with no vegetation

Unlimited Ducks?

A wetland restoration project by Ducks Unlimited Canada has brought back crucial breeding habitat for waterfowl. It's Quack -tastic!

**********This card only applies if you have <0.3 m of water. Otherwise, draw another card and put this one back into the deck*****************

- Your marsh is dug out and restored to a depth of 0.5m

****Print Disturbance Cards single-sided****

Disturbance Cards Page 2

Loosestrife on the Loose!

Purple Loosestrife has invaded!! This invasive species quickly overtakes native plants, and increases the natural fill-in rate. These plants were eventually noticed & removed, but their impact can still be felt...

The loosestrife increased the rate that the marsh filled in; your marsh is now 0.2 m shallower.

- Use the Succession Key to guide which plants will come and go as a result of the decreased water level

What a drain...

Local landowners drained your wetland in order to plant more crops!

The drainage has removed all standing water from your wetland, but the soil is still <u>fully</u> saturated.

- All submerged plants die as the water disappears
- Emergent plants continue to grow in the saturated soil
- Grasses and shrubs begin to sprout
- Trees can begin to sprout if there are areas with partially saturated or mostly dry soil

Fire!

A wildfire is sweeping through the area.

The fire will burn all non-submerged plants

- Cattails and arrowhead have large underground roots, and regenerate quickly after a fire. They are still in the activity.
- Grasses and shrubs burn quickly, but not deeply. They also regenerate after a fire. They are still in the activity.
- Trees are burned and killed. They are out of the activity.

Mooooo!

Cattle have been let out to graze in the fields around your wetland. They won't turn up their nose at a cool bath or some tasty vegetation.

Cattle stirring up the mud smother any submerged plants. They graze on the grasses, and trample young trees

- Any trees that just entered the wetland die
- Submerged plants die due to sediment in the water (so they are out of the wetland)
- Grasses are able to regenerate after grazing, but some shrubs don't do as well. 1/2 of the willows present die.

Drought!

An unusually dry season has led to a drought. Water everywhere is drying up!

The drought is drying up your wetland. You have lost 0.3 m of water.

- Use the Succession Key to guide which plants will come and go as a result of the decreased water level

Nowhere to go?

Other wetlands in the area have been in-filled for a housing development. After a heavy rainstorm the water has nowhere else to go and floods your wetland.

The flood has added 0.1 m of water to your wetland

- All trees, grasses, and shrubs will die off as their roots drown
- Submerged and emergent plants will continue to do well in shallow areas
- Deep areas (>1.5 m of water) will become patches of open water, with no vegetation