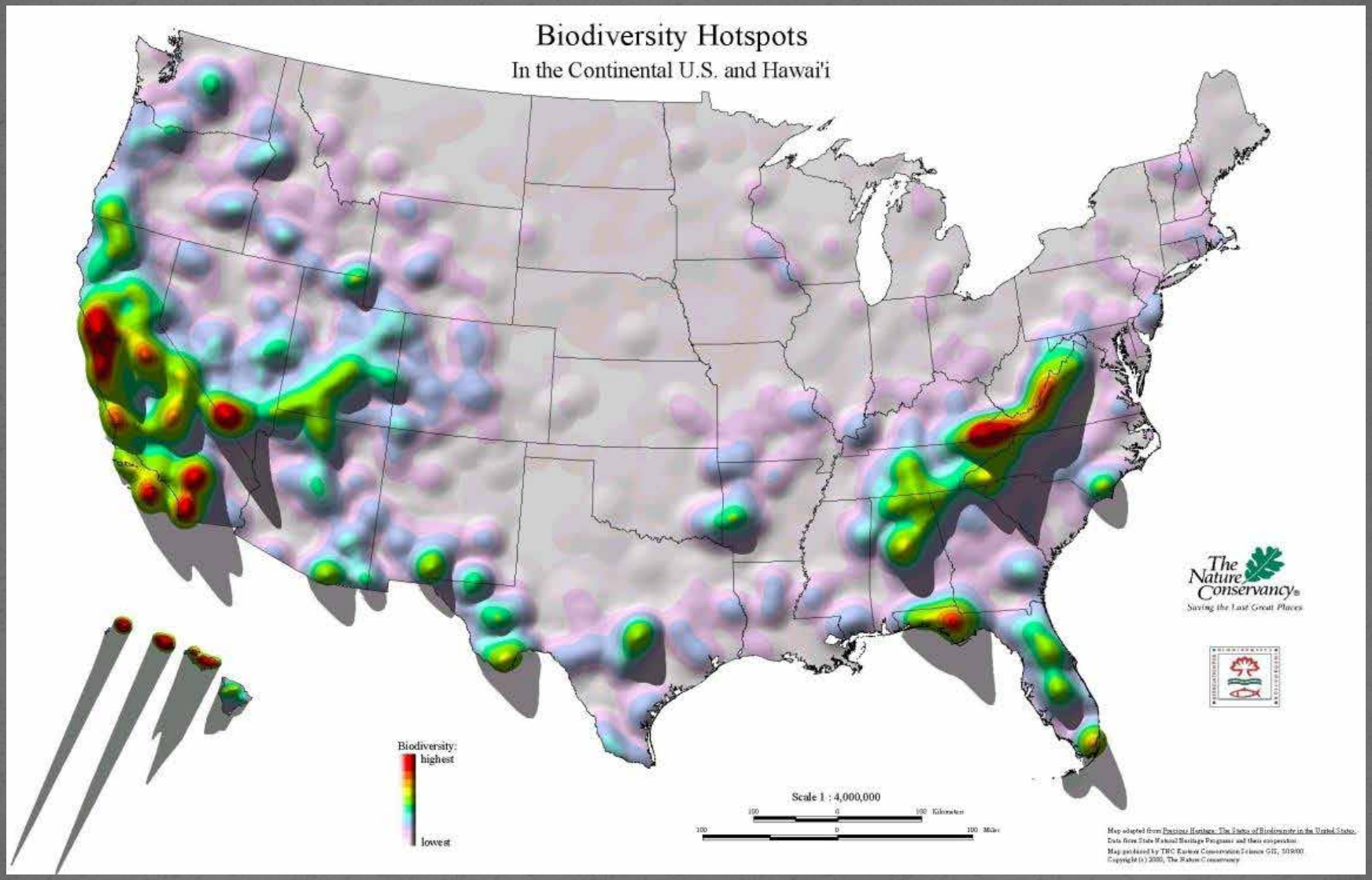
Climate Change Resilience and Adaptation through Restoration

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


Biodiversity Hotspots
In the Continental U.S. and Hawai'i
The Nature Conservancy
Saving the Last Great Places
Biodiversity:
highest
lowest
Scale 1 : 4,000,000
100 0 100 Kilometers
100 0 100 Miles
Map adapted from Precious Heritage: The Status of Biodiversity in the United States.
Data from State Natural Heritage Programs and their cooperators.
Map produced by TNC Eastern Conservation Science GIS, 5/1900
Copyright (c) 2000, The Nature Conservancy

