Climate Change Resilience and Adaptation through Restoration

Monongahela National Forest, West Virginia
The Monongahela National Forest

- ~1 million acres
- High elevation
- Location of headwater streams for millions in the East
- Rain shadow effect – The Allegheny Front
- Sedimentary geology and acidic environments
- Biodiversity hotspot
Climate Change Resiliency – National Forest Planning Rule

“...the Forest Service find that a planning rule must address the following eight purposes and needs:

1. Emphasize restoration of natural resources to make our NFS lands more resilient to climate change, protect water resources, and improve forest health.

2. Contribute to ecological, social, and economic sustainability by ensuring that all plans will be responsive and can adapt to issues such as the challenges of climate change; the need for forest restoration and conservation, watershed protection, and species conservation; and the sustainable use of public lands to support vibrant communities.” (2012 Federal Register)
The 2012 planning rule emphasizes restoring the function, structure, composition, and connectivity of ecosystems and watersheds to adapt to the effects of a changing climate and other ecosystem drivers and stressors, such as fire and insect and disease infestations. A baseline assessment of carbon stocks required in the assessment phase and monitoring will check for measurable changes in the plan area related to climate change and other stressors.
MNF Land and Resource Management Plan

- Published in 2006
- Originally had no explicit mention of climate change
- Updated in 2011 to address climate change
- Upon review of management direction, we determined that it addresses climate change resilience and adaptation
- Strong focus on maintaining and restoring ecosystem integrity – generally equates to enhancing resilience and preserving adaptive capacity
MNF Land and Resource Management Plan

- Maintain, restore, or enhance ecosystem resiliency (facilitated adaptation/mitigation)
- Promote carbon sequestration (mitigation)
- Promote air or water quality, cooler temperatures, moister conditions (facilitated adaptation)
- Reduce or prevent NNIS establishment and spread (facilitated adaptation)
- Retain or promote biological diversity (facilitated adaptation)
Role of Restoration on the MNF

- As populations grow and threats of climate change loom, the National Forest grows in importance in providing ecosystem services to downstream communities.

- Restoration seeks to speed recovery of the landscape from century-old impacts.

- Restoration also seeks to build resilience and adaptability to future changes.

- Conducted within the context of ongoing stressors (acid deposition, non-native invasive species, potential new energy development and related infrastructure, etc.)
Ecosystem Restoration on the MNF

- Red spruce forest
- Watersheds and aquatic habitat
- Non-native invasive species
- Oak ecosystems/fire regimes
1900-1910

500,000 ha of spruce and mixed spruce - northern hardwood
Why is Spruce Important??

- High number of “species of concern”
  - 158 plants (75% are S1-S2)
  - 137 wildlife (40% S1-S2)
- Carbon Sequestration (esp. below ground)
- Natural Refrigerator (fosters cool moist microclimate)
Simulation of C dynamics in the aboveground biomass and the soil after harvesting. — Assumptions: Biomass-C stock typical for Central European Norway spruce forest; rotation period ≈100 years; 25% of SOM are labile, total SOM loss from literature (Olsson et al., 1996).
Understory Spruce Release
Spruce Restoration on Mined Land

Non-native grassland

Non-native conifer plantation
Site Prep Activities
Plant Red Spruce & Other Native Plants
Beyond Business as Usual: IL Scale Climate Change Adaptation

- Maximal intact natural landscape coverage for south to north movement of species
- Maximal area at higher elevations for species to occupy in future (elevation map below; lightest areas approximately above 1000 m contour)
- High biodiversity (Central & Southern Appalachians among highest in Eastern North America)
- High level of environmental variation to maximize opportunities for emigrating species (Central & Southern Appalachians have the most variation in Eastern North America)
Watershed Restoration
Aquatic Habitat Restoration – Large Woody Material
Site Prep Activities
Non-native Invasive Species Control
Appalachian Forests
Oak and pine-oak

- Variety of communities dominated by various mixtures of oaks, yellow and white pines, hickories
- Can have closed canopy or semi-open woodland structure depending on fire regime
- Disturbance regime dominated by frequent, low-intensity fire (Native American burning dates back at least several thousand years)
- C. 3 yr fire return interval for savannas/woodlands
- Fire return highly variable in forests; 7 - 30+ years
Oak Ecosystem Restoration – Rx Fire
Adaptation Workbook

- Lambert mined land restoration project
- Big Rock timber management project
### All forest types

- **Restore native red spruce and mixed hardwood forests**
  - Climate change tips the competitive balance in favor of NH trees, where disturbance can reduce biological climax. Beech and hemlock (rare where hemlock exists) are already risk for red spruce.
  - Red spruce and other northern hardwoods already exist in the area. Species composition and structure is a quadrat gets and the amount of coarse woody material is away.
  - Long term: high, short term: moderate
  - Opportunity: monitoring, species diversity
  - Consideration: restoration of this area would be more important in the larger context of Okean Mountain.

