



Unit Title: Wetlands 101

Subject/target grade: High School Biology or Science Elective

Unit Summary: *The purpose of this unit is primarily to get students interested in natural resources and realize how important the lowly wetland is to humans, wildlife, and other ecosystems. This unit is designed to address the “nature-deficit” of both rural and urban students, since very few students grew up playing outdoors, and even fewer have explored wetlands. The use of a wetland theme throughout a class such as biology provides a common thread that can tie together the seemingly (to students) disparate subjects included in biology classes, such as DNA, genetics, food webs, nutrient cycles and evolution. This unit was designed to provide students a basic understanding of the various components of wetlands (hydrology, wetland plants, wetland soils) which can then be used as a common theme across the rest of the semester/year curriculum. Students should have a basic understanding of the water cycle, photosynthesis and respiration, but the remainder of the lessons can be expanded/modified to include more basic information that develops into progressively more advanced topics.*

Key words: hydrology, hydroperiod, hydric soils, hydrophytic plants, invasive plants, botany, growth form, nutrient cycling (water, carbon, nitrogen, phosphorus, sulfur).

Next Generation Science Standards:

HS-ESS2 Earth’s Systems

ESS2.C: The Roles of Water in Earth’s Surface Processes: The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s dynamics

HS-ESS2.E: Biogeology: The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. (HS-ESS2-7)

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.

ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ETS1 Engineering Design

ETS1.B: Developing Possible Solutions

HS-LS2: Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience (HS-LS2-2, HS-LS2-6)

HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience (HS-LS2-2, HS-LS2-6)

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4 Biological Evolution: Unity and Diversity

LS4.D: Biodiversity and Humans

LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations

LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Learning Objectives: Students will be able to:

Lesson 1

1. Describe the criteria that must be met for an ecosystem to be classified as a wetland.
2. Identify characteristics that distinguish at least 2 different types of wetlands.
3. Explain the hydrologic criteria that influence wetlands and comprise hydroperiod.
4. Associate the way that water levels impact soil formation and plant species present in wetlands.
5. Exemplify how wetlands promote and maintain air, water and habitat quality.
6. Identify three or more functions of wetlands.
7. Conceptualize the value of wetlands.

Lesson 2

1. Experience, first hand, what different types of wetlands look, feel, and smell like.
2. Discern the differences between natural and created wetlands.
3. Explore flora and fauna within different wetlands.
4. Observe the differences between urban and rural wetlands.
5. Describe what terrestrialization is, and what it feels like.
6. Characterize vegetation zones along a shoreline and how they contribute to shoreline stabilization.
7. Measure water levels and gas flux in a university wetland research site.

Lesson 3

1. Describe how plants have adapted to living in wet conditions
2. Identify the various growth forms of plants
3. Distinguish between aquatic plant forms and wetland plants
4. Use wetland plant indicator status to postulate hydrology of a site
5. Chronicle how invasive plants impact wetlands and their effect on native flora and fauna

Lesson 4

1. Describe how scientists quantify vegetation using the relevé technique in wetlands
2. Identify different growth forms in a wetland
3. Explore different plant communities in a wetland
4. Examine the impact invasive species are having on a local wetland

Lesson 5

1. Explain how water and key nutrients (carbon, nitrogen, phosphorus and sulfur) cycle in wetlands.
2. Differentiate how sulfur cycles within fresh water and salt water wetlands.
3. Describe how sulfur emissions from wetlands can influence weather.



Table of Lessons:

Lesson Title- Brief Description	Learning Objectives Students will be able to:	NGSS Addressed	Materials
<p>Lesson 1: Introduction to Wetlands <i>Provides basic information as to what classifies a wetland</i></p>	<ol style="list-style-type: none"> 1. Describe the criteria that must be met for an ecosystem to be classified as a wetland. 2. Identify characteristics that distinguish at least 2 different types of wetlands. 3. Explain the hydrologic criteria that influence wetlands and comprise hydroperiod. 4. Consociate the way that water levels impact soil formation and plant species present in wetlands. 5. Exemplify how wetlands promote and maintain air, water and habitat quality. 6. Identify three or more functions of wetlands. 7. Conceptualize the value of wetlands. 	<p>HS-LS2: Ecosystems: Interactions, Energy, and Dynamics</p> <p>HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.</p> <p>HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.</p> <p>HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <p>HS-ESS2.C: The Roles of Water in Earth's Surface Processes: The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics</p> <p>ESS2.E: Biogeology: The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)</p> <p>HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.</p>	<p>Overhead projector</p> <p>Powerpoint or presentation software for student presentations</p> <p>Computers for students to conduct research and develop presentations</p> <p><i>01 Lesson 1 Intro to Wetlands Lesson Plan</i></p> <p><i>02 Lesson 1 Lecture Slides Intro to Wetlands</i></p> <p><i>03 Lesson 1 Wetland Type Presentation Assignment</i></p> <p><i>04 Lesson 1 Wetland Type Presentation Rubric</i></p>

