

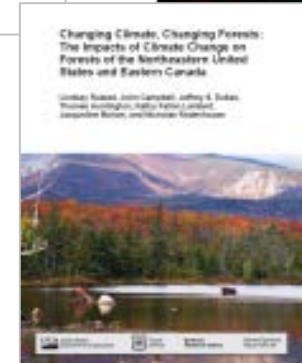
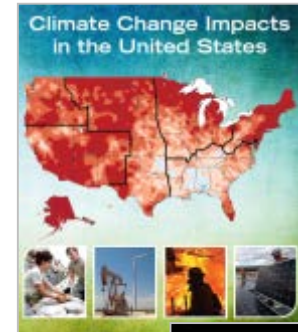
# 9 WAYS THAT CLIMATE CHANGE WILL AFFECT FORESTS

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A Synthesis of Anticipated Impacts in  
West Virginia and the Central  
Appalachians Region

# Climate Change Impacts

- 1) Longer Growing Season
- 2) Shorter Winters
- 3) Potential for Summer Drought
- 4) CO<sub>2</sub> Fertilization
- 5) Changes in Suitable Habitat
- 6) Extreme Events
- 7) Wildfire Risk
- 8) Forest Pests and Diseases
- 9) Invasive Plants



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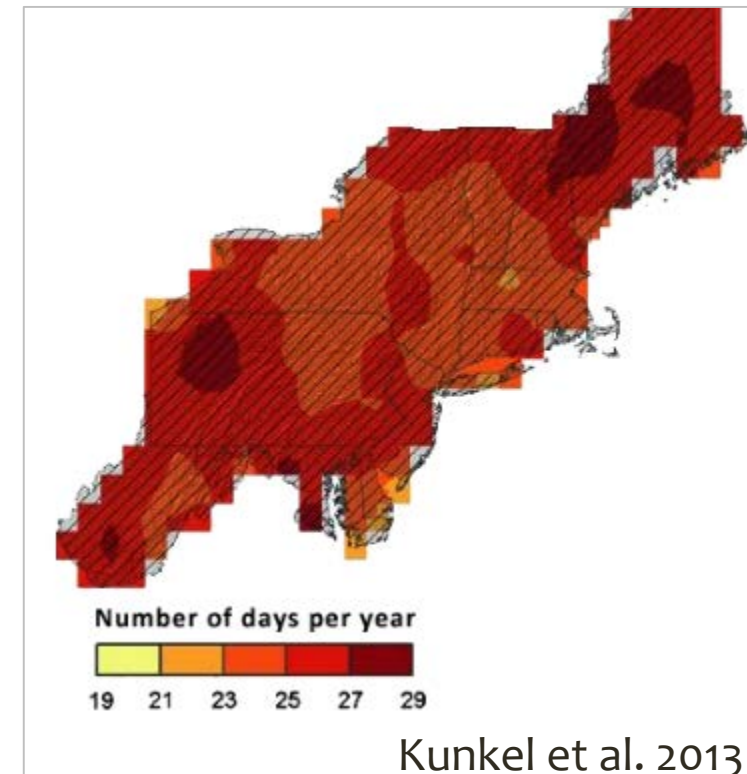


