**A 4DEE introduction to wetlands: Basic principles, online mapping, and field identification**



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**Abstract:***Wetlands are ecosystems characterized by the presence of saturated soils or inundation (flooding) that occur with sufficient frequency and length of time so as to influence the mix of plant species able to tolerate those conditions. Wetlands include marshes, bogs, swamps and similar communities. Wetlands are ecologically important because they clean polluted water, reduce downstream flooding, and provide habitat for many species. Wetlands are great examples of how spatial and temporal change in the water table, impacted by humans, can affect biodiversity in local and adjacent habitats. Because of their importance to humans, wetlands are protected from development by federal and state law. Identifying wetlands is an important skill that anybody should know how to do. This activity, which follows the Ecological Society of America’s Four Dimensional Ecology Education (4DEE) approach (4DEE Committee 2020), contains three components. The first is a Powerpoint presentation that provides background into the basic principles of wetlands, including the definition and classification of wetlands, their functions and values, and some legal aspects surrounding wetlands. The second component provides students with the opportunity to identify wetlands through the National Wetland Inventory maps produced by the US Fish & Wildlife Service. Those maps are online and freely available to the public. In the third component, students learn how to identify wetlands in the field. To do so, they travel to a site containing a known wetland. They examine vegetation, soils, and pattern of water flow in a portion of the site that is wetland and compare it to a portion that is not wetland.*

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**Learning objectives:**This activity has three components. The first is a Powerpoint presentation that provides basic principles about wetlands. After viewing that presentation, students should be able to demonstrate knowledge about wetland ecology, classification, their functions and values, and laws that relate to wetland preservation. In the second component, students will use online mapping tools to identify wetlands in proximity to the school, to a park, or to a field station. In the third component, the students will conduct a field exercise, after which they will learn about how the vegetation, soils, and pattern of water availability differ between wetlands and adjoining uplands. The overall goal of this exercise is to improve the ability of students to think as ecologists, combining theory with mapping and field observations. That skill should carry over to subsequent assignments in the course.

By combining the Powerpoint presentation to the mapping activity and the in field wetland identification, this exercise satisfies all four of the dimensions of the 4DEE framework, endorsed by the Ecological Society of America (4DEE Committee 2020). See pp. 7-8 for additional explanation.

**Timeframe:**For the Powerpoint component, the instructor should spend at least one hour familiarizing him / herself with the presentation. That presentation should take 50-75 minutes to complete in class, depending on the degree of elaboration that the instructor provides. For a class of upperclass college students, the instructor may wish to assign the Powerpoint to be reviewed by the students on their own. For instructors who prefer a flipped-classroom experience, the students could be provided with the presentation, divided into groups, and then give the presentation using a jigsaw approach. Regardless, reviewing the presentation should take 60-90 minutes.

The online mapping component can be performed in about 30-45 minutes.

For the field component, the instructor should devote about two hours scouting out a likely site for wetland identification, familiarizing themselves with the dominant plant species, and digging soil pits. The field time with students will likely take 2-3 hours. Travel time is not included.

**List of materials:**Powerpoint presentation - A computer connected to a projector. Handouts for students to complete (included in this packet).

Online mapping component – Computers linked to the internet, each with a web browser. Datasheets (included in this packet).

Field component – Field guide to plants of the area, tile spade, Munsell soil color chart, smart phone, ruler or meter stick, insect repellent. Datasheets (included in this packet).

**A primer in wetland identification using online maps and in the field**

**Guide for Instructors**

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A. Overview

Wetlands are defined as transitional ecosystems between uplands and open water habitats like streams, rivers, ponds, lakes, and oceans. Unlike uplands, wetlands are dominated by plant species that can tolerate prolonged inundation or soil saturation (a.k.a. hydrophytes). Unlike open-water habitats, wetlands are typically dominated by vascular plants that emerge from the water surface.

Our perspectives on wetlands have changed markedly over the past 40 years. Before the 1970s, wetlands were considered to be waste areas, and were filled or drained to make them more productive. But thanks to recent research, we now know that wetlands are important ecosystems because they clean polluted water, prevent downstream flooding, and provide habitat to many species. Wetlands are also valued because they serve as spawning areas for fish, provide valuable natural products (e.g., cranberries, peat moss, fish), mitigate the effects of severe weather, and are ecologically productive. Because of their importance, wetlands are protected by law. For that reason, wetlands must be objectively defined in nature (identification) and their spatial extent determined (delineation).

Wetlands can be studied from a number of perspectives including their community dynamics, ecosystem processes, distribution over the landscape, and relations to humans. Wetlands are studied at various scales and are susceptible to spatial and temporal change in biodiversity generated by human activity and natural disasters. Thus, wetlands can be used to teach about many ecological concepts, major ecological practices, and system level understanding.

Because wetlands are so important within nature and are regulated by law, most adults should have some familiarity with key concepts including their definition, classification, functions, values, and legal dimensions. Further, knowing how to identify and delineate wetlands is an important skill for ecologically literate individuals to possess. Indeed, many ecologists find lucrative employment as consultants and with civil engineering firms identifying and delineating wetlands.

