



MONO: A Diverse Experience: Stream Ecology Lesson

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Overview

The theme for this week is MONO: a diverse experience. We see it in the interactions between rural and urban landscapes, historic and modern structures, paved roads and unpaved trails, and agricultural and conservation activities. It also gives us a glimpse into the diversity in ecosystems in the interactions between the living and the non-living factors of the world. In this lesson, we will learn about stream ecology and how biotic and abiotic factors interact to sustain the diverse ecosystems found at MONO.

Learning Objectives

- YCC precipitants will have a general understanding of stream ecology and its threats.
- YCC precipitants will distinguish between biotic and abiotic factors in aquatic ecosystems.
- YCC precipitants will hear about mitigating solutions to reduce stressors to streams.

Materials Needed

- Whiteboard (or big paper)
- Markers

General Outline

1. Stream Ecology

- a. MONO River and Tributaries*
- b. Stream Health*
- d. Environmental Risks*
- e. Mitigating Activities*

2. Fish and Invertebrates

- a. Aquatic communities*
- b. Fish at MONO*
- c. Invertebrates at MONO*

3. Biotic and Abiotic Factors

- a. Activity*

Background (for park employee benefit)

The relationship between biotic and abiotic ecology is important to the functioning of the ecosystem. There are three streams running through MONO and a river that flows along the boundary of MONO.

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Procedure

1. Stream Ecology

a. MONO River and Tributaries

- i. Ask YCC precipitants: do you know what rivers and streams run through the park?¹
 1. Monocacy River: flows through and along the boundary of MONO. It is a tributary of the Potomac River.
 2. Bush Creek: it flows through the Gambrill Farm. It is a tributary of the Monocacy River.
 3. Harding's Run: flows from West Lewis through the Baker Farm and around Brooks Hill. It is a tributary of the Monocacy River.
 4. Gambrill Creek: flows through the Thomas Farm and along the Gambrill Mill boardwalk. It is a tributary of the Monocacy River.
- ii. Definitions²:
 1. River: a natural flowing watercourse of freshwater that flows from high to low ground and drains into another body of water
 2. Run: a small smoothly flowing stream
 3. Creek: small and narrow body of water with a slight current

b. Stream Health

- i. Bodies of water provide habitat for countless organisms, including plants, fish, and vertebrates. Bodies of freshwater also provide water for land plants, humans, and land animals. The physical and chemical qualities of a stream are crucial for the survival of aquatic and terrestrial life.
- ii. Physical Health
 1. The National Capital Region Network (NCRN) Inventory & Monitoring (I&M) program have monitored stream physical habitats at 37 sites throughout NCR (including MONO) since 2008 every 6 years³. Monitoring helps:
 - a. Determine current stream conditions
 - b. Determine trends in species of fish and invertebrates
 - c. Track long-term trends
 2. Factors considered in the Physical Habitat Index (PHI) include⁴:

¹ NPS. "Monocacy." (2015) https://www.nps.gov/mono/learn/nature/rivers_streams.htm

² Broome, K. (2018) "Bodies Of Water: Complete List."

³ Nortrup, M. (2013) "NCRN Resource Brief: Stream Physical Habitat, Monocacy National Battlefield."

⁴ Nortrup, M. (2013) "NCRN Resource Brief: Stream Physical Habitat, Monocacy National Battlefield."

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- a. Riffle quality (section with fast flow and high turbulence. The movement provides adds oxygen and is a habitat)
 - b. Quantity of woody debris and lumps of roots in the stream
 - c. Suitability of stream bed surface materials for macroinvertebrates (they prefer hard, stable materials)
 - d. Shading, which reduces water temperatures
 - e. Embeddedness: extent to which rocks are covered by the bottom of the stream (mud, sand, silt). Low embeddedness (loose rocks) gives habitat for small fish and invertebrates
- iii. Chemical Stream Health
 - 1. NCRN I&M also monitors stream chemical health, including:⁵
 - a. Dissolved oxygen
 - b. Air and water temperature
 - c. pH
 - d. Salinity
 - e. Discharge (nutrient, pollution)
- c. *Environmental Risks*
 - i. Scientists monitor so many factors because bodies of water are incredibly susceptible to environmental contaminants.
 - ii. Eutrophication⁶
 - 1. Excess nutrients in a body of water, which causes a dense and quick growth of algae. When they die quickly, decomposers multiply rapidly to consume the dead algae, and this uptick in decomposers use up a lot of the oxygen in the water. If they use too much, they create “hypoxia”, areas where there is not enough oxygen for most life to survive.
 - a. Most important nutrients: Nitrogen and Phosphorus.
 - 2. Runoff is the process where rain carries chemicals into water from:
 - a. Agriculture fields that use a lot of chemicals (fertilizers, pesticides, insecticides, herbicides, fungicides, etc.)
 - b. Animal waste runoff
 - c. Vehicle exhaust from nearby roads and parking lots
 - iii. Altering stream flow⁷

⁵ Nortrup, M. 2014. “NCRN Resource Brief: Water Monitoring.”

