The Role of Coarse Woody Debris and Microtopography in Wetland Function: A Review and Recommendations to Improve Wetland Restoration

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Microtopography for the purpose of this presentation includes the variation in the soil surface caused by natural ecological processes such as:

•Tree mortality whether by uprooting (thereby forming mounds and pits) or mortality in place (e.g., snags).

•Accumulations of organic material and soil by processes such as tussock formation, shallow rooting, buttressing, etc.

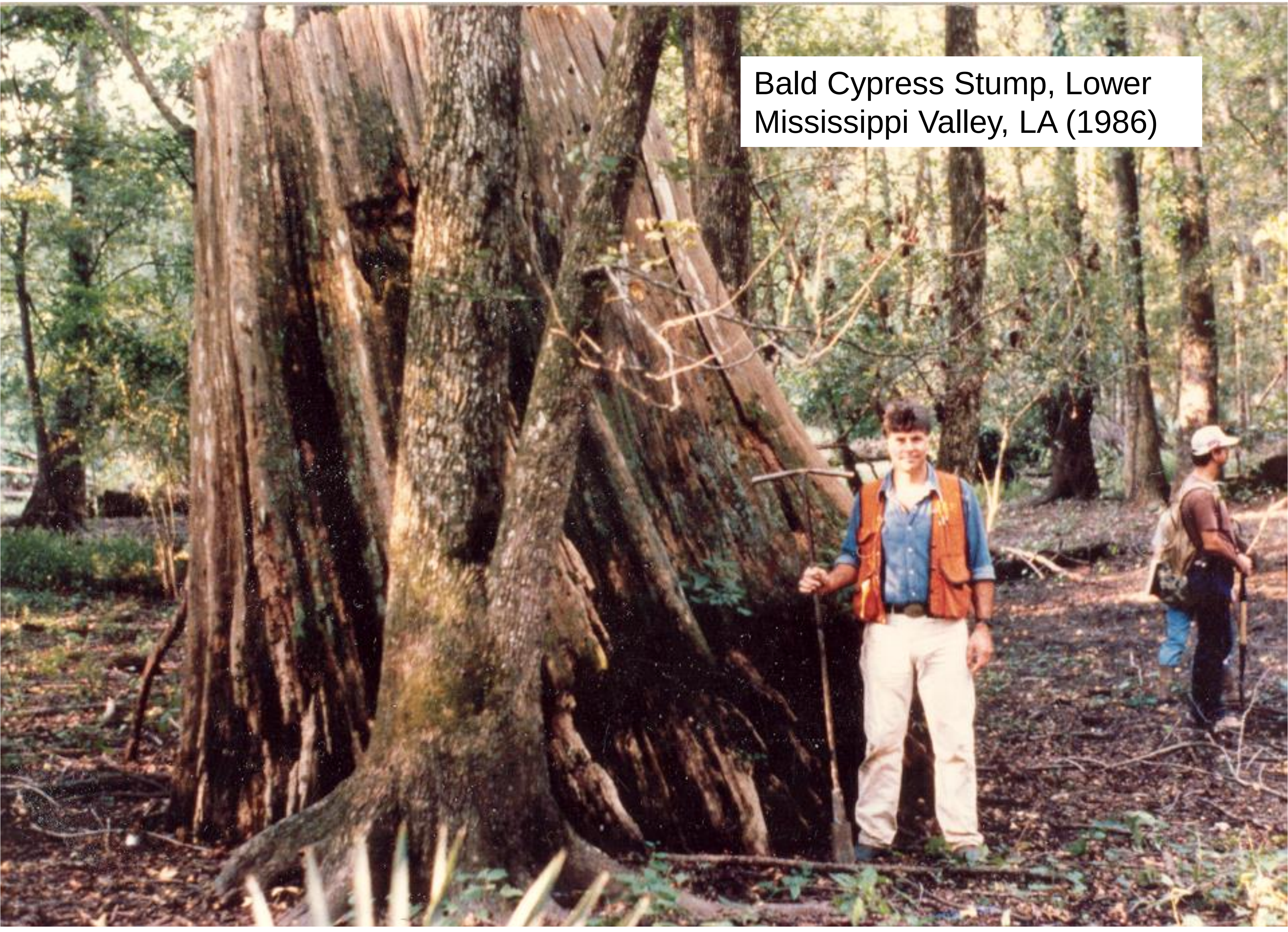
•The more constant but less long-lived deposition of large branches and twigs.