This exercise first introduces students to essential concepts regarding wetlands through a Powerpoint-based presentation that can be delivered by the instructor or by the students using a jigsaw approach. Second, it provides students with skills needed to identify wetlands, both through online maps and in the field. As a word of caution, this exercise is not intended to be the sole means to prepare students to delineate wetlands on a professional basis. Instead, it is designed to provide perspective and whet the student’s appetite to learn more about these fascinating and valuable ecosystems.

This exercise is consists of three parts: an introductory Powerpoint-based presentation covering key aspects of wetland ecology and protection, a second component in which students identify the presence and types of wetlands in an area using online maps, and a third component in which they identify a wetland in the field and contrast it with a non-wetland (upland) habitat.

This exercise covers all dimensions associated with the Ecological Society of America’s Four Dimensional Ecology Education (4DEE) framework (4DEE Committee 2020). By virtue of the presentation, students learn about wetland communities and ecosystems, thus covering Core Ecological Concepts. The impact of humans on wetlands is an example of Human-Environment Interactions. Through the online mapping and field components, students gain valuable skills in Ecology Practices. Finally, wetland valuation and historical perspectives address Cross-Cutting Themes. Pages 7-8 provide additional explanation, especially relating to interactions between the various dimensions.

B. Powerpoint Presentation

A Powerpoint-based presentation is the first part of this exercise. Its purpose is to provide the students with background information regarding wetlands. A skeletal set of notes is included in these instructions on pp. 9-14. Each student is to receive a set of notes and then flesh them out while viewing the presentation.

C. Online component

The second part of the assignment asks the students to visit a website that contains maps of wetlands throughout the United States. Students are to select an area that is familiar to them, navigate to the site, and determine the presence and extent of any wetlands in that area.

As historical background, beginning in the 1980s, the US Fish and Wildlife Service (FWS) mapped wetlands throughout the United States through their National Wetlands Inventory (NWI) program (https://www.fws.gov/wetlands/). Most mapping was done by experts trained in the interpretation of aerial imagery, as opposed to having wetland scientists conducting detailed ground-based investigations. The result of the NWI effort can be found through the FWS’s Wetland Mapper resource (<https://www.fws.gov/wetlands/data/mapper.html>). Access to that resource is free, and it is easy to navigate. Students should have little difficulty getting to the Wetlands Mapper imagery. The mapping is intuitive, though the interpretation of the accompanying wetland codes probably requires some explanation.

The procedure for accessing the maps is outlined in the Instructions for Students. Before lab, you should familiarize yourself with the FWS’s online mapping system, and be prepared to help the students direct the map to a location (ideally one that the students can visit) that contains wetlands. This exercise will be most successful if the students avoid heavily urbanized areas, deserts, as well as those with a long history of intensive farming or other disturbance. Students should have more luck with “natural” areas, such as state parks or field stations.

Students will use the zoom control in the upper-left corner of the map. Make sure that the students pay attention to the scale given at the bottom-left corner. Moderately large lakes and rivers will be evident at a scale of 1:2,300,000. Wetlands should be evident at a scale of 1:144,000. Wetland codes, depicting the type of wetland mapped, should appear at about 1:18,000.

When the students click a particular wetland, a box should appear depicting the size of the wetland in acres, the type of wetland (e.g., Freshwater forested, estuarine), and the code. A link to the meaning of the code is also provided. Included in the box is information regarding the basis of the mapping.

As they progress through the exercise, students will complete datasheets – provided below – that require them to record their observations made at various stages of the exercise. As noted, once the student begins, working through the online mapping component should take approximately 30-45 minutes. If necessary, it can be done at home.

D. Field Component

You do not need to have considerable expertise in wetland science in order for this portion of the lab to be successful. Detailed instructions for conducting the field component are provided to the students, and you will need to familiarize yourself with those instructions regardless of your level of wetland expertise. Your role is to give students an opportunity to examine a wetland and an upland site for comparison. Ideally, the two sites should be in relatively close proximity to each other – suggested 50-300’ apart.

For the best learning experience, your selected location should be free of recent disturbance to the soils and vegetation, as disturbance tends to confound assessment of the wetland and upland. State or federal parks make ideal sites to find wetlands and uplands in proximity, but permission should be obtained from park managers. County Conservation Districts, Extension Agents, or Wildlife Officials are typically knowledgeable about suitable locations for students to sample.

Selecting a site that is mapped as wetland on the NWI maps would help link those two phases of this exercise together.

It is highly recommended that the instructor conduct a reconnaissance trip to the site before running the lab. During that initial visit, the instructor should become familiar with the “lay of the land” in terms of terrain, vegetation, and presence of surface hydrological features such as ponds, lakes, streams, rivers, bays, and lakes. The instructor should then identify two sites for detailed assessment: one upland and the other wetland. Well-selected, highly contrasting wetland and upland will lead to a successful learning experience for the student.