# 1: *Longer Growing Season*

## Warmer temps result in longer growing seasons

- Projected to increase 25+ days
- Evidence of phenological shifts

## Longer period for plant growth





# 1: *Longer Growing Season*

## **Warmer temps result in longer growing seasons**

- Evidence of phenological shifts
- Projected to increase 3-7+ weeks

## **Longer period for plant growth**

### **Potential risks:**

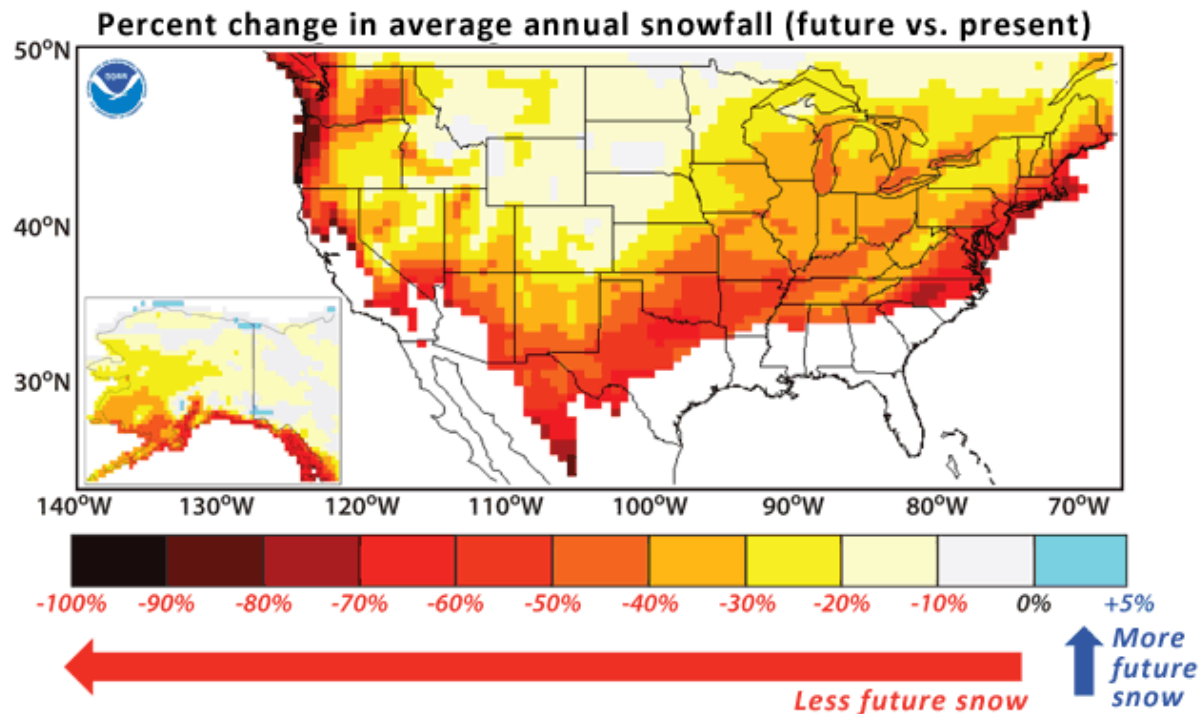
- Early bud break/loss of cold hardening
- Frost damage during spring freezing



## 2: Shorter Winter (Less Snow)

### Projected decreases in snow fall, cover, and depth

- 20-40% decreases in snowfall over the next 70 years
- Greatest loss in December/January



## 2: *Shorter Winter (Less Snow)*

### **Projected decreases in snow fall, cover, and depth**

- 20-40% decreases in snowfall
- Greatest loss in December/January

### **Decreased snowpack**

- Decreased soil frost and root damage in cold temps
- Warmer soil temperatures and altered processes