“When the winds tear up a tree by the root, a quantity of loose soil commonly comes up with it and sticks to them (sic) for a time, but at last it drops off and forms a little hillock, which is afterwards augmented by leaves. In this way many holes and mounds are formed.”

Kalm, Peter. 1770. Travels in North America. Adolph B. Benson, translator and editor, Wilson-Erickson Inc., New York, NY (1937).

Microtopography may be linked to century-old mounds or recent accumulations by herbaceous vegetation.

In many forests large trees are often located on pre-existing windthrow mounds or “butt-hillocks” (soil displaced by the basal growth of trees).



Bald Cypress Stump, Lower Mississippi Valley, LA (1986)

Both standing and breaking kinds of tree death contribute decaying logs and stumps to the forest floor but they may be relatively short-lived when compared to mounds created from the uprooting of trees.

Most historical pit and mound studies have focused on upland areas, but given the wetland environment, the rate of formation may be more dynamic than in upland areas (e.g., more rapid filling of pits, greater frequency of tree fall).

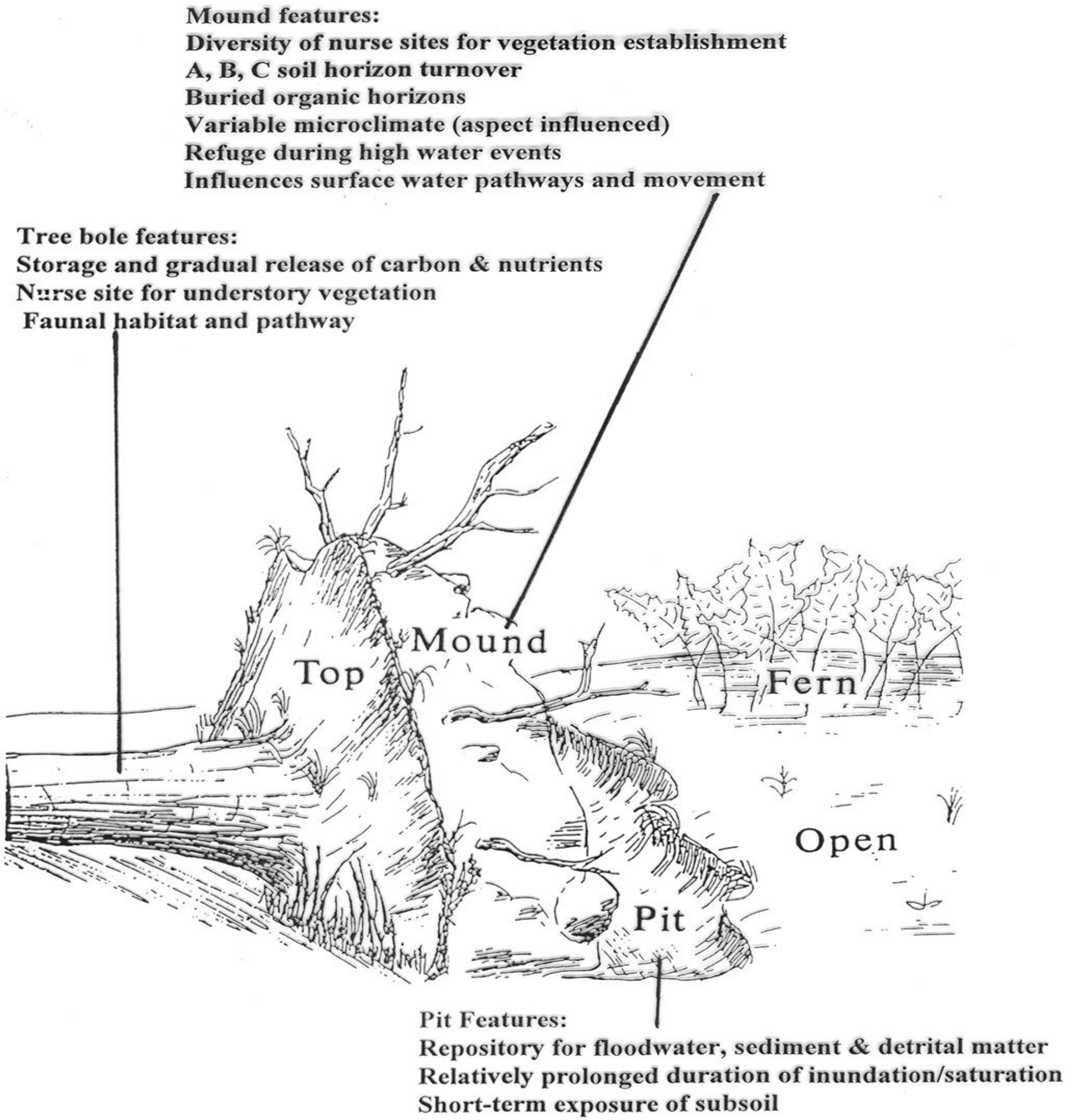
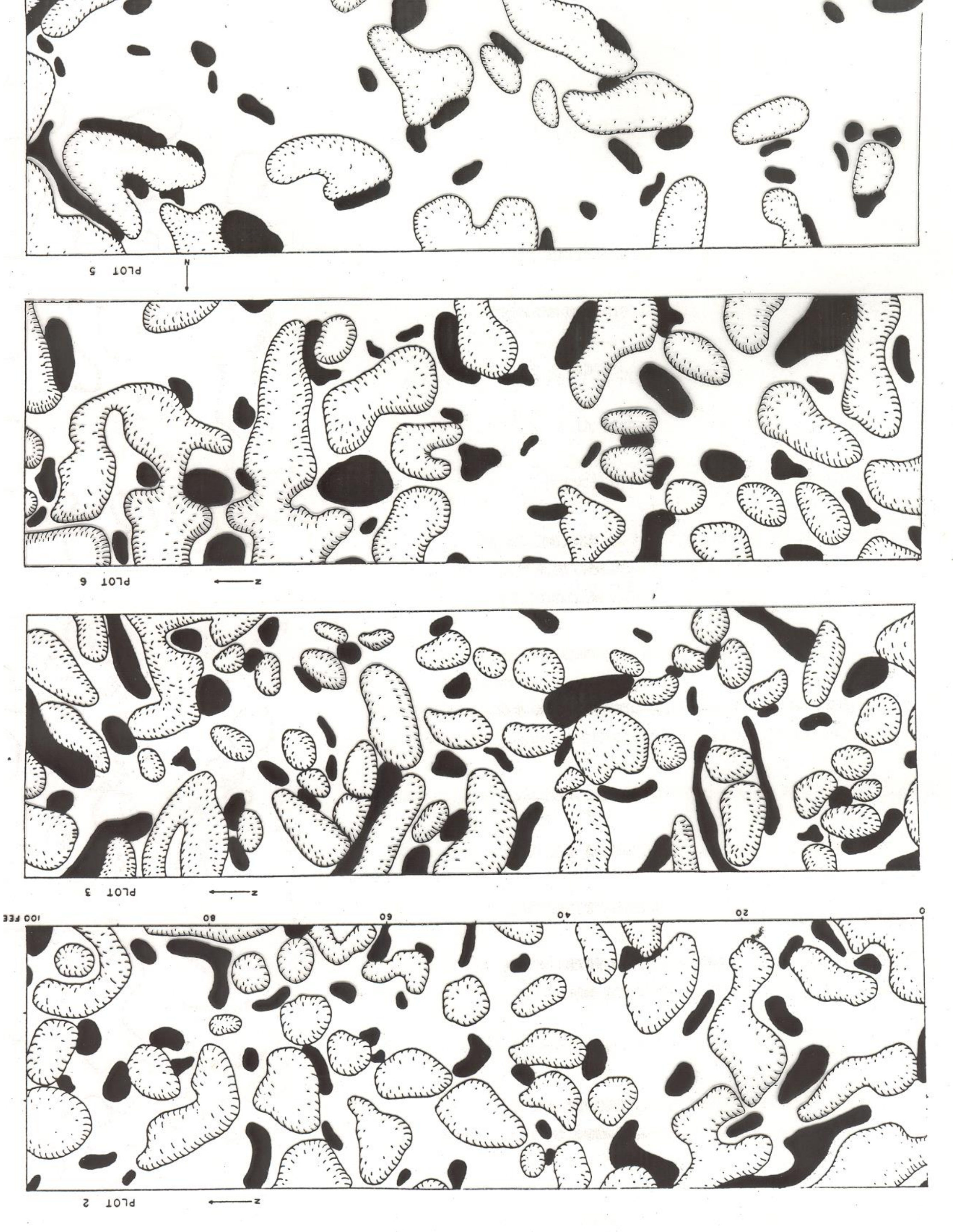
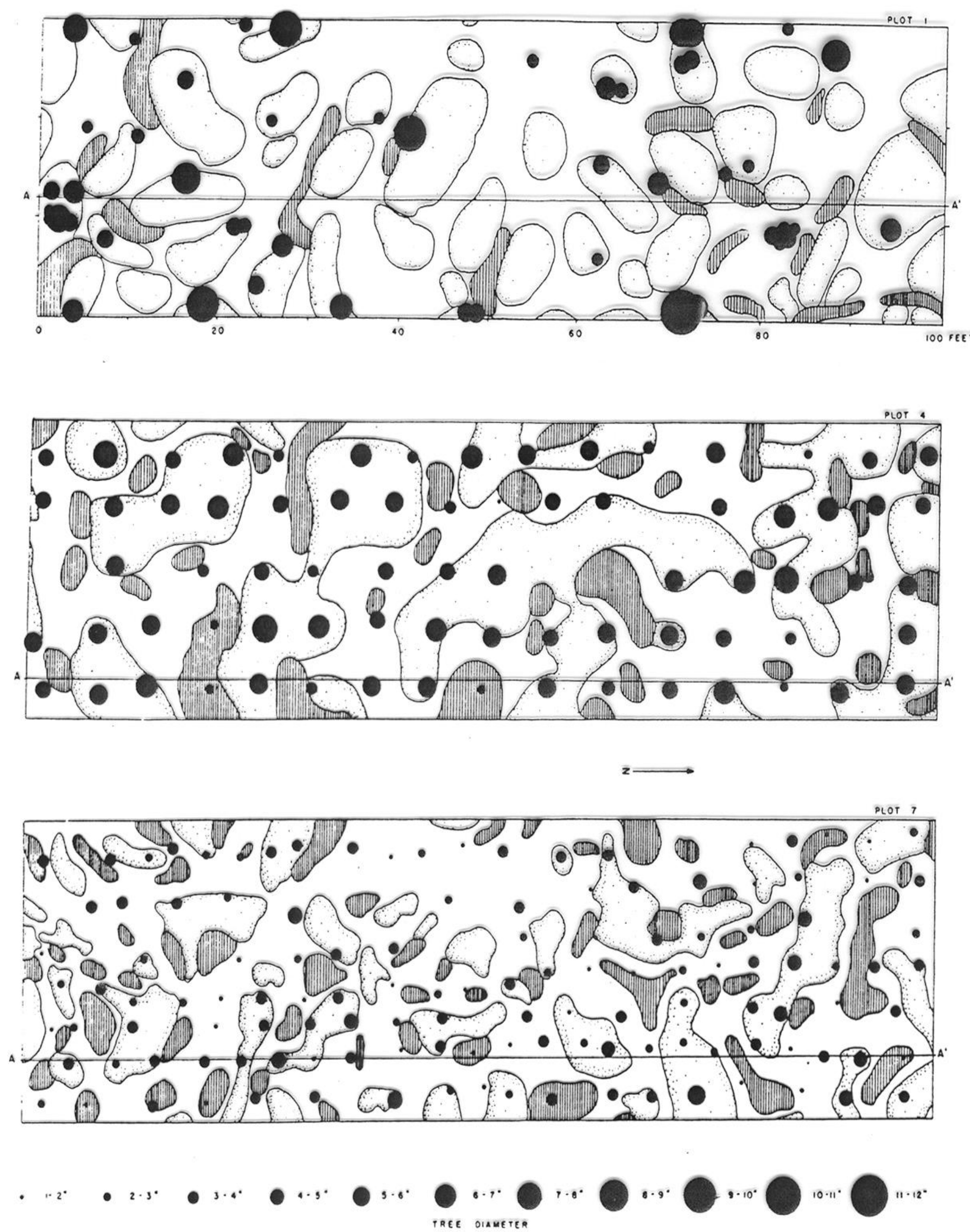