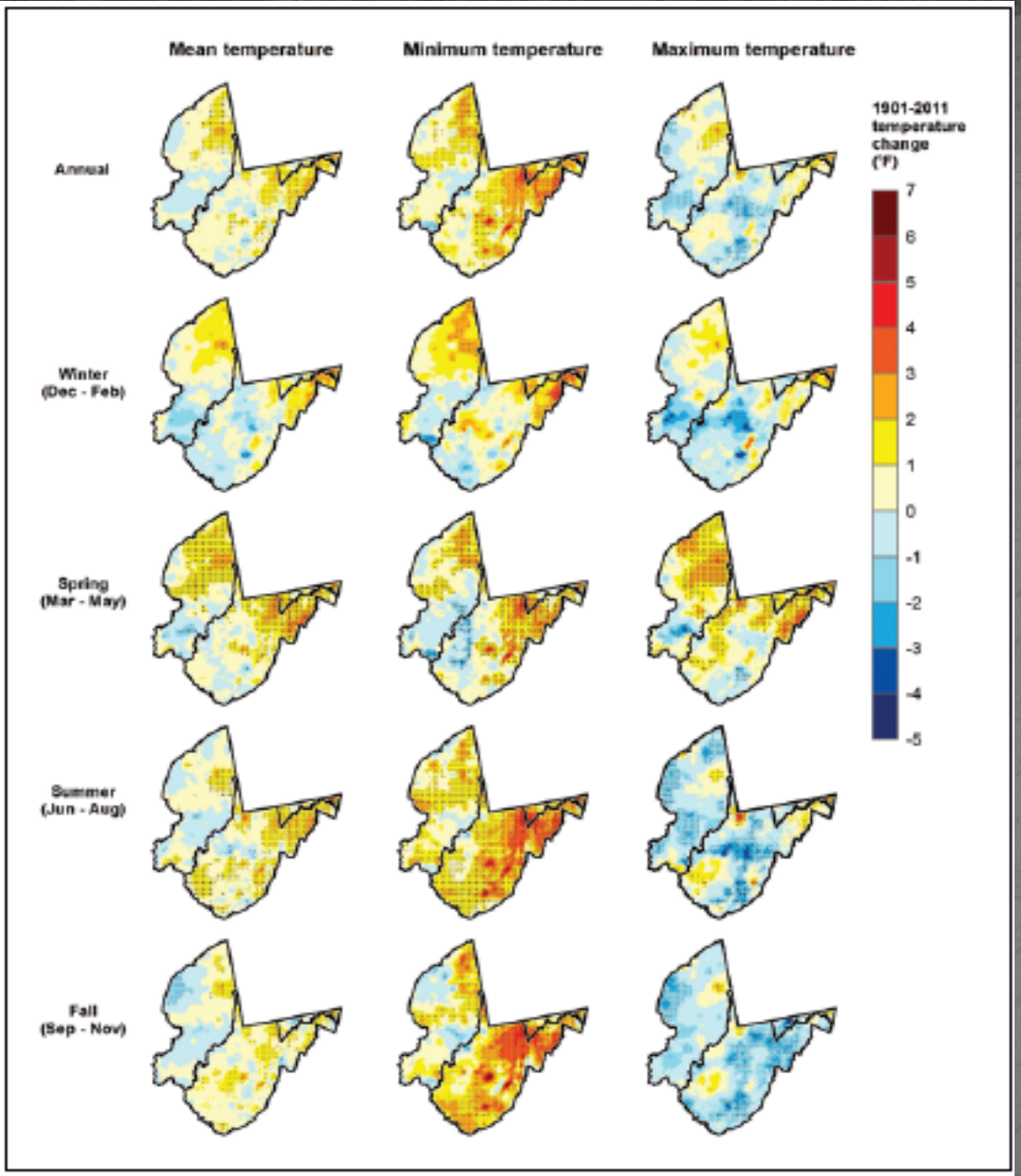


Figure 19.—Annual and seasonal change in mean, minimum, and maximum temperatures across the assessment area from 1901 through 2011. Stippling indicates there is less than 10-percent probability that the trend could have occurred by chance alone. Data source: ClimateWizard (2013).

Butler et al. 2015. Central Appalachians Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Central Appalachians Climate Change Response Framework Project. General Technical Report NRS-146.

