TERRESTRIAL ECOSYSTEMS

Students will explore various terrestrial ecosystems with a series of field experiments designed to teach them about the terrestrial environment from the ground up using the concept of a "meso-ecotone." Students will obtain data and present their findings to other group members.

LESSON LENGTH:

- 7.5 hours

GOALS:

- To understand basic layers of a terrestrial ecosystem, what makes up a terrestrial ecosystem, and how subdivisions of terrestrial ecosystems known as meso-ecotones may differ in terms of their resilience to human impacts.

OBJECTIVES:

Students will be able to

- Describe and identify soil types on a) a ridge top, b) a slope, OR c) a creek bottom (groups will be in at least three different meso-ecotones, which are small boundaries of different terrestrial ecological systems).
- Measure plant abundance and diversity in a meso-ecotone.
- Reach conclusions about *why* these three different meso-ecotones have different characteristics with respect to plant abundance and diversity. This will require discussion among different groups assigned to different meso-ecotones.
- Use data collected on soil type and plant abundance and diversity to estimate which of these three different meso-ecotones is most at risk from human impacts and *why*. This will require discussion among different groups assigned to different meso-ecotones.
- Use the scientific method to develop and test their own hypothesis about a meso-ecotone.
- Discuss their findings with the group and come to conclusions after each

NATIONAL, STATE, LOCAL STANDARDS

NC Standard Course of Study

- Bio.2.1 Analyze the interdependence of living organisms within their environments
    - Bio.2.1.1 Analyze the flow of energy and cycling of matter (such as water, carbon, nitrogen, and oxygen) through ecosystems relating the significance of each to maintaining the health and sustainability of an ecosystem.
    - Explain why ecosystems can be relatively stable over hundreds or thousands of years, even though populations may fluctuate (emphasizing availability of food, availability of shelter, number of predators and disease)
- Bio.2.2 Understand the impact of human activities on the environment (one generation affects the next).
    - Bio.2.2.1 Infer how human activities (including population growth, pollution, climate change, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment.

STUDENT TAKEAWAYS FROM LESSON:

- Essential question / theme
    - How abiotic and biotic factors (soil, forest floor, and forest layers) lead to diversity of terrestrial meso-ecotones and resilience of meso-ecotones to potential human impacts.
- Key concepts and vocabulary (define them here)
    - **Ecosystem**: a collection of communities of both living and non-living things (biotic and abiotic factors) that are interrelated.
    - **Ecotones**: zones of transition between adjacent ecological systems, i.e., the transitional zone between a forest and a grassland.
    - **Meso-ecotones**: zones of transition between adjacent ecological systems on a relatively small scale, i.e., the transitional zone between a ridgetop and a slope.
    - **Abiotic factors:** non-living things; things that cannot grow, move, breathe, or reproduce.
    - **Biotic factors:** Living things, those that display the following characteristics:
        - an organized structure
        - being made up of a cell or cells
        - requires energy to survive or sustain existence
        - ability to reproduce
        - ability to grow
    - **Terrestrial ecosystem**: While many ecosystems exist on land and in the waters of the world, ***terrestrial*** ecosystems are those that are found only on land.
    - **Biodiversity**: the number and types of plant and animal species that exist in a particular area or in the world generally (biotic factors!).

ASSESSMENTS:

- Formative:
    - Check-in discussions after meso-ecotone assessments.
    - Analysis of data from each meso-ecotone assessment.
- Summative:
    - Students will synthesize data collected during group investigations of each meso-ecotone.
    - Students will develop presentations for the rest of the groups and instructors (poster, interactive, or other creative format) about the meso-ecotone that they evaluated.

DIVERSITY (REACHING STUDENTS OF ALL LEVELS/ABILITIES):

- Prompt teams to give each member a job and rotate the jobs after each measurement conducted.
- Participants are working on hands-on activities using instruments scientists use in the field.
- Participants are working in groups during the entire activity.