⁶ USGS. “Nutrients and Eutrophication”

⁷ USGS. “Flow Modification of the Nation’s Streams and Rivers”

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1. Like aquatic organisms, humans need water. We manage water for flood control, urban infrastructure, irrigation of agriculture, among others, which affects the natural flow of streams and rivers
 - a. Ask YCC precipitants:
 - i. What are some ways that the streams and rivers near MONO have been altered for human use?
 1. Discuss: agriculture use, building roads and highways, drinking water
 - ii. What evidence of an altered stream bed do you see within MONO?
 1. Discuss: dry bed on the drive in
 - iii. What do you think caused the stream to change course, undercut the bank, downcutting of the bed?
 1. Discuss: roads, highways, agriculture
 - iv. Impervious surfaces
 1. Hard surfaces (roads, parking lots) increase the amount of rain that reach streams by preventing soil from soak the water. They carry pollution from urban areas and increase the speed of this polluted water flowing into streams.
 2. The increased water volume can sweep away the organisms living in the stream, cause erosion around the stream edge, and wash away the materials that make up important parts of the habitat (wood debris, roots, rocks).
- d. *Mitigating Activities*⁸
 - i. Contour farming
 1. Row patterns that run around the hill instead of up and down.
 2. Reduces soil erosion, and sediment and nutrient runoff.
 - ii. Watering crops
 1. Irrigating efficiently for specific crop needs and applying only what's needed reduces runoff.
 - a. Drip irrigation, sub irrigation, water trays and saucers.
 - iii. Fertilizers and pest control
 1. Mechanical pest control by other animals completely removes chemical usage.

⁸ EPA. "The Sources and Solutions: Agriculture"

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2. Like irrigation, understanding specific crop needs and applying only what's needed reduces runoff.
- iv. Vegetation buffer
 1. A buffer is akin a barrier between the body of water and fields.
 2. Plants and trees absorb nutrient runoff, reducing eutrophication.
 3. Buffers also provide shade, reducing water temperatures, and habitat through their root wads.
- 2. Fish and Invertebrates**
 - a. *Aquatic communities*
 - i. Fish and aquatic communities are excellent indicators of water quality. They are sensitive to many factors, including pollution, stream physical habitat, diseases, and invasive organisms.
 - b. *Fish at MONO*
 - i. NCRN I&M also monitors fish populations in small streams across the NCA. At each site, teams set two electrofish passes through 75m portions.
 1. Electrofishing: mild electric current stuns fish. They are netted, counted, identified, weighed, illnesses/anomalies are noted.
 2. Game fish (trout, bass, walleye) are separately tracked.
 3. All fish are released alive!
 - ii. The Fish Index Biotic Integrity (FIBI) Score includes:⁹
 1. Number of fish per stream area
 2. Species abundance
 3. Disturbance-tolerant or generalist feeders
 4. Bottom-dwelling fish
 5. Fish who need silt-free rocky stream beds to spawn
 - iii. Bush Creek: Good FIBI. 2010, 4.67 out of 5
 1. 27 species, roughly 2,000 fish
 2. 2 species were noted as invasive
 - iv. Gambrill Creek: Poor FIBI. 2010, 2.67 out of 5
 1. 7 species, roughly 400 fish
 2. 1 species was noted as invasive
 - v. Electrofishing in the Stream: [Video](#)
 - c. *Invertebrates at MONO*
 - i. Macroinvertebrates: animals without a spine that are large enough to be seen by the naked eye. Includes aquatic insects, crayfish, and mussels.

⁹ Nortrup, M. (2012) "NCRN Resource Brief: Fish, Monocacy National Battlefield."

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Some eat organic matter, while others filter nutrients and sediment from the water. All are a food source for other animals, land and aquatic.

- ii. NCRN I&M also monitors macroinvertebrate populations in small streams across the NCR. Organisms are dislodged from their habitat and captured in a fine-meshed net. Some individuals are preserved and identified (if possible), using stereoscopes or microscopes.
- iii. The Benthic Index of Biotic Integrity (BIBI) includes:¹⁰
 - 1. Number and diversity of taxonomic groups
 - 2. Proportion of individuals in the same taxonomic group
 - 3. Degree of tolerance of individuals to pollution, stream flow changes, or habitat degradation in the short- and long-term
 - 4. Feeding tendencies (scrapers, predators, collectors, filterers)
 - 5. Habit tendencies (burrowers, climbers, clinger)
- iv. Bush Creek: Poor BIBI. 2010, 2.33 out of 5
 - 1. 25 species found
 - 2. No invasive species
- v. Gambrill Creek: Very poor BIBI. 2010, 1.67 out of 5
 - 1. 33 species found
 - 2. No invasive species

3. Biotic and Abiotic Factors

a. Activity

- i. Ask YCC precipitants: how do living and non-living things relate? Why must we protect both?
 - 1. Ecosystems are a combination of both! We can't have living organisms without sun or water, and the actions of living organisms impact the functionality of non-living factors, like human activity and water quality
- ii. On the whiteboard, draw a stream. Put the cards on the table, and have a student read one. Have the student draw something that represents the scenario on the card. Brainstorm answers for the questions on the back of the card as a group. Have another student draw the solution presented.

¹⁰ Nortrup, M. (2012) "NCRN Resource Brief: Macroinvertebrates, Monocacy National Battlefield."

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Scenario: It rains on a bare, freshly plowed plot of farm. Some of the loose soil moved with the rain and into the body of water.	Consider: - Impact on physical habitat - Impact on invertebrates - Initiatives to reduce the impact on both
Scenario: A suburban house overwatered its lawn. The aquatic plants grew quickly thanks to the fertilizer runoff, and are now decaying.	Consider: - Impact on water quality - Impact on fish - Initiatives to reduce the impact on both
Scenario: Many cars driving on highway 270 are leaking oil onto the road. After a rainfall, the oil reaches the body of water.	Consider: - Impact on water quality - Impact on invertebrates - Initiatives to reduce the impact on both
Scenario: A developer cuts many trees and shrubs around the body of water for a clear view. The woody material decreases.	Consider: - Impact on physical habitat - Impact on fish - Initiatives to reduce the impact on both



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