

NORTHEASTERN FRESHWATER STREAM ECOSYSTEM SNAPSHOT

Read this short story to help orient to and immerse learners in the Northeastern freshwater stream ecosystem. Note: You may need to create ecosystem snapshots and disruption scenarios that are more regionally specific to your local area and more familiar to participants. For suggestions and tips please refer to the Ecosystem Engineers facilitator guide.

Set the scene

You're sitting on the side of a **freshwater creek**. It's right at the edge of the neighborhood where you're visiting family, and you hear the sounds of a pickup basketball game a block or so away. You can feel the warm **sun** on your face as it shines down, the light passing through an **oak tree's** leaves. Looking closer at the stream, you make out the outline of a **crayfish**, camouflaged against the **algae-covered** rocks of the **stream bed**. Maybe it's looking for **dragonfly larvae** or other aquatic insects to eat.

You look across the creek and see a **group of people** fishing on the other bank. The **mosquitoes** have begun to bite and you notice your stomach rumbling. You stand up and begin to walk slowly along the **stream bank** toward the basketball courts, hoping to find a decent snack and watch the next game.

After a few steps, you are distracted by a mossy, decaying log. You pause to turn it over. Beneath the damp wood, you find a large brownish-black **salamander** with yellow spots that dives into its burrow. **Earthworms** retreat into the dark, rich dirt that they've made from wood and leaves. You gently replace the log and continue your walk along the stream. A **red-tailed hawk** is perched on a tree branch over the stream. Suddenly, it swoops down to the water! It must have spotted some prey: a **trout** that has swum upstream to spawn or a **water snake** basking in the noontime sun.

Disruption scenario 1: Upstream concentrated animal feeding operation

A year later, you return to that same neighborhood for another visit. This time, riding into town on the bus, you pass a massive dairy farm that has moved in upstream. The little farmhouses and fields that you remember occupying that land have been replaced with acres and acres of tightly packed livestock. Even inside the bus, you're forced to cover your nose with your t-shirt to mask the smell of so many animals.

When you walk down to the stream, you find that you can hardly see into the water. It has become cloudy with fertilizer runoff and manure. No one is fishing: it's not safe to eat the fish from this stream anymore, and fewer and fewer trout (your favorite) are swimming up this way anyway. The water is just too dirty for them. You wonder what the hawks are eating now, and whether any aquatic insects have survived the change in water quality.

Back in the neighborhood, the basketball courts are empty, and you can understand why. The light breeze brings with it an unpleasant manure smell, so people are staying indoors. Some folks, you hear, have gotten jobs at the big farm up the road, but no one is quite sure who owns it. At least, you think, the people who used to eat fish can have beef if they want it.

Scenario-specific discussion prompts

Which abiotic environmental ecosystem components (sun, stream bed, stream bank, freshwater stream) are affected by a large cattle farm moving in upstream?

- Reduced water quality in stream (fertilizer, manure) affects creekbed and freshwater environments

Which animals or plants are directly impacted by this change? (*SDGs #14: Life Below Water and #15: Life on Land*)

- Water snake, trout, humans, aquatic insects (dragonfly larvae), crayfish, algae, humans

How do these changes in the ecosystem affect the human community's access to jobs and food? (*SDGs #1: No Poverty and #2: Zero Hunger*)

- CAFO may employ some people from the neighborhood and increase access to cheap meat
- People are less able to eat fish from the stream

How does the large-scale cattle farm affect local human and non-human communities' access to clean water? (*SDG #6: Clean Water and Sanitation*)

- People may need to upgrade water treatment options to make up for pollution from the farm, or bring in water from an outside place
- Stream water is contaminated, so animals will be affected

What other aspects of people's lives (e.g. health and recreation) are affected by this ecosystem changes? (*SDG #3: Good Health and Well-being*)

- People don't want to spend time outside having fun and exercising because of the bad smells

Key Issues: Water pollution, air pollution (including odor), decreased biodiversity, fewer healthy food options

Background information

The United States Environmental Protection Agency (EPA) defines Animal Feeding Operations (AFOs) as "agricultural operations where animals are kept and raised in confined situations" (2020). "AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland" (USDA Natural Resources Conservation Service). "Manure and wastewater from AFOs have the potential to contribute pollutants such as nitrogen and phosphorus, organic matter, sediments, pathogens, hormones, and antibiotics to the environment" through leaching and decay (Environmental Protection Agency). Any AFO of a certain size (e.g. 700+ mature dairy cattle) or that has been identified as a "significant contributor of pollutants" by permitting agencies is considered a Concentrated Animal Feeding Operation, and is subject to certain regulations.