## 2: *Shorter Winter (Less Snow, More Rain)*

Precipitation is projected to increase = more rain

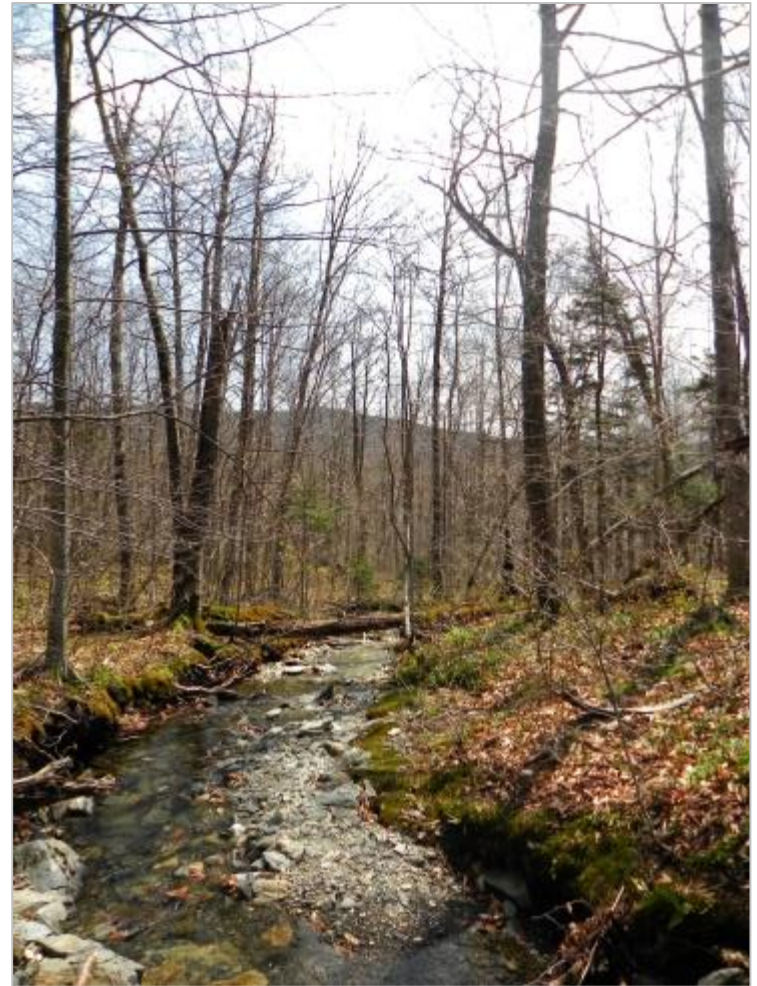


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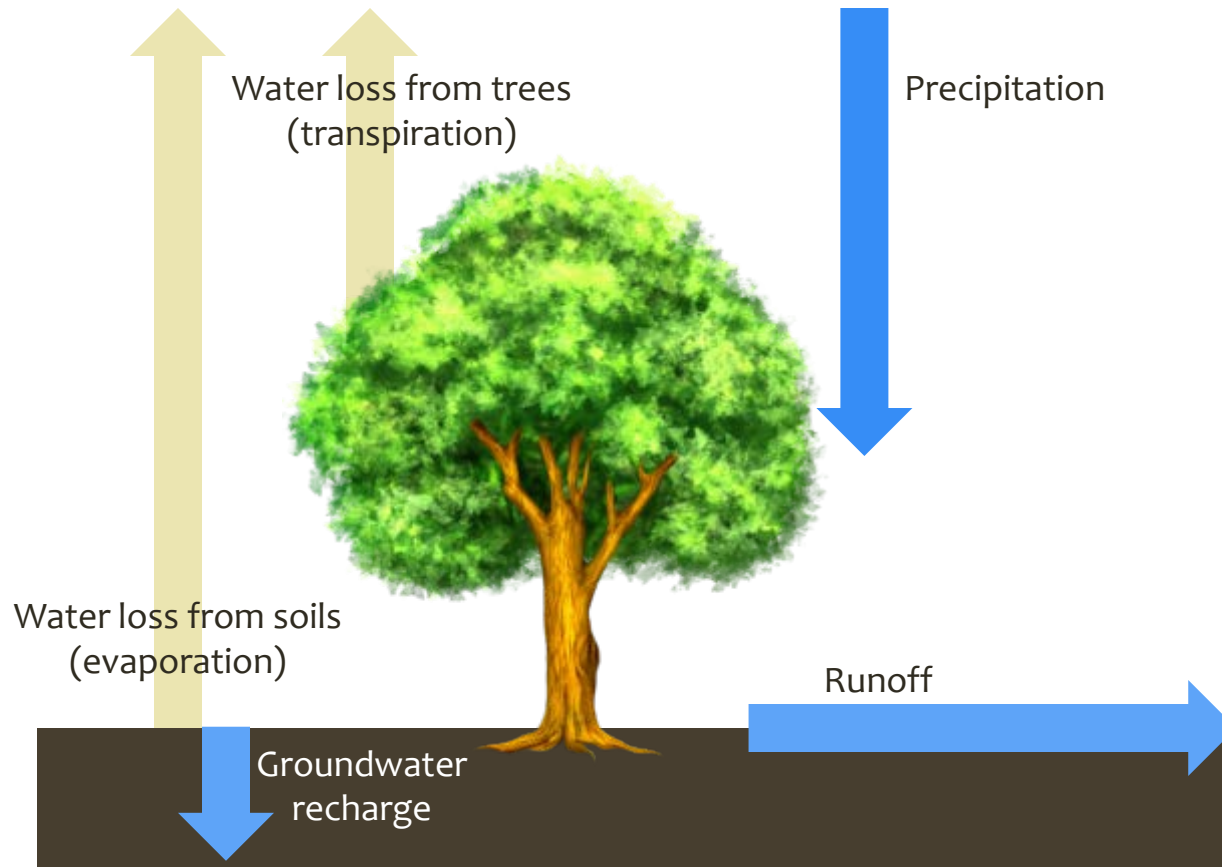
### **Altered streamflow timing and amount**

- Earlier spring peak flows
- Potential increases in flashiness and episodic high flows
- Potential declines in summer seasonal stream flow



