Wetlands

An Introduction

Richard Jerofke, ODOT Region 5

Surprise…

Let’s start with a POP QUIZ

Wetland?

Wetland?

Wetland?

Wetland?

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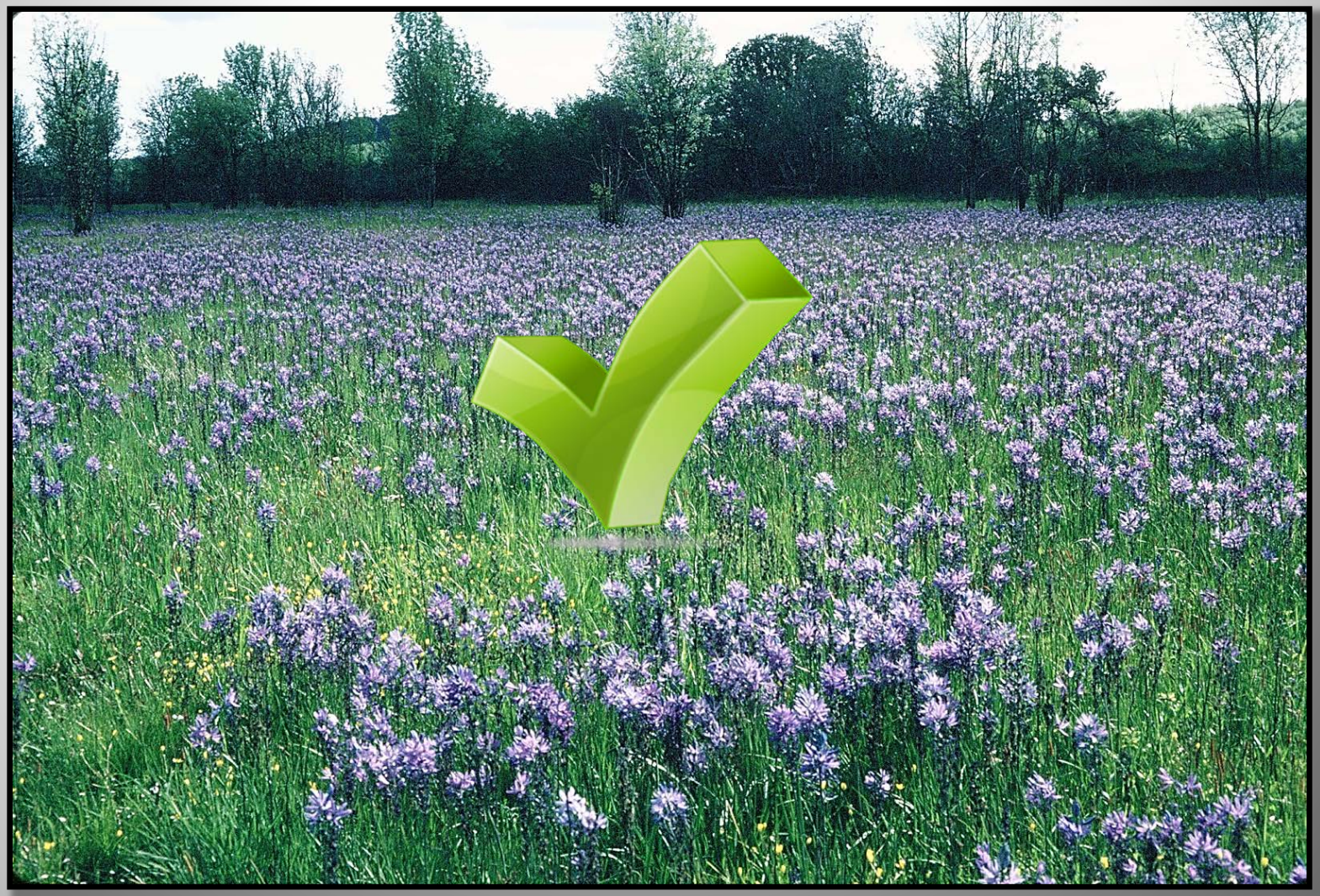
Wetland?



Wetland?

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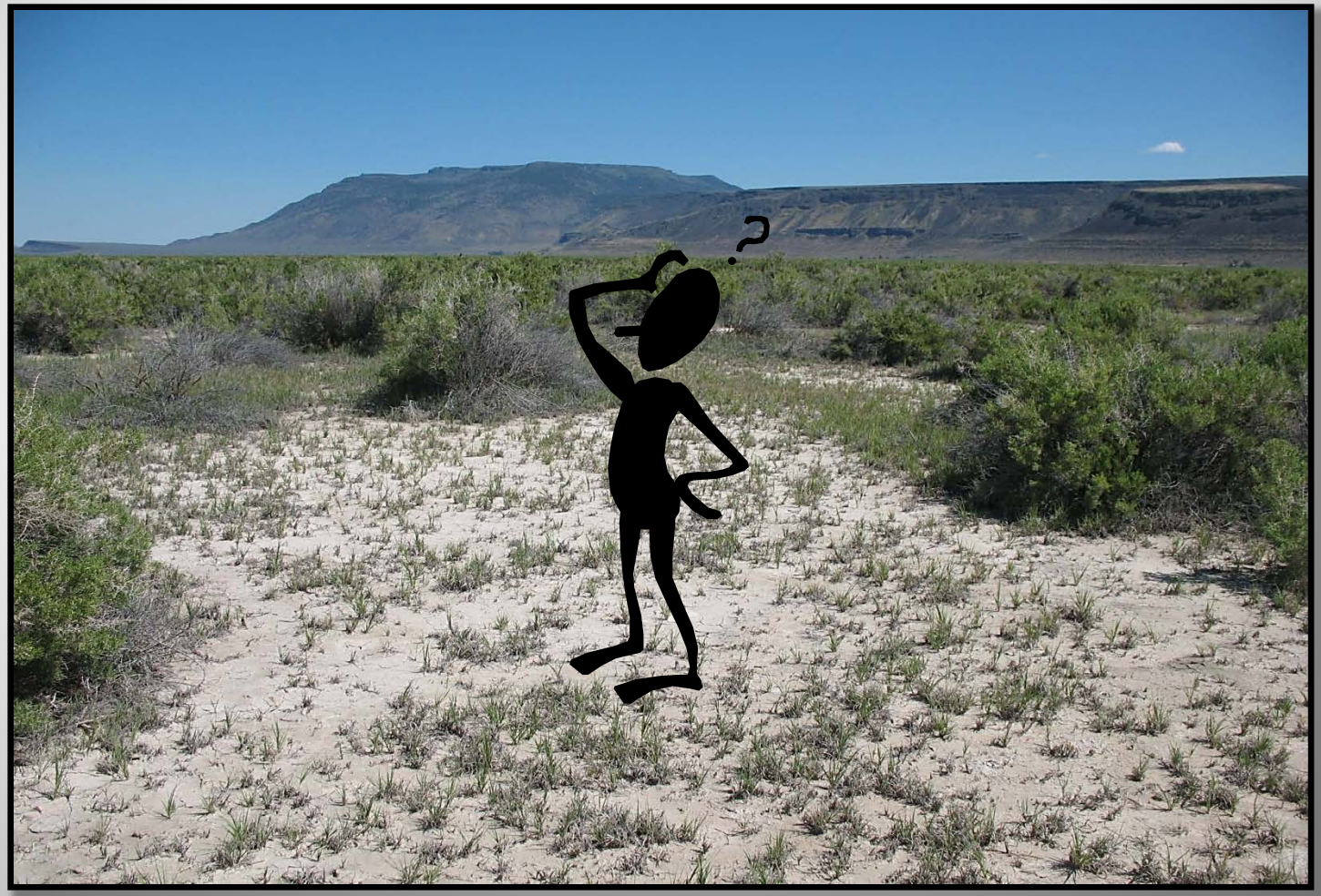


How did you do? 10 out of 10?

Many wetlands and non-wetlands are fairly easy to identify, but that is not always the case.

We will now go over what makes a wetland a wetland…

Definition of Wetlands

A broad term for all the different kinds of wet habitats where the land is wet for some period of time each year but not necessarily permanently wet.

US Army Corps of Engineers' Definition of Wetlands

The CE (*Federal Register* 1982) and the EPA (*Federal Register* 1980) jointly define wetlands as: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Oregon’s Definition of wetlands

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

DIVISION 85 OAR 141-085-0510 (101)