The instructor should bring a variety of materials during the reconnaissance visit. The first would include a field guide that encompasses the local vegetation. In many instances, multiple guides – including one for trees, another for flowering herbs and shrubs, another for ferns, and perhaps one for grasses and sedges – may be needed. A tablet computer or smart phone might be useful to help identify vegetation (e.g., using iNaturalist), as well as to determine wetland indicator statuses using the USDA Plants website. A Munsell soil color book (obtainable from vendors like Forestry Suppliers) is needed as a standard reference. Finally, a tile spade (a shovel with an elongated blade) is needed to take the soil sample. While a soil auger might be used, the spade brings up more soil for examination. Also, a ruler or meter stick is helpful for measuring water depths above or within the soil.

In terms of attire, suitable field clothes (denims, comfortable shirt, and sturdy hiking boots) should be worn. Waterproof boots may be helpful, especially if there is abundant standing water at the site. However, visualizing the soil is easier if the site is not inundated by more than 2-3” of water. Soils that are merely saturated are ideal. Indeed, if you get more than the top of your feet wet, you are in too deep. You should also have insect repellent and a first-aid kit available. Other safety considerations are mentioned in the guide to students.

During the reconnaissance, try to identify as many plants as possible and look up their Wetland Indicator Statuses. Having an expert in plant identification will make the process run smoother. Create several soil pits following the guidelines provided to the students, and familiarize yourself with the presence and thickness of the topsoil and subsoil. Then using the Munsell soil color booklet, identify the color(s) of the subsoil. Be prepared to encounter mottled subsoils, and be ready to help students identify the matrix (background) and mottles (blotches).

When students arrive in the field, assemble them into teams of four or five to ensure that everybody is involved. You can array the student teams 50-100’ apart, both in the upland, as well as the wetland. Students will probably need most assistance in identifying the plants, looking up the Wetland Indicator Statuses, determining the interface between the topsoil and subsoil, and using the Munsell color book. Some students may also need assistance with entering data into the datasheets.

When the students finish identifying both the upland and the wetland, you may attempt to determine the boundary – if time remains. In general, the boundary can be located where the soil makes the transition from being brightly colored to being predominantly gray, where the vegetation starts to become dominated by hydrophytic species (FACW and OBL), and where indicators of wetland hydrology start to become dominant. A worthwhile exercise would be for student teams to each take a shot at identifying the wetland-upland boundary, and seeing how close they come to each other.

When the exercise is completed, make sure that the students fill in the holes that they excavated with the plugs of soil and that they clean off equipment.

**Consistency with ESA’s 4DEE Framework**

This exercise is consistent with the Ecological Society of America’s Four Dimensional Ecology Education (4DEE) framework. By aligning with 4DEE, students are better able to analyze the components of ecological phenomena, as well as integrate information along the four dimensions thus preparing the students to address today’s environmental issues.

To that end, the Powerpoint presentation, the mapping exercise, and the field-based exercise cover: (1) Core ecological concepts, (2) Ecology practices, (3) Human-environment interactions, and (4) Cross-cutting themes. Various interactions between the four dimensions are also explained. Further information regarding the 4DEE Framework can be found at <<https://www.esa.org/4DEE/framework/>>.

|  |  |  |  |
| --- | --- | --- | --- |
| **Dimensions** | **Present (P)/ Absent (A)** | **Item(s) covered****(see list)** | **Additional description** |
| Core ecological concepts (CEC) | P | Individuals, populations, communities, ecosystems, landscapes all pertain to wetlands. | Wetlands are ecosystems that contain hydrophytic vegetation communities. |
| Ecology practices (EP) | P | Natural history, fieldwork, quantitative reasoning, and collaboration can all apply to wetlands. | Students learn marketable skills by interpreting maps and identifying wetlands. |
| Human-environment interactions (HEI) | P | Wetlands have values to society, humans have disturbed wetlands. | Values include prevention of downstream flooding, and purification of drinking water. |
| Cross-cutting themes (CCT) | P | Wetlands are systems that have scale, structure, function, transform matter and energy, and can be disturbed. | Functions include providing habitat to animals, having high productivity. |
| **Integration of Dimensions** | **Present (P)/ Absent (A)** | **Identification of interactions by coverage item(s)** | **Additional description** |
| CEC x EP | P | Students learn how to identify different wetland communities in the field | Provided by fieldwork portion of exercise. |
| CEC x HEI | P | Wetland ecosystems have values to society | Provided by Powerpoint presentation. |
| CEC x CCT | P | Wetland communities have structure and function | Provided by Powerpoint presentation. |
| EP x HEI | P | Students learn through fieldwork that humans can impact wetlands. | Provided by extension to fieldwork. |
| EP x CCT | P | Through mapping exercise, students can learn scale and structure of wetlands | Provided by mapping exercise |
| HEI x CCT | P | Some wetland values are based on their ability to transform matter and energy. | Provided in Powerpoint presentation. |
| CEC x EP x HEI | P | Through fieldwork, students learn that wetland plant communities can be impacted by human activities such as draining or filling. | Student observation based on extension of principles taught. |
| CEC x EP x CCT | P | Through computer-based mapping, students learn that wetland communities have spatial scale. | Student observation based on exercise. |
| EP x HEI x CCT | P | Though interpreting graphs, students learn that wetland systems can prevent downstream flooding. | Provided in Powerpoint presentation. |
| CEC x EP x HEI x CCT | P | Using a natural history approach, students can determine how larger wetland ecosystems produce more natural products than smaller wetlands. | Thought question for students. |
|  |  |  |  |

