Microclimates of Wisconsin

fyi.extension.wisc.edu/uphamwoods/ | uphamwoods@extension.wisc.edu | 608-254-6461

Program Purpose: Participants will explore the concept of microclimate using the tools of forestry and meteorology to answer the Essential Question, "How does microclimate influence what living things are found in different habitats?"

Length of Program: 2.5 hours

Maximum Number of Participants: 24

Ideal Age: Elementary - Adult

Learning Standards: NGSS Cross Cutting Concept Standard 9. *Interpret cause and effect relationships*. (HSSCI9)

Wisconsin Science Standard. *Students use science and engineering practices, disciplinary core ideas, and cause and effect relationships to make sense of phenomena and solve problems*. (SCI.CC2)

Wisconsin Environmental Literacy and Sustainability Standards:

- *Students develop and connect with their sense of place and well-being through observation, exploration, and questioning.* (ELS.C1)
- *Students evaluate relationships and structures of natural and cultural systems and analyze their interdependence.* (ELS.EX2)

Objectives:

After participating in this lesson, participants will be able to:

- Define the terms "aspect" and "microclimate" and describe the importance of each in determining what lives in a habitat
- Use measurement tools such as a Kestrel weather meter, densiometer, infrared thermometer, and thermal camera to describe a habitat's characteristics
- Use scientific vocabulary and data to answer the Essential Question, "How does microclimate influence what living things are found in different habitats?"
- Describe how changes in microclimate can impact where populations of living things are found
- List some current and expected changes in Wisconsin's climate

Teacher Preparation:

- Gather all program equipment. **Ensure that thermal cameras are charged using the charge cords and kestrels/infrared thermometers have working batteries.**
- Instructors should scope out the areas of microclimate that youth will be investigating. Ideally data collection areas should be observably different in both species and measurements.
- Consider marking boundaries for the two youth data collection areas.
- If possible, choose 2-4 common tree/plant species in each area to highlight and review identification characteristics.

Materials in the Kit

- 10 densiometers
- 7 clipboards
- 7 Data Collection packets
- Golf pencils
- 6 Kestrel pocket meters
- 6 infrared thermometers
- 6 thermal cameras + charging supplies
- 7 tree identification guides
- Extra AAA batteries + charging station
- *Optional*: Calculators
- Appendix: GLOBE Investigation Instruments: Densiometer

Safety Information:

- This program involves collecting measurements in natural areas, which may involve entering tick habitat. Long pants and insect repellant are recommended.
- Before this lesson, scout the areas where data collection will take place for poison ivy, stinging/wood nettle, or thorned plants. Modify the data collection location to avoid these plants.

Program Activities:

1. Introduction: Introduce yourself and the title of the program, "Microclimates." Ask participants to imagine where they live (their house, apartment, etc). Then ask if they know what a thermostat is and for a participant to describe what a thermostat does:

- A thermostat is a sensor connected to the heating/cooling system of a house.
- If the temperature drops below a certain threshold, or set temperature, the heating system will kick on.
- If the temperature rises above a certain threshold, the cooling system will kick on.

A thermostat helps maintain an **average overall temperature** in the home.

Ask participants if, even with a thermostat, there are areas of the house which are above or below that average temperature. Ask participants what areas of the house feel warmer than the average?

- Kitchen, due to cooking
- Laundry room, due to the dryer
- Attic, due to heat rising
- Room that receives the most sunlight, etc.

Ask participants what areas of the house feel cooler than the average?

- The basement, due to being underground
- Shaded areas of the house, etc.

These areas may also differ in their humidity, or the amount of moisture in the air. Ask which may be more humid (laundry room, kitchen, basement) or less humid (attic, room with sunlight).

Ask the youth to shift their attention from inside of where they live, to the outside environment. Just like inside the house, there may be an average temperature and humidity level outside. (We get this information when looking up a weather forecast for a given day in a given location.) But also like a house, there may be areas outside that feel warmer or cooler than the average temperature and humidity. Ask the youth to picture the outside of where they live. Are there areas that are warmer or cooler than the average?

- Shaded areas may be cooler
- Blacktop or paved areas may be warmer
- Areas immediately around water may be more humid

Now ask youth to shift their attention to a totally natural area. What factors might influence whether a particular area would be warmer or cooler (or more or less humid) than the surrounding area?