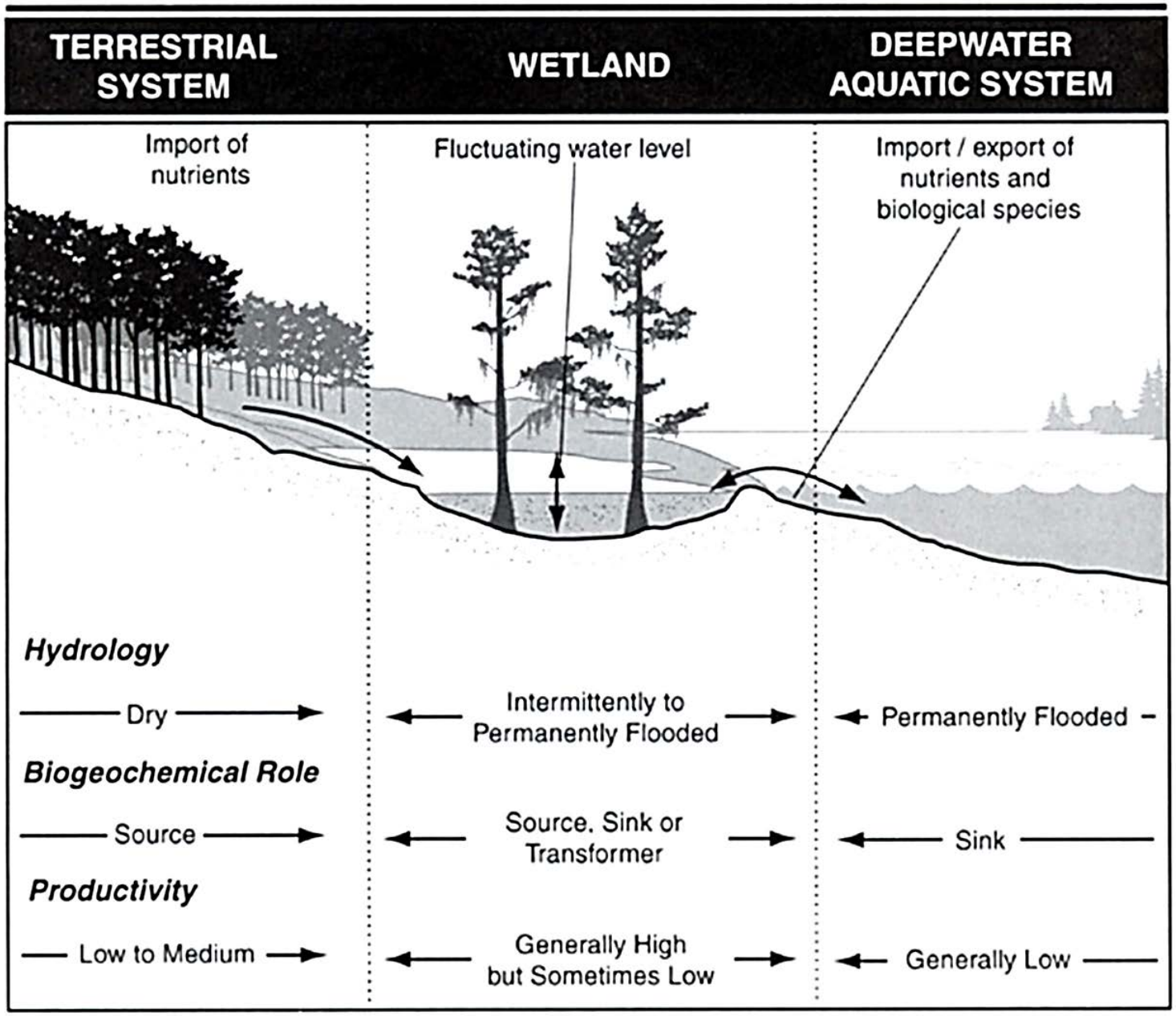
Alternative Definitions of Wetlands

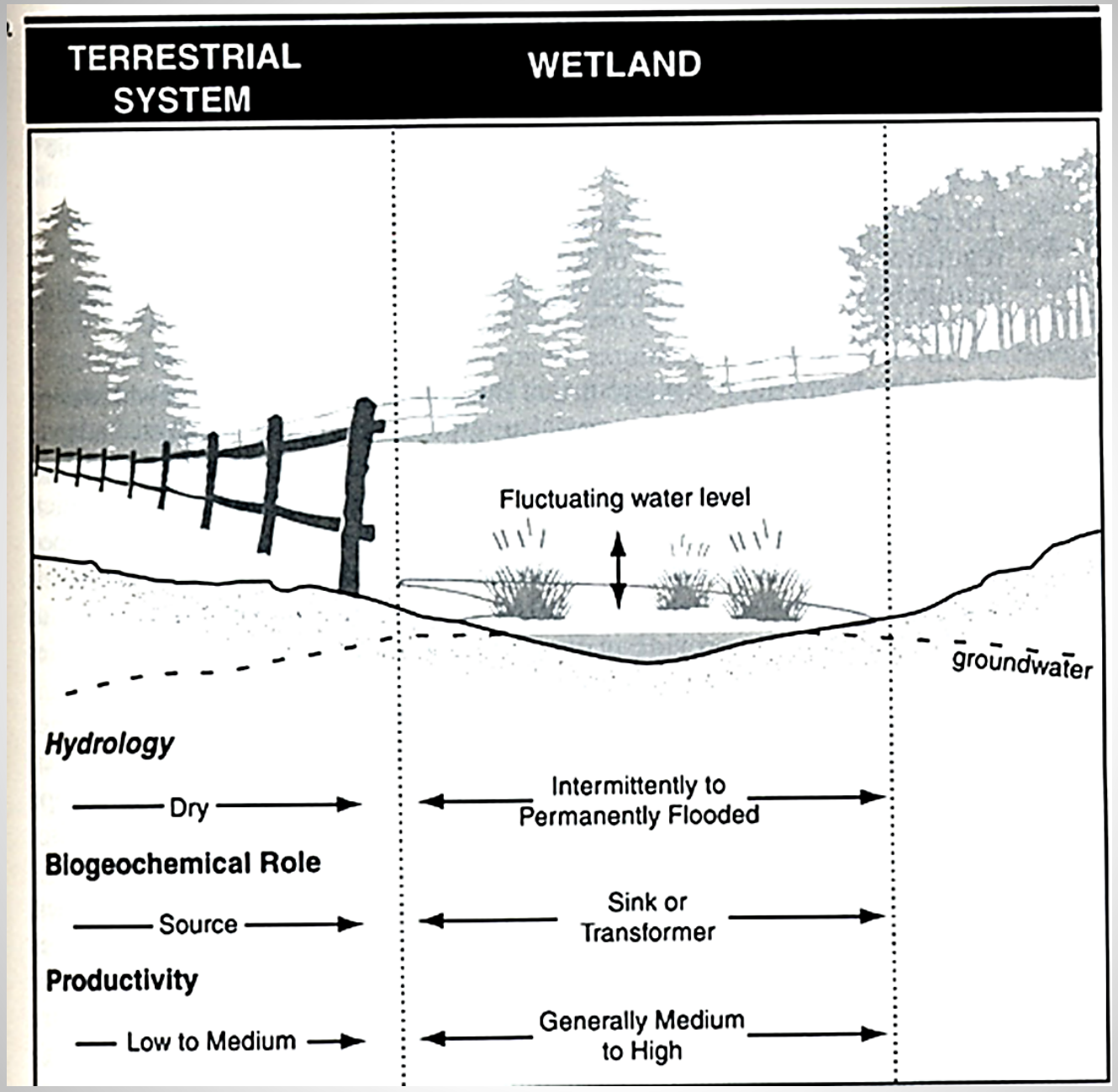
Another initiative at the Competitiveness Council was to oversee the rewriting of the Federal Wetlands Manual. President Bush had promised “no net loss” of wetlands, and people in [environmental] agencies tried to widen the definition of wetland. This caused thousands of acres of dry land to be reclassified as wetland, including a lot of perfectly tillable Indiana farmland. We asked the bureaucracy to consider a revolutionary idea: <u>if the land isn’t wet, maybe we shouldn’t call it a wetland</u>.

Source: Dan Quayle-Speech to Competitive Enterprise Institute, Washington DC , Apr 21, 1999

U.S. Fish and Wildlife Service (Cowardin and others, 1979)

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.


TERRESTRIAL SYSTEM
WETLAND
DEEPWATER AQUATIC SYSTEM
Import of nutrients
Fluctuating water level
Import / export of nutrients and biological species
Hydrology
Dry
Intermittently to Permanently Flooded
Permanently Flooded
Biogeochemical Role
Source
Source, Sink or Transformer
Sink
Productivity
Low to Medium
Generally High but Sometimes Low
Generally Low


TERRESTRIAL SYSTEM
WETLAND
Fluctuating water level
groundwater
Hydrology
Dry
Intermittently to Permanently Flooded
Biogeochemical Role
Source
Sink or Transformer
Productivity
Low to Medium
Generally Medium to High

How can wetlands be recognized?

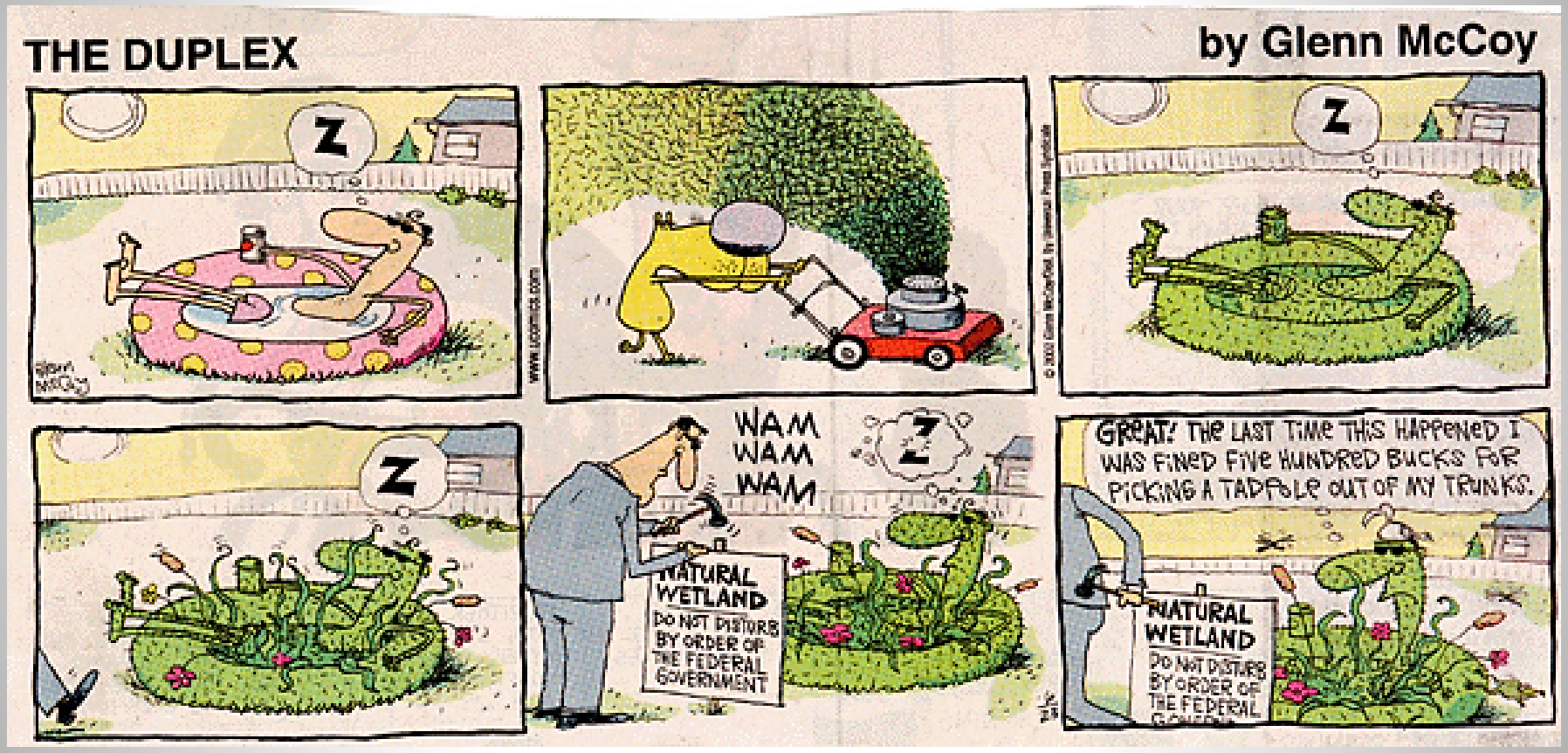
The US Army Corps of Engineers(Corps) uses three characteristics of wetlands when making wetland determinations: **vegetation**, **soil**, and **hydrology**. Unless an area has been altered or is a rare natural situation, wetland indicators of all three characteristics must be present during some portion of the growing season for an area to be a wetland.