MATERIALS & EQUIPMENT:

- Student worksheets (1 per student)
- NPK Soil Kits
- Soil pH kits
- Soil pH and NPK color charts (1 per group of 2-3 students, 9 total)
- Terrestrial Ecosystems Resource Packet (1 per group of 2-3 students, 9 total)
- Notebook for taking notes.
- Tape measures.
- Four 2-meter long pieces of string (thick enough to see on ground) for each group.
- Digging tools.
- Pencils.
- Compasses (can be carried by instructors for quick use by participants).
- Calculators (1 per two students)
- Safety goggles (1 pair per student)
- Waste container for chemical waste
- Bucket of clean water for hand-washing
- Soap (biodegradable if possible)
- Towels
- Plastic gloves
- Eye wash bottle

LOCATION:

- Pick a location with space for groups to maneuver in. There must be access to trees and soil that has at least three different meso-ecotones (i.e., a ridgetop, a slope, and a creek bottom) so that different groups measure different meso-ecotones.

RISK MANAGEMENT & SAFETY CONCERNS:

- Participants will be in areas that may have dense ground cover that could include thorny bushes and poison ivy. It is recommended that participants wear long pants or shorts with long socks.

- Dense ground cover may harbor ticks, venomous and non-venomous snakes, and other biting/stinging insects and/or animals. Participants should not approach animals.
- Digging tools have sharp cutting edges and must be handled with care.
- Ensure that soil pits are marked off so everyone avoids the holes. Fill the pits back in after conducting the experiment.
- Students must wear safety goggles while performing soil chemistry tests that require shaking a chemical mixture. Students must wash hands after performing tests and avoid placing hands in contact with eyes or mouth during testing. All reacted samples must be poured together into a waste container for later disposal. They can be disposed of back home by flushing them down the drain with excess water.

BAD WEATHER ALTERNATIVE:

- All activities can still be done in rainy conditions provided there is no thunder and lightning.
- In the case of thunder and lightning, samples of soil can be collected and evaluated for texture. Some plants can be assessed as long as they can be collected from the ground and not pulled, plucked, or broken.

PRE-LESSON PREPARATION:

- Teach participants how to use the soil color chart.
- Teach participants how to use the plant identification keys.
- Go over safety guidelines.

LESSON:

Activity	Time
Engage: Pre-Activity Questions	10 minutes
Explore: Each group of 8 students will be assigned to different meso-ecotones such as a ridgetop, a slope, a creek bottom, a grassland, or a transitional zone (whatever meso-ecotones that can be identified at the site). Students will perform a soil exercise and define the layers of the meso-ecotone, largely through plant identification. Each group will divide into three groups of 2-3 students and do a replicate for soil and plant analyses, for a total of three replicates for the group's assigned meso-ecotone, which they will record on their **student worksheet**. Students will then come together to find averages for their meso-ecotone, which they will record in their notebooks.	Approx. one hour for soil exercise and two hours for plant identification.
Break for lunch	1 hour
Explain: As a full group of 24, review all of the results from each group (if more than one group is in the same meso-ecotone, have them work together). Use big paper to draw big conclusions about habitat type and species diversity and abundance.	1 hour
Explore: Relocate the group areas with notable impacts from human development (roads, tree cutting, hiking trails, erosion). In groups, students make observations about how these impacts affect meso-ecotones and devise a testable hypothesis about those impacts.	30 minutes to explore, develop hypotheses, develop a plan
Students should run the plan by instructors for approval before beginning to collect data	
Explore: Groups investigate their own hypothesis and collect the data necessary to test their predictions.	1-2 hours
Explain: Groups analyze data and create visual aids to present their results.	1-2 hours
Break for dinner	
Extend/Elaborate: Groups present their findings and ask/answer questions.	12-15 minutes each
Debrief as a group about meso-ecotones and human impacts	30 minutes