Figure 1. Ecological features of various pit and mound sites. Graphic adapted from Carlton, G. C. And F. A. Bazzaz. 1998. Resource congruence and forest regeneration following an experimental hurricane blowdown. Ecology 79(4): 1305-1319.

Areal distribution of mounds and pits on four 30 x 100 foot plots. Stippled areas are mounds, darkened areas are pts. From Lyford, W.H., and D. W. MacLean. 1966. Mound and pit microrelief in relation to soil disturbances and tree distribution in New Brunswick, Canada. Harvard For. Pap. 15. 18 pp.



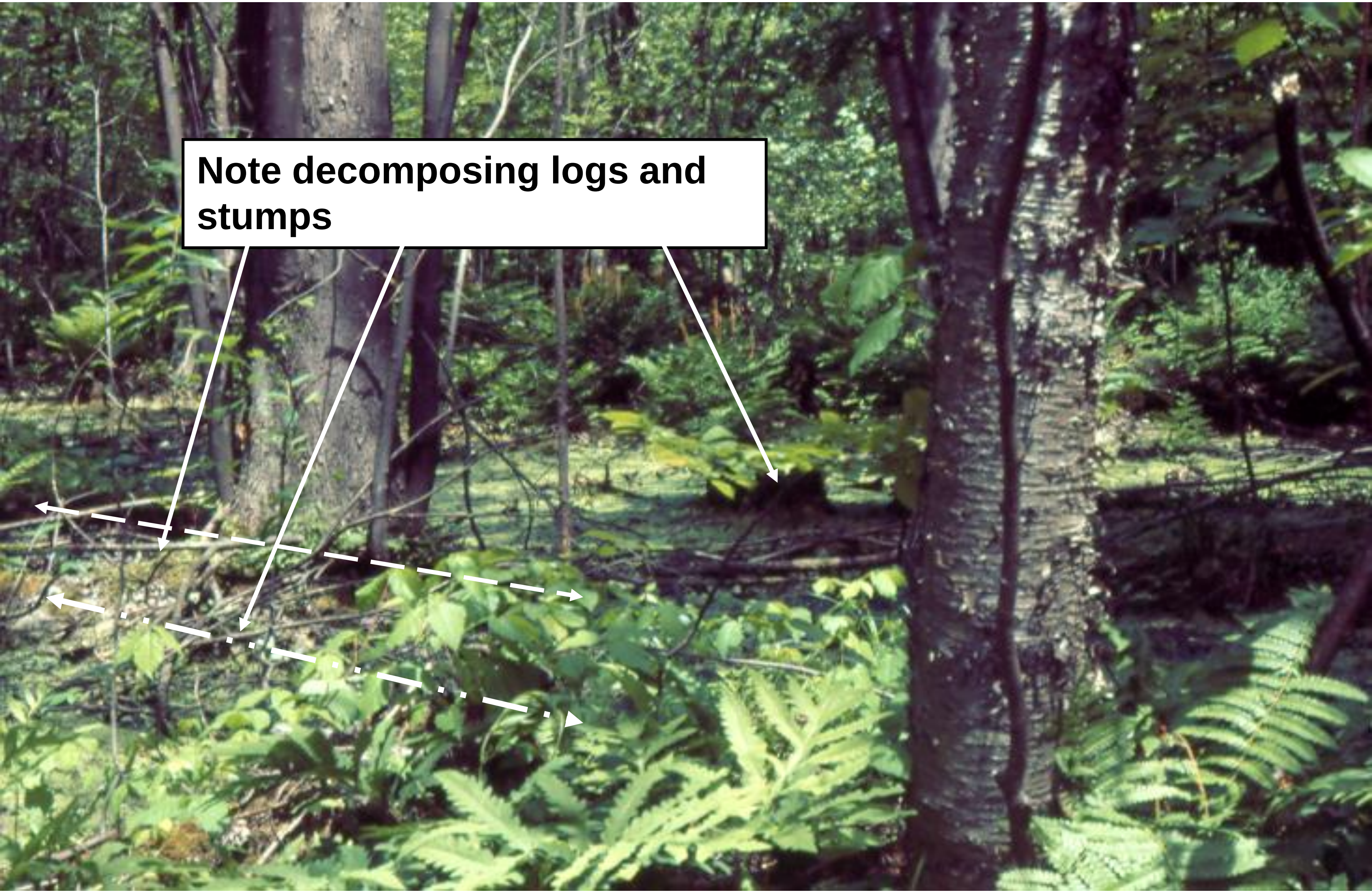


Location and diameter size of live trees in relation to mounds and pits in a natural stand (top), red pine (middle) and white spruce (bottom) plantations. From Lyford, W.H., and D. W. MacLean. 1966. Mound and pit microrelief in relation to soil disturbances and tree distribution in New Brunswick, Canada. Harvard for. Pap. 15. 18 pp.

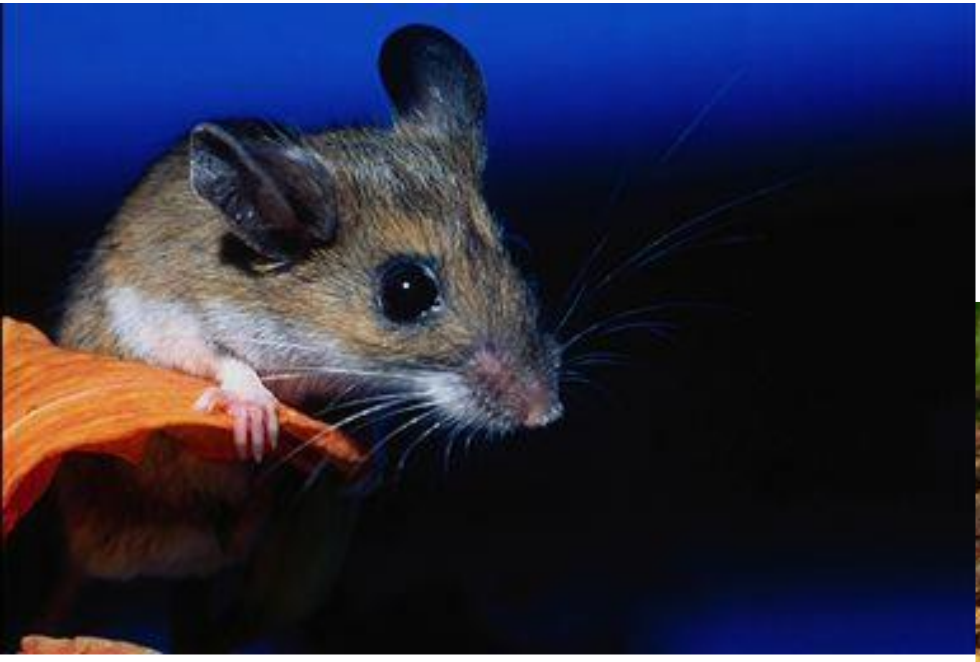
Note: Dark polygons are pits and the light polygons are mounds.

Some plants are established on fallen logs where there is a ready source of organic material. Additionally they are elevated above the prevalent flooding regime. Often as the log decomposes the established trees can withstand deeper, more prolonged flooding.

For example, yellow birch (Betula alleghaniensis) is a major codominant tree in northeastern upland and wetland forests. In wetlands, yellow birch seedlings often become established on fallen logs. What appear to be prop roots on mature trees are in fact locations where the "nurse" log has decomposed out from beneath the mature tree.


Note decomposing logs and stumps

Downed logs and stumps are the establishment site for the succession of decomposition communities. Moreover they are preferred habitat and movement pathways for small mammals, amphibians, etc..



Often they are preferred locations for their predators as well. (e.g., Hikers' axiom—always step <u>on</u> a log, not <u>over</u> it.)