Think of it in this way…

Wetland

Wetland Hydrology

Three Wetland Characteristics?



Five Major Wetland Systems

- **Marine** – Associated with coastal areas
- **Estuarine** – Associated with estuaries (places where salt water and fresh water mix along coastlines)
- **Riverine** – Associated with rivers
- **Lacustrine** – Associated with lakes
- **Palustrine** – Occur in topographic low spots

Oregon's diverse wetlands are classified informally into 15 generalized types that most people will recognize

- Alkaline wetlands
- Aquatic beds
- Fens
- Forested wetlands
- Freshwater marshes
- Freshwater tidal wetlands
- Salt marshes and brackish marshes
- Serpentine Fens
- Shrub swamps and shrub riparian
- Snowbed depressions
- Spray zones
- Springs
- Vernal pools
- Wet meadows
- Wet prairies

http://oregonexplorer.info/wetlands/DiversityandClassification/WetlandTypes

Wetland Plants

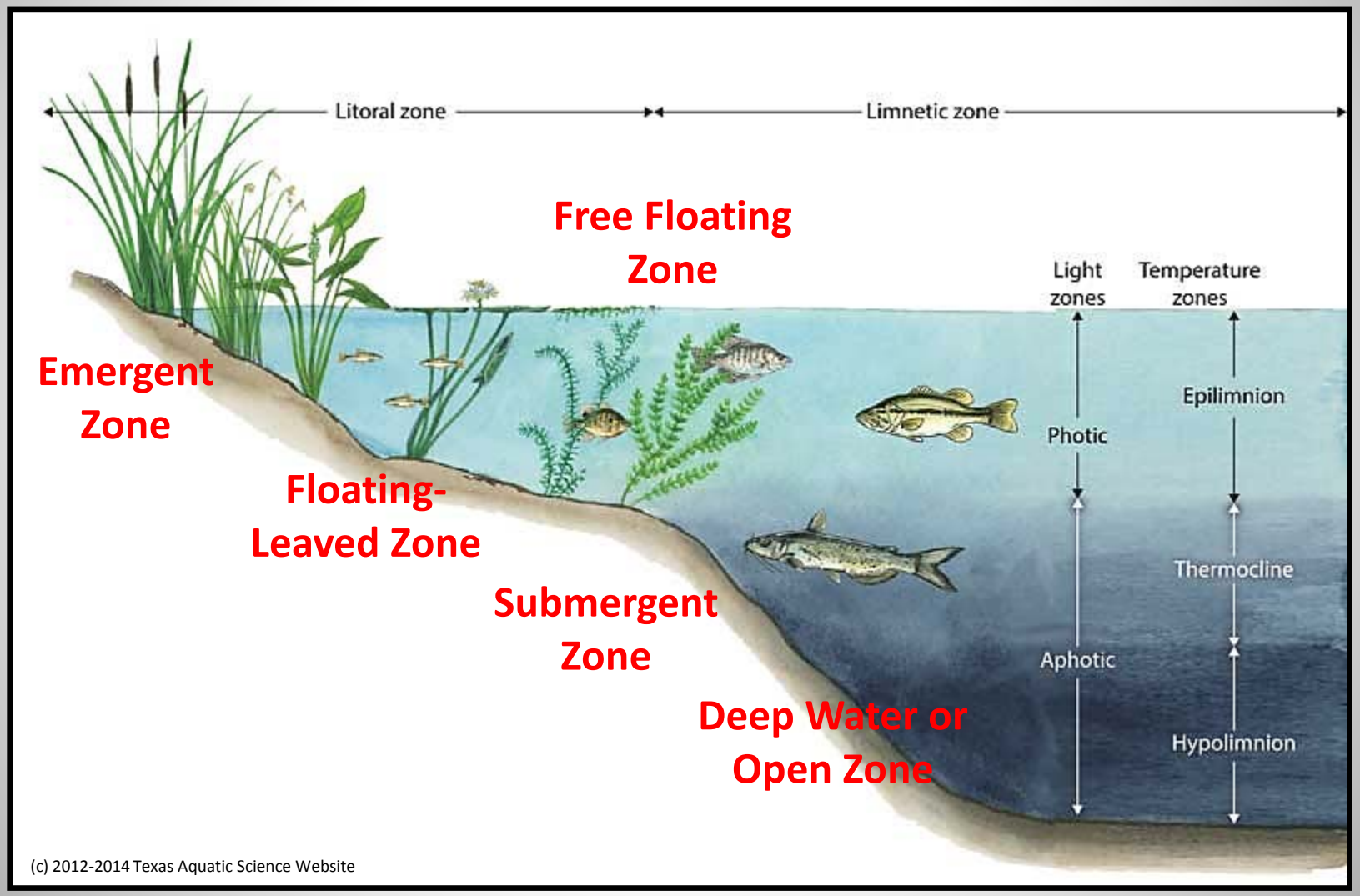
Wetland Plants

Hydrophyte-Any macrophyte that grows in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; plants typically found in wet habitats.

(Wetland Training Institute 1987. Field Guide for Wetland Delineation, Corps of Engineers Manual)

Fun Fact-Word origin of hydrophyte: Greek hýdōr (water) + Greek phutón (plant)

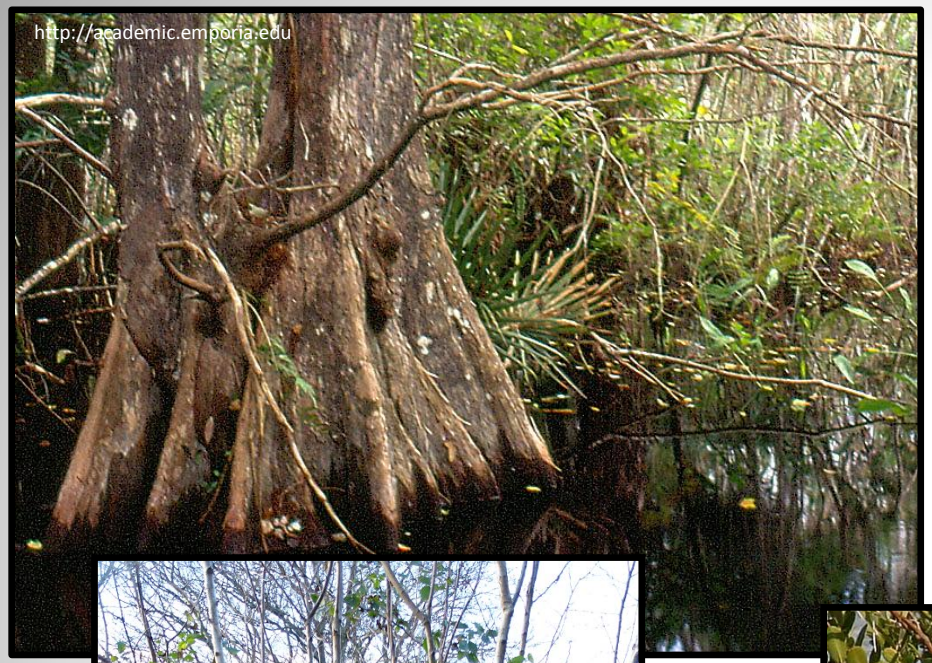
Structural Groups



(c) 2012-2014 Texas Aquatic Science Website

Wetland Plants

Hydrophytes have morphological (structural), physiological and reproductive adaptations that allow them to thrive in inundated or saturated soils where non-hydrophytes (upland plants) cannot.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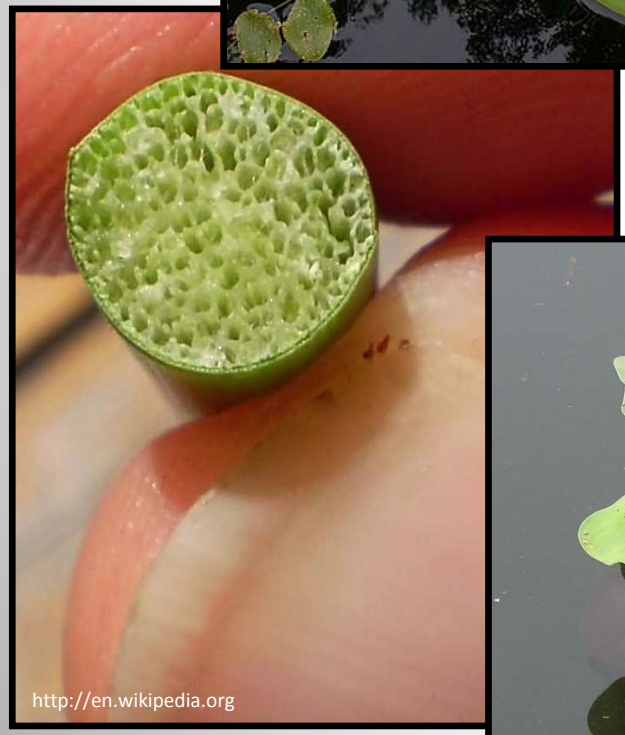
http://www.lakeandwetlandecosystems.com


http://en.wikipedia.org

http://blackwarriorriver.org

www.leicestershirevillages.com

it.