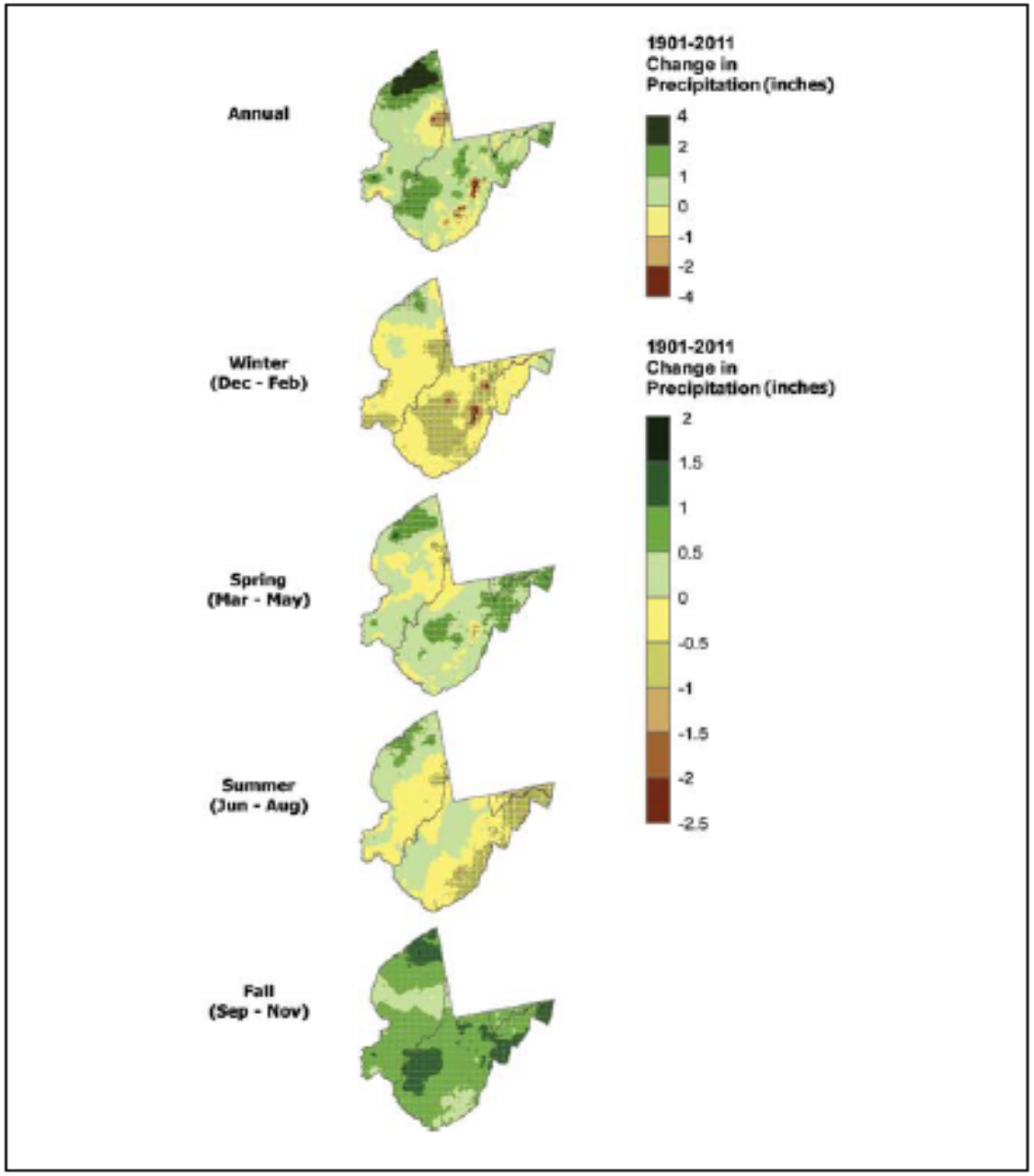


Figure 23.—Annual and seasonal changes in mean precipitation from 1901 through 2011 in the assessment area. Stippling indicates there is less than 10-percent probability that the trend has occurred by chance. Data source: ClimateWizard (2013).

Butler et al. 2015. Central Appalachians Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Central Appalachians Climate Change Response Framework Project. General Technical Report NRS-146.

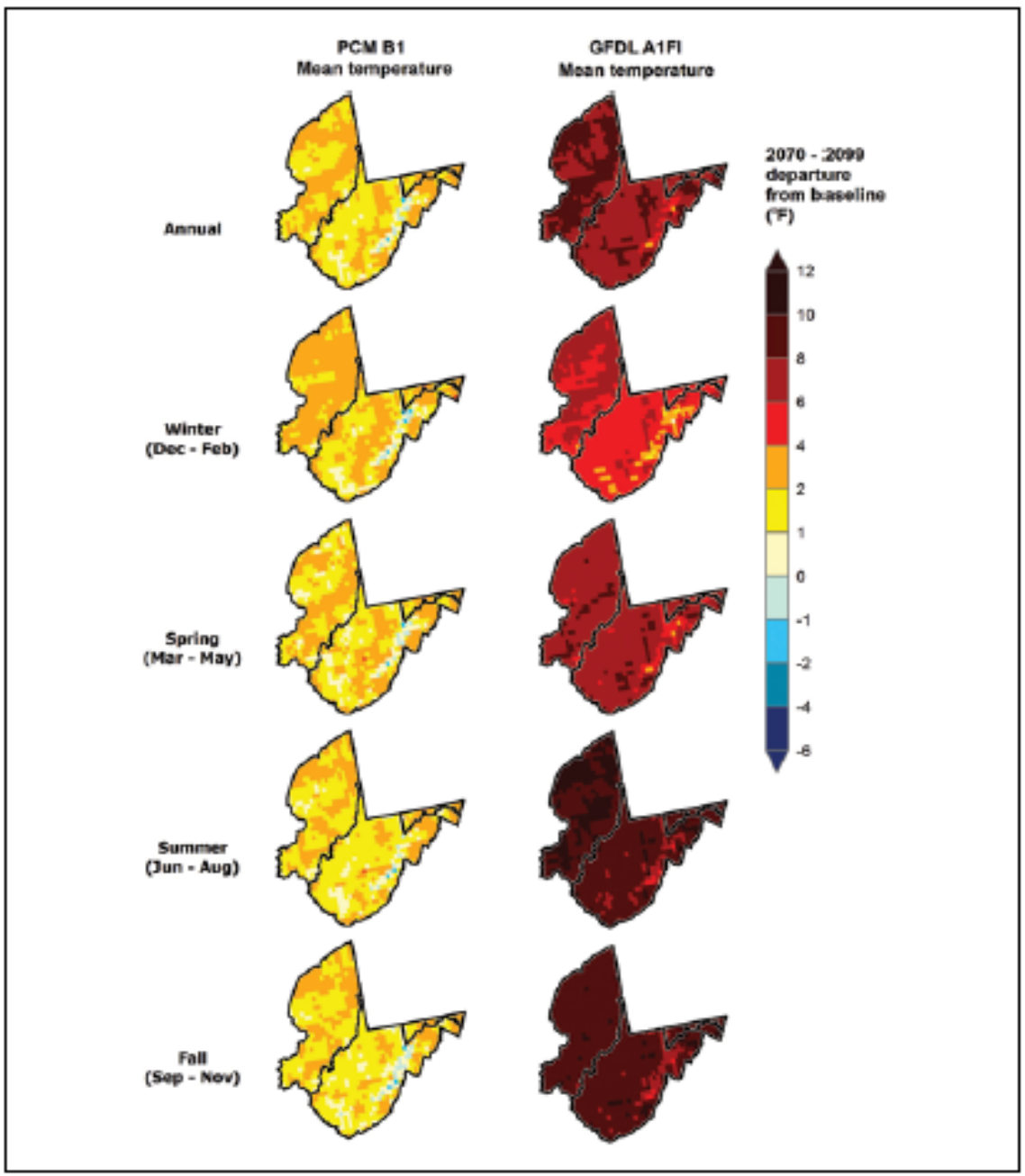


Figure 25.—Projected difference in daily mean temperature at the end of the century (2070 through 2099) compared to baseline (1971 through 2000) for two climate scenarios.