### 3: *Potential for Summer Drought*

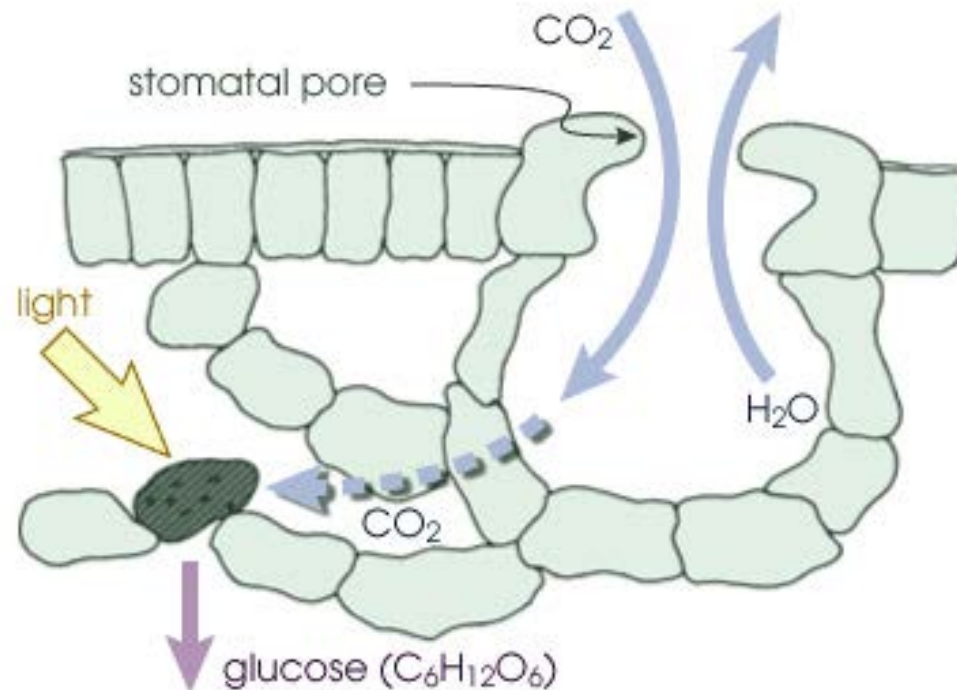
Greater uncertainty about future precipitation, but increased risk of summer moisture stress



# 4: CO<sub>2</sub> Fertilization

## Benefits

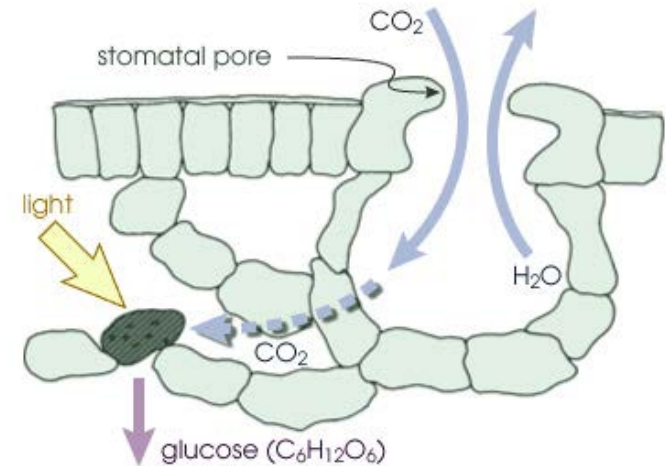
- Increased photosynthesis
- Increased water use efficiency