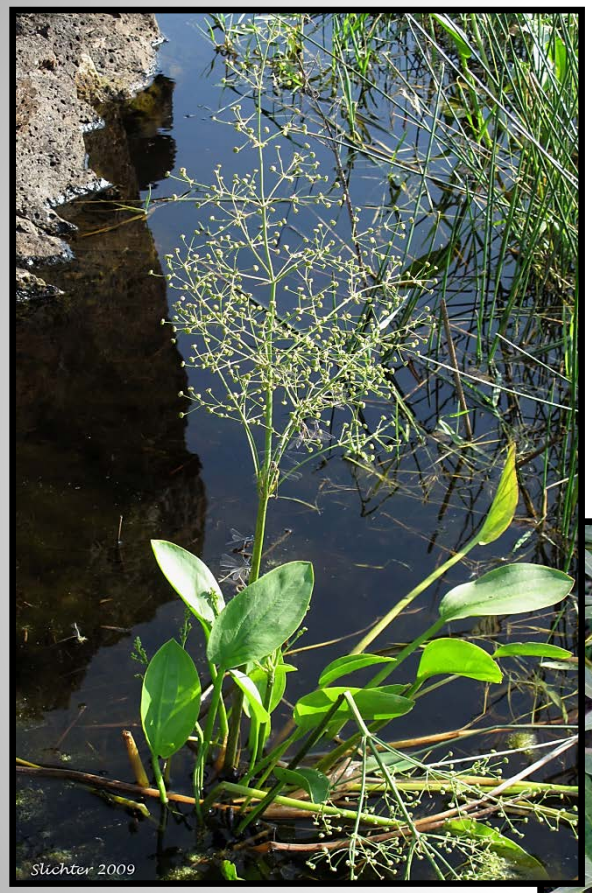
Yellow floating heart
Nymphoides peltata
Photo by Vic Ramey
Copyright 2002 Univ. Florida

it.wikipedia.org

Indicator Categories

Indicator Code	Indicator Status	Designation	Comment
OBL	Obligate Wetland	Hydrophyte	Almost always occur in wetlands (>99%)
FACW	Facultative Wetland	Hydrophyte	Usually occur in wetlands (67-99%), but may occur in non-wetlands (1-33%)
FAC	Facultative	Hydrophyte	Occur in wetlands and non-wetlands (33-67%)
FACU	Facultative Upland	Nonhydrophyte	Usually occur in non-wetlands (67-99%), but may occur in wetlands (1-33%)
UPL	Obligate Upland	Nonhydrophyte	Almost never occur in wetlands (>99%)

Obligate Wetland



Facultative Wetland

Facultative

‘Sedges have edges, rushes are round and grasses are hollow right up from the ground’

Carex aquatilis (water sedge)

Juncus effusus (soft rush)

Glyceria striata (fowl mannagrass)

http://upload.wikimedia.org/wikipedia

ERDC/CRREL

Cold Regions Research and Engineering Laboratory

US Army Corps of Engineers

ERDC
INNOVATIVE SOLUTIONS for a safer, better world

ARID WEST
2014 Regional Wetland Plant List

Lichvar, R.W., M. Butterwick, N.C. Melvin, and W.N. Kirchner. 2014.
The National Wetland Plant List: 2014 Update of Wetland Ratings.
Phytoneuron 2014-41: 1-42.

http://wetland_plants.usace.army.mil/

Mimulus guttatus *DC.* (Seep Monkey-Flower) Photo: Ben Legler

User Notes:
1) Plant species not listed are considered UPL for wetland delineation purposes.
2) A few UPL species are listed because they are rated FACU or wetter in at least one Corps region.

Approved for public release; distribution is unlimited.

ERDC/CRREL

Cold Regions Research and Engineering Laboratory

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WESTERN MOUNTAINS, VALLEYS, AND COAST
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The National Wetland Plant List: 2014 Update of Wetland Ratings.
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http://wetland_plants.usace.army.mil/

Scutellaria galericulata *L.* (Hooded Skullcap) Photo: William Gray

User Notes:
1) Plant species not listed are considered UPL for wetland delineation purposes.
2) A few UPL species are listed because they are rated FACU or wetter in at least one Corps region.

Approved for public release; distribution is unlimited.

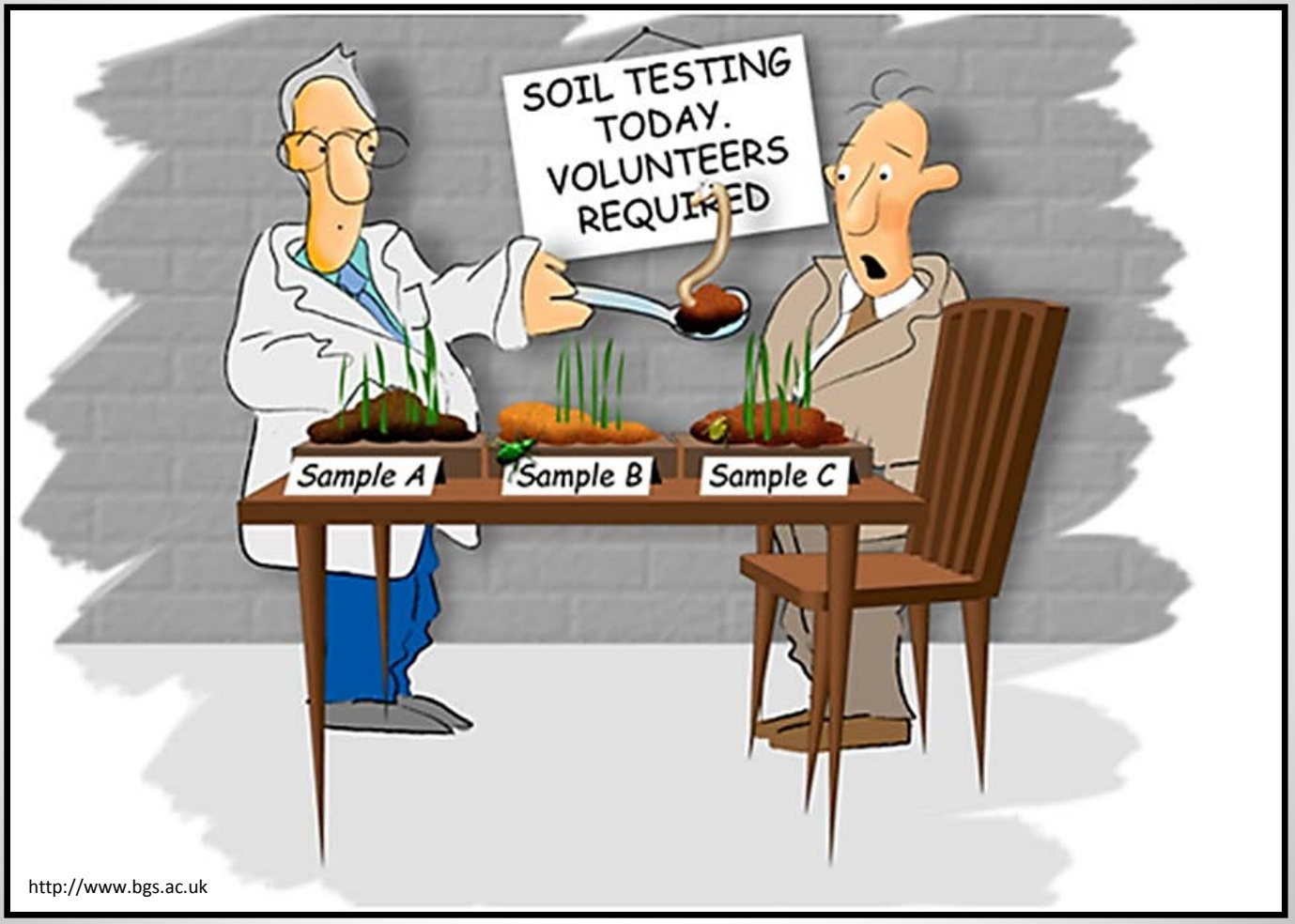
Fun Facts:

- 504 Native and 55 Introduced Obligate Plant Species in Oregon
- 613 Native and 88 Introduced Facultative Wetland Plant Species in Oregon
- 595 Native and 178 Introduced Facultative Plant Species in Oregon