**Notes to Accompany “Introduction to Wetlands” Powerpoint Presentation**

1. What are wetlands?
	1. Transitional areas
	2. Effect of saturation or inundation
	3. Legally defined
	4. Percent of landscape covered
2. What is not wetland?
	1. Upland
	2. Open water
	3. Watercourse
3. Wetland overview
4. Where can wetlands be found?
	1. Adjoining open water
		1. Tidal
		2. Riverine
		3. Lacustrine
	2. Where shallow groundwater occurs
		1. Groundwater discharge zones
		2. Natural depressions
		3. Man-made depressions
5. Wetland classification
	1. By ecological system
	2. By dominant vegetation
	3. By landscape position
	4. By water chemistry
6. Wetland functions and values
	1. Wetland functions
		1. Repositories of biodiversity
		2. Flood storage / desynchronization
		3. Water purification
		4. Biomass production
	2. Wetland values
		1. Water quality enhancement
		2. Downstream flood protection
		3. Protect low-lying areas
		4. Habitat for commercially important species
		5. Scenic beauty and recreation
		6. Education and cultural value
	3. Financial value of wetlands
7. Historical perspectives on wetlands
	1. Original viewpoints
	2. Loss of wetlands in U.S.
	3. Fate of “lost” wetland
8. Federal protection of wetlands
	1. Section 404 of Clean Water Act
	2. Role of Secretary of U.S. Army
	3. Bodies of water included
9. Three-parameter definition
	1. Hydrophytic vegetation
	2. Hydric soils
	3. Wetland hydrology
10. Disturbing a wetland
	1. Permit applications made through U.S. Army Corps of Engineers
	2. Role of General Permits
	3. Review criteria
11. Wetland mapping
	1. Purpose
	2. How performed
	3. Image interpretation
	4. National Wetland Inventory
		1. Responsible agency
		2. Purpose
		3. Wetland Mapper
12. Wetland delineation
	1. Purpose
	2. What to look for
		1. Vegetation
		2. Soils
		3. Inundation / saturation
		4. Normal circumstances
13. Compensatory mitigation
	1. Purpose
	2. Last resort
	3. Need approved plan with Corps and relevant state agencies
	4. How to do
	5. Monitoring
	6. Ratios (mitigated acreage : lost acreage)

1. Non permitted encroachments
	1. Penalties
	2. Post encroachment delineation
	3. Mitigation ratio

**A primer in wetland identification using online maps and in the field**

**Instructions for Students**

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*A. Overview*

Wetlands are defined as transitional ecosystems between uplands and open water habitats like streams, rivers, ponds, lakes, and oceans. Unlike uplands, wetlands are dominated by plant species that can tolerate prolonged inundation or soil saturation (a.k.a. hydrophytes). Unlike open-water habitats, wetlands are typically dominated by vascular plants that emerge from the water’s surface.

Our perspectives on wetlands changed markedly over the past 40 years. Before the 1970s, wetlands were considered to be waste areas, and were filled or drained to make them more productive. But thanks to recent research, we now know that wetlands are important ecosystems because they clean polluted water, prevent downstream flooding, and provide habitat to many species. Wetlands are also valued because they serve as spawning areas for fish, provide valuable natural products (e.g., cranberries, peat moss, fish), mitigate the effects of severe weather, and are ecologically productive. Because of their importance, wetlands are protected by law. For that reason, wetlands must be objectively defined in nature (identification) and their spatial extent determined (delineation).

Wetlands can be studied from a number of perspectives including their community dynamics, ecosystem processes, distribution over different landscapes, and relations to humans. Wetlands are studied at various scales and are highly susceptible to spatial and temporal change in biodiversity generated by human activity and natural disasters. Thus, wetlands can be used to teach about many ecological concepts, can be used for learning about major ecological practices, and system level understanding.

This exercise will introduce you to essential skills needed to identify wetlands, both through online maps and in the field. It is not intended to serve as the sole source of information to prepare you to serve as a wetland consultant – but instead to provide perspective and maybe whet your appetite to learn more about these fascinating and valuable ecosystems.

To best understand the nature and importance of wetlands, you are urged to first view the accompanying Powerpoint presentation “Introduction to Wetlands: Basic Principles” and complete the packet of notes provided by your instructor.

*B. Online component:*

1. Background Information

Land developers (e.g. those who build housing tracts, shopping malls, factories, mines and quarries, etc.) must abide by federal, state, and local regulations involving issues such as wetlands, soils, and possible conflicts with rare plants and animals. These issues are generally handled by experts who work with the developer, usually by conducting on-site investigations.

Thanks to the advent of online mapping tools often provided by various federal and state government agencies, it is possible to conduct a preliminary determination from a computer. While not a replacement for on-site investigation, the preliminary determination can be useful as an initial site screening. Indeed, some agencies require a site screening before onsite investigations can proceed.