ENGAGE

- Overall: Divide participants into groups of 8 and assign them to **three different meso-ecotones** (i.e., a ridgetop, a slope, or a creek bed, if available).
- Pre-Activity Questions: Ask your group of 8 students the following questions (instructor answers in italics):
    - What is an **ecosystem?**
        - *A group of parts that work together in some way.*
    - What is a **terrestrial ecosystem**? What does "**terrestrial**" sound like? (terrarium, or the Spanish word "tierra" = Earth)
        - *A terrestrial ecosystem is a type of ecosystem found only on land. Six primary terrestrial ecosystems exist: tundra, taiga, temperate deciduous forest, tropical rain forest, grassland, and desert. It is a community of organisms and their environment that occurs on the land masses of continents and islands.*
    - What type of terrestrial ecosystem are the forests in western NC?
        - *Our forests are temperate deciduous forests. These are forests that are "always changing," as they have four distinct seasons (spring, summer, autumn, winter) and receive about 30-60 inches of precipitation/year. The soil is rich and fertile and supports many species of hardwood trees. As a result, they have been impacted by human activities as hardwood trees are desirable building products. These types of forests are also characterized by a huge diversity of plant species that make up the four main layers of a forest: canopy, understory, shrub, and herbaceous layers. They also may have emergent trees (trees that poke up over the canopy) and varying thicknesses of the forest floor layer (fallen trees, decaying leaves/twigs, mosses, detritus, and other items covering the soil). They have biodiversity in animal life that depends on the plant diversity. The animals have to be adaptable to the seasons and may migrate or hibernate.*
    - What type of terrestrial ecosystem do you all live in back home?
        - *Discussion among participants, but all should likely be a temperate deciduous forest, unless they come from the west or northwest.*
    - What characteristics comprise a **terrestrial system**?
        - *An ecosystem is a collection of communities of both living and non-living things that are interrelated. While many ecosystems exist on land and in the waters of the world, terrestrial ecosystems are those that are found only on land. The biotic, or living things found in an ecosystem, include various life forms, such as plants and animals. The abiotic, or non-living things found in an ecosystem, include the various land-forms, soil, and climate.*
    - How do you think the components (biotic and abiotic factors) of a terrestrial system interact? What factors or more/less important?
        - *This will largely be a discussion to get participants to think about why we are measuring soil in addition to plants and how soil and the forest floor layer help to determine the primary productivity for the terrestrial ecosystem.*

EXPLORE

- Hand out student worksheets.
- Have participants make general observations on their meso-ecotones. They may want to make sketches to help them remember locations of various objects. Observations they might make could include:
    - General temperature (warm, cool).

- General humidity (high, low).
- Amount of sunlight/shade.
- Water present or absent.
- Rocks present or absent.
- Slope (steep, shallow, none).
- Deadfalls/forest openings.
- Other.

- Pre-Activity Questions for **SOIL**: Ask students the following questions (instructor answers in italics):
  - Description of soil type (color, texture, etc.) and forest floor layer (thickness of fallen trees, decaying leaves/twigs, mosses, detritus, and other items covering the soil).
  - How does soil form?
    - *Every soil particle is originally formed from parent material, which is a deposit at the Earth's surface. The material could have been bedrock that weathered in place or smaller materials carried by flooding rivers, moving glaciers, or blowing winds. It also could have been biotic material that was decomposed into small particles.*
  - What is soil made of?
    - *Organic and inorganic materials.*
- Activity:
  - In their assigned meso-ecotone, have your 8 students break into 3 groups of 2-3 students. Have each group clear an area of about one foot in diameter from the forest floor layer covering the top of the soil and record observations about the forest floor layer. What is it composed of (fallen trees, decaying leaves/twigs, mosses, detritus, and other items covering the soil)?
  - Dig soil pits that are deep enough to observe different soil horizons (about 1.5 to 2 feet deep and 1 foot in diameter).
  - Record general observations about the pit, including number of observable layers (see Figure 1) and how they differ in terms of color, texture, and odor.