USDA Plants Database

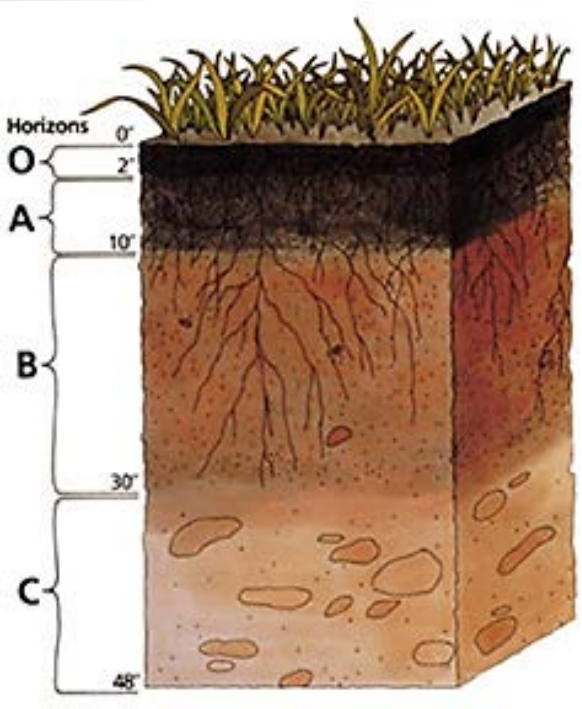
We'll be right back

Soil Basics



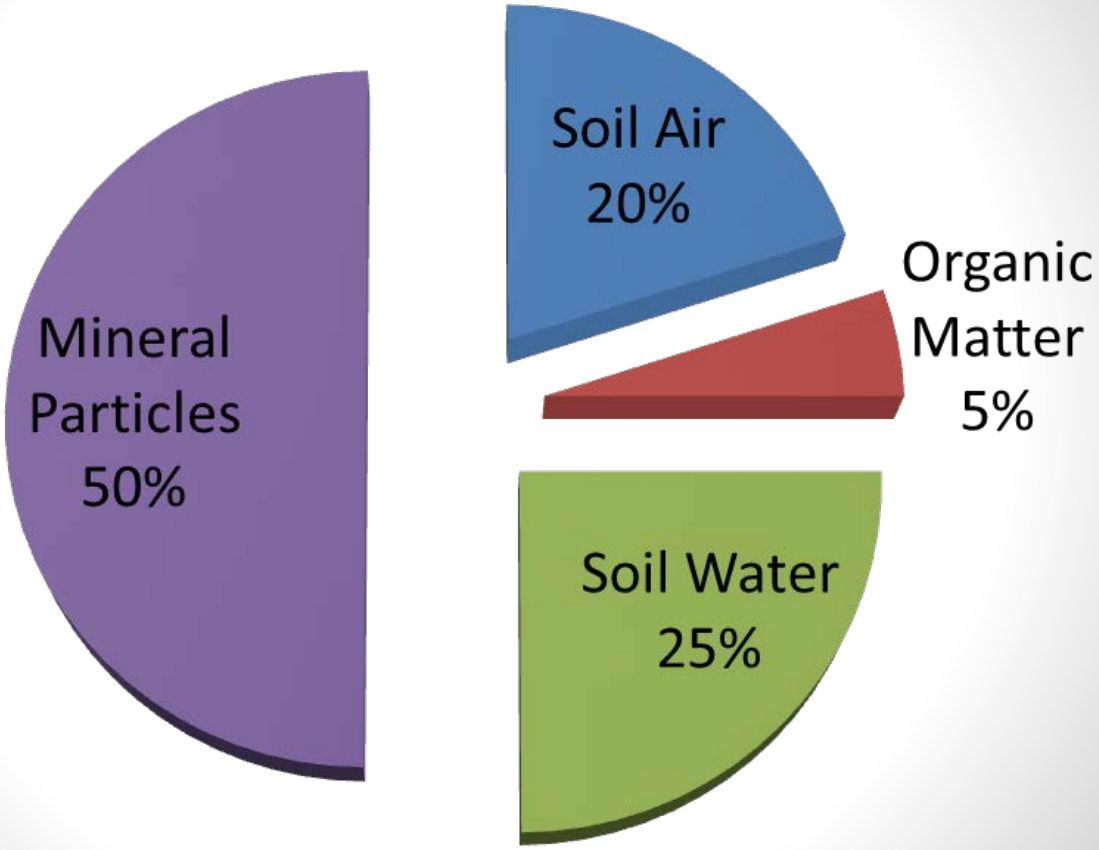
http://www.bgs.ac.uk

Soil Basics-Soil Horizons



Soil Horizon-layer of soil parallel to the land surface which can be differentiated from adjacent layers, or horizons, by identifiable physical, chemical, and biological characteristics.

Soil Basics-Soil Components



Soil Basics-Soil Matrix

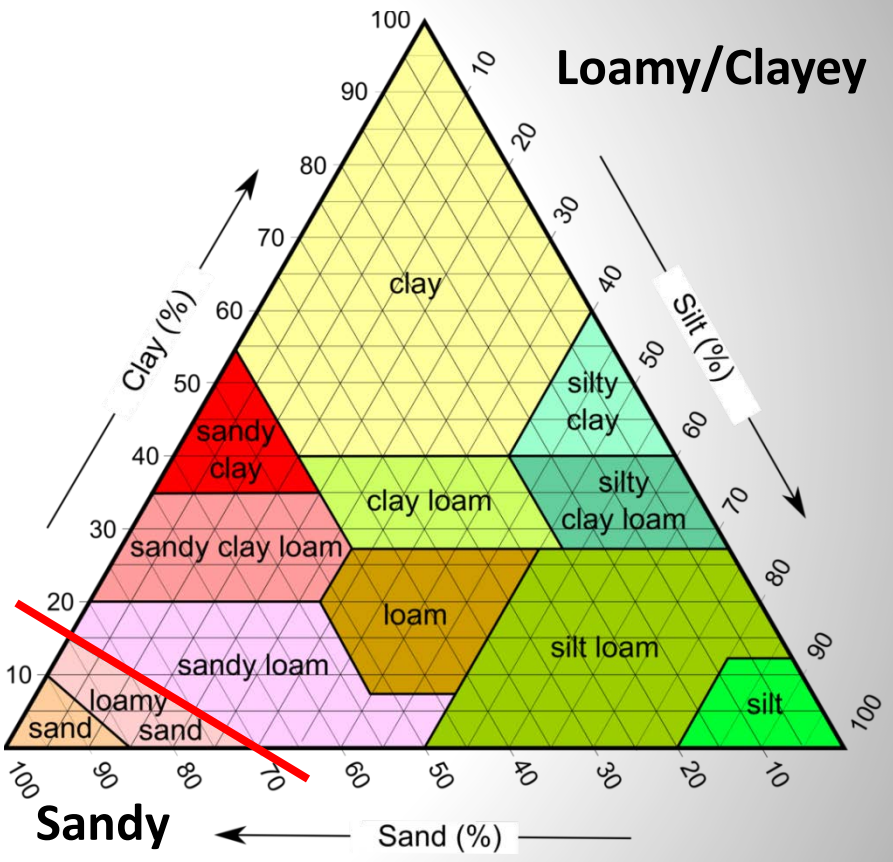
The portion of a given soil having the dominant color. In most cases, the matrix will be the portion of the soil having more than 50 percent of the same color.

Soil Basics-Soil Color

In subsoil horizons, Fe and Mn oxides and other minerals give soils their characteristic brown, red, and yellow colors.

Soil Basics-Soil Texture

- Defined by relative proportion of sand, silt, and clay
- Influenced by interaction of geologic and environmental factors
- Important property affecting permeability
- **Distinguish sandy and non-sandy soils**



Soil Basics-Drainage Classes

Degree of natural drainage in the soil determined by the depth to the water table surface; depth to water table increases with increased drainage.

Soil Basics-Drainage Classes

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained ? possible wetland
- Poorly drained } wetland
- Very poorly drained

Soil Basics-Drainage Classes

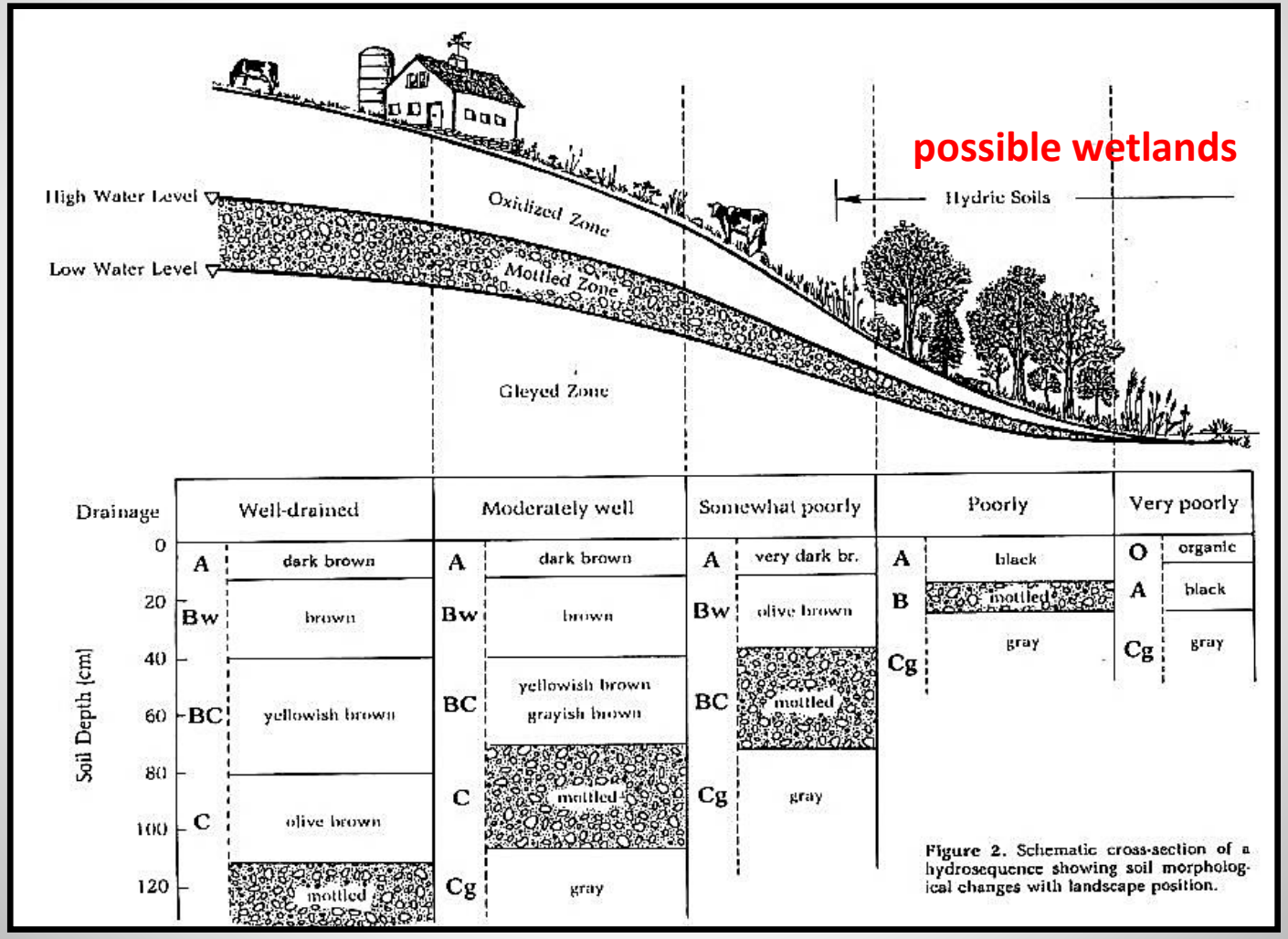


Figure 2. Schematic cross-section of a hydrosequence showing soil morphological changes with landscape position.

Wetland Soils

Definition of Hydric Soil

A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

(Federal Register July 13, 1994; National Technical Committee for Hydric Soils)

It is anaerobic conditions that cause a soil to be hydric, not just saturation!!!