Butler et al. 2015. Central Appalachians Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Central Appalachians Climate Change Response Framework Project. General Technical Report NRS-146.

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)

Climate Change, Restoration, and Carbon

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 measureable 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

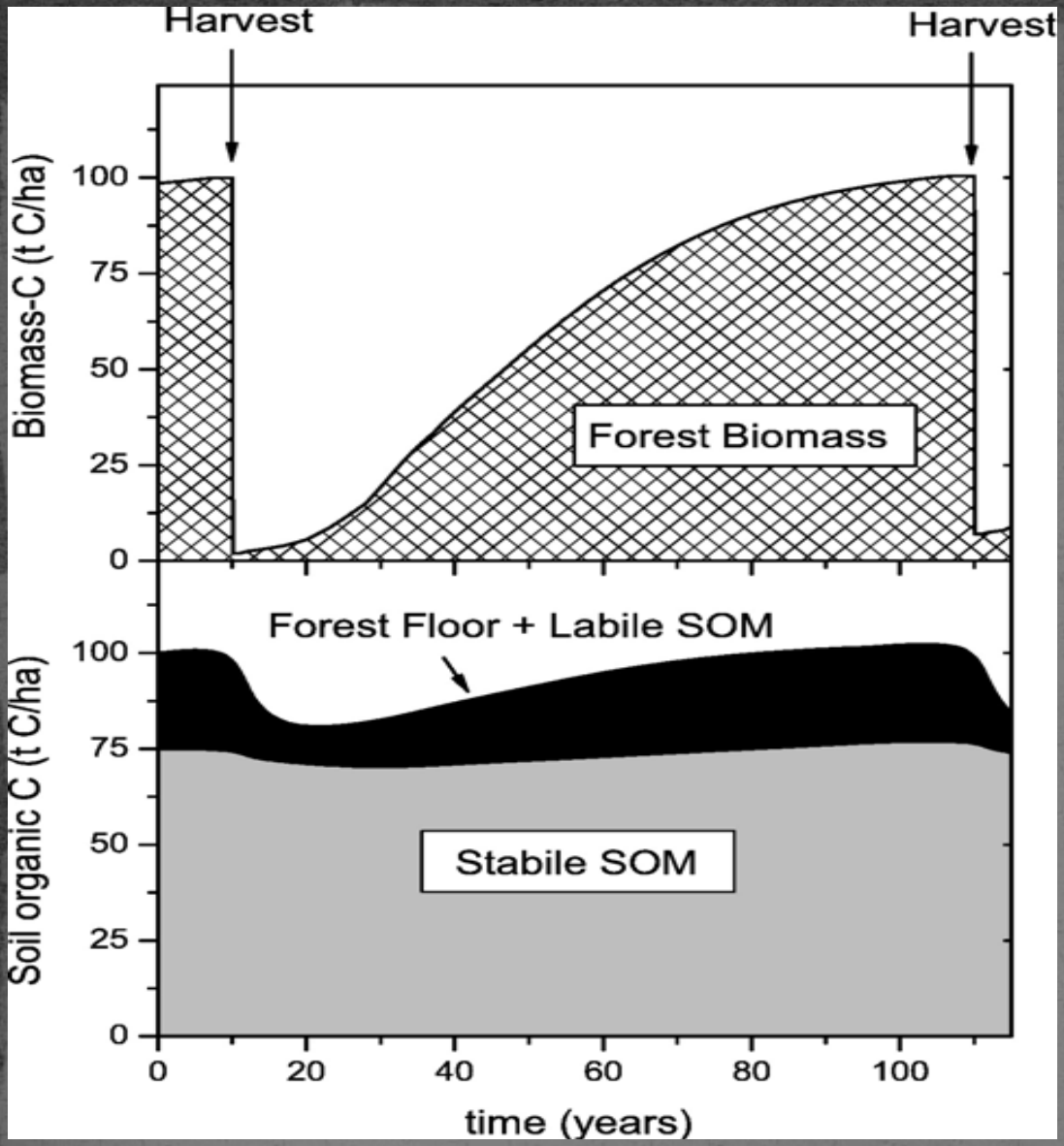
1900-1910

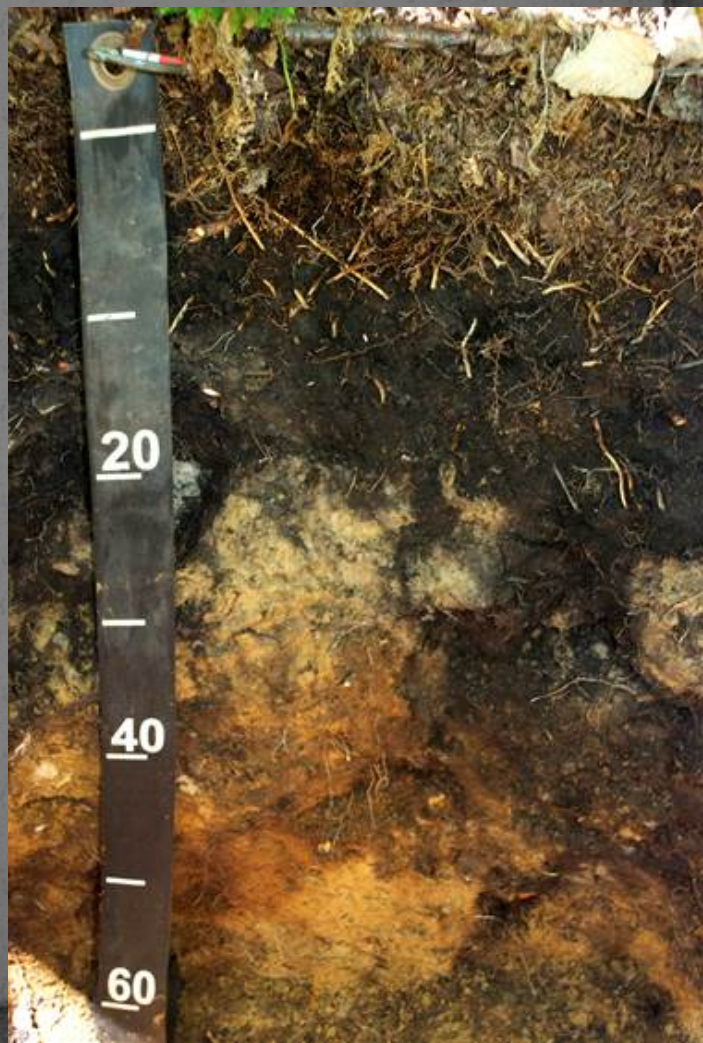
500,000 ha of spruce and mixed spruce – northern hardwood