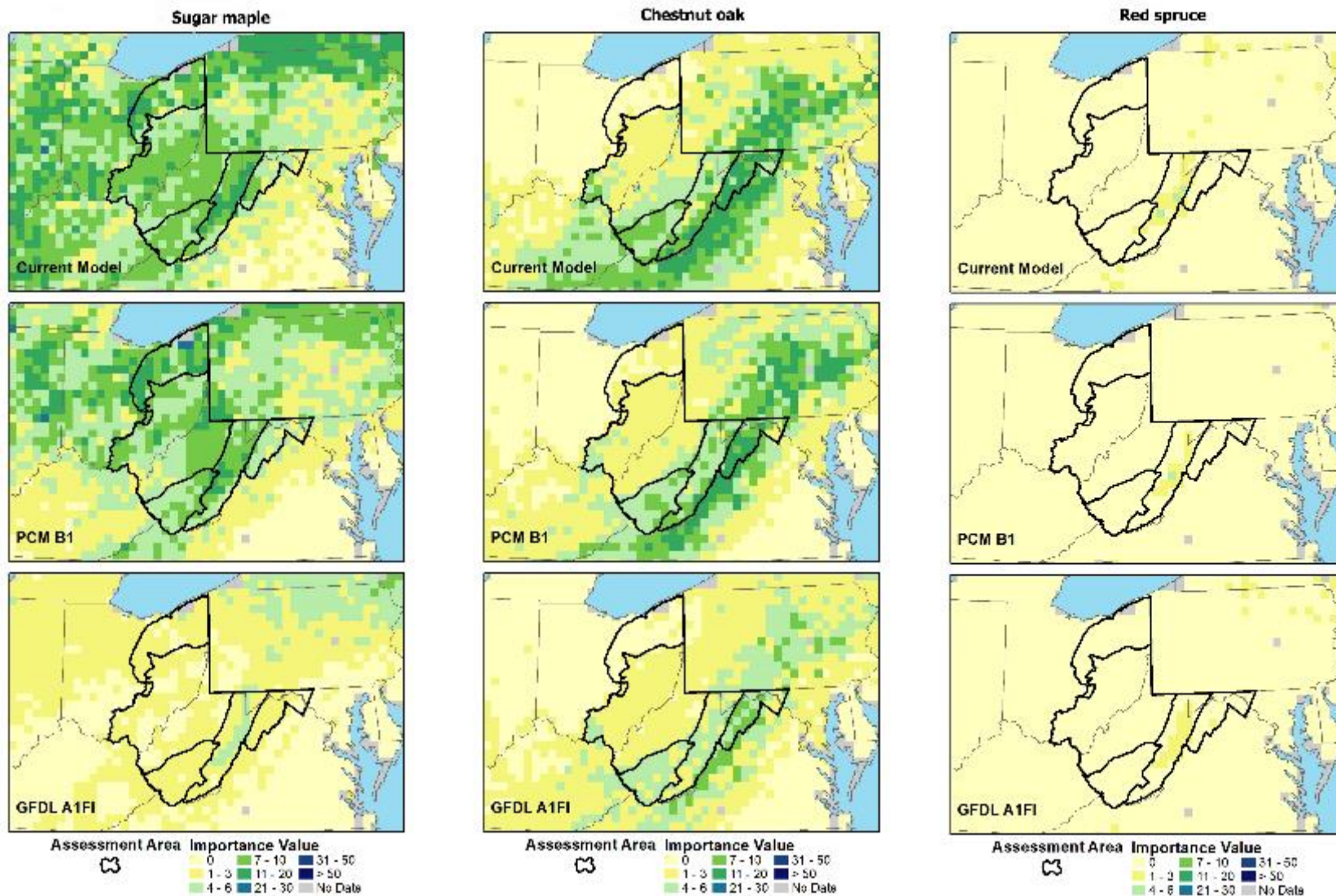
# 4: CO<sub>2</sub> Fertilization

## Limits to CO<sub>2</sub> fertilization

- Varies by species and site
- Nutrient deficiencies (especially N)
- Sensitive to ozone pollution
- Limited sink strength
- Limited evidence of long-term sequestration
- Any productivity increases may be offset by reductions from increased drought stress or disturbance



# 5: Changes in Suitable Habitat



# 5: *Changes in Suitable Habitat*

## Habitat based on:

- Temperature
- Precipitation
- Elevation
- Latitude
- Soils
- Slope & Aspect
- Land use
- Competition
- Past management





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## Habitat based on:

- *Temperature*
- *Precipitation*
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## Climate Change Atlas:

What happens to tree and bird habitat when climate changes?

