Ecological Sites in Pennsylvania Landscapes and their Response to Land Use Change.

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1. Identifying Ecological Sites in MLRAs 127 and 140, and developing Ecological Site Descriptions;

2. Quantifying soil change on select Ecological Sites; and

Pennsylvania MLRA regions of interest.
Complex Land Use History
Does a Native Site Still Exist?
Example Conditions Affecting a Sugar Maple Eco-Site

Multiple Factors

Ecological Site

Topography
Deposition
Climate
Defoliation
Soils
Land Use
Oil & Gas
Deer
Timber
Percent changes in forest composition with historic logging (Whitney, 1990).

<table>
<thead>
<tr>
<th>Species</th>
<th>Pre-Settlement</th>
<th>Post Settlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beech</td>
<td>44</td>
<td>6</td>
</tr>
<tr>
<td>Hemlock</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Sugar Maple</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Red Maple</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>White Pine</td>
<td>5</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Black Cherry</td>
<td>&lt;1</td>
<td>23</td>
</tr>
</tbody>
</table>
1990 Map

After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

2006 Map

National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Zone

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Elevation and Position

Change is subtle: 10 year period

<table>
<thead>
<tr>
<th>Topo. Position</th>
<th>Decline</th>
<th>Non-declining</th>
<th>%Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot/toe slope</td>
<td>1</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Back slope</td>
<td>5</td>
<td>12</td>
<td>16%</td>
</tr>
<tr>
<td>Ridge/nose</td>
<td>3</td>
<td>3</td>
<td>21%</td>
</tr>
<tr>
<td>( p)-value</td>
<td>0.53</td>
<td>0.63</td>
<td></td>
</tr>
</tbody>
</table>

Drohan et al. (2002)
Figure 7. Mean annual sulfate wet deposition across Pennsylvania and neighboring states before (1983-1994) and after (1995-2006) implementation of Title IV of the Clean Air Act Amendments of 1990.
Soil chemistry change over 30 years

Original samples taken in 1967

Bailey et al. (2005)
AMD Surface Crusts
Key Landscape/Soil Variables

- **Topography**
  - Slope, aspect, elevation
  - Concavity or convexity
  - Potential wetness or droughtiness

- **Profile depth to a restricting layer**
  - Drainage class

- **Inherent versus dynamic properties**
  - Mineralogy, texture, structure or lack of
1. EPA Level 4 Ecoregions

Woods et al. (1999)
The Low Catskills (62e) is a forested and highly dissected ecoregion less than 5 miles (8 km) wide in northeastern Pennsylvania. Here, the Delaware River has deeply entrenched into the glaciated Appalachian Plateau, creating cliffs and steep-walled valleys. Many high-gradient tributaries occur and stream organisms associated with riffles are common. Topography is rugged for this part of the commonwealth and local relief ranges from about 450 to 800 feet (137-244 m). Crestal elevations are from approximately 1,300 to 1,800 feet (396-549 m) and are high enough to insure a short growing season of about 130 days, varying according to local topography and slope aspect.

The soils of Ecoregion 62e are mostly Inceptisols. Most formed on Olean Till and some developed on Quaternary alluvium. They overlie nearly horizontal, Devonian age sandstone, siltstone, and shale of the Catskill Formation. The soils are characterized by stoniness, shallowness, low fertility, and acidity, which, together with the rugged terrain and brief growing season, make the area best suited to woodland (Higbee, 1967). The natural vegetation was mostly Northern Hardwoods (dominants: sugar maple, yellow birch, beech, and hemlock) (Cuff and others, 1989, p. 52). Some wetland vegetation occurs on poorly drained sites, and northern rock plants grow on the Delaware River cliffs in northeastern Wayne County (Erdman and Wiegman, 1974, p. 50).

The boundary between Ecoregion 62e and the less dissected Northeastern Uplands (60b) occurs at the forest density and topography break shown on the Scranton 1:250,000-scale topographic map; Ecoregion 62e is much more rugged and wooded than Ecoregion 60b. Ecoregion 62e extends across the Delaware River into New York, where it becomes much more extensive.
2. Vegetation, state specific data
Mixed deciduous, coniferous forests, alpine meadow

Deciduous mixed forest - coniferous forest - meadow

Lake broadleaf forests, continental

Broadleaf forests, oceanic

McNab et al. (2005)
USEPA Level 4 Ecoregions and FIA Data
3. PA Land Use Data ~2005

Strong trends because of topography, climate and soils
Degree of forest connectivity

*USFS FIA, ~2000 Land Use Data*
Hot Spot Analysis: Getis-Ord Gi-* statistic

Fragmentation clusters

What was the pattern of landscape fragmentation prior to the Marcellus boom?
4. STATSGO and SSURGO

1. STASGO drives LVL 5 selection
2. SSURGO refines ESs (LVL 6)
4. Topography

Ciolkosz et al. 1986
6. Agro-Climatic Regimes

Agro-climatic regions were derived from the Newhall Simulation Model (Van Wambeke et al., 1992) using 1961 to 1990 normals. The annual water balance (PREC–PET) and growing degree-days were integrated to spatially represent areas of relatively homogeneous moisture and thermal characteristics related to agronomic crop production.

Source: USDA/NRCS Climate Data Access Facility, Water and Climate Center, Portland, OR; Gwynby and Ezell (1992); Albers Equal Area Projection; AUG 1996.

Figure 15. Agro-climatic regions of Pennsylvania.

Soil Climate Regimes of PA
Waltman et al. (1997)
Pennsylvania Ecological Sites

• Wildland (MLRA 127 and 140): ~26 so far
• Wetland (state-wide): 15 -17 based on Brooks et al. (2011)
• Subaqueous (state-wide): 8-11 based on Erich (2010), and non-published work.
• Agricultural and Urban areas are “states” of Ecological Sites.
Key Observations of States

• Change from native in %cover, basal area or stand index
• O horizon presence *relative to native*
• A horizon thickness (or A over Ap)
• Truncated profiles; no silt loam A....right to a silty clay.
• Buried surfaces (Euro-alluvium)
• Whole profile %OC
• Phosphorus
• pH and conductivity (too flashy?)
Ecological States

- Urban/Suburban
  - New (>30% veg)
  - Old (>25 years per Scharenbroch et al. (2005); >30% veg)
- Park/Native
- Transition/Abandoned lot
- Built/Industrial; ~100% surface sealed
Ecological States

• Agricultural
  – *Prime*: row cropping
  – *Secondary*: pasture or CRP (tertiary?)
  – *Degraded*: abandoned/transitional or eroded lands
Ecological States

• Wildlands
  - Old growth
  - Secondary timber – old growth model
  - Secondary timber – managed for “x”
  - Secondary timber – degraded
  - Rights-of-way
  - Shrub-land natural recovery
  - Shrub-land due to disturbance
Poorly drained soil
Well drained soil
Well drained soil
Drohan et al. (2011)
Next Steps

• Continued development and validation
  – Refinement using LiDAR modeling
  – Field visits with DCNR and USFS
• State and Transition Model Assessment
  • Mike Marsicano thesis
  • Cody Fink thesis
Conclusions

• ESD development East of the Mississippi is possible; and not as hard as thought.
• Easy to be a splitter; fall back on “true” native condition, and not the ideal $$$ managed condition.
• ESDs greatly advance soil science communication.
• ESDs nicely link the historical landscape to the present
  - Coming of age for USA soil science
• The speed of change is incredible and our biggest problem.
Questions?