### Spruce/ hardwood

- **Maintain spruce/hardwood forest with at least 30% spruce in the area**
  - Climate change tips the competitive balance in favor of NH trees, where disturbance can reduce biological climax. Beech and hemlock (rare where hemlock exists) are already risk for red spruce.
  - Red spruce and other northern hardwoods already exist in the area. Species composition and structure is a quadrat gets and the amount of coarse woody material is away.
  - Short term: high, long term: moderate
  - Opportunity: monitoring, species diversity
  - Consideration: restoration of this area would be more important in the larger context of Okean Mountain.

### Dense Red Spruce

- **Thinning to enhance growth rate and stand structure**
  - Climate change will enhance forest growth and structure.
  - Species composition and structure is a quadrat gets and the amount of coarse woody material is away.
  - Long term: medium, short term: high
  - Opportunity: monitoring, species diversity
  - Consideration: restoration of this area would be more important in the larger context of Okean Mountain.

### Mixed Hardwood

- **Improve composition by increasing red spruce component to 30%**
  - Climate change working against red spruce component in the long term.
  - Yellau birch is more susceptible to drier conditions than other species.
  - Red spruce already exists in the area. Species composition and structure is a quadrat gets and the amount of coarse woody material is away.
  - Short term: high, long term: medium
  - Opportunity: monitoring, species diversity
  - Consideration: restoration of this area would be more important in the larger context of Okean Mountain.

### Mine bench

- **Establishment of native species**
  - Species diversity increases in the area. Species composition and structure is a quadrat gets and the amount of coarse woody material is away.
  - Long term: high, short term: medium
  - Opportunity: monitoring, species diversity
  - Consideration: restoration of this area would be more important in the larger context of Okean Mountain.
### Step 4: Identify adaptation approaches and tactics for implementation.

**What actions can be taken to enhance the ability of the area to cope with change and meet management needs/indications?**

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>Adaptation Tactic (Climate-adapted Activity)</th>
<th>Time Frame</th>
<th>Benefit</th>
<th>Drawbacks</th>
<th>Practiceability of Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spruce hardmound</strong></td>
<td>Objective(s): Maintain spruce/hardmound forest with at least 30% spruce in the overstory</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.2</td>
<td>Prescribed burning for site preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td><em>Burn brush piles for site prep for spruce</em></td>
<td>Arsenic regeneration</td>
<td>Wildlife habitat loss</td>
<td>Moderate</td>
<td>Yes</td>
</tr>
<tr>
<td>1.2</td>
<td><em>Modify mine retention pond to re-connect surface and groundwater, incorporate existing infrastructure (e.g., armored ditch for storm water overflow) where it makes sense</em></td>
<td>Currently water is withhold at the surface, but this tactic would allow infiltration and flow to surrounding areas</td>
<td>Would still be maintaining inherent risk of mine pond on the landscape (e.g., blowout or pollutants in the pond)</td>
<td>Moderate</td>
<td>Yes</td>
</tr>
<tr>
<td>9.1</td>
<td>Assessing/improving road/stream crossings and upgrading culverts</td>
<td>Improve aquatic organism passage</td>
<td>Very expensive</td>
<td>High</td>
<td>Yes</td>
</tr>
<tr>
<td>1.2</td>
<td><em>Modify/ create wetland habitat to restore natural hydraulics</em></td>
<td>Restore hydraulic function</td>
<td>Require carefull placement to avoid erosion issues and failure to connect</td>
<td>High</td>
<td>Yes</td>
</tr>
<tr>
<td>1.2</td>
<td><em>Decommission roads that are impeding hydraulic function or repurpose roads/trails for recreation</em></td>
<td>Restore hydraulic function</td>
<td>Road may need to be something else</td>
<td>Moderate</td>
<td>Yes</td>
</tr>
<tr>
<td>2.2</td>
<td>Remove non-native trees mechanically (Norway spruce) and herbaceous species (spotted knapweed)</td>
<td>Adding coarse woody material (may benefit) from Norway spruce that is being knocked over</td>
<td>Initially looks terrible</td>
<td>Moderate (can get expensive in large or complicated areas)</td>
<td>Yes</td>
</tr>
<tr>
<td>6.2 and 9.1</td>
<td><em>Plant native tree species and herbaceous species (within general area of the watershed) in general strategy here is to prioritize native species in this location, which may serve as refuges for them in the future. In the long term, keep an eye on new species and native associations.</em></td>
<td>Restoration of red spruce in this landscape takes advantage of smaller and less intense portions of the landscape (in the long term high risk to those who do not want it)</td>
<td>Availability of native species (both black cherry, aspens, poplars)</td>
<td>Moderate (high risk for those who want it)</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Thank You

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http://www.fs.usda.gov/mnf