Fig. 2—Red spruce trees dwarf the lumberjacks who are soon to cut them. Cheat Mountain, Pocahontas County on lands of the West Virginia Pulp and Paper Co., 1910. *Courtesy Mrs. Emory P. Shaffer.*

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

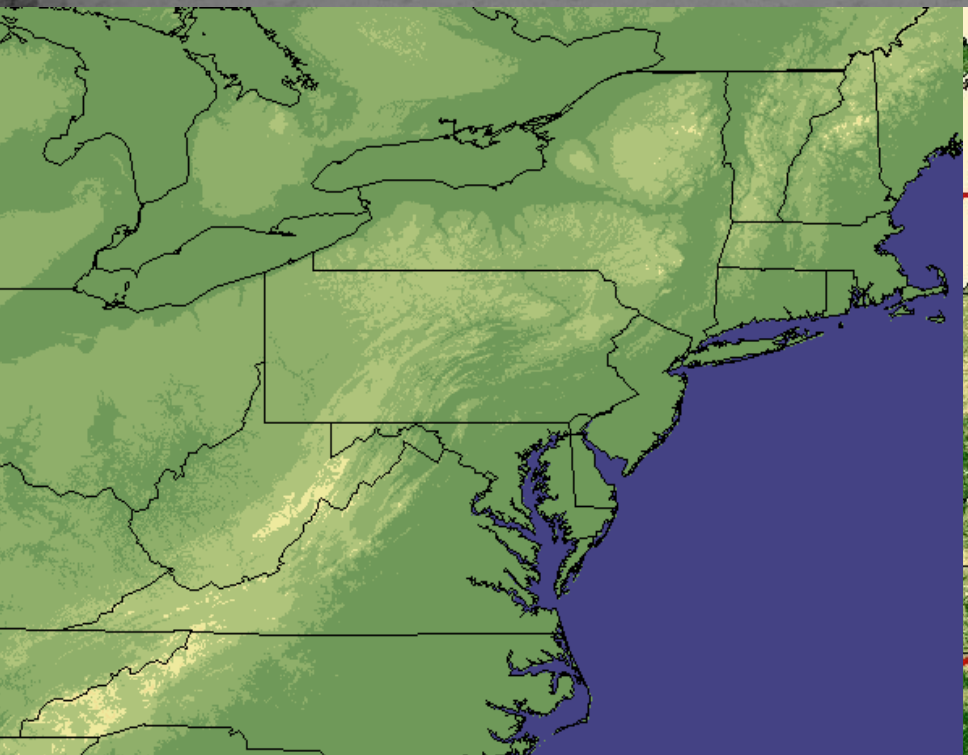
Plant Red Spruce & Other Native Plants

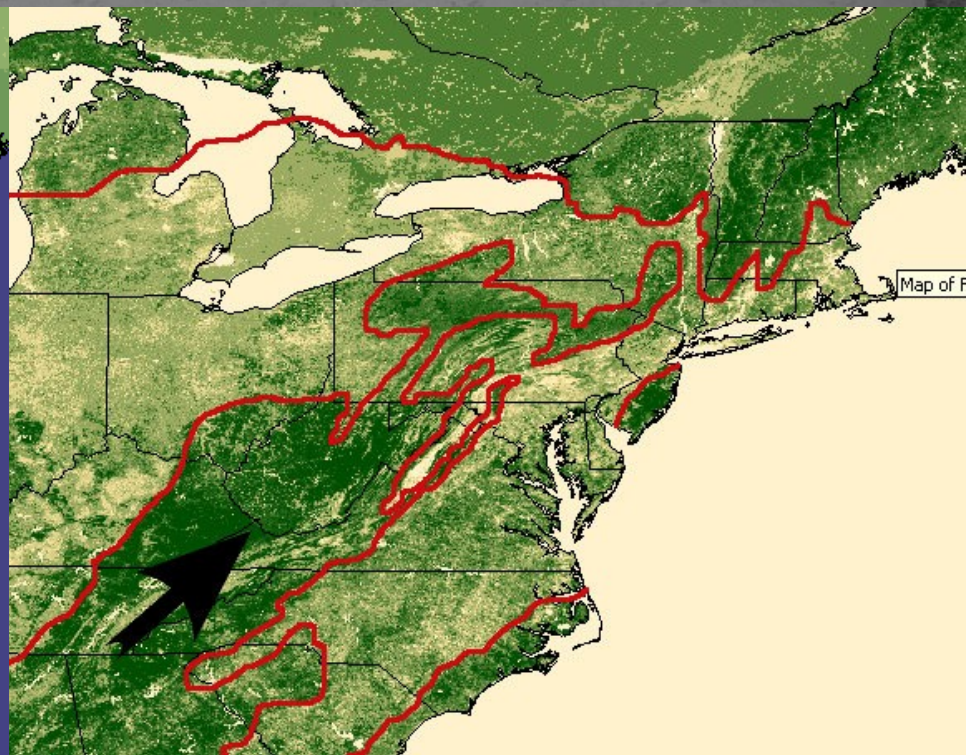
Beyond Business as Usual: IL Scale Climate Change Adaptation