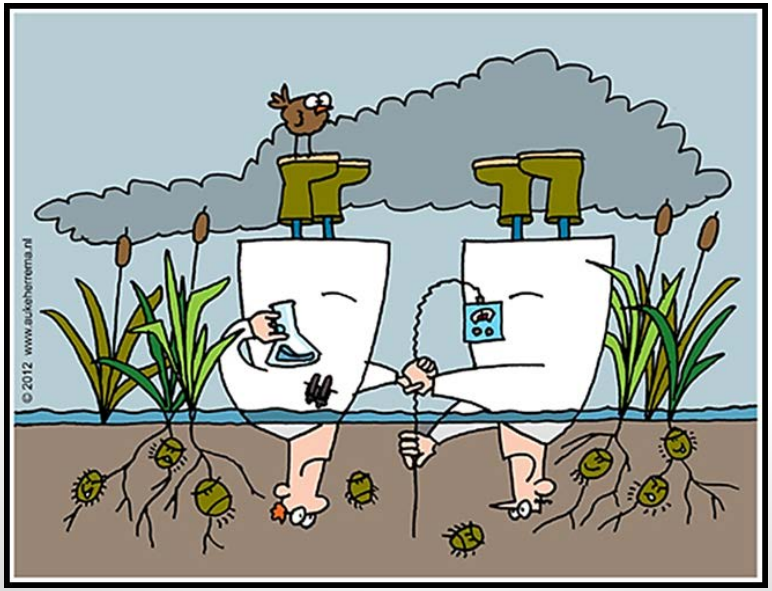
Definition of Hydric Soil

- All Histels except Folistels and Histosols except Folists
- The “saturation” criteria
- Soils that are frequently <u>ponded</u> for long or very long duration during the growing season
- Soils that are frequently <u>flooded</u> for long or very long duration during the growing season

The criteria for Hydric Soils (Fed. Reg., 2/24/95)

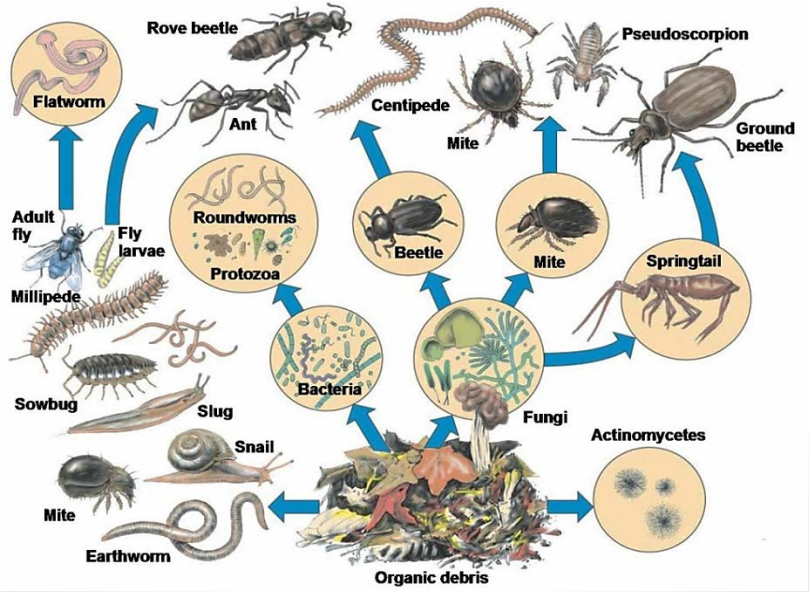
The Dirt on Hydric Soils

Soil must contain active microorganisms, which is dependent on soil temperature. Most can function as long as the soil temperature remains above Biological Zero (40°F/5°C).



The Dirt on Hydric Soils

Soil microorganisms rely on carbon compounds (dead or decomposed plant leaves or roots, or animal material) to sustain their respiration.



Quick and Dirty Soil Biochemistry

Aerobic Respiration-Soil microbes oxidize carbon compounds to obtain energy (i.e. respiration) and require chemical elements to act as terminal electron acceptors in these reactions. In aerobic environments, oxygen serves as the primary electron acceptor, forming water as the respiratory by-product.

$$\underset{\text{Electron acceptor}}{O_2} + \underset{\text{Electron donor (α-D-Glucose)}}{C_6H_{12}O_6} \longrightarrow CO_2 + H_2O$$

Quick and Dirty Soil Biochemistry

Anaerobic Respiration-Water saturates (filling 95% of pore space) or floods soil retarding oxygen diffusion to soil.

Aerobic bacteria and other organisms use up free and dissolved oxygen (anaerobiosis) within hours to days and go dormant, leave, or die.

Facultative and obligate anaerobic bacteria become ascendant in the soil's microbic community.

Quick and Dirty Soil Biochemistry

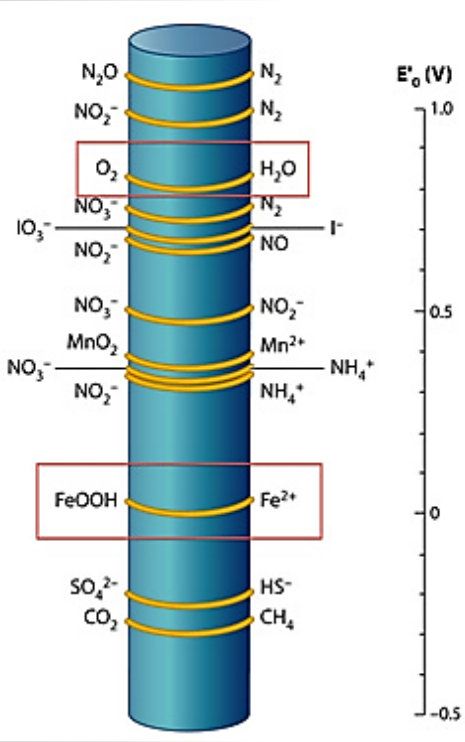
Anaerobiosis (without molecular oxygen or O_2) promotes certain biogeochemical processes:

- accumulation of organic matter
- reduction, translocation, or accumulation of iron and other reducible elements

Quick and Dirty Soil Biochemistry

Soil organic matter accumulates because the microorganisms decompose plant and animal material slower in anaerobic soils. This decrease in decomposition causes organic matter to build up at the surface. As a result, anaerobic soils usually have a dark and almost black surface.

Quick and Dirty Soil Biochemistry



The more electropositive the potential, the higher the energy yield from the reduction

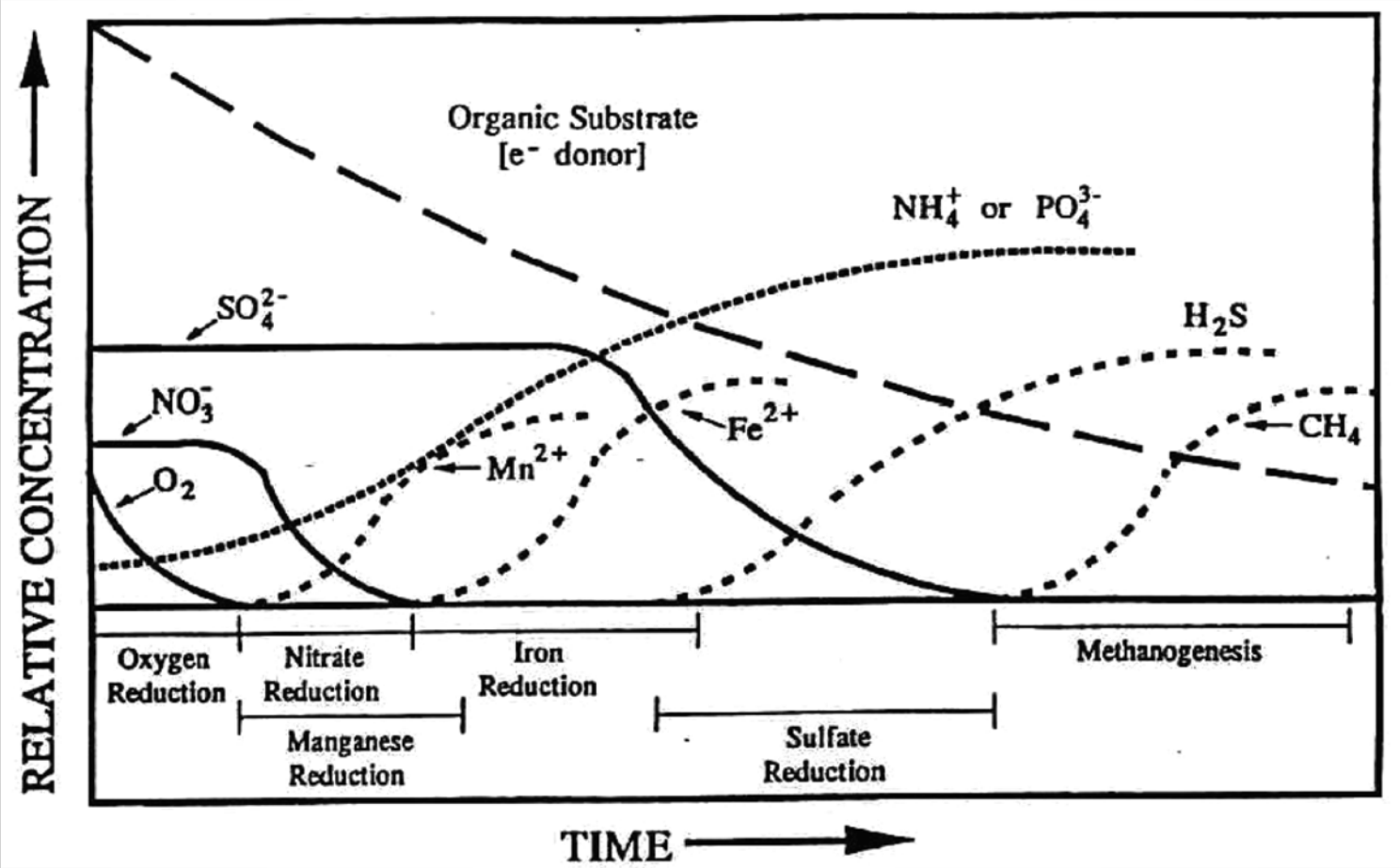
Anaerobic organisms do not use dissolved oxygen, rather they utilize oxidized forms of nitrogen, manganese, iron, sulfur, and carbon as terminal electron acceptors (in that order).

Quick and Dirty Soil Biochemistry

Reduction Sequence

nitrate (NO_3-) ➞ nitrite (NO_2-), nitrous oxide (N_2O)
manganic Mn (Mn^{+4}) ➞ manganous Mn (Mn^{+2})
ferric iron (Fe^{+3}) ➞ ferrous iron (Fe^{+2})
sulfate (SO_4^{-2}) ➞ sulfide (S^{-2}), hydrogen sulfide (H_2S)
carbon dioxide (CO_2) ➞ methane (CH_4)

Quick and Dirty Soil Biochemistry



Quick and Dirty Soil Biochemistry

Iron and Manganese Reduction, Translocation, and Accumulation-When these elements are reduced in a soil, several things happen:

- Fe^{+2} and Mn^{+2} begin to dissolve in water
- the soil colors change to gray
- Fe^{+2} and Mn^{+2} diffuse move with the soil water to other parts of the soil horizon or may be leached from the soil.

Quick and Dirty Soil Biochemistry

When reduced, Fe and Mn are mobile and can be stripped from the soil particles, leaving the characteristic mineral grain color usually a “grayish” color.