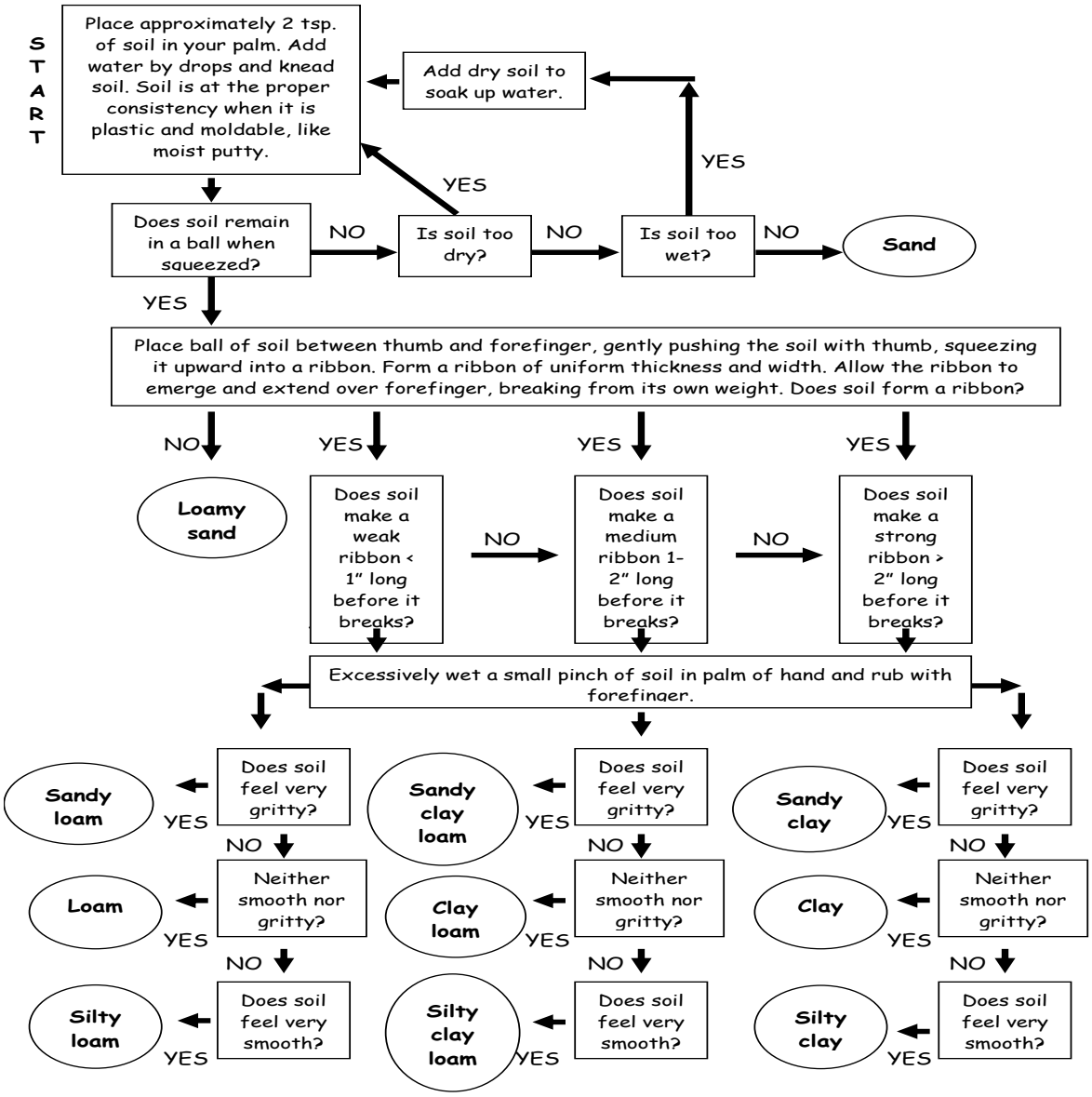
Figure 1. A general description of soil horizons.

