Soils and Land Use Learning Objectives for the NCF-Envirothon

You may not pay much attention to it, but there is a lot going on underneath your feet! Soil is the foundation for all terrestrial life. Soil shapes our landscape. It nourishes plants – growing crops, grasses, and forests to form the basis of our food webs. It serves as a natural purifier for water, filtering out toxins and pollutants. It helps to recycle nutrients and provides habitat for fungi, microbes, and fossorial animals. The health of the soil is essential to the health of terrestrial ecosystems and to our way of life.

Just like the ecosystems we study, human society and culture are incredibly diverse. In the same way that biodiversity makes ecosystems more resilient, these differences in human perspective and experience make us stronger as a global community. Every person's story and relationship with the environment is important, and we must work together to ensure that everyone's stories are heard, including the historically marginalized and economically disadvantaged. We invite you to seek out stories from your own communities – to discover the unsung conservation heroes, to learn the histories that aren't typically taught in classrooms, to highlight local environmental issues, and to explore what types of natural resource conservation are occurring in your local community, state/province, and nation.

Students should be able to:

- Provide an informed opinion about current issues in soil conservation.
- Think critically about the role of soil in climate adaptations.
- Link soil knowledge to the broader topic of climate change
- Work collaboratively in a team to synthesize and apply knowledge.
- Make connections between the concepts in Soils and Land Use and the subjects of Forestry, Aquatic Ecology, Wildlife, and the Current Issue.

Students will be able to:

Geology

1. Explain the impact of geomorphology on landforms and landscapes, and how these processes relate to soil formation.
2. Identify unique geological features of the state/province, nation, and world.
3. Describe the role of tectonic plate movement to create landforms and geologic events (such as earthquakes and volcanic eruptions) and how it impacts soil formation.
4. Describe the characteristics of the three major types of rocks (igneous, sedimentary, and metamorphic) and give examples of each.
5. Identify and describe the layers of the Earth (crust, mantle, outer core, inner core) and how they were formed.
6. Describe how the rock type of a parent material determines what minerals are present in a soil.
7. Explain the importance of different types of weathering (mechanical and chemical) in soil formation.
8. Describe how geology influences topography, on both micro and macro scales.

Soil Structure and Function

9. Define the five soil-forming factors and describe their influence on a particular soil.
10. Identify different types of parent material and how they are formed (such as residual material, eolian deposits, alluvial and marine deposits, colluvial deposits, volcanic deposits, glacial deposits, and organic deposits).
11. Identify soil forming processes (additions, losses, translocations, and transformations) and describe their effects on soil.
12. Describe the characteristics of the major soil orders.
13. Describe how different soil components (mineral composition, organic matter, particle size, et cetera) affect the properties of a soil.
14. Connect a variety of soil processes to observed soil characteristics. (For example, the incorporation of organic matter resulting in darker topsoil and improved soil structure.)
15. Explain the importance of pore space, types of pores (macropores and micropores), and pore connectivity in relation to soil health and vegetation growth.
16. Describe the importance of organic matter in various forms (humus, litter, et cetera) to soil health, structure, and fertility.
17. Identify the different particle sizes in a soil (sand, silt, and clay) and describe how their proportions influence soil properties.
18. Describe what factors influence soil structure and explain the impact of soil structure on soil properties.
19. Identify different types of erosion and recommend management practices to prevent and mitigate erosion.
20. Describe how pH affects soil health, nutrient availability, and other soil properties.
21. Explain the causes of soil compaction and recommend management practices to prevent and mitigate compaction.
22. Describe what factors influence available water capacity in a soil, and how this affects vegetation growth.
23. Explain the requirements for a Prime Farmland designation and identify potential candidates.
24. Describe the following soil properties and their importance:
    a. Density
    b. Porosity
    c. Permeability
    d. Cation exchange capacity
    e. Salinity
    f. Shrink-well capacity
    g. Friability
    h. Plasticity
25. Identify characteristics and properties of hydric soils.

Soil Ecology

26. Describe the cycles of essential elements (such as nitrogen, phosphorus, and carbon) as they relate to soil, nutrient availability, and plant growth.
27. Understand how essential elements in the soil relate to climate change(for example more carbon in soil means less carbon in the atmosphere)
28. Explain how plants take in nutrients and water, and what soil conditions and characteristics influence this uptake.

28. Explain the interactions of soil with the water cycle, including infiltration, runoff, and reservoirs such as aquifers.
29. Describe the ecosystem services provided by soil, such as water filtration, carbon sequestration, nutrient cycling, et cetera.
30. Describe the roles and services of soil organisms (including microorganisms, fossorial animals, fungi, et cetera) in the overall health and functioning of the soil.
31. Describe how soil type and other soil properties can influence the plant communities found on a particular soil.
32. Explain how soils impact the biodiversity of an ecosystem, and how biodiversity in an ecosystem may impact the soil.

Adapting to a Changing Climate

Across the globe both native and manufactured systems are feeling the effects of climate change. In the face of high levels of greenhouse gases in the atmosphere and changing climactic conditions soils have the potential to become a critical tool in mitigating and adapting to climate change. The FAO (Food and Agriculture Organization) estimates that by 2050 approximately 90% of earths topsoil is at risk and this number will not change unless soil starts getting managed appropriately to adapt to climate change.

The following Learning Objectives should be applied on a local, state/provincial, national and/ or worldwide (international) scale as appropriate to each objective and the unique parameters under consideration.

33. Understand how conventional till and no till agricultural systems affect different aspects of the soil (nutrient retention, organic matter, water retention, etc.)
34. Understand the relationship between climate change and the erosion of soils in different land use settings (agricultural, forested, urban, etc.)
35. Explain what the conversion of soil from natural systems (forest, grassland, etc.) to agricultural production does to soil nutrients, organic matter, and nutrient cycling
36. Explain the benefits and drawbacks of nutrient additions to soils keeping in mind the greater ecosystem and climate
37. Describe the impacts of climate change on soil ecology
38. Explain how certain types of soil are better suited than others for specific human uses (mining, farming, septic tanks, et cetera).
39. Understand how to manage soils in order to maximize carbon sequestration
40. Understand and be able to explain ways that microbes and organic matter can be brought back to a degraded soil that lacks microbial life
41. Understand different types of soil amendments (compost, wood chips, manure, etc.) and what they do for the soil
42. Understand how wetlands and peat lands contribute to carbon and methane sequestration and emission
43. Describe how soils can be managed to buffer for both warmer and colder climates
44. Understand what layer (topsoil, subsoil, substratum/parent material) of soil is the most important to manage to adapt to changing climactic conditions