Quick and Dirty Soil Biochemistry

If a soil reverts to an aerobic state, iron that is in solution will oxidize and become concentrated in patches and along root channels and other pores. These areas of oxidized iron are called *redox concentrations*

Quick and Dirty Soil Biochemistry

Determining Reducing Conditions in Hydric Soils

- Redox potential measurement using Pt electrodes
- IRIS (Indicator of Reduction In Soils) Tubes
- Alpha, Alpha-Dipyridyl to test for iron reduction

Quick and Dirty Biochemistry

Anaerobes also reduce sulfate hydrogen to hydrogen sulfide producing the characteristic rotten egg odor of certain wetlands. Typically found in very waterlogged sites but sulfur compounds must be present.

2013 Pocket Guide to Hydric Soil Field Indicators

Based on

Field Indicators of Hydric Soils in the United States v. 7.0 with Updates

Prepared by

Wetland Training Institute, Inc.

USDA United States Department of Agriculture

In cooperation with the National Technical Committee for Hydric Soils

NRCS Natural Resources Conservation Service

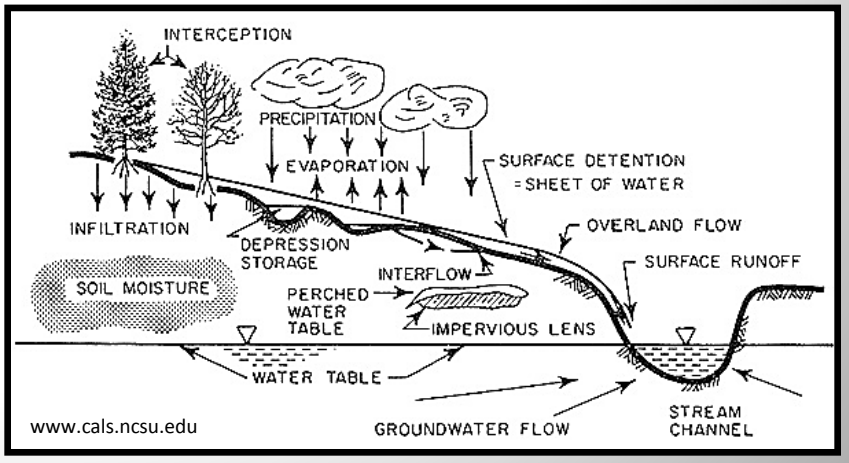
Field Indicators of Hydric Soils in the United States

A Guide for Identifying and Delineating Hydric Soils, Version 7.0, 2010

Wetland Hydrology

Wetland Hydrology

Hydrology refers to the movement of water in the environment. However, wetland hydrology looks at water levels relative to the soil surface, temporal variability of water levels, and residence, or travel time, of water movement through the wetland.



Wetland Hydrology

The term "wetland hydrology" encompasses all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season.

Before deciding if an area is a wetland, one should be able to identify where the water is coming from, how much water there is, how long it stays, and how it leaves.

Wetland Hydrology

Hydrologic processes occurring in wetlands are collectively are referred to as the hydrologic cycle. Major components of the hydrologic cycle are precipitation, surface-water flow, ground-water flow, and evapotranspiration. Wetlands and uplands continually receive or lose water through exchange with the atmosphere, streams, and ground water.

Wetland Hydrology-Sources

- Direct Precipitation*
- Headwater Flooding*
- Backwater Flooding*
- Tides*
- Ground Water
- Combinations of above

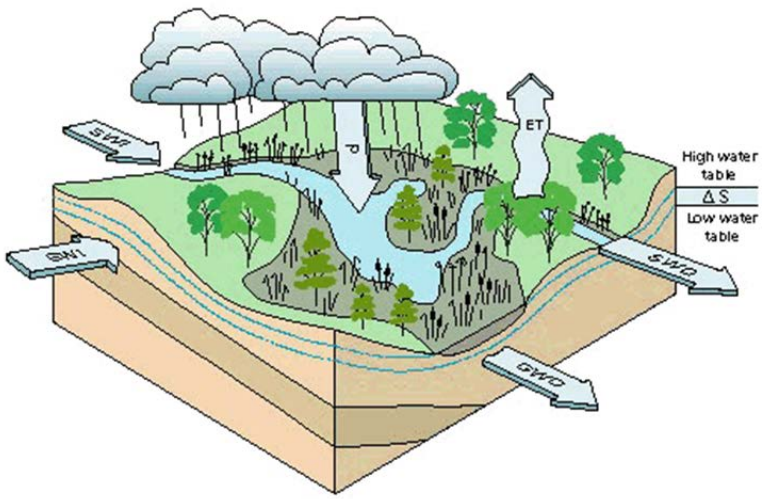


Figure 18. Components of the wetland water budget. (P + SWI + GWI = ET + SWO + GWO + ΔS, where P is precipitation, SWI is surface-water inflow, SWO is surface-water outflow, GWI is ground-water inflow, GWO is ground-water outflow, ET is evapotranspiration, and ΔS is change in storage.)

*surface water flows

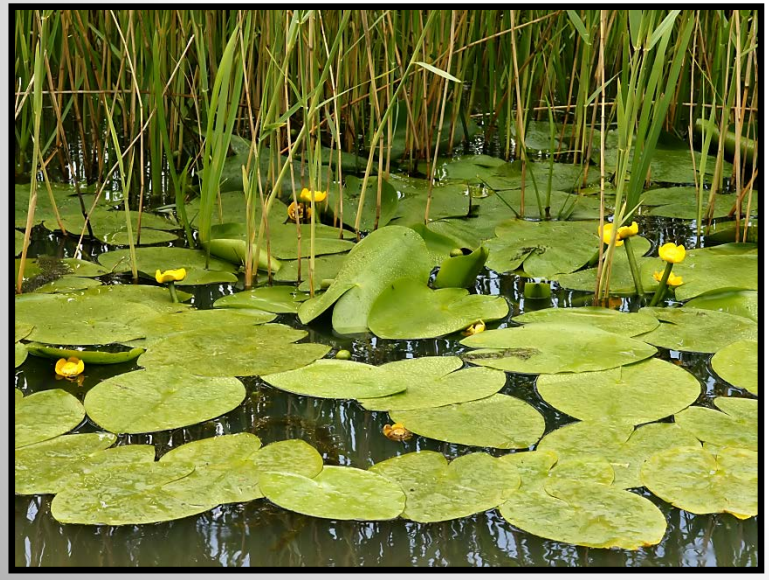
Wetland Hydrology-Hydropattern

Frequency, timing, and aerial extent of water influences wetland characteristics:

- **Duration** - The length of time during which water stands at or above the soil surface (inundation), or during which the soil is saturated. Duration refers to a period during the growing season.
- **Frequency** - The periodicity of coverage of an area by surface water or soil saturation. It is usually expressed as the number of years the soil is inundated or saturated at least once each year during part of the growing season per 100 years or as a 1-, 2-, 5-year, etc., inundation frequency.

Wetland Hydrology

The hydrology of a wetland is largely responsible for the vegetation of the wetland, which in turn affects the value of the wetland to animals and people.



Wetland Hydrology

Both a favorable geologic setting and an adequate and persistent supply of water are necessary for the existence of wetlands.

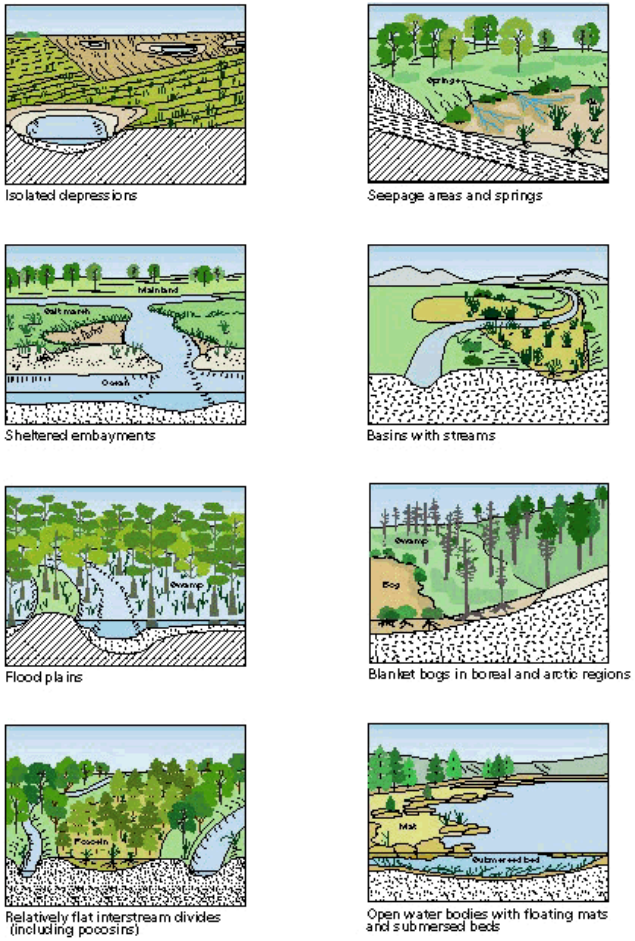
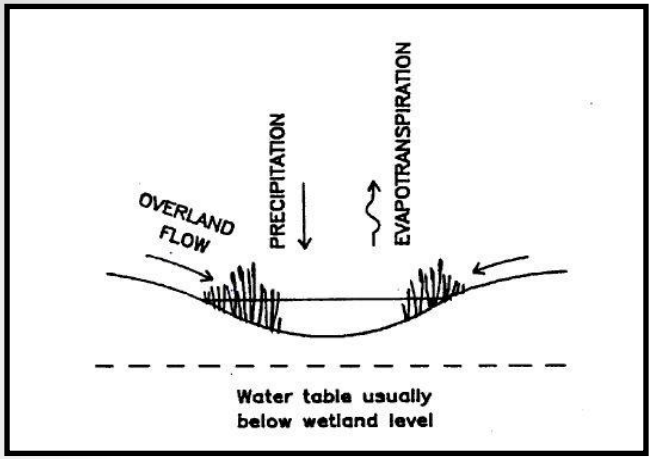


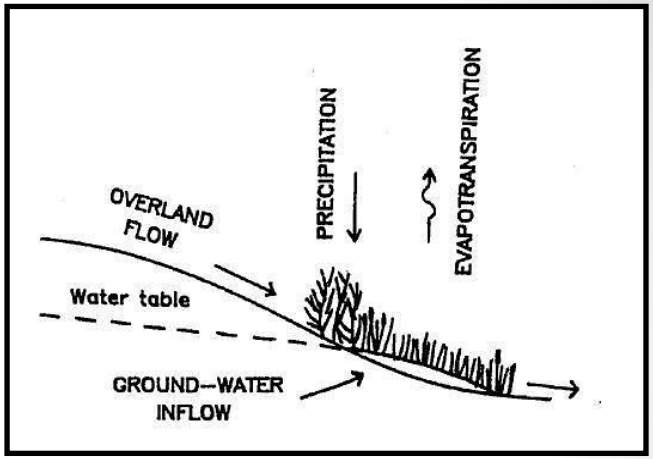
Figure 14. Cross sections of selected wetland landscapes showing typical positions of wetlands relative to topographic features.