  - Record the physical characteristics of the soil – it is gritty, sandy, clay, dry, damp, etc.?
  - Identify the color of the soil with a soil color chart. For example, a color of 5Y 6/3 means:
    - 5Y = hue. Hue is a measure of the chromatic composition of light that reaches the eye. Color charts for soil use five principal hues: red (R), yellow (Y), green (G), blue (B), and

purple (P) as well as five intermediate hues: yellow-red (YR), green-yellow (GY), blue-green (BG), purple-blue (PB), and red-purple (RP). Each of these ten major hues are divided into four segments designated by numerical values, from 2.5 to 5 to 7.5 to 10.

- 6/ = value. Value is the degree of lightness or darkness of a color in relation to a neutral grey scale, going from pure black (0/) to pure white (10/).
- /3 = chroma. Chroma is the relative purity or strength of the spectral color and indicates the degree of saturation of neutral grey by the spectral color. Neutral colors are /0 and strong colors are /8.

- Determine the soil's texture using the flow chart.



Texture Class	Properties
Sand	A coarse-textured soil. In a wet or moist state, sand will form a cast which will crumble when touched. In a dry state, sand is loose and single grained and will not form a cast or a ribbon.
Sandy loam	Sand grains are readily felt and enough silt and clay are present to bind particles. When moist, sandy loams will form a cast which will withstand pressure. A dry cast will crumble and readily fall apart. When rubbed between figures, sandy loams form a sheen on the rubbed surface. Sandy loams will not form a ribbon.
Loam	A medium-textured soil. A loam has a relatively even mixture of sand, silt, and clays. It is mellow, may feel somewhat gritty, slightly smooth, and plastic. Dry casts will bear carefully handling, while moist casts can withstand pressure.
Silty loam	A medium-textured soil. When dry, a silty loam has a floury or talcum powder feel and is slightly plastic when wet. When dry, it appears cloddy and can be readily broken. Silty loam will ribbon slightly but will form cracks and have a broken appearance. Wet, silty loam forms casts that will withstand rough handling.
Clay loam	A fine-textured soil that forms hard lumps or clods when dry. In a moist state, clay loam will form a ribbon that will break readily, barely sustaining its own weight. When moist, clay loam is plastic and readily forms a cast. It has a smooth feel but some grittiness can be detected when it is rubbed between the fingers.
Clay	A fine-textured soil that forms hard aggregates when dry. In a moist state, clay forms ribbons, is sticky, plastic, and will exhibit a bright sheen when rubbed. No coarse fragments (sand) can be detected by rubbing between the fingers or on the end of teeth.

- **Soil Chemistry**
  - Instruct the students to use the directions on the Soil Analysis Resources pages to find the pH and levels of nitrogen (N), phosphorous (P), and potassium (K) in their soil samples (3 measurements that they will take the average of at the end). Students will collect a soil sample from the soil that they removed from their soil pit and mix it together to get samples from each of the layers; this will give them an "average" set of values in case they have different soil types in the soil pit.
- ***Safety information:***
  - ***Students must wear safety goggles while performing soil chemistry tests that require shaking a chemical mixture.***
  - ***Students must wash hands after performing tests and avoid placing hands in contact with eyes or mouth during testing.***
  - ***All reacted samples must be poured together into a waste container for later disposal. They can be disposed of back home by flushing them down the drain with excess water.***
- Discuss: Why do pH and NPK levels in soil matter? (they affect the types of plants that can live there, etc. From pH Test Kit: "Soils become acidic or "sour" through continuous cropping and through leaching of the soil by rain water. Decaying leaves and bark also increase the acidity. Lime is the best material to use in neutralizing the acidic condition of the soil. It is readily available, low in cost, and also supplies the lime salts essential to many plants. Some soils are alkaline or "sweet" due to the presence of natural limestone deposits or form lime previously applied to the soil. Plants, as a rule, do not like soils that are too alkaline and seldom show good growth when more than the correct amount is present.")