Wetland Functions Influenced by Microtopography (From Wardrop et al., 1998)*

1. Solute Adsorption Capacity = (V sorgm + V tex + (V slope + *V micro* + Vpcrm)/3)/3

2. Maintain Characteristic (Native) Plant Community Structure = (V strata * Vsize class) + *V micro*)/2 - V disturb

3a. Energy Dissipation/Short-Term Surface Water Detention = (V surface area * *V roughness*)$^{1/2}$ or…. 3b. Energy Dissipation = (V slope + *V roughness* + V surface area + V shape)/4

***Hydrogeomorphic (HGM) Functional Assessment Models for Pennsylvania Wetlands, Interim Draft. Rpt. No. 98-6 PA State Coop. Wetlands Ctr. 19 pp + appendices.**

Wetland Functions Influenced by Microtopography (Cont.)
(From Wardrop et al., 1998)*

5. Retention of Inorganic Particulates = (V roughness + V macro)/2
or (V roughness + Vslope + Vperm)/3
6. Export of Organic Particulates = (C avail/C seq + V macro-out - V roughness)/3
7. Export of Dissolved Organic Matter =[(V macro * V anaerobic * C avail) 1/3 + V
macro-out - V roughness)/3

***Hydrogeomorphic (HGM) Functional Assessment Models for Pennsylvania Wetlands, Interim Draft. Rpt. No. 98-6 PA State Coop. Wetlands Ctr. 19 pp + appendices.**

In their 2001 review of issues concerning wetland mitigation the National Academy of Science observed:*

1. **Concern at meeting hydrological criteria often encouraged construction of permanently flooded open-water wetlands.**
2. **Compliance criteria sometimes specified plant species that site conditions could not support, or were unnecessary or inappropriate.**

In their conclusions their recommendations included:

1. **All mitigation wetlands should be self-sustaining.**
2. **Biological dynamics should be evaluated in terms of populations present in reference models.**
3. **Hydrological variability should be incorporated into mitigation design and evaluation.**

***National Research Council. 2001. Compensating for Wetland Losses Under the Clean Water Act. National Academy Press, Washington, DC.**

As a result of the concern to insure “adequate” hydrology many mitigation sites result in “duck donuts” even when the target is to restore wooded wetlands.

In an effort to experiment with the introduction of coarse woody debris, stumps were incorporated into this highway mitigation project in Delaware.

The US Fish and Wildlife Service in cooperation with Delaware state personnel have perfected a technique of transplanting entire trees and shrubs with their root wad intact as part of Partners in Wildlife wetland restoration projects. (Rizzo A., and Barthlemeh, T., pers. comm.)

Transplants are taken from the edge of adjacent, established wetlands and are placed at the equivalent elevation in the restored area.

“Partners in Wildlife” restoration in progress…..

A New Model: Rather than the "plantation" approach of many wetland restoration efforts (e.g., relatively homogenous topography, hydrology and plant communities) wetland restoration practitioners may wish to mimic the ecology of forest gaps.

First/second order coastal plain headwater wetland, Yorktown, VA

This Yorktown, VA wetland was most recently affected by Hurricane Isabel in September 2003 which resulted in the blow down of a significant number of canopy trees.

A Hypothetical New Recipe:

1. **Locate appropriate restoration site based on landscape position, soils, available hydrology, reference wetland, etc.**
2. **Establish appropriate sized “vessel” (e.g., depression, flat, floodplain).**
3. **“Moisten” to establish requisite hydrology (e.g., redirect/reestablish flow, plug ditches, break drainage tiles, establish low head berms or weirs). Care should be taken to establish appropriate heterogeneity of hydrology.**
4. **“Mix” (soil) vigorously (e.g., root rake, disc) until desired microtopography is established).**

A Hypothetical New Recipe (cont):

5. **"Season" liberally with a mix of litter, twigs, branches and large specimens of coarse woody debris (size and volume based on reference wetland conditions).**
6. **"Mix" in appropriate "nurse" stock of the appropriate species to provide cover/shade (e.g. Populus, Betula) and/or enhance soil (e.g. Alnus, Gleditsia). Selectively cut later at intervals if appropriate.**
7. **Plant or transplant "target" species at the appropriate time.**
8. **Monitor regularly (e.g., 1-2-3-4-5-7-9-12-15-20+) to control for invasive, nuisance species. Apply adaptive management when and where appropriate.**
9. **Upon successful completion "serve" to appropriate public or private entity.**

Thank you for your time, attention and consideration!