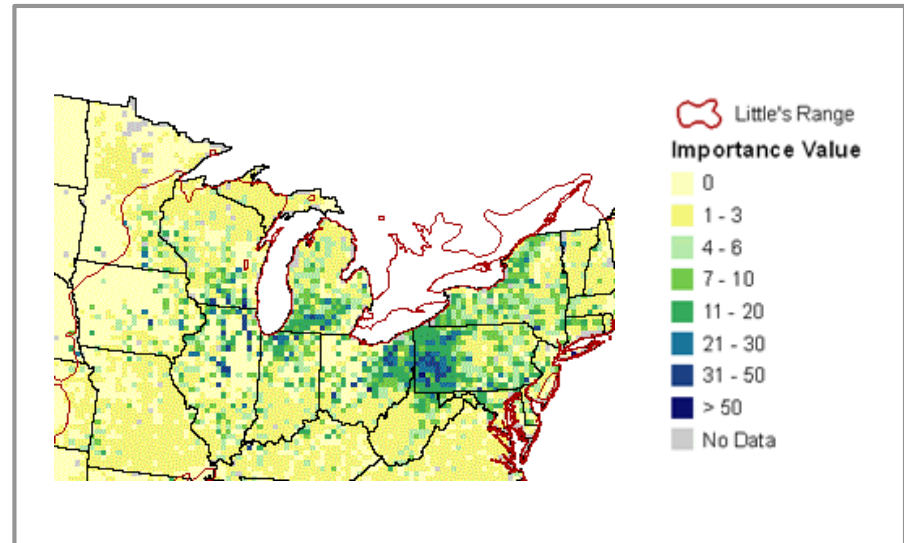
- 134 Trees
- 147 Birds

# 5: *Changes in Suitable Habitat*

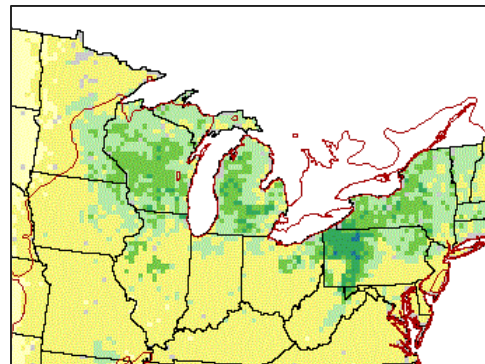
## Habitat based on:

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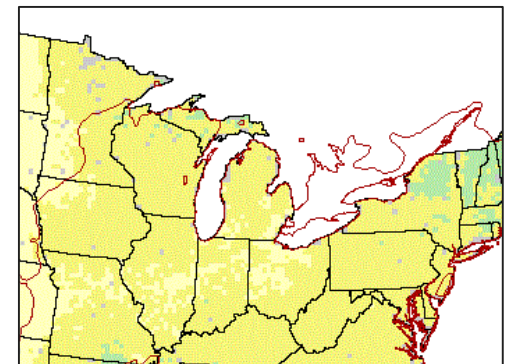
## Black Cherry: Current Habitat (modeled)



## PCM B1 (Less Change)



## GFDL A1FI (More Change)

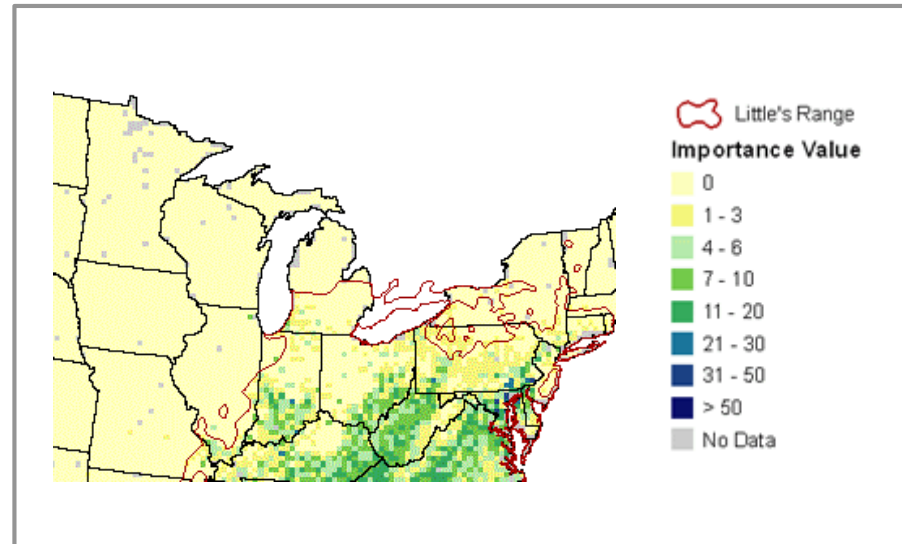


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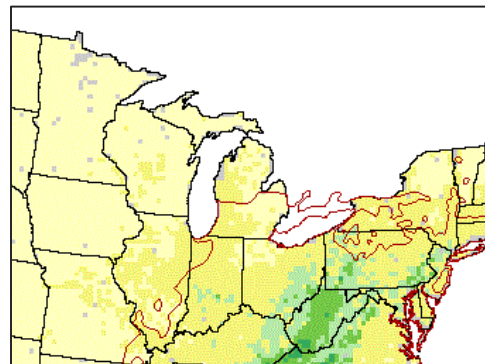
## Habitat based on:

- *Temperature*
- *Precipitation*
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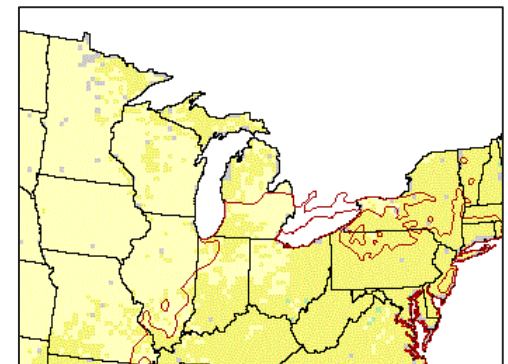
Tulip Tree: Current Habitat (modeled)