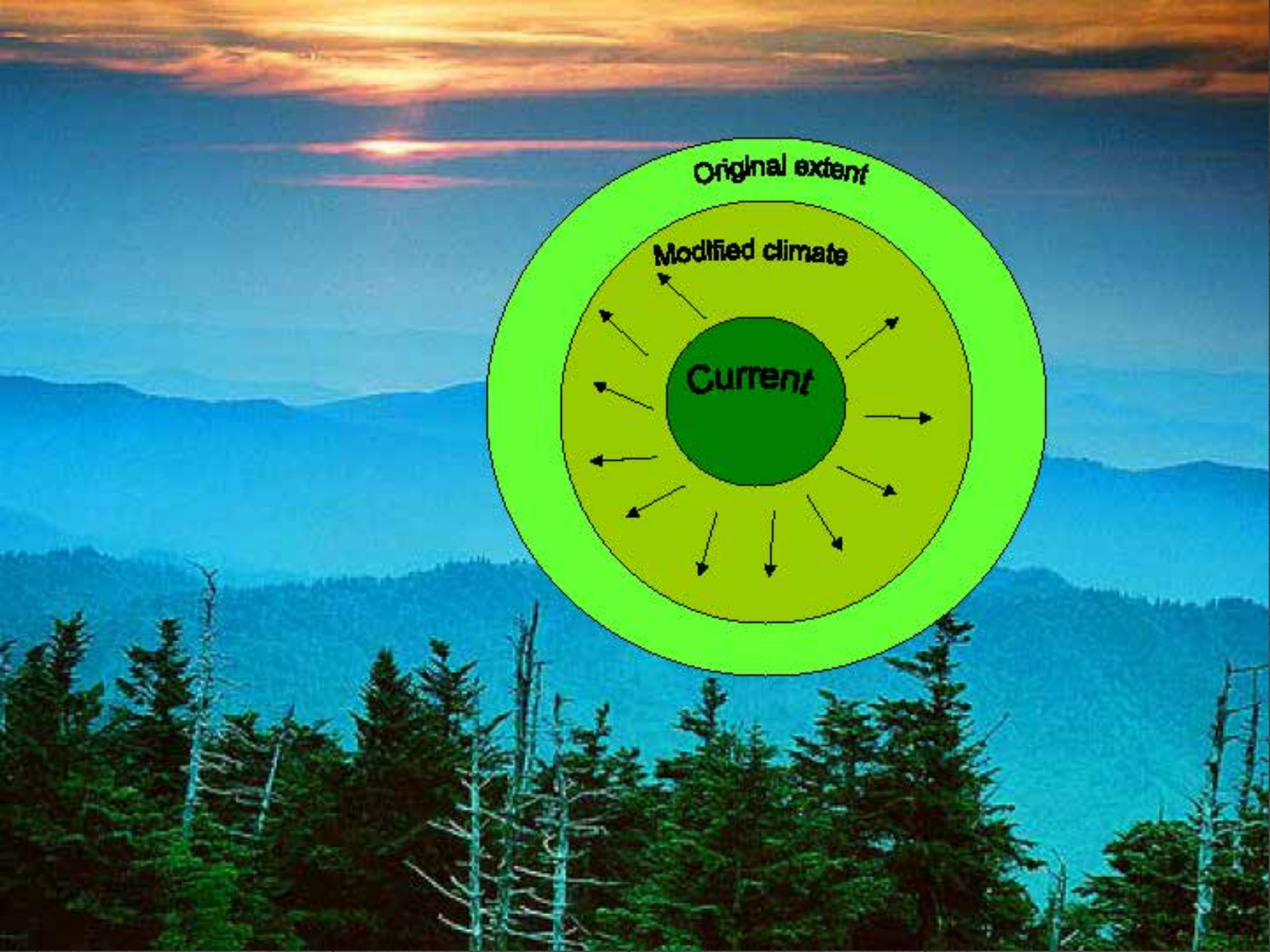
•Maximal intact natural landscape coverage for south to north movement of species