1. **Elevation** (the top of a hill might be warmer than the bottom of a valley)
2. **Natural wind breaks** (in winter, a completely open field will be windier, and therefore cooler, than an area with large trees. In summer, the open field will be sunnier, and therefore warmer, than a forested area)
3. **Large bodies of water** (areas along coasts or next to large lakes are cooler than areas a few miles

inland)

4. **Aspect** (which direction a hill faces with respect to the sun. The south side will receive more sun and be warmer and drier than the north side)

Those areas that differ from the average are examples of **microclimates**. Ask participants to break down the word and define “micro” and “climate” separately.

- **Micro** = very small
- **Climate** = the average weather in a place over a long period of time

Ask how climate differs from weather.

Weather = the day-to-day state of the atmosphere which varies from minutes to hours to days.

Use multiple participant responses to develop a group definition for microclimate:

Microclimate is the **climate of a very small area that differs from the surrounding climate**.

Microclimate is important because it helps determine what living things can best survive in a given habitat.

In our investigation today, we’ll be taking data to examine the microclimate of a habitat and then examining what plants and animals live there to see if the two are related. Our data will help us answer the Essential Question below.

***Essential Question*: “How does microclimate influence what living things are found in different habitats?”**

Field investigation equipment & procedure (Site #1):
Today, each group of participants will be part of a team to study the microclimate in two habitats to answer the Essential Question (6 teams, 4 youth per team). Ask youth to self-select into 6 teams, or ask teachers to form teams.
Pass out the Data Collection packets and clipboards to the individual in each team with the best hand writing. This person will be the **Data Recorder.** As a team, groups should answer questions #1 and #2 on their Data Collection Sheet. For #2, possible answers are below (bolded characteristics are data the participants will collect and record):

1. **Temperature**
2. **Wind speed**
3. **Humidity**
4. Soil moisture
5. **Plant species present**
6. **Animal species present**
7. **Canopy cover**

Each team member has a role and a set of tools to use.

1 - **Data recorder**: keeper of the data sheet/clipboard/writing utensil + infrared thermometer
2 – **Wildlife biologist:** observes and reports animal signs (burrows, nests, tracks, chew marks, scat, calls/songs, live animal sightings, etc) + thermal camera
3 - **Climate scientist**: keeper of the Kestrel (measures and reports air temperature, wind speed and humidity)
4 – **Forester**: measures and reports % canopy cover (densiometer) + tree identification with field guide (for younger youth, consider counting different species based on leaves/bark instead of identifying species, or use the Younger Microclimates Data Collection Journal pages)

The procedure for each stop where data is collected is outlined below. Each team member will collect data <u>three times</u> at each stop point. Participants should always be within the boundaries you set for data collection but should spread out to try to take data from three distinct areas within the habitat.

*If participants have not already been matched with a role, take a few minutes to assign them. For teams of 5-6, separate the thermal camera from the Wildlife Biologist and the Infrared thermometer from the Data recorder.

**If participants have not already been introduced to the tools (Kestrel pocket meter, densiometer, thermal camera, and infrared thermometer), demonstrate how to use each of the tools while a participant reads the instructions for that tool below.

***SAFETY INFORMATION: Students **MUST NOT** look into the laser pointers of the thermal camera or the infrared thermometer!! These tools should **NEVER** be pointed in a person's face, nor should they be looked into by the operator. Doing so can cause damage to vision! If the instructor witnesses misuse of the tool, the operator will lose the privilege of using the tool.

<u>Procedure:</u>

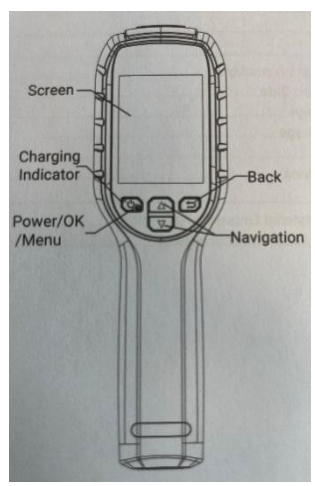
Each group member is responsible for reporting to the **Data Recorder** their findings. The **Data Recorder** is also responsible for working with the **Wildlife Biologist** to find the areas of maximum and minimum temperature, and recording on the data sheet.

#1: Data recorder: write all data provided by group members onto the data sheet.