PCM B1 (Less Change)



GFDL A1FI (More Change)





## 5: *Changes in Suitable Habitat*

### ▪ **Winners**

- Black oak
- Chestnut oak
- Pignut hickory
- Scarlet oak
- White oak
- Post oak
- Shortleaf pine
- Flowering dogwood

### ▪ **Losers**

- American beech
- Eastern hemlock
- Red spruce
- Balsam fir

# 5: *Changes in Suitable Habitat*

- Immense lag times
  - Range shifts  $\neq$  instant catastrophic dieback
- Factors causing change will increase over time
  - Temperature
  - Moisture
  - Competition
- Mature and established trees should fare better
  - Developed root system
  - Greater carbohydrate reserves
- Game changers: Disturbance, Land use, ...

## 6: *Extreme Events*

- Heavy precipitation
- Ice storms
- **“Events” are not well modeled**
- Heat waves/droughts
- Wind storms
- Hurricanes



Charleston, WV 2015. Photo by Todd Harrell



Parsons, WV 2012. Photo by Norman Lenburg

# 7: *Wildfire Risk*

## **Fire may increase:**

- Warmer/drier summers
- Increased stress or mortality from less suitable conditions
- Shift toward fire-associated species like oaks and pines

## **Fire may not change:**

- Spring/early summer moisture
- Current regeneration of more mesic species
- Spatial patterns of land use and fragmentation
- Fire suppression



North Mountain fire 2013. Photo by Darin Vance

# 8: *Forest Pests and Diseases*

**Indirect:** Stress from other impacts increases susceptibility

**Direct:**

- Pests migrating northward
- Decreased probability of cold lethal temperatures
- Accelerated lifecycles



Gypsy Moth damage. Photo by Tim Tigner



Gypsy Moth. Photo by John H. Gent

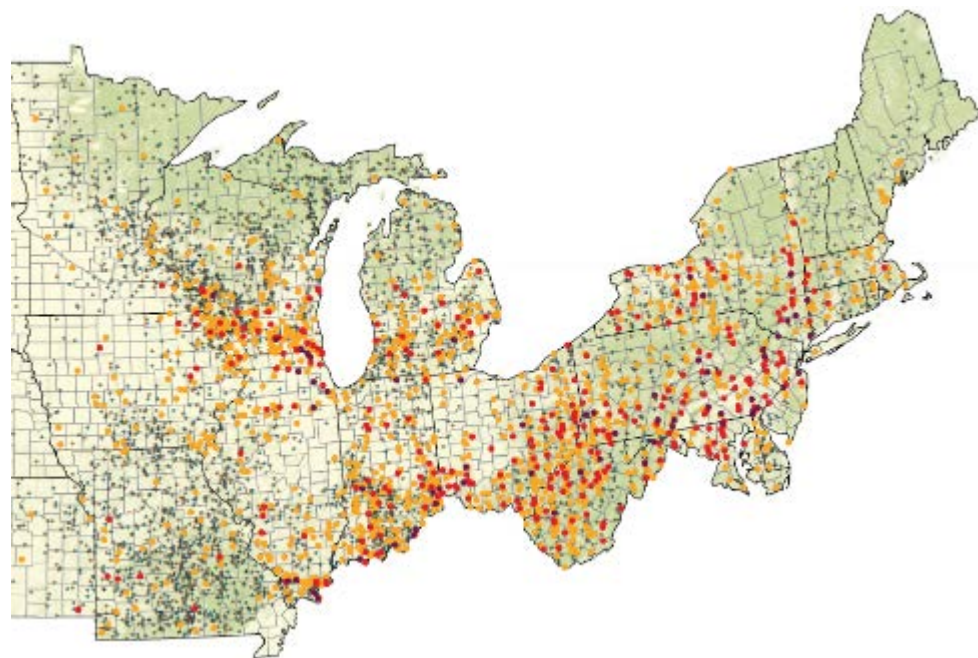
# 9: *Invasive Plants*

**Indirect:** Stress or disturbance from other impacts can affect the potential for invasion or success

**Direct:**

- Expanded ranges under warmer conditions
- Increased competitiveness from ability of some plants to take advantage of elevated CO<sub>2</sub>

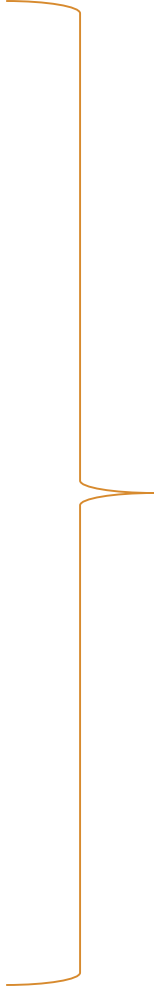
Invasive plant species found per plot



Kurtz 2013

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*What  
conclusions  
can we draw  
from all this?*



# Vulnerability: *Spruce-fir*

## High Vulnerability

### DRIVERS:

Increasing temperatures, decreased snow cover, decreased soil moisture

### DOMINANT SPECIES:

red spruce, balsam fir, yellow birch, eastern hemlock, red maple, sweet birch, black ash.....