In this part of the exercise, you will use a resource called “Wetlands Mapper” produced by the U.S. Fish and Wildlife Service. The Wetland Mapper website (<http://www.fws.gov/wetlands/Data/Mapper.html>) gives you access to an online version of the National Wetland Inventory.

2. To do:

Open your web browser to the Wetland Mapper URL given above. You should see a page that provides background information, and at the bottom the numbers “1”, “2”, and “3”. Under number “3”, note a map of the United States, and click it. A page containing a disclaimer will appear. Click the “I accept the terms and conditions” link at the bottom of the page.

You will see a map of the US that you can pan and zoom in or out. Using the pan and zoom controls, move the map so it covers an unbuilt or semi-unbuilt area in proximity to your campus. Then zoom down to a scale of approximately 1:36,000 (see box in lower left corner). At that scale, you should see features like roads, rivers and lakes. You should also see areas that are shaded by green and/or blue shapes.

Answer the questions in the datasheet.

Next select one of the green shapes, and zoom to approximately 1:9000 scale. You should see a code (e.g., PFO1A) in the center of that shaded area.

Click the green shape (hint: it’s a wetland), and a box should appear. Answer the questions on the datasheet.

*C. Field Component*

1. Background Information

Wetlands can be objectively defined in the field if you know what to look for. In this part of the unit, you will learn the basics of wetland identification. Being able to identify wetlands in the field provides many ecologists with a marketable skill that is required to determine whether land development projects can move forward. Such knowledge can also help one determine whether a developer has run afoul of federal laws and state regarding wetland impacts.

As noted in the Powerpoint presentation, wetlands are defined according to three parameters: presence of water for at least part of the year (wetland hydrology), wetland (hydrophytic) vegetation, and wetland (hydric) soils. These will be discussed briefly in turn. Your instructor will then work with you to help you see the difference between wetland and non-wetland (upland) ecosystems.

1. Hydrophytic vegetation

Most plants require soils that are moist in order to stay alive. We all know that all plants die unless you give them some water. But most plants die when they receive too much water – simply because their roots need oxygen in order to respire. However, a category of plants called hydrophytes can survive anoxic conditions associated with prolonged soil saturation or inundation because of structural or physiological adaptations. Representative hydrophytes include cattails, bulrushes, mangroves, buttonbush, marsh marigold, and many sedges. In contrast, other plants like apple trees, chestnut oaks, and common milkweed don’t survive flooding well. They are considered to be upland species. In between are plants that can survive both upland conditions and being occasionally overwatered. Red maple and certain species of buttercups are good examples.

To determine whether an area has hydrophytic vegetation, one must analyze the plant community that is present. The first step is to determine the dominant species, meaning those that cover the most ground. Dominants collectively comprise up to 50% of the total percent cover. Each of those species must be accurately identified to species level.

The second step is to determine the Wetland Indicator Status for each species. That information, available on the USDA Plants Database website (<http://plants.usda.gov>), categorizes each plant species as to whether it essentially always lives in wetland conditions (Obligate - OBL), occurs in either wetland or upland (Facultative - FAC), or essentially never lives in wetland (Upland -UPL).

Over the years, biologists have expanded this classification system to include two additional categories. Specifically, species that occur in wetlands most of the time, but are occasionally found in upland are classified as FACW. Those that occur in uplands most of the time, but are occasionally found in wetlands are classified as FACU.

The vegetation is determined to be hydrophytic If more than half of the dominant species are OBL, FACW, or FAC.

1. Hydric soils

Soil is a mix of mineral fragments of various sizes, intermingled with organic matter and air spaces called pores. Soils are also layered, with a surface layer of decaying leaves and other plant remains. Beneath the surface layer is a 2-10” thick layer of topsoil that contains mineral fragments, but is usually rich in decomposed plant and other organic materials. Beneath the topsoil is a layer of subsoil that has less organic matter, but often accumulates fine mineral fragments called clay. The lowest layer is the bedrock. The distance between the surface and the bedrock varies greatly from one place to another due to many factors that are beyond the scope of this lab.

In upland soils, the upper part of the subsoil is typically brightly colored due to the presence of oxidized elements – particularly iron. In contrast, soils in which the pores are filled with water for prolonged times undergo a process of chemical reduction in which the elements become soluble and wash away, leaving a gray subsoil made up mainly of silica. These are strongly hydric. Soils that are transitional between wetlands and uplands often appear blotchy or mottled, with zones of gray interspersed with brightly colored zones. Soils that are predominantly gray with brightly colored mottles are determined to be hydric, while those that are brightly colored with some gray are not hydric.

The determination of soil color can be arbitrary, and therefore standards must be used. Such standards are typically in the form of Munsell soil color charts. If a soil has a prevailing intensity (chroma) of 0, 1, or 2 on the Munsell scale, it is deemed hydric. If the dominant color has a chroma that is greater than 2, it is deemed non hydric.

You should be aware that soil color may be determined by factors other than saturation. Thus, care should be used when using that feature alone to classify whether a soil is hydric. But for the purpose of this lab, we will use low-chroma subsoils as a wetland indicator.