Lesson Title- Brief Description	Learning Objectives	NGSS Addressed	Materials
<p>Lesson 2: Wetland Types Field Trip</p> <p><i>Introduces students to various types of wetlands</i></p>	<p>Students will be able to:</p> <ol style="list-style-type: none"> 1. Experience, first hand, what different types of wetlands look, feel, and smell like. 2. Discern the differences between natural and created wetlands. 3. Explore flora and fauna within different wetlands. 4. Observe the differences between urban and rural wetlands. 5. Describe what terrestrialization is, and what it feels like. 6. Characterize vegetation zones along a shoreline and how they contribute to shoreline stabilization. 7. Measure water levels and gas flux in a university wetland research site. 	<p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience (HS-LS2-2, HS-LS2-6)</p> <p>HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.</p>	<p>Permission slips, notification</p> <p>Transportation</p> <p>Wetland Types Field Trip handout</p> <p>Temperature/pH/conductivity probes</p> <p>Appropriate clothing and footwear</p> <p><i>05 Lesson 2 Wetland Types Field Trip Lesson Plan</i></p> <p><i>06 Lesson 2 Student Handout Wetland Types Field Trip</i></p> <p><i>07 Lesson 2 Quiz: what is a wetland</i></p>

Lesson Title- Brief Description	Learning Objectives Students will be able to:	NGSS Addressed	Materials
<p>Lesson 3: Wetland Botany</p> <p><i>Describes the various types of vegetation found in wetlands</i></p>	<ol style="list-style-type: none"> 1. Describe how plants have adapted to living in wet conditions 2. Identify the various growth forms of plants 3. Distinguish between aquatic plant forms and wetland plants 4. Use wetland plant indicator status to postulate hydrology of a site 5. Chronicle how invasive plants impact wetlands and their effect on native flora and fauna 	<p>ETS1.B: Developing Possible Solutions</p> <p>LS4.D: Biodiversity and Humans</p> <p>HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.</p>	<p>Overhead projector</p> <p><i>08 Lesson 3 Wetland Botany Lesson Plan</i></p> <p><i>09 Lesson 3 Lecture Slides Wetland Botany</i></p>
<p>Lesson 4: Wetland Botany Field Trip</p> <p><i>Students see wetland vegetation first hand and learn how scientists measure vegetation</i></p>	<ol style="list-style-type: none"> 1. Describe how scientists quantify vegetation using the relevé technique in wetlands 2. Identify different growth forms in a wetland 3. Explore different plant communities in a wetland 4. Examine the impact invasive species are having on a local wetland 	<p>HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations</p> <p>HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.</p> <p>HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.</p>	<p>Permission slips, notification</p> <p>Transportation</p> <p><i>10 Lesson 4 Wetland Botany Field Trip Lesson Plan</i></p> <p><i>11 Lesson 4 Student Handout Wetland Botany Field Trip</i></p> <p><i>12 Lesson 4 Quiz Wetland Botany</i></p> <p>Temperature/pH/conductivity probes</p> <p>Appropriate clothing and footwear</p>

Lesson Title- Brief Description	Learning Objectives Students will be able to:	NGSS Addressed	Materials
Lesson 5: Nutrient Cycling in Wetlands <i>Water and nutrient cycles in the context of wetlands</i>	<ol style="list-style-type: none"> 1. Explain how water and key nutrients (carbon, nitrogen, phosphorus and sulfur) cycle in wetlands. 2. Differentiate how sulfur cycles within fresh water and salt water wetlands. 3. Describe how sulfur emissions from wetlands can influence weather. 	<p>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</p> <p>HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.</p> <p>ESS2.C: The Roles of Water in Earth's Surface Processes</p> <p>ESS2.E: Biogeology</p>	<p>Overhead projector</p> <p><i>13 Lesson 5 Nutrient Cycling in Wetlands Lesson Plan</i></p> <p><i>14 Lesson 5 Lecture Slides Nutrient Cycle Review</i></p> <p><i>15 Lesson 5 Student Handouts Nutrient Cycle Review</i></p> <p>Earth Cycles Trivia Game (home made, folder <i>16 Lesson 5 Earth Cycles Trivia Game</i>)</p>