The Infrared thermometer measures surface temperatures.

1. Turn the thermometer on by pressing the trigger
2. Turn OFF the laser pointer function by pressing the button with a light inside a triangle
3. Change units by pressing the deg C/deg F button
4. Turn on the screen light by pressing the light bulb button
5. **Write down the maximum and minimum surface temperatures on the Data Sheet**

#2 - Wildlife biologist: within the area specified by your instructor, search for signs of animal activity (burrows, nests, tracks, chew marks, scat, calls/songs, live animal sightings, etc.) It is okay to not know for certain what made these signs, but you should make an educated guess based on what you see.



Using the thermal camera, locate areas of the <u>greatest temperature difference</u> within the area specified by your instructor and describe on the data sheet.

1. Turn the thermal camera on by pressing the red power button. Note the vertical color and temperature scale on the right side of the screen (blue shows colder, red shows hotter).
2. The Max and Min temperatures are on the top left in white.
3. The red & blue cross hairs show the hottest and coldest points in the view.
4. On the data sheet, draw or describe the area in the habitat with the greatest temperature difference.
5. **Report all evidence of animal activity observed to the Data Recorder.**

 # 3 - Climate scientist: To determine the temperature, wind speed and humidity:

1. Turn the Kestrel pocket meter device on by pressing white circle button with a line through it.
2. Use the down arrow to scroll through wind speed, temperature and humidity. NOTE THE UNITS on the screen (mi/hr and deg F).
3. Hold the Kestrel towards the wind with the screen facing you. (If a plastic cover is over the impeller, open the plastic cover to allow air to pass through the impeller). You will see the impeller spin if the wind is blowing. **Report the wind speed number and units to the Data Recorder.**
4. Use the down (*or right*) arrow button to scroll to the temperature. **Report the temperature number and units to the Data Recorder.**
5. Use the down (*or right*) arrow to scroll past wind chill to humidity. **Report the % humidity to the Data Recorder.**
6. Repeat this procedure two more times for 3 locations total, each time **reporting results to the Data Recorder.**

#4 - Forester

1. How much canopy of trees overhead can be measured with a densiometer as a percentage.
   - ❖ If there are no trees overhead, that would be rated as 0% canopy cover.
   - ❖ If half of your view overhead is trees and half is sky, that would rate as 50% canopy cover.
   - ❖ If you can only see trees overhead and no sky, that would rate as 100% cover.

38%

50%

2. Hold the densiometer (toilet paper tube with cross hairs) up to the sky straight overhead. Estimate how much of your view of the sky is blocked by tree canopy by choosing a number between 0 and 100.
3. **Report the % canopy cover to the Data Recorder**.
4. Repeat this procedure two more times for 3 locations total, each time **reporting results to the Data Recorder.**
5. Using the tree identification guide, try to identify a few common trees. **Report the tree species to the Data Recorder.**

Give participants about 15 minutes to collect data for Site #1 and report to the Data Recorder. Provide time checks so participants know how much time remains. Ask participants to hold on to all their materials as you hike to the second habitat to investigate.

Before leaving the site, gather all the groups together and point out the major plant species in the area. **Data recorders should write the plants identified on the data sheet.**

Field investigation (Site #2): Before beginning data collection again, ask a participant to read the Essential Question. Without any data, ask participants *how does this place feel different from the previous location where they took measurements*?

Reiterate the guidelines:
Each team member will collect data three times. Participants should always be within the boundaries you set for data collection but should spread out to try to take data from three distinct areas within the habitat.

Give participants about 15 minutes to collect data for Site #2 and report to the Data Recorder. Provide time checks so participants know how much time remains.

Gather all the groups together and point out the major plant species in the area. **Data recorders should write the plants identified on the data sheet.**

Before departing, tell participants they now have the data they need to answer the Essential Question. Ask participants to hold on to all their materials as you hike to the third stop, which is where they will share and summarize the data they've collected.

Summarizing the data (Site #3): Ask groups to share out the data they collected using some guiding questions:

1. Which habitat had a higher average temperature? How did the humidity compare between the two habitats?
2. Which habitat had the greatest difference between maximum and minimum temperatures?
3. How was the canopy cover different between the two habitats? How was the wind speed different?
4. What plants were identified in each habitat? Were some plants found in both?
5. What animal signs were observed in each habitat? Were some animal signs found in both?
6. How would you answer the Essential Question: **"How does microclimate influence what living things are found in different habitats?"**

Why changes in microclimate matter:
Tell participants they have just compared the microclimates of two different habitats. Ask participants how they think this information is useful? If students struggle, suggest that scientists and foresters often track the populations of where plants and animals are found. If the microclimate of an area changes, how will that impact where plants and animals are found?