1. Wetland hydrology

In order to qualify as a wetland, a piece of ground needs to have appropriate hydrology in the form of groundwater or surface water. Timing is important though, because the water has to be present for three consecutive weeks during the growing season. Thus, it is possible to visit an upland site that is temporarily flooded, such as after a heavy rainstorm. Conversely, many wetland sites appear dry when visited in the late summer or fall due to natural seasonal drawdown of the groundwater. In that case, we look for indicators of wetland hydrology, in the form of discolored (black or gray) leaf litter, a soil surface or ground-level vegetation covered with silt, signs of surface scour, or trees with shallow roots.

1. Putting it all together

Normally, all three parameters must be present in order for an area to be determined to be a wetland. If one or more of the parameters is lacking, the site fails to qualify as wetland. It is worth noting that unusual circumstances, such as severe disturbance, can override these three parameters. In that case, experience and insight are needed to determine whether a site qualifies as wetland.

e. Noteworthy

Knowing how to identify and determine the spatial extent of wetlands is a highly marketable skill. The instructions provided below give you a glimpse into how it’s done. If you find yourself enjoying the process of identifying wetlands, and would like to do it professionally, you are urged to take a formal course in wetland identification and delineation. Such courses are offered at universities and through organizations such as the Wetland Training Institute or the Society for Wetland Scientists.

2. To Do

Your instructor will take you to a site that contains a mix of wetland and upland. Typically, the upland will be topographically higher than the wetland. Before you get into the methods discussed below, familiarize yourself with safety information discussed at the end of this section.

1. Getting a feel for the lay of the land

As you walk around the site, get a feel for the nature of the vegetation and how it might change as you go from higher to lower ground. As you walk downhill, you should notice that the soil becomes evidently waterlogged at some point. You may also see any places where standing or flowing water occurs. If so, determine whether the surface water seems relatively long term, or whether it results from a recent rainfall or snowmelt event. Try to discern a shift in the color of the leaf litter, from being predominantly brown to being more gray or black.

Walk back to the area of higher ground, away from any zone of saturated soils. You should be in an area of upland, which will provide a context for your examination of the wetland. Note: If any of the plot has saturated soils, you likely did not select your upland well enough. Move upslope until none of the soils appear saturated.

1. Assessment of putative upland

Background information.

Locate the first of two Wetland Identification Datasheet located in this packet. Provide the requested background information regarding the site location, date, field investigators, etc. The photo app on your smart phone should provide you with latitude / longitude information. For “community / plot” put “Upland”.

Vegetation

You will first assess the vegetation. For sake of simplicity we will use a method that borrows from the approach recommended by the federal and state agencies responsible for wetland protection.

First, if the zone is forested, define a relatively uniform area that measures approximately 10m x 10m. Use 5 x 5 m if the vegetation lacks trees, but contains shrubs and herbaceous plants.

Classify the plants into up to four categories:

* Trees: Woody plants that have a diameter of >3”, as measured 4’ from the ground.
* Saplings / Shrubs: Woody plants with a diameter of <3”, but >1m tall.
* Herbaceous: Non-woody plants (grasses, sedges, wildflowers), regardless of height, and woody plants <1m tall.
* Vines: Creeping / climbing woody plants >1 m tall.

If the zone contains trees, select the three most dominant species from each layer present. If the zone lacks trees, select the five most dominant species from each layer.

In either case, identify each species and look up the wetland indicator status for your geographic region from the USDA Plants website. Record on the datasheet provided in this packet. Determine the percentage of species that are OBL, FACW, or FAC. If the result is >50%, you have hydrophytic vegetation. If <50%, it is not hydrophytic.

Soils

Use a tile spade to excavate a plug of soil measuring approximately 1’ in diameter by 15” deep. Take care to keep the plug as intact as possible. You may need to cut through plant roots as you excavate the plug. Also, if the soil is too stony, select another nearby location.

As you remove the plug, lay it on its side. You should be able to see a dark topsoil layer that should be between 3 to 12” thick. Below that should be the subsoil.

Look at the upper 3-4” of the subsoil. Is it uniform in color, or can you see blotches of different color? Blotchy soils are called mottled. The dominant color is the matrix, the smaller patches are the mottles.

Take a clod of the subsoil measuring approximately 4” x 4” and break it in half. Match the newly exposed face to the Munsell color charts. Note that you will need to find the correct page that represents the hue (color of the rainbow) of the subsoil. Once you land on the correct page, you will see that the paint chips form a grid, where the horizontal rows define the value (lightness or darkness), and the vertical rows define the chroma (intensity of color). Match the soil to the paint chip that best depicts its color. Pay closest attention to the chroma columns. If the soil has a chroma of 3 or more, we will call it non-hydric. If the chroma is 0, 1, or 2 – we will call it hydric.

Record the color on the datasheet provided in this packet. Express it in terms of “hue value/chroma.” Examples would be 10 YR 5/4 or 2.5 Y 6/1. If the subsoil is mottled, record the color of the matrix, and those of the mottles.

Hydrology

The last parameter that you will examine relates to the presence of water on the site. As you may recall, wetlands require three continuous weeks of inundation or soil saturation during the growing season.