- Pre-Activity Questions for **PLANTS**: Gather students back into the big group of 8 and ask them the following questions (instructor answers in italics):
  - Assess the diversity and abundance of plant species among the four main layers of a forest for a meso-ecotone.
  - Do forests have layers? If so, what are the layers?
    - *Forests have four main layers: 1) Canopy = tall deciduous trees, 2) Understory = saplings that grow in the spaces between taller trees, 3) Shrub = shrubs and shorter trees, 4) Herbaceous = wildflowers and other small soft-stemmed plants. Some forests also may include an emergent layer, a few very large trees that peek up over the canopy. All forests will also include a forest floor layer.*
  - What abiotic factors are most important for plants?
    - *Temperature and precipitation as well as nutrients from the soil.*
  - What types of plants are most common to temperate deciduous forests?
    - *Broadleaf trees (maple, oak, beech, chestnut, elm, hickory) predominate and form the canopy, which shades out most of the ground below. Many understory trees are considered "shade-tolerant," as they can survive with lesser amounts of sunlight than other plants (rhododendron, buckthorn, sumac, dogwood). Many of the other types of shrubs and soft-stemmed plants (i.e., wildflowers) are perennials, which means that they grow only in the warmer summer months. Many wildflowers emerge from the ground before trees have fully "leafed out" to take advantage of the extra sunlight.*
    - Why do broadleaf trees do well in temperate deciduous forests?
      - *Moist soil with lots of nutrients (NPK).*

        - What types of disturbances produce the greatest change in temperate deciduous forests?
            - *Any event that creates a gap in the canopy and lets in more sunlight will lead to changes in that particular area. Dormant seeds will grow, and over time, new trees will grow and shade out the area again. Disturbances can be natural, such as an old tree falling over, fires, tornadoes, and insect damage. Disturbances also can be human-induced, such as road building or clear-cutting.*

- Activity:
    - Break students back into their 3 groups of 2-3 students.
    - Use string to create a 2m x 2m plot. Within the plot, perform each of the following (if time permits, repeat two more times on a nearby plot so that plant measurements are collected in three replicates within the meso-ecotone):
        - Record observations about canopy trees (the largest trees, generally 30-45m tall): a) total number of canopy trees, b) number of different species of canopy trees (each will need to be identified), c) diameter at breast height (DBH) of each canopy tree (trees that are ≥ 10 inches DBH), and d) estimate of percent coverage of plot (100% shaded, 50% shaded, etc.).
        - Record observations about understory trees (the layer between shrubs and canopy): a) total number of understory trees, b) number of different species of understory trees (each will need to be identified), c) DBH (trees that are < 10 inches DBH) of each understory tree.
        - Record observations about shrubs (bushes and brambles): a) relative abundance of shrubs and b) number of different species of shrubs (each will need to be identified).
        - Record observations about herbs (grasses, ferns, wildflowers, and other soft-stemmed plants): a) total number of herbs and b) number of different species of herbs (each will need to be identified).
        - Are there any emergent trees (trees whose crowns emerge above the rest of the canopy)?
- Conclusions/summing up: Have the three groups of 2-3 students come together to find averages for each data point for their meso-ecotone (from both the soil and plant analyses). Have them record these averages in their notebooks.

EXPLAIN

- The three groups of 8 come back together for a DISCUSSION facilitated by instructors:
    - What were the characteristics of the three (or more) different meso-ecotones?
        - *Each group will talk about what they found, including the soil characteristics of their meso-ecotones, the plant diversity/abundance, and how the meso-ecotones differ.*
    - What factors (abiotic or biotic) contributed the most/the least to the characteristics of the different meso-ecotones?
        - *The participants should recognize that the general observations that they made at the beginning of the activity will help them to answer this question. Micro-climate, water, humidity, forest openings, etc. all determine the basic type of meso-ecotone that they were working it. These are the factors that separate the meso-ecotones from each other.*
    - Which meso-ecotones are the most sensitive/most resilient to natural and/or human-induced changes and why?
        - *There really is no right or wrong answer to these questions. This is a chance for the participants to talk about factors that they think make terrestrial ecosystems more or less resilient to changes.*