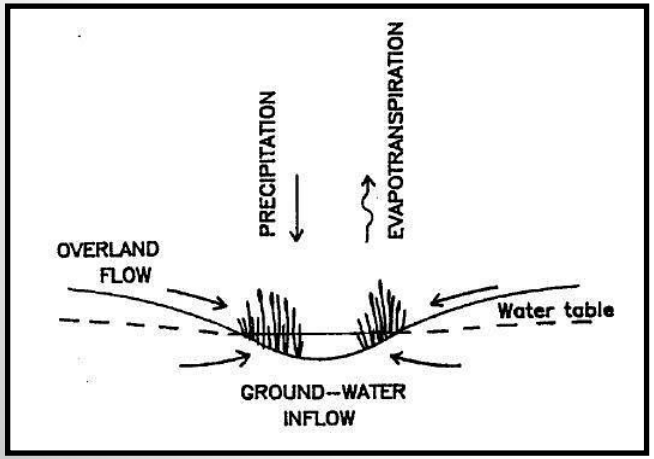
Wetland Hydrology

Surface water depression wetland



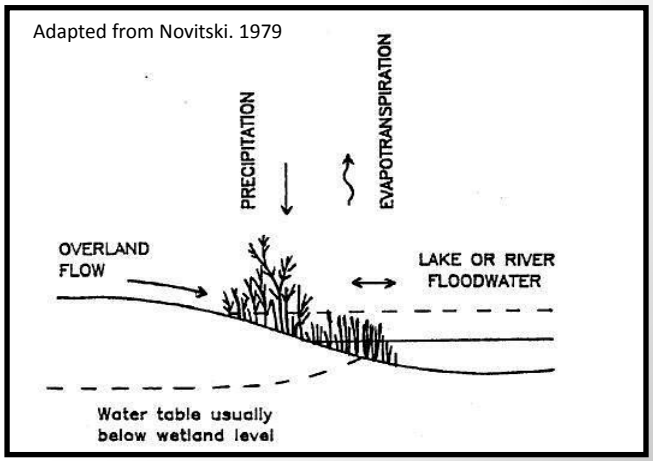
Groundwater slope wetland





Groundwater depression wetland

Adapted from Novitski. 1979



Surface water slope wetland

Wetland Hydrology-Water Table

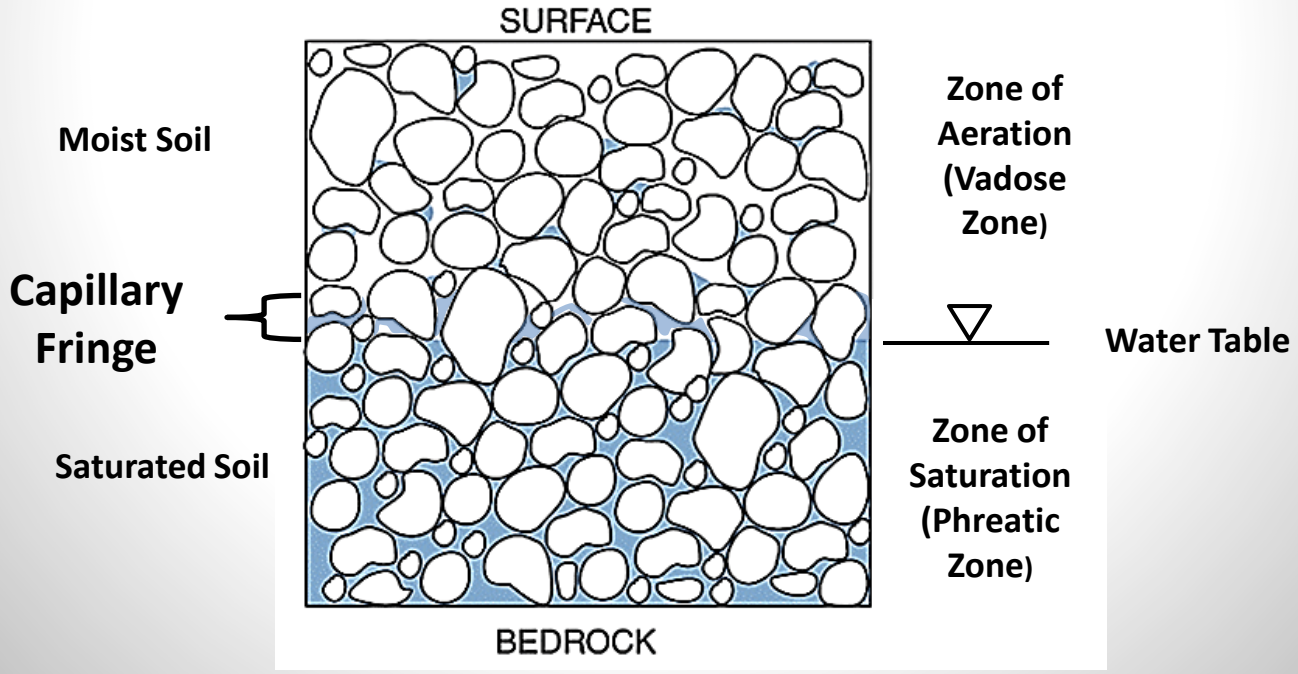
Level below the ground's surface at which the ground becomes saturated or filled with water. The water table is defined by that point in the soil column where water is free to move.

Wetland Hydrology-Saturated Soil

A condition in which all easily drained voids (pores) between soil particles are temporarily or permanently filled with water. Significant saturation during the growing season is considered to be usually one week or more.

Wetland Hydrology-Capillary Fringe

Subsurface layer zone of soil immediately above the water table that acts like a sponge sucking water up from the underlying water table.



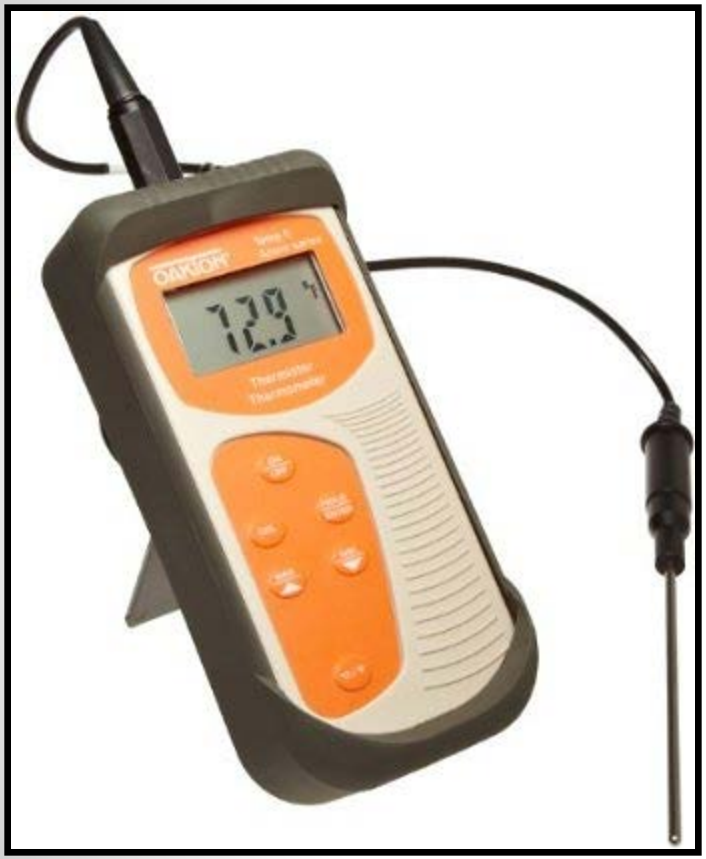
Wetland Hydrology-Ponded

A condition in which free covers the soil surface. Commonly stagnant water standing in a closed depression. The water is removed only by percolation, evaporation, or transpiration.

Wetland Hydrology-Flooded

Condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides or any combination of sources.

Wetland Hydrology-Growing Season



>41°F at 12” below surface*

WETS Station : LA GRANDE, OR4622 Creation Date: 05/21/2014
Latitude: 4519 Longitude: 11804 Elevation: 02755
State FIPS/County(FIPS): 41061 County Name: Union
Start yr. - 1971 End yr. - 2000

Month	Temperature (Degrees F.) avg daily max	avg daily min	avg	Precipitation (Inches) avg	30% chance will have less than	more than	avg # of days w/.1 or more	avg total snow fall
January	37.3	23.1	30.2	1.83	1.14	2.21	5	7.9
February	42.8	26.4	34.6	1.32	0.82	1.59	4	2.9
March	50.3	30.5	40.4	1.50	1.06	1.78	5	1.5
April	57.7	35.1	46.4	1.58	0.98	1.91	5	0.4
May	66.2	41.8	54.0	1.90	1.29	2.27	6	0.0
June	74.9	48.3	61.6	1.53	1.04	1.82	5	0.0
July	84.7	53.0	68.9	0.70	0.29	0.86	2	0.0
August	85.0	51.8	68.4	0.86	0.23	1.03	2	0.0
September	75.6	43.5	59.6	0.84	0.24	1.03	3	0.0
October	62.6	35.4	49.0	1.26	0.70	1.55	4	0.1
November	45.6	29.8	37.7	2.22	1.40	2.68	6	2.5
December	38.2	24.2	31.2	1.94	1.06	2.37	6	6.1
Annual	-----	-----	-----	------	15.57	19.08	--	----
Average	60.1	36.9	48.5	------	------	------	--	----
Average	-----	-----	-----	17.48	------	------	52	22.7

GROWING SEASON DATES

Probability	Temperature: 24 F or higher	28 F or higher	32 F or higher
	Beginning and Ending Dates Growing Season Length		
50 percent *	4/ 6 to 10/23 199 days	4/26 to 10/ 7 164 days	5/16 to 9/21 128 days
70 percent *	4/ 1 to 10/28 209 days	4/21 to 10/12 174 days	5/10 to 9/27 140 days

QUESTIONS?