Walk around the area of interest. Again, it will be 10 m x 10 m if forested, 5 m x 5 m if dominated by shrubs or herbs. You should not see any standing water, nor saturated soils.

Return to the soil plug that you excavated. Is any of the deeper soil saturated? If so, what is the depth of the top of the zone of saturation (measured from the top of the plug). Looking into the hole that you created, do you see any water entering the hole? Of so, how far from the soil surface is the top of the water collecting in the hole?

Next, determine the presence of wetland hydrology indicators. Some of the more common include:

* Gray or blackened leaf litter
* Silt covering the leaf litter
* Surface scour caused by flowing water
* Trees with shallow roots
* Plants with spongy leaves
* Soils that are highly organic
* Soils that give off the odor of rotten eggs (hydrogen sulfide)
* Oxidized zones surrounding root strands

Complete that part of the datasheet.

Putting it all together

Are you seeing all three parameters (hydrophytic vegetations, hydric soils, wetland hydrology)? Does the site indeed qualify as upland? (Hint: if you selected your site well, it should come up as upland).

1. Assessment of putative wetland

Having examined the upland, you will now move into the area designated by your instructor as wetland. Repeat the procedures used for the determination made in the upland, again examining the vegetation, soils, and hydrology.

Topographically, was the zone classified by the instructor as putative wetland higher, lower, or at the same elevation as the upland? Is the vegetation made up of different species? How does their wetland indicator statuses compare to the plants growing in the upland?

How do the soils compare? Can you see evidence of low chroma (gray) subsoils? Are they mottled, with a low chroma matrix? Is the upper layer organic?

Can you see any indicators of wetland hydrology, such as inundation, saturation, or surface scour? Is the leaf litter discolored or silted leaf litter? Do trees appear to have shallow roots? Are other indicators of wetland hydrology shown in the datasheet evident?

When you put together all three parameters, does the site really qualify to be wetland?

1. Final steps

Submit the completed datasheets to your instructor. Return the soil plugs to the holes, and tamp down the top with your foot to reduce evidence that the site was disturbed. Clean the tile spade to the best of your ability. Answer the questions provided in the assessment form.

1. Safety considerations

If you are careful and observe common-sense safety precautions, this exercise will be a great learning experience. Familiarize yourself with your institution’s Field Safety Manual. As you proceed, keep the following in mind:

* + - 1. Some risks include biting insects and poisonous plants, so dress appropriately. Wear shoes/boots that are comfortable, yet sturdy; long-legged jeans or khakis that you don’t mind getting dirty, and a comfortable long-sleeved shirt.
			2. When you walk in the field or forests, be on the lookout for trip hazards.
			3. Be on the lookout for potentially dangerous animals like snakes and other predators.
			4. Bring a well-charged cell phone.
			5. During hunting season, avoid areas that might be frequented by hunters. Wear orange.
			6. Remain in visual contact with one or two students or your instructor.**Wetland Identification Exercise – Preparedness Questionnaire**
1. List three benefits that wetlands provide to society.
2. Explain the difference between a UPL species and one that is listed as OBL.
3. What is soil chroma, and how does it relate to wetland identification?
4. List four indicators of wetland hydrology.
5. How is having knowledge about wetlands beneficial to an ecologist?

Thought question:

1. Why don’t animals figure into the determination of wetlands?

**Wetland Mapping Exercise – Student Datasheet**

Part A – Online Component

Questions for view at scale of 1:36,000

1. What’s the difference between a blue and green shape? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. How many shaded shapes are present in the field of view? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. What percentage of the area is shaded with blue? with green? \_\_\_\_\_\_\_\_\_\_\_\_\_

Questions for view at scale of 1:9000

1. What is the code of the wetland? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. How large is the wetland in acres? \_\_\_\_\_\_\_\_\_\_\_\_\_

3. What kind of a wetland is it? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Was the wetland determined by a field visit or by interpreting a map, photo, or other imagery? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. In what year was that determination made? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. Does the wetland appear to be disturbed in any way (e.g., by roads, railroads, power lines, buildings, agriculture)? \_\_\_\_\_\_\_\_\_\_\_\_\_

**Wetland Field Identification Exercise – Student Datasheet**

Site: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Community / Plot: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Municipality: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ County: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ State: \_\_\_\_\_\_

Latitude: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Longitude: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Elev. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Field Investigators \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Slope \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Aspect: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Veg. Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Describe any disturbance to soils or vegetation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Within growing season? \_\_\_\_\_\_\_\_\_

**Conclusions: Hydrophytic Vegetation? \_\_\_\_ Hydric Soils? \_\_\_\_\_ Wetland Hydrology? \_\_\_\_\_\_**

 **Is the community or plot a wetland? \_\_\_\_\_\_\_\_\_\_\_\_**

**Vegetation:**

Species: Stratum WIS Species: Stratum WIS

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# FAC / FACW / OBL species \_\_\_\_\_\_\_\_ # species \_\_\_\_\_\_\_\_ Percent \_\_\_\_\_\_\_