EXTEND

- Group Investigation:
    - In this section, the participants will conduct a group investigation of their own choosing. Instruct the participants that they are trying to find an example of impacted versus non-impacted meso-ecotones. These can be from natural disturbances (i.e., downed trees) or from human disturbances (i.e., roads).
    - Try to relocate the participants to an area that has noticeable impacts (i.e., roads, parking areas, campsites, tree cutting, or other activities).
    - In groups, participants can make observations about how these impacts affect meso-ecotones and devise a testable hypothesis about those impacts.
        - Example: Hypothesis: Forest openings create more diverse habitats than closed-canopy areas. Question: Do forest openings, such as from roads, create edge habitat that differs from internal forest habitat in terms of plant diversity and/or abundance?
        - Example: Hypothesis: Sunlight creates differences in soil moisture, which then influences plant diversity and/or abundance. Question: Do slopes facing different directions (i.e., north-facing versus south-facing) have different soil types?
        - Example: Hypothesis: Forest openings created from natural events will produce larger understory trees than forest openings created from human-made events. Question: Does clear-cutting/logging lead to greater intensity of sunlight and drier soil and therefore lower plant growth than natural openings?
    - Ensure that participants check in with instructors about their testable hypotheses before beginning their investigations.
    - Instruct students to collect data, etc. in order to test their hypothesis.
- More topics for continued discussion:
    - Introduce the concept of a forest succession and how forests move into openings. What types of plants grow first? What types grow last? What abiotic factors are important in this process?
    - Introduce the concept of invasive species, including plants and animals. Cowbirds, for example, are nest parasites that like habitat along forest edges. When more forest edges are created from roads or logging, cowbirds can start to enter into deeper forests areas and negatively impact species that depend on deep forests. Similarly, many invasive plants emerge and start growing earlier in the season than native plants and therefore overshadow native herbs. They can then take over forest openings and change the pattern of succession as well as available habitat.
    - Relate to news (climate change, agricultural land use, suburbanization).

ELABORATE

- Why do we care?
- Direct benefits: relationship between humans and terrestrial ecosystem quality. Why does biodiversity matter? Why do trees matter?
- Preview of tomorrow's lesson: What are relationships between the terrestrial and aquatic ecosystems? Does one affect the other? If so, how?
- Why do terrestrial ecosystems matter to humans?
- Why do terrestrial ecosystems matter to the environment?

EVALUATE

- Instructor should ask participants these closing questions:
    - Why is it important to study terrestrial ecosystems?

    - How do humans impact terrestrial ecosystems? (e.g. pollution, land use changes, slope erosion, loss of tree cover, etc.)
- Ask the participants to compile the data they collected while investigating their hypothesis, analyze the data, and create a 10-minute presentation assessing their meso-ecotone's health based on plant abundance and diversity. Encourage them to create graphs, tables, or other visualizations.
- Participants will present their findings to the entire group or to the smaller groups of eight.

REFERENCE MATERIALS/RESOURCES

- Based on, in part: http://www.d.umn.edu/~tbates/curricularesources/ModelLessonPlan.pdf.
- Project Wild and Project Learning Tree

Terrestrial Ecology:
Assessing terrestrial ecosystems at the "meso-ecotone" level

Your name: **Your partner(s) names:**

Site:

OBJECTIVE:
The abundance and diversity of plant communities in terrestrial ecosystems varies with the type and distribution of both abiotic and biotic factors in addition to natural and human-induced modifications. In this activity, groups will evaluate different "meso-ecotones," or small boundaries of different terrestrial ecological systems. For example, within a forest, a ridgetop may have very different plant communities than a creek bottom. Your objective is to describe your assigned meso-ecotone from a big picture perspective (what does it look like), at the level of soil, and at the level of plants.