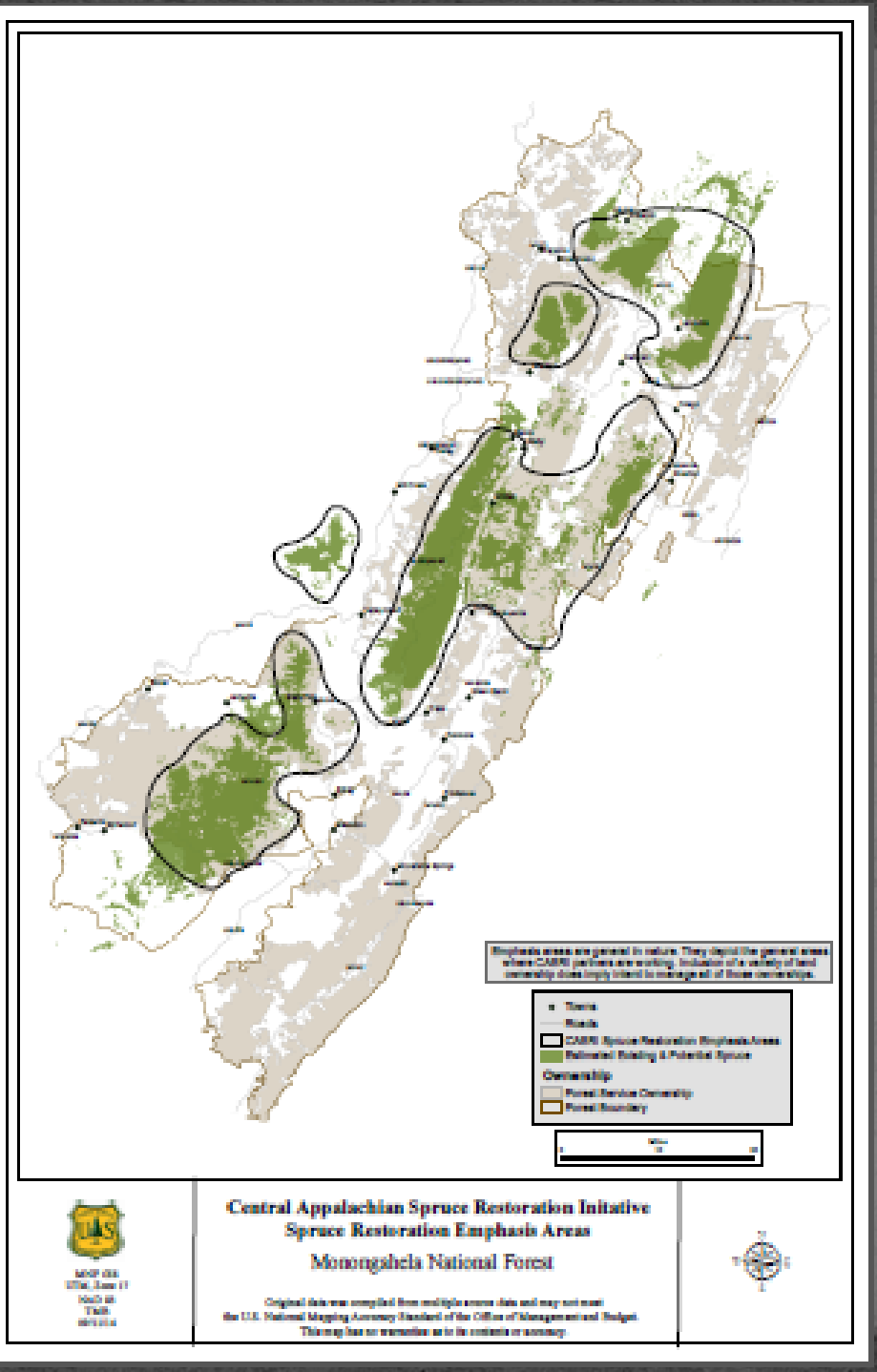
•Maximal area at higher elevations for species to occupy in future (elevation map below; lightest areas approximately above 1000 m contour)

- 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)






Original extent
Modified climate
Current



Central Appalachian Spruce Restoration Initative
Spruce Restoration Emphasis Areas

Monongahela National Forest

Watershed Restoration

Aquatic Habitat Restoration – Large Woody Material

Watershed Restoration – Road Decomissioning

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

Adaptation Workbook A Climate Change Tool for Forest Management and Conservation

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NIACS and Key Partners

Learn more about the Northern Institute of Applied Climate Science (NIACS)

A major effort of NIACS is the Climate Change Response Framework, a collaborative effort to support climate-informed forest management and conservation. Visit ForestAdaptation.org to learn more about tools and resources that have been produced as part of this effort. You can also get information about real-world projects that have used the Adaptation Workbook.

The following partners have supported this online version of the Adaptation Workbook:

USDA Forest Service - Northeastern Area, Eastern Region, Northern Research Station

Michigan Technological University

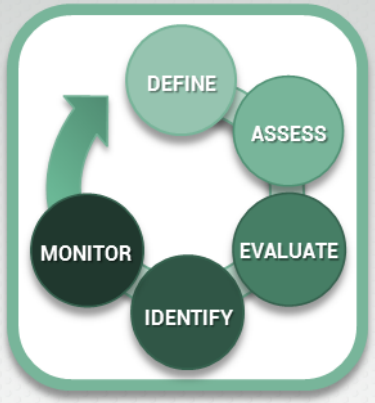
About

The Adaptation Workbook

What is it?

The Adaptation Workbook is a structured process to consider the potential effects of climate change on forest ecosystems and design forest management and conservation actions that can help prepare for changing conditions. The process is completely flexible to accommodate a wide variety of geographic locations, scales, forest types, management goals, and ownership types. The Workbook consists of 5 basic steps:

1. ***Define*** *goals and objectives*
2. ***Assess*** *climate impacts and vulnerabilities*
3. ***Evaluate*** *objectives considering climate impacts*
4. ***Identify*** *adaptation approaches and tactics for implementation*
5. ***Monitor*** *effectiveness of implemented actions*



Why was it created?

More and more information is becoming available on climate change projections and potential impacts on forest ecosystems. Unfortunately, most of this information doesn't seem applicable because many forest managers are unsure how climate change might actually apply at the scales that are relevant to their work. The Adaptation Workbook was created to bridge this gap. The Workbook provides forest managers and natural resource professionals a flexible, logical process to consider climate change information and design customized management actions that can help achieve their management objectives. The Workbook was created by the Northern Institute of Applied Climate Science, and this process was described in Forest