References

For more information on the designation and size of Concentrated Animal Feeding Operations:

https://www.epa.gov/sites/production/files/2015-08/documents/sector_table.pdf.

Environmental Protection Agency. (2020). National Pollutant Discharge Elimination System (NPDES). Animal Feeding Operations (AFOs): <https://www.epa.gov/npdes/animal-feeding-operations-afos>

USDA Natural Resources Conservation Service. (2020). Animal Feeding Operations: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/livestock/afo/>

Disruption scenario 2: Storm/Flooding

A year later, you return to that same neighborhood for another visit. Riding into town on the bus, you notice that the landscape outside the windows has changed dramatically, flattened by flooding. Everything looks brown and muddy, punctuated by outcroppings of bare rock. Most of the little farmhouses and fields that used to stand along this route have disappeared. You've heard news reports about the severe storms in this area, but it's different seeing the effects of extreme weather with your own eyes.

Walking down to the stream that afternoon, you pass a number of abandoned houses at the edge of the neighborhood. The sidewalks here are still full of debris and litter that washed up in the storms. In some places, broken pipes stick up out of the ground. Many of the oak trees have fallen as the soil erodes out from under them, and you pick your way through their rotted roots. The stream bank has become a floodplain, and you can't help but think of all the earthworms and salamanders and other stream-dwellers that must have been washed away in the rains. The stream has widened, and you notice more algae than ever before. The algae has taken over, and seems to be choking out other signs of life.

No one is fishing today. You learn from your family who still live here that the storms stirred up pollutants from surrounding areas, so the water can't be trusted anymore and it's not safe for anyone to eat the fish. The mosquitoes have gotten particularly bad and there's not enough shade, so people don't spend much time down by the stream these days. How long, you wonder, will it take for this place to recover? How can the people living here help to protect and manage it while rebuilding their community?

Scenario-specific discussion prompts

Which abiotic environmental ecosystem components (sun, stream bed, stream bank, freshwater stream) are affected by storms and flooding?

- Reduced water quality in stream (fertilizer, manure) affects stream bed and freshwater environments

Which animals or plants are directly impacted by this change? (*SDGs #14: Life Below Water and #15: Life on Land*)

- Algal blooms use up oxygen and choke out other life in stream (aquatic insects, trout, crayfish)
- Habitat loss for stream bank dwellers, including spotted salamanders, earthworms, oak trees
- Fewer perches and less prey for red-tailed hawks
- More breeding areas for mosquitoes
- Loss of human infrastructure/habitat

How do these changes in the ecosystem affect the human community's access to food? (*SDG #2: Zero Hunger*)

- Fewer local farms and fresh produce/meat available
- Decreases people's ability to eat fish from the stream

How does the flooding affect local human and non-human communities' access to clean water? (*SDG #6: Clean Water and Sanitation*)

- Heavy storms and flooding bring pollutants from surrounding areas, often results in the spread of disease
- Sewage and plumbing infrastructure compromised

What other aspects of people's lives (e.g. housing, recreation) are affected by this ecosystem changes? (SDGs #3: Good Health and Well-being, #9: Industry, Innovation and Infrastructure and #11: Sustainable Cities and Communities)

- Some people's housing is gone and they may have had to move to other communities
- Loss of opportunities to spend pleasant time outside in nature

Key Issues: Habitat Loss (human and non-human), Water Pollution, Litter, fewer healthy food options, climate change

Background Information

Climate models predict increases in extreme weather. As the climate changes, some regions are undergoing or will experience severe drought, while other areas have already seen higher-impact storms (Pidcock et. al., 2019). While models vary with regards to the exact regional distribution of extreme weather, there is general agreement that precipitation events--when and where they do occur--will have increased intensity. (Hausfather, 2018).

One consequence of heavier rainfall is flooding. Depending on the size of the event, flooding may have mixed positive and negative impacts on aquatic ecosystems (Talbot et. al., 2018), but almost always negatively impacts human communities in the floodplain by destroying infrastructure (including sewage pathways), dirtying water reservoirs, and facilitating the spread of disease (Alberta WaterPortal Society, 2019).

References

Alberta WaterPortal Society. (2019). Environmental Impacts of Flooding: <https://albertawater.com/what-are-the-consequences-of-flooding/environmental>

Hausfather, Zeke. (2018). Climate Brief: Clear on Climate. Explainer: What climate models tell us about future rainfall: <https://www.carbonbrief.org/explainer-what-climate-models-tell-us-about-future-rainfall>

Pidcock, Roz et. al. (2019). Climate Brief: Clear on Climate. Mapped: How climate change affects extreme weather around the world: <https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world>

Talbot, Ceara J. et. al. (2018). The impact of flooding on aquatic ecosystem services. *Biogeochemistry* 141, pp. 439-461.