Safety Considerations:

The only safety concern in this unit involves the two field trips to visit various local wetlands. Students will be traipsing through woods, through and along the edge of wetlands and waterways. All standard safety procedures for field trips will be followed, including parental consent to participate. A list of participating students and staff, and destination will be provided to school administrators prior to departure. Students will need to dress for the weather, with sturdy, preferably waterproof footwear. Weather and temperatures can range widely during fall and spring, and visiting wetlands may entail muddying footwear. A first aid kit should be accessible and a means of mobile communication.

Evaluation Plan:

Formative assessment tools include:

- Student participation through note-taking, question and answer, think-pair-share, silent observations, oral presentations of research and sharing information between classmates.
- Working in small groups to describe local wetland vegetation, water quality, and human and invasive species impacts on wetlands.
- Constantly referring to previously learned information to provide continuity across lessons and demonstrate how knowledge and understanding builds on basic information and principles.
- Follow up questions after field trips to stimulate student thinking toward solving environmental problems. Lectures provide additional background information useful during the field trips.
- Creating a diagram of water levels in piezometers installed to different depths, and using that diagram to determine water table movement.
- Development of an informational oral presentation requiring research into specific types of ecosystems.
- Questions within each field trip student handout to check comprehension

Summative assessment tools include:

- Two short quizzes after lectures and field trips to reinforce foundational information.
- Earth Cycles Trivia Game (similar to Trivial Pursuit™) designed to evaluate student retention of information in a fun, informal setting.

Resources (websites, articles and textbooks):

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Rydin, H., & Jeglum, J. (2006). *The Biology of Peatlands* (J. K. H. A. Jeglum, Trans.). Oxford; New York: Oxford University Press.

Tarr, Matt and Kim Babbitt, 2013. Hydroperiod in Wetland Assessment A guide for community officials, planners, and natural resource professionals. University of New Hampshire Cooperative Extension. URL: http://extension.unh.edu/resources/files/resource000812_rep847.pdf, accessed 24 August 2013.

United States Department of Agriculture, 1995. Functions, Benefits and the Use of Best Management Practices. United States Department of Agriculture Forest Service Report NA-PR-01-95. URL: http://www.na.fs.fed.us/spfo/pubs/n_resource/wetlands/wetlands5_soils.htm, accessed 24 August 2013.

United States Department of Agriculture, 2013. Wetland plant indicator status interpretation. URL: <http://plants.usda.gov/wetinfo.html>, accessed 6 June 2013.

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Brief description of how this unit relates to your graduate research. (1 page):

My research project is investigating the effectiveness of a hydrologic restoration on hydrology, gas flux and water chemistry in a wetland located in a National Wildlife Refuge. The wetland was ditched in an attempt to drain and convert it to farmland, and then diked to form pools for waterfowl habitat after designation as a national wildlife refuge. The flooded and dried areas have been reconnected in an attempt to restore the wetlands to their former function.

Much of our groundwater recharge occurs in wetlands, and most streams have wetlands forming their headwaters. Wetlands are important ecosystems that can have a direct influence on the health of other ecosystems, yet humans still view wetlands as wasteland and strive to overturn wetland protection policies in pursuit of economic development. I have developed this introduction to wetlands in an effort to raise awareness of the importance of wetlands, and use it to reconnect students with their local environment. Most regions in which this unit could be taught have wetlands, even if only in the form of seasonal flooding during melt-off of mountainous spring snow. Many threatened and endangered species are dependent upon wetlands, as well as some of our commercially desirable fish and wildlife. Concurrent with growing pressures on wildlife habitat, our environmental laws are being eroded in the name of economic progress.

If more people are aware of the importance of wetlands to human, animal, and environmental health and well-being, they might view them as favorable places to protect and live near and not try to drain and develop them.