	A	B	C	D	E
7	**Management Objective (Step #1)**	**Challenges to Meeting Management Objective with**	**Opportunities for Meeting Management Objective with Climate Change**	**Feasibility of Meeting Obj. under Current**	**Other Considerations**
8	***Abiotic Climate Change Impacts and Vulnerabilities for the Area of Interest (from Step 2) for additional Challenges and Opportunities.***				
9	**All forest types**				
10	Restore native red spruce and mixed hardwood forests				• Long term risk for red spruce is high, but short term taking advantage of current expansion is best chance to restore function in the near term and not it up for being more resilient
11	**Spruce/ hardwood**				
12	• Maintain spruce/hardwood forest with at least 30% spruce in the overstory	• Climate change tips the competitive balance in favor of NH, esp. where disturbance restores biological clock • Beech and hemlock (rare where hemlock exists) are already	• Red spruce and other northern hardwoods already exist in the overstory • Species composition and structure is as good as it gets and the amount of coarse woody material is okay.	• Short term: high • Long term: moderate	
13	**Dense Red Spruce**				
14	• Thinning to enhance growth rate and stand structure • Enhance structure composition by creating small openings.	• Climate change will enhance perturbations such as wind throw and other disturbances • Drier soils will be stressful on red spruce	• Below ground structure is already in place for red spruce • Climate change may enhance efforts to diversify red spruce • Monoculture breaks up as other other native species fill in and take advantage	• High	• Long term: restoration of this area will become more important in the larger context of Cheat Mountain WV Flying Squirrel conservation.
15	**Mixed Hardwood**				
16	• Improve composition by increasing red spruce component to 30% • Enhance structure composition by creating small openings. (selective removal of trees provides source for coarse woody material)	• Climate change working against red spruce component in the long term • Yellow birch is more susceptible to drier conditions than other species	• Red spruce already exists in understory and midstory; this species is currently expanding on the landscape (esp. on northwest slopes and in ravines) • Many other species are already present (red maple, black cherry, cucumber tree, black birch, etc.) • Climate-related stressors (storms,	• Short term: high • Long term: medium (uncertainty whether spruce will be pushed beyond it's ecological tolerance)	• Future management considerations may evaluate species that are beneficial for wildlife and commercial purposes. Actions now may be evaluated for promoting these species?
17	**Mine bench**				
	• Establishment of native species • Add/create coarse woody material • Restore hydrologic infiltration, reduce surface runoff, reconnect surface and groundwater connection	• Uncertainty about success of red spruce advance regeneration • Yellow birch is more susceptible to drier conditions than other species • Bigtooth aspen is projected to decline • Native species will be	• The microtopographies in this watershed may be the best refugia (buffered from future climate changes) and it will be easier to establish native species now than when species face additional climate stressors. • Experimental planting of blight-resistant chestnut restoration may help increase species diversity (where	• High	• There are other goals to enhance recreational use on restoration sites, scenic vistas, hunting opportunities that benefit from these objectives • Existing ponds may function better when hydrology is restored (considering potential for

Step1 | Step2 | **Step3** | Step 4 | Step 5 | Demo Write-up

	A	B	C	D	E	F	G
1	***Step 4. IDENTIFY adaptation approaches and tactics for implementation.***						
2	***What actions can be taken to enhance the ability of the area to cope with change and meet management goals/objectives?***						
3	**Adaptation**	**Adaptation Tactic (Climate-adapted Activity)**	**Time Frame**	**Benefits**	**Drawbacks and**	**Practicability of**	**Recommend**
4	**Spruce/hardwood**	**Objective(s): Maintain spruce/hardwood forest with at least 30% spruce in the overstory**					
15							
16	**Mine bench**	**Objective(s):** **• Establishment of native species** **• Add/create coarse woody material** **• Restore hydrologic infiltration, reduce surface runoff, reconnect surface and groundwater connection**					
17	2.2	• Prescribed burning for site preparation			• This tactic was tested in Barton Bench, but mostly		NO
18	6.2	• Burn brush piles for site prep for aspen (seed or sprout)		• Aspen regeneration	• Wildlife habitat loss • Requires a lengthy burn plan	• Moderate	yes
19	1.2	• Modify mine retention pond to reconnect surface and groundwater. Incorporate existing infrastructure (e.g., armored ditch for storm water overflow) where it makes sense		• Currently water is withheld at the surface, but this tactic would allow infiltration and flow to surrounding area	• Would still be maintaining inherent risk of mine ponds on the landscape (e.g., blow out or pollutants in the	• Moderate (some uncertainty about end result of hydrologic function)	yes
20	8.1	• Assessing/improving road/stream crossings and upgrading culverts		• Improve aquatic organism passage • Improves capacity of culverts for handling extreme	• Very expensive	• High	yes
21	1.2	• Modify/create wetland habitat to restore natural hydrology		• Restore hydrologic function • Create or improve wildlife habitat (amphibians using recently built ponds, also	• Requires careful placement to avoid erosional issues and failure to	• High	yes
22	1.2	• Decommission roads that are impeding hydrologic function or repurpose roads/trails for recreation		• Restore hydrologic function • Reduce erosion and sedimentation • Provide recreational access (when turned into a trail)	• Road may needed for something else • Difficult to prevent ATVs • Very expensive to decommission	• Moderate	yes
23	2.2	• Remove nonnative trees mechanically (Norway spruce) and herbaceous species (spotted knapweed)		• Adding coarse woody material (so many benefits!) from Norway spruce that is being knocked over • Removal of undesirable species	• Initially looks terrible • Temporary loss of wildlife cover in some areas (that probably aren't	• Moderate (can get expensive in large or complicated areas)	yes
	6.2 and 8.1	• Plant native tree species and herbaceous species (within general area of the watershed)[general strategy here is to prioritize native species in this location, which may serve as refugia for them in the future. In the long-term, keep an eye		• Restoration of red spruce in this landscape takes advantage of cooler and wetter positions on the landscape (in the long	• Availability of native species (border black cherry, aspen,	• Moderate (high for there easily available,	yes

Step1 | Step2 | Step3 | **Step 4** | Step 5 | Demo Write-up

Thank You

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