- Mushrooms, mosses and ferns grow best in moist, humid, shaded environments. If the microclimate becomes hotter and drier in an area, they may not survive as well and their populations may be reduced or even disappear.
- Amphibians like salamanders, newts, frogs,and toads need water, often ponds, to reproduce. If an area is warmer and drier, they may not reproduce as successfully. If an area becomes warmer and wetter, they may be more successful at reproducing.
- Warmer and wetter climates are better for fungus, some of which causes disease in amphibians. They may become more vulnerable to fungal infections.
- In winter, reptiles and amphibians hibernate in soil or in the bottom of waterways. If the microclimate is warmer in winter, they may have to burrow deeper into the ground or the river bottom to stay cold enough to hibernate successfully.
- If there is more rain and less snow in winter, animals like small mammals may be less successful because they shelter in deep snow cover for insulation.
- Animals with big, 'snowshoe' feet, like snowshoe hares, lynx, and wolves, survive better in winters

with deep snow as they're better adapted to move through it than deer and other mammals with small feet. More rain and less snow may reduce populations of snowshoe hare, lynx and wolves.
- Warmer winters may not get cold enough to freeze insects, so insects may move into areas they've never been before. This may mean plants may now face insect predators they've never faced before.
- As insect populations move, some birds that eat insects may change their migration patterns.

Is the climate changing in Wisconsin & the world? The facts:

Globally, some parts of Earth are warming faster than others. But on average, global air temperatures near Earth's surface have gone up around 2 degrees Fahrenheit in the past 100 years[1].

- Wisconsin is experiencing more 80+°F degree days statewide in June, July, August, and September.[2]
- LaCrosse is getting warmer on average in both the winter and summer compared to historical data going back to 1945.[3]
- Summers in Door county are getting warmer on average compared to historical data going back to 1910.[3]
- Wisconsin has become about 10-20% wetter since 1950, but the increase is not evenly distributed across the state: southern and central Wisconsin have experienced the biggest change.[4]
- Wisconsin's average winter temperature (December, January, February) has already increased on average 4-7 °F from 1950-2024.[5]

The Wisconsin Initiative on Climate Change Impacts (WICCI) predicts that Wisconsin's climate will continue to change in several ways:

- An average annual mean temperature increase between 2-8 °F.[5]
- More 90 degree or higher days.
- Annual average precipitation will likely increase by 2050, especially during fall, winter and spring.
- In winter we are likely to see more precipitation as rain rather than snow.
- Animals and some plant species likely to migrate farther north, but some tree species are migrating farther west.[6]

Conclusion

By collecting microclimate data in different habitats, youth are helping to investigate and track changes in microclimate. Collecting data on a regular basis enables us to document changes over time and helps us determine what we can expect in the future. It helps us predict migration pattern changes for plants and animals. It helps us understand how growing seasons are changing and how the ranges for plants might be expanding or contracting in the future. It also gives us an opportunity to take action to slow or lessen changes we do not like and work towards preparing for climate changes in the future.

Thank the youth for investigating the microclimates of different habitats today. Ask for ideas on how they could independently track changes over time in Wisconsin's climate (when robins return in the spring, when frogs start calling, when maple sap starts running, when lakes freeze over or ice off, when plants leaf out or bloom, etc). Encourage the youth to talk to their parents, grandparents, neighbors, farmers, or others in their community about whether and how Wisconsin's climate is different now compared to how it was when they were growing up.

References:

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5. https://wicci.wisc.edu/wisconsin-climate-trends-and-projections/
6. Fei, S., Desprez, J. M., Potter, K. M., Jo, I., Knott, J. A., & Oswalt, C. M. (2017). Divergence of species responses to climate change. *Science Advances*, *3*(5), e1603055.

Appendix:

- GLOBE Investigation Instruments: Densiometer

Learning Extension:

- "Beings on the Move" Activity
  - Role play activity where youth take the identity of a living being culturally important to the Ojibwe and simulate movement based upon responses to climate change.