*Was hydrophytic vegetation criterion met? \_\_\_\_\_\_\_\_\_\_\_\_\_*

**Soils:**

Depth to subsoil: \_\_\_\_\_\_\_\_\_ Color of subsoil \_\_\_\_\_\_\_\_\_\_\_\_\_ Color of mottles \_\_\_\_\_\_\_\_\_\_\_

Organic topsoil? \_\_\_\_\_\_\_\_\_ Hydrogen sulfide odor? \_\_\_\_\_\_\_\_\_\_\_\_\_

*Was hydric soil criterion met? \_\_\_\_\_\_\_\_\_\_\_\_\_*

**Hydrology:**

Depth of any inundation \_\_\_\_\_\_\_\_\_ Depth to saturated zone \_\_\_\_\_\_\_\_\_\_

Gray or blackened leaf litter \_\_\_\_\_\_\_\_\_ Siltation of leaf litter \_\_\_\_\_\_\_\_\_\_

Surface scour caused by flowing water \_\_\_\_\_\_\_\_\_\_ Trees with shallow roots \_\_\_\_\_\_\_\_\_\_\_\_

Plants with spongy leaves \_\_\_\_\_\_\_\_\_\_ Oxidized zones surrounding root strands \_\_\_\_\_\_\_\_\_\_

*Was wetland hydrology criterion met? \_\_\_\_\_\_\_\_\_\_\_\_*

Note: Datasheet not approved by US Army Corps of Engineers, not for jurisdictional determinations

**Wetland Field Identification Exercise – Student Datasheet**

Site: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Community / Plot: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Municipality: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ County: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ State: \_\_\_\_\_\_

Latitude: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Longitude: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Elev. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Field Investigators \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Slope \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Aspect: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Veg. Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Describe any disturbance to soils or vegetation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Within growing season? \_\_\_\_\_\_\_\_\_

**Conlusions: Hydrophytic Vegetation? \_\_\_\_ Hydric Soils? \_\_\_\_\_ Wetland Hydrology? \_\_\_\_\_\_**

 **Is the community or plot a wetland? \_\_\_\_\_\_\_\_\_\_\_\_**

**Vegetation:**

Species: Stratum WIS Species: Stratum WIS

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_

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# FAC / FACW / OBL species \_\_\_\_\_\_\_\_ # species \_\_\_\_\_\_\_\_ Percent \_\_\_\_\_\_\_

*Was hydrophytic vegetation criterion met? \_\_\_\_\_\_\_\_\_\_\_\_\_*

**Soils:**

Depth to subsoil: \_\_\_\_\_\_\_\_\_ Color of subsoil \_\_\_\_\_\_\_\_\_\_\_\_\_ Color of mottles \_\_\_\_\_\_\_\_\_\_\_

Organic topsoil? \_\_\_\_\_\_\_\_\_ Hydrogen sulfide odor? \_\_\_\_\_\_\_\_\_\_\_\_\_

*Was hydric soil criterion met? \_\_\_\_\_\_\_\_\_\_\_\_\_*

**Hydrology:**

Depth of any inundation \_\_\_\_\_\_\_\_\_ Depth to saturated zone (in hole) \_\_\_\_\_\_\_\_\_\_

Gray or blackened leaf litter \_\_\_\_\_\_\_\_\_ Siltation of leaf litter \_\_\_\_\_\_\_\_\_\_

Surface scour caused by flowing water \_\_\_\_\_\_\_\_\_\_ Trees with shallow roots \_\_\_\_\_\_\_\_\_\_\_\_

Plants with spongy leaves \_\_\_\_\_\_\_\_\_\_ Oxidized zones surrounding root strands \_\_\_\_\_\_\_\_\_\_

*Was wetland hydrology criterion met? \_\_\_\_\_\_\_\_\_\_\_\_*

Note: Datasheet not approved by US Army Corps of Engineers, not for jurisdictional determinations

**Post Activity Assessment:**

1. Was the transition between wetland and upland abrupt or gradual?
2. Did any of your soil pits yield mottled soils? If so, how did you use that feature to help you identify the site as wetland or upland?
3. Based on the soils, was the wetland larger or smaller than you would expect from surface features alone?
4. Explain the change in color of leaf litter as you transitioned from upland into wetland.
5. Was the surface of the wetland flat, or did you see small knolls (called hummocks)?
6. Was your wetland isolated, or did it connect to a larger body of water like a lake or a stream?
7. From a permitting perspective, why does it matter if the wetland is isolated vs connected?
8. What changes to the water level within the soils would you get to see throughout the year?
9. Is it always possible to find water within the soil of wetlands? Explain.
10. If you dig a hole and find water, does that automatically mean that the site is a wetland? Explain.
11. How did the vegetation change between upland and wetland? Which species disappeared in the transition? Which species appeared?

Consistency with 4DEE:

1. Identify and briefly explain two core ecological principles that this exercise addresses.

 A.

 B.

1. Identify and briefly discuss two ways that humans interact with wetlands?

 A.

 B.

1. What ecological practices did you learn by virtue of conducting this exercise?
2. What cross-cutting themes did this exercise address?
3. Identify at least two ways in which this exercise demonstrates an integration between any two or more dimensions of 4DEE.

 A.

 B.