### STRESSORS:

Acid deposition, pests and diseases, disturbance

### ADAPTIVE CAPACITY:

geographically limited, species already declining from pests, currently expanding to former range, highest elevations may be somewhat buffered from most severe changes





# Vulnerability: *Northern Hardwoods*

## High Vulnerability

### DRIVERS:

Decreasing precipitation, increasing temperatures: reduced soil moisture during summer and fall

### DOMINANT SPECIES:

American beech, eastern hemlock (keystone where occurs), sugar maple, tulip tree, black cherry, white ash, red spruce

### STRESSORS:

Increased drought, pests and diseases, disturbance

### ADAPTIVE CAPACITY:

High diversity, geographically limited, combined effects of acid deposition, increased temperatures and drought





# Vulnerability: *Dry/mesic Oak Forest*

## Low-Moderate Vulnerability

### Drivers:

Dry to mesic soils, gap-phase dynamics, fire was historically important

### Dominant Species:

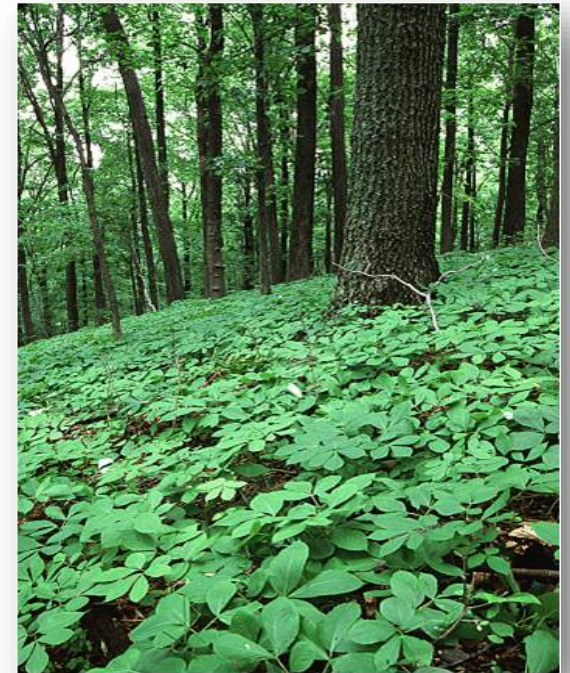
Pignut hickory, white oak, mockernut hickory, shagbark hickory, chestnut oak, scarlet oak, black oak

### Stressors:

Increased drought, pests and diseases, Ailanthus and other invasive plants

### Adaptive Capacity:

Past shift to mesic species (sugar maple, beech, etc. wide distribution, variety of habitat conditions, increased fire could help oak regen.





# Vulnerability: *Forest Ecosystems*

## Forest communities will be affected differently

### May have greater risk:

- Low diversity
- Static
- Threatened, rare, or endangered
- Already in decline
- Fragmented

### May have less risk:

- More diversity (species, genetics, ...)
- Adapted to disturbance
- Wider ecological range of tolerances
- Currently increasing
- Larger, contiguous blocks

# Summary

- **Uncertainty is guaranteed**
  - Consider a range of future conditions
  - Uncertainty varies across scales
- **Expect a new mixture of stresses**
  - Mostly familiar stresses, but new combos, timing, etc.
- **Severity is affected by local conditions**
  - Consider broad projections, adjust to local reality
- **Changes occur gradually**
  - Small changes now can have big impact later

# Activity: How does climate change affect your work?

1. Take 20 minutes to fill out worksheets on your own
  - What major challenges do you deal with at work?
  - What are some ways that this will be affected by climate change?
  - What are some general ways to overcome these challenges?
  - What are some really specific ways to address these challenges?
2. Choose one to share with your table
3. Each group will choose one or two to share with the room
  - What are some common themes being discussed in your group?
  - What are solutions that seem to have multiple benefits?
  - How might you explain adaptation to a colleague or client?