Each group of 2-3 students needs:

- 1 Terrestrial Ecosystems Reference Packet
- Flower/plant keys
- Soil color charts (pH and NPK)
- Soil Chemistry kit
- Safety goggles
- String for setting up square point sample areas
- Digging tool
- Tape measure
- Pencil
- Notebooks

1. **Observe, contemplate, draw:**

   Take 10 minutes to observe your group's meso-ecotone. Sit or walk quietly (do not speak during this period) and take in what you see, hear, and smell. Take notes or sketch out the general area. Observations that you might make could include:

   - General temperature (is it warm or cool or a mix?).
   - General humidity (is it high or low?).
   - Amount of sunlight/shade.
   - Water present or absent.
   - Rocks present or absent.
   - Slope (steep, shallow, none).
   - Deadfalls/forest openings.
   - Other observations (bird and/or insect sounds, sounds of water or human activity, signs of animal activity, etc.).

2. Soil horizon, color, and texture

Clear an area of about one-foot in diameter from the forest floor layer covering the top of the soil and record observations about the forest floor layer.

a. What is the forest floor layer composed of (fallen trees, decaying leaves/twigs, mosses, detritus, and other items covering the soil)?

Dig a soil pit that is deep enough to observe different soil horizons (about 1.5 to 2 feet deep and 1 foot in diameter).

a. Record general observations about the pit, including number of observable layers (see Figure 1 on the Soil Analysis Resources page) and how they differ in terms of color, texture, and odor.

b. Record the physical characteristics of the soil – it is gritty, sandy, clay, dry, damp, etc.?

c. Identify the color of the soil in the different horizons with a soil color chart using the Soil Color Chart Directions on the Soil Analysis Resources Page.

d. Determine the texture of the soil from the horizon closest to the surface (but clear of detritus) using the soil flow chart on the Soil Analysis Resources Page.

3. Soil Chemistry

Collect a soil sample from the soil that you removed from your soil pit. Mix it together to get samples from each of the layers; this will give you an "average" set of values in case you have different soil types in your soil pit. Use the directions in your Soil Chemistry Kit or the Soil Analysis Resources Page to find the pH and levels of nitrogen (N), phosphorous (P), and potassium (K) in your soil sample. Repeat each measurement three times with different soil samples from your pit, and find the average value.

Safety information:

- *Students must wear safety goggles while performing soil chemistry tests that require shaking a chemical mixture.*
- *Students must wash hands after performing tests and avoid placing hands in contact with eyes or mouth during testing.*
- *All reacted samples must be poured together into a waste container for later disposal. They can be disposed of back home by flushing them down the drain with excess water.*

pH

			Average:

Nitrogen

			Average:

Phosphorous

			Average:

Potassium

			Average:

4. Plants in 2m-square point-samples

Use string to create a 2m x 2m plot. Within the plot, perform each of the following. Use the Plant Identification Resources Page to help you.

a. *Record observations about canopy trees (the largest trees, generally 30-45m tall)*

i. Total number of canopy trees:

ii. Number of different species of canopy trees (each will need to be identified):

iii. Diameter at breast height (DBH) of each canopy tree (trees that are ≥ 10 inches DBH):

iv. Estimate of percent coverage of plot (100% shaded, 50% shaded, etc.)

b. *Record observations about understory trees (the layer between shrubs and canopy)*

i. Total number of understory trees:

ii. Number of different species of understory trees (each will need to be identified):

iii. DBH (trees that are < 10 inches DBH) of each understory tree:

c. *Record observations about shrubs (bushes and brambles)*

i. Relative abundance of shrubs:

ii. Number of different species of shrubs (each will need to be identified):

d. *Record observations about herbs (grasses, ferns, wildflowers, and other soft-stemmed plants)*

i. Total number of herbs:

ii. Number of different species of herbs (each will need to be identified):

e. *Are there any emergent trees (trees whose crowns emerge above the